# *STORMWATER DRAINAGE REPORT*

*for*

# *WINCHESTER NORTH*

***416 Cambridge Street (Route 3)***
***Assessors Map #26, Lot 140***
***Town of Winchester &***
***Assessor's Map #74 Block 2, Lot 2***
***City of Woburn***
***Massachusetts***
***Middlesex County***


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#W141161

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**APPENDICES**

## I. EXECUTIVE SUMMARY

This report examines the changes in drainage that can be expected as the result of construction of a 95-unit apartment building at 416 Cambridge Street (MA Route 3) and Wainwright Road in Winchester and Woburn, Massachusetts. More specifically, the site is known as tax map #26, lot 140 in Winchester and tax map #74, block 2, lot 2 in Woburn. The site area is approximately 2.99 acres containing mostly wooded area, areas of ledge, and three buildings and two sheds. The house on the property is to remain.

The project falls under M.G.L. Chapter 40B for affordable housing and therefore local bylaws can be waived as part of the Chapter 40B process as long as state regulations are met. Although a small portion of the project could be considered a redevelopment, the entire project will meet the Massachusetts Stormwater Handbook requirements for new developments. Runoff will be treated by hydrodynamic water quality units before discharging to one of two proposed underground infiltration basins. The site drains in two directions; to off-site wetlands to the north and to Cambridge Street to the east. Post-redevelopment runoff rates to the two analyzed points of interest will be less than existing as shown in the below tables. Note that the project will have a beneficial impact on Cambridge Street storm sewer system by decreasing the peak rate of runoff for all design storms, and the runoff volume for the more frequent storms (2 year and less).

**Table 1 - Stormwater Runoff Rates to Off-Site Wetlands to North**

| Storm Frequency | Existing Flow (CFS) | Proposed Flow (CFS) | Change (CFS) |
|---|---|---|---|
| 2 year | 0.51 | 0.48 | -0.03 |
| 10 year | 1.83 | 1.15 | -0.68 |
| 25 year | 2.78 | 1.62 | -1.16 |
| 100 year | 4.34 | 3.54 | -0.80 |

**Table 2 - Stormwater Runoff Rates to Cambridge St.**

| Storm Frequency | Existing Flow (CFS) | Proposed Flow (CFS) | Change (CFS) |
|---|---|---|---|
| 2 year | 1.60 | 0.85 | -0.75 |
| 10 year | 3.19 | 2.84 | -0.35 |
| 25 year | 4.17 | 3.93 | -0.24 |
| 100 year | 5.67 | 5.44 | -0.23 |

A catch basin / water quality unit is proposed at the project's driveway intersection with Wainwright Road, but a small amount of impervious area cannot be collected by the catch basin and runoff from it will discharge to Wainwright Road as listed in the below table. There will also be a small area of impervious area at the lower driveway that will drain to Wainwright Road. These discharges meets MassDEP standards for being a de minimis discharge (less than one cfs) and will have no adverse impact to the Wainwright drainage system. Since runoff from Wainwright Road ultimately discharges to the same point as Cambridge Street, the volumes for this insignificant amount of impervious area are not listed separately, but are included in the Cambridge Street volumes listed below.

**Table 3 - Stormwater Runoff Rates to Wainwright Road**

| Storm Frequency | Existing Flow (CFS) | Proposed Flow (CFS) | Change (CFS) |
|---|---|---|---|
| 2 year | 0 | 0.02 | 0.02 |
| 10 year | 0 | 0.08 | 0.08 |
| 25 year | 0 | 0.10 | 0.10 |
| 100 year | 0 | 0.13 | 0.13 |

The total runoff volumes are calculated to be the following:

**Table 4 - Stormwater Runoff Volumes to Off-Site Wetlands to North**

| Storm Frequency | Existing Volume (ac-ft) | Proposed Volume (ac-ft) | Change (ac-ft) |
|---|---|---|---|
| 2 year | 0.060 | 0.104 | 0.044 |
| 10 year | 0.161 | 0.230 | 0.069 |
| 25 year | 0.231 | 0.310 | 0.079 |
| 100 year | 0.350 | 0.437 | 0.087 |

Although the above table shows an increase in volumes, the site drains to an off-site pond and surrounding wetlands. Based on the area of the pond and wetlands, the theoretical increase in volume during the 100-year storm would cause an increase of less than ¼" in the off-site pond water surface elevation, assuming no further attenuation or infiltration by the surrounding wetlands, which is negligible and will cause no adverse downstream impacts.

**Table 5 - Stormwater Runoff Volumes to Cambridge St.**

| Storm Frequency | Existing Volume (ac-ft) | Proposed Volume (ac-ft) | Change (ac-ft) |
|---|---|---|---|
| 2 year | 0.138 | 0.089 | -0.049 |
| 10 year | 0.271 | 0.232 | -0.039 |
| 25 year | 0.354 | 0.327 | -0.027 |
| 100 year | 0.485 | 0.479 | -0.006 |

**Table 6 – Total Stormwater Runoff Volumes from site**

| Storm Frequency | Existing Volume (ac-ft) | Proposed Volume (ac-ft) | Change (ac-ft) |
|---|---|---|---|
| 2 year | 0.198 | 0.193 | -0.005 |
| 10 year | 0.432 | 0.462 | 0.030 |
| 25 year | 0.585 | 0.637 | 0.052 |
| 100 year | 0.835 | 0.916 | 0.081 |

≈ 3,500 ft³

Water quality for the developed site will meet or exceed the State's standards by the use of Best Management Practices (BMP's) including deep sump, hooded catch basins, stormwater quality units (Stormceptor or approved equal), and infiltration basins. These treatments will exceed the 80% total suspended solids requirement by the state's stormwater management regulations.

## II. EXISTING SITE CONDITIONS

The subject site is a 2.99 acre area on the west side of Cambridge Street (Route 3) and the north side of Wainwright Road. The site drains generally from high points along the west to low points either in a northeasterly direction to an area of off-site wetlands, or in a southeasterly direction toward Cambridge Street.

The existing conditions drainage analysis contains two drainage areas (see Existing Drainage Tributary Map in Appendix C). The first area is 1.88 acres of grassed and wooded area with a Curve Number of 62 and time of concentration of 11.3 minutes. The second area is 1.59 acres consisting of mostly grassed and wooded area with some paved driveway areas with an overall CN of 77 and time of concentration of 13.7 minutes.

Based on site-specific geotechnical information from test pits dug within this site showing sandy loam and loamy sand within the site, the hydrologic soil type has been classified as "B", consistent with a moderately well-drained soil. Areas where ledge is apparent or close to the surface are classified as type "D" soils. Please see the test pit information contained in Appendix B and a delineation of the soil types on the pre and post development drainage area maps in Appendix C.

## III. PROPOSED SITE CONDITIONS

The proposed project involves the construction of a 95 unit apartment building and associated site improvements including parking areas, landscaping, lighting, utilities and stormwater infrastructure. The existing house on the site is to remain. Proposed drainage patterns will be similar to existing with drainage flowing to the north and south. Infiltration basins are proposed to attenuate post-development flow rates to below pre-development rates.

Under post construction conditions the site is broken into six drainage areas. Area P-1 is an area that will remain mostly vegetated to the north of the building and will drain in a northerly direction unattenuated to the wetlands to the north. The CN for this 0.66 acre area is 61 and will have the minimum allowable time of concentration of 6 minutes (0.1 hr).

Area P-2 is 0.45 acres of mostly lawn area that will drain directly to Cambridge Street, similar to existing conditions. The only impervious areas in this drainage subarea will be a portion of the driveway at the existing house and the roof of the existing house. The CN is 65 and the time of concentration is 6 minutes.

Area P-2A is a 0.01 acre area of mostly impervious area at the intersection of the proposed driveway and Wainwright Road that does not drain to the proposed site drainage system but drains to Wainwright Road and ultimately Cambridge Street. The CN for this area is 87 and the time of concentration is 6 minutes.

Area P-3 contains 1.20 acres of the proposed driveway, lawn, and existing woodland fringe that will drain to the proposed storm sewer system and routed to infiltration basin #2. The CN is 73 and time of concentration is 6 minutes.

Area P-4 will be 0.34 acres of the almost entirely impervious north parking lot draining to infiltration basin #1. The CN is 94 and time of concentration is 6 minutes.

Areas P-5 and P-6 represent the two roof areas and both have CNs of 98 and times of concentration of 6 minutes. Area P-6 is the majority of the roof with an area of 0.58 acres and will drain to infiltration basin #1 and ultimately the off-site wetlands to the north. Area P-5 is 0.23 acres of roof on the south side of the building that will drain to infiltration basin #2 and ultimately to the Wainwright Road drainage system.

Storm Sewer System

A storm sewer system is proposed to collect runoff from the paved, roof, and grassed areas around the proposed building. A series of roof drains will collect runoff from the hill draining toward the building from the south. Minimum pipe size will be 8 inches for roof leaders and yard drains in grass areas and 12 inches for catch basins draining paved areas. Minimum pipe slope will be 0.5%. Storm sewer sizing calculations are included in Appendix F.

Infiltration Basins

Two underground infiltration basins are proposed. The first will be located under the northern parking lot and will consist of 45 Stormtech MC-3500 prefabricated plastic storage units over a nine inch base of crushed stone and surrounded on all sides by crushed stone. The storage

volume of this basin will be 9,013 cubic feet (0.21 ac-ft). The basin will outlet through a four-inch low level orifice and an upper overflow weir.

Basin #2 will consist of 60 Stormtech SC-740 plastic storage units over a six inch base of crushed stone and surrounded on all sides by crushed stone. The storage volume of this basin will be 4,910 cubic feet (0.11 ac-ft). The basin will discharge through a 12" diameter culvert and will have a grated cover to allow storms larger than the 100-year to overflow.

An infiltration rate of 1.02 inches per hour was used in the basin routing calculations based on the Rawl's rate for type B sandy loam listed in the DEP Stormwater Handbook and is consistent with the sandy loam found in test pit excavations dug in the areas of the proposed infiltration basins (see Appendix B). Test pits #'s 3,7,9 and 10 were excavated in the area of the proposed basins, and the distance to the estimated seasonal high groundwater (SHGW) is indicated on the test pit logs in Appendix B. Basin #1 is more than four feet above SHGW and Basin #2 is more than two feet above SHGW, but less than four feet, so a groundwater mounding analysis was performed for Basin #2 and can be found in Appendix I. Please note that basin #2 lies between test pits 9 and 10. Groundwater was highest to the west in test pit #9 and lower in test pit #10 to the east, but the SHGW elevation of test pit #9 was used as SHGW. In reality, the maximum SHGW under basin #2 should be an average of the SHGW found in test pits #9 and #10, so the basin will be higher above SHGW than stated in this report.

Water Quality

As outlined below, the proposed drainage system was designed in accordance with the Massachusetts Stormwater Handbook.

> ***Standard #1*** **No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.**
>
> The project will not result in any direct discharge of untreated stormwater into, or cause erosion of wetlands or waters of the Commonwealth. The parking areas will be drained by a system of deep sump catch basins with trap hoods, conveying runoff to one of two infiltration basins. Infiltration basin #1 will discharge to a riprap pad and basin #2 will

discharge to a level spreader that will overflow to Cambridge Street with an outflow of less than 0.15 cfs per linear foot of level spreader.

***Standard #2:*** **Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.**

Runoff rates for the post-development conditions were calculated for the 2-year, 10-year, 25-year and 100-year 24-hour storm events. These are provided in the stormwater attenuation calculations in Appendix D. As summarized in Section I of this report, post-development peak discharge rates will be less than existing rates.

***Standard #3:*** **Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance.**

There will be an increase in impervious area of 1.282 acres as a result of the proposed construction. Although there are type D soils present, the recharge calculations contained in Appendix E assume that the site contains 100% type B soil to be conservative. This results in 1,629 cubic feet of required recharge volume. Approximately 3,344 cubic feet of groundwater recharge is provided.

***Standard #4:*** **Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS)**

The proposed Best Management Practices (BMPs) for this site will provide a weighted TSS removal of 83% percent and consists of a "process train" which includes both nonstructural and structural techniques (see Appendix E). Proposed BMPs include catch basins with deep sumps and trap hoods, Stormceptor units, and infiltration basins. The required 44% TSS removal rate prior to infiltration will be provided, as demonstrated by the TSS removal calculations in Appendix E.

***Standard #5:*** **For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.**

The proposed project is not considered a land use with "Higher Potential Pollutant Loads (LUHPPL). Daily trips to the site will be less than 1,000 trips per day. A long-term pollution prevention plan has been developed and is included in Appendix G.

***Standard #6:*** **Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution**

**prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.**

The site does not discharge to any known critical areas.

***Standard #7:*** **A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable**

This project will meet or exceed the State's stormwater management standards for new developments.

***Standard #8:*** **A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.**

A Stormwater Pollution Prevention Plan (SWPPP) will be integrated into the site plan design documents and will be prepared and filed with the EPA in accordance with NPDES requirements prior to construction.

***Standard #9:*** **A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.**

An Operation and Maintenance Plan for the proposed BMP's has been developed for this project, and is included in Appendix H.

***Standard #10:*** **All illicit discharges to the stormwater management system are prohibited.**

The Stormwater Management System has been designed such that prior to stormwater runoff discharging from the site, it is treated through a series of best management practices. To the Engineer's knowledge, there are no known or designed non-stormwater discharges that are or will be connected to the stormwater collection system that would convey pollutants directly to groundwater or surface waters.

## IV. METHODOLOGY

Storm Sewer System

The storm sewer system was analyzed using Hydraflow Storm Sewers computer program by Intellisolve, which is based on the Rational Formula method. Times of concentration for all of

the drainage areas were assumed to be 5 minutes, which produces the most conservative results. Runoff "C" coefficients were calculated using a value of 0.3 for grassed areas and 0.9 for impervious areas.

Stormwater Management Basins

The post development rates from the basins were computed using the Hydrocad computer program. The drainage area information, pond volume and outlet information were entered into the program, which routes storm flows based on NRCS TR-20 and TR-55 methods. The other components of the model were determined following standard NRCS procedures for Curve Numbers (CNs) and times of concentrations. The following rainfall data was utilized in the hydrologic calculations (See Appendix D):

| Frequency | 2 year | 10 year | 25 year | 100 year |
|---|---|---|---|---|
| Rainfall (inches) | 3.1 | 4.5 | 5.3 | 6.5 |

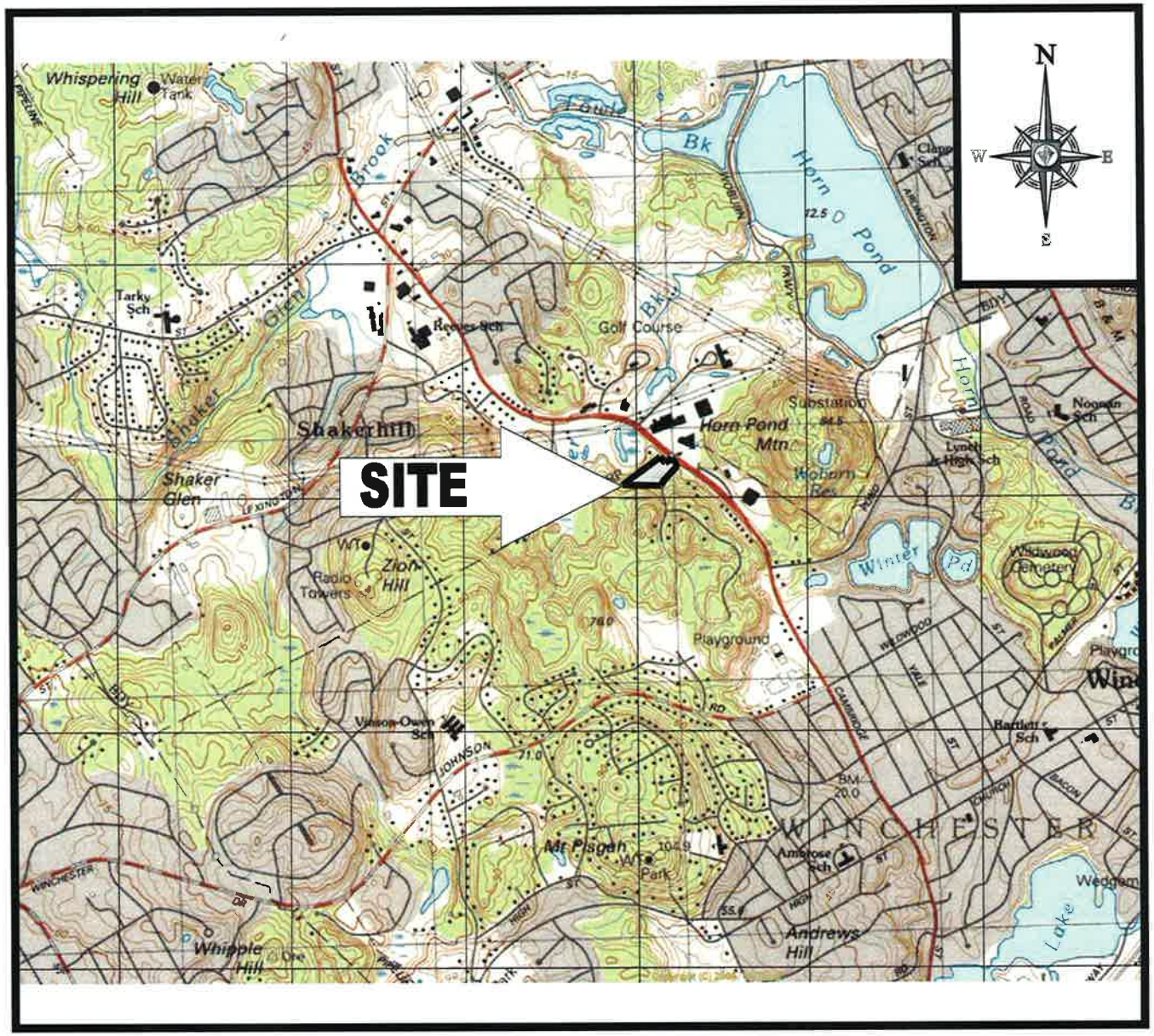
## V. SUMMARY

Storm runoff from the proposed development and associated parking areas and driveways will be collected by a storm sewer system with deep sump, hooded catch basins that will discharge through hydrodynamic water quality units to one of two infiltration basins. Runoff rates for storm events up to and including the 100 year will be less than the pre-development rates. Runoff volumes will be decreased for the more frequently occurring storms up to the 2-year storm. Note that the project will have a beneficial impact on the Cambridge Street storm sewer systems by decreasing the peak rate of runoff for all design storms, and the runoff volume for the more frequent storms (2 year and less).

Water quality BMPs at the site will exceed the Massachusetts DEP Stormwater Management requirements, and will incorporate the use of catch basins with deep sumps and trap hoods, stormwater quality units, and two underground infiltration basins. The combination of these treatments will result in a total suspended solids removal rate of 83%, as documented in

Appendix E. The project meets or exceeds the applicable stormwater management requirements, and therefore it is anticipated that this project will have no adverse impacts on the surrounding environment.

# APPENDIX A
# USGS MAP




# LOCATION MAP

SCALE: 1"=2000'
PLAN REFERENCE: BOSTON NORTH USGS QUADRANGLE

# APPENDIX B
# TEST PIT SOILS INFORMATION

TP #1214-1

TP #1214-2

TP #1214-3

TP #1214-4

TP #1214-5

TP #1214-7

TP #1214-8

TP #1214-9

TP #1214-10

TP #1214-11

APPROX. AREA OF VISABLE LEDGE ? ROCK

APPROX AREA OF POOR DRAINING SOILS OVER LEDGE

APPROX AREA OF FRACTURED ROCK FILL OVER POOR DRAINING SOILS ABOVE LEDGE

TOWN LINE: CITY OF WOBURN / TOWN OF WINCHESTER

WAINWRIGHT ROAD

CAMBRIDGE STREET

PREPARED BY

BOHLER ENGINEERING

# SOIL TEST PIT LOCATION SKETCH

416 CAMBRIDGE STREET

WINCHESTER, MASSACHUSETTS

SCALE:1"=50'

DATE: 12/18/2014

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-1 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |
| Distance From: | | | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. | | |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. | | |
| Property Line: | 40± ft. | Other: | | | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-11 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 11-22 | B | Sandy Loam | 10YR 5/6 | abk, mfr, <2% gravel |
| 22-75 | C1 | Sand | 2.5Y 6/6 | sg, loose, <2% gravel |
| 75-107 | C2 | Loamy Sand | 2.5Y 6/3 | m, loose, 25% gravel, 15% cobbles |
| 107-180 | C3 | Loamy Sand | 2.5Y 5/3 | m, loose, 25% gravel, 15% cobbles |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | >180" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 101" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | N/A | | | |
| | | Depth to weeping from side of obs. hole: | | N/A | | | |
| | | Depth to soil mottles, description: | | @ 101" 5Y 5/1 | | | |
| | | Groundwater adjustment: | | N/A | | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |

| | |
|---|---|
| Notes: | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-2 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |

| | | | |
|---|---|---|---|
| Distance From: | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. |
| Property Line: | 40± ft. | Other: | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-9 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 9-24 | B | Sandy Loam | 10YR 5/6 | abk, mfr, 5% gravel |
| 24-102 | C1 | Loamy Sand | 2.5Y 6/3 | m, loose, 25% gravel, 15% cobbles |
| 102-185 | C2 | Loamy Sand | 2.5Y 5/3 | m, loose, 25% gravel, 15% cobbles |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | >185" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 98" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | @ 98" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |

| | |
|---|---|
| Notes: | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-3 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |
| Distance From: | | | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. | | |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. | | |
| Property Line: | 40± ft. | Other: | | | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-30 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 30-45 | B | Sandy Loam | 10YR 5/6 | abk, mfr, 5% gravel |
| 45-115 | C1 | Loamy Sand | 2.5Y 6/3 | m, loose, 20% gravel, 15% cobbles |
| 115-175 | C2 | Loamy Sand | 2.5Y 5/3 | m, loose, 20% gravel, 20% cobbles, pockets of sand |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | >175" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 110" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | N/A | | | |
| | | Depth to weeping from side of obs. hole: | | N/A | | | |
| | | Depth to soil mottles, description: | | @ 110" 5Y 5/1 | | | |
| | | Groundwater adjustment: | | N/A | | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |

| | |
|---|---|
| Notes: | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-4 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |
| Distance From: | | | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. | | |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. | | |
| Property Line: | 80± ft. | Other: | | | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-4 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 4-18 | B | Sandy Loam | 10YR 5/6 | abk, mfr, 10% gravel |
| 18-100 | C1 | Loamy Sand | 2.5Y 6/3 | m, loose, 10% gravel, 20% cobbles, many boulders |
| 100-135 | C2 | Loamy Sand | 2.5Y 5/3 | m, loose, 15% gravel, 10% cobbles |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | 135" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 97" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | @ 97" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |
| Notes: | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-5 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |

| | | | |
|---|---|---|---|
| Distance From: | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. |
| Property Line: | 100± ft. | Other: | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-9 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 9-18 | B | Sandy Loam | 10YR 5/6 | abk, mfr, 10% gravel |
| 18-91 | C1 | Loamy Sand | 2.5Y 6/3 | m, loose, 20% gravel, 20% cobbles, many boulders |
| 91-117 | C2 | Loamy Sand | 2.5Y 5/3 | m, loose, 20% gravel, 20% cobbles |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | 117" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 88" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | @ 88" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |

| | |
|---|---|
| Notes: | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-6 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |
| Distance From: | | | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. | | |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. | | |
| Property Line: | 55± ft. | Other: | | | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-2 | A | Sandy Loam | 10YR 2/2 | gr, mvfr, <2% gravel |
| | - | - | | |
| | - | - | | |
| | - | - | | |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | 12" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | N/A" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | N/A | | | |
| | | Depth to weeping from side of obs. hole: | | N/A | | | |
| | | Depth to soil mottles, description: | | N/A | | | |
| | | Groundwater adjustment: | | N/A | | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |
| Notes: | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-7 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40 ° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |
| Distance From: | | | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. | | |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. | | |
| Property Line: | 50± ft. | Other: | | | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-24 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 24-34 | B | Sandy Loam | 10YR 5/6 | abk, mfr, <2% gravel |
| 34-80 | C | Sand | 2.5Y 6/6 | sg, loose, 5% gravel |
| | - | - | | |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | 80" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | N/A" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | N/A | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |
| Notes: | | | | | | | |

| | | | | |
|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | DEEP HOLE # 1214-8 |
| Applicant/owner: | SEB, LLC | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40° |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | |

| | | | |
|---|---|---|---|
| Land Use: | Residential | Landform: | Morraine |
| Vegetation: | Field Grass w/ Mixed Pines & Hardwoods | Slope: | 0-5% |
| Stone Walls: | ☒ Y ☐ N | Surface Stones: | ☒ Y ☐ N |

| | | | |
|---|---|---|---|
| Distance From: | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. |
| Property Line: | 50± ft. | Other: | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-10 | A | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 10-22 | B | Sandy Loam | 10YR 5/6 | abk, mfr, <2% gravel |
| 22-56 | C | Silt-Loam | 2.5Y 7/3 | m, fr, 5% gravel |
| | | | | |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | 56" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | 48" | |
| | Estimated Seasonal High Groundwater: | | 30" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | 30" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |
| Notes: | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-9 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Lawn | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |

| | | | |
|---|---|---|---|
| Distance From: | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. |
| Property Line: | 10± ft. | Other: | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-18 | Fill | --- | --- | sand & gravel fill |
| 18-30 | Ab | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 30-45 | Bb | Sandy Loam | 10YR 5/6 | abk, mfr, <2% gravel |
| 45-85 | C1 | Med. Sand | 2.5Y 6/6 | sg, loose, 5% gravel |
| 85-156 | C2 | LS | 2.5Y 5/3 | m, loose, 10% gravel, 5% cobbles |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | >156" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 80" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | 80" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |
| Notes: | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-10 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Lawn | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |

| | | | |
|---|---|---|---|
| Distance From: | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. |
| Property Line: | 10± ft. | Other: | |

DEEP OBSERVATION HOLE LOG

| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-12 | Fill | --- | --- | topsoil / loam |
| 12-24 | Ab | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 24-36 | Bb | Sandy Loam | 10YR 5/6 | abk, mfr, 5% gravel |
| 36-136 | C | Loamy Sand | 2.5Y 5/3 | m, loose, 15% gravel, 15% cobbles |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | >136" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | N/A | |
| | Estimated Seasonal High Groundwater: | | 60" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | 60" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |

| | |
|---|---|
| Notes: | |

| | | | | | |
|---|---|---|---|---|---|
| Site Location or lot # | 416 Cambridge Street, Winchester, MA | | | | DEEP HOLE # 1214-11 |
| Applicant/owner: | SEB, LLC | | | | |
| DATE: | December 18, 2014 | WEATHER: | Cloudy | TEMP: 40° | |
| LOCATION: (Refer to sketch attached) | (See Attached Sketch) | | | | |
| PERFORMED BY: | Matthew Bombaci, P.E. | | | | |
| WITNESSED BY: | Sean Broderick, Winchester Engineering Department | | | | |
| Land Use: | Residential | | Landform: | Morraine | |
| Vegetation: | Lawn | | Slope: | 0-5% | |
| Stone Walls: | ☒ Y ☐ N | | Surface Stones: | ☒ Y ☐ N | |
| Distance From: | | | | | |
| Open Water Bodies: | >100 ft. | Possible Wet Area: | >100 ft. | | |
| Drinking Water Well: | >100 ft. | Drainageway: | >100 ft. | | |
| Property Line: | 45± ft. | Other: | | | |

DEEP OBSERVATION HOLE LOG

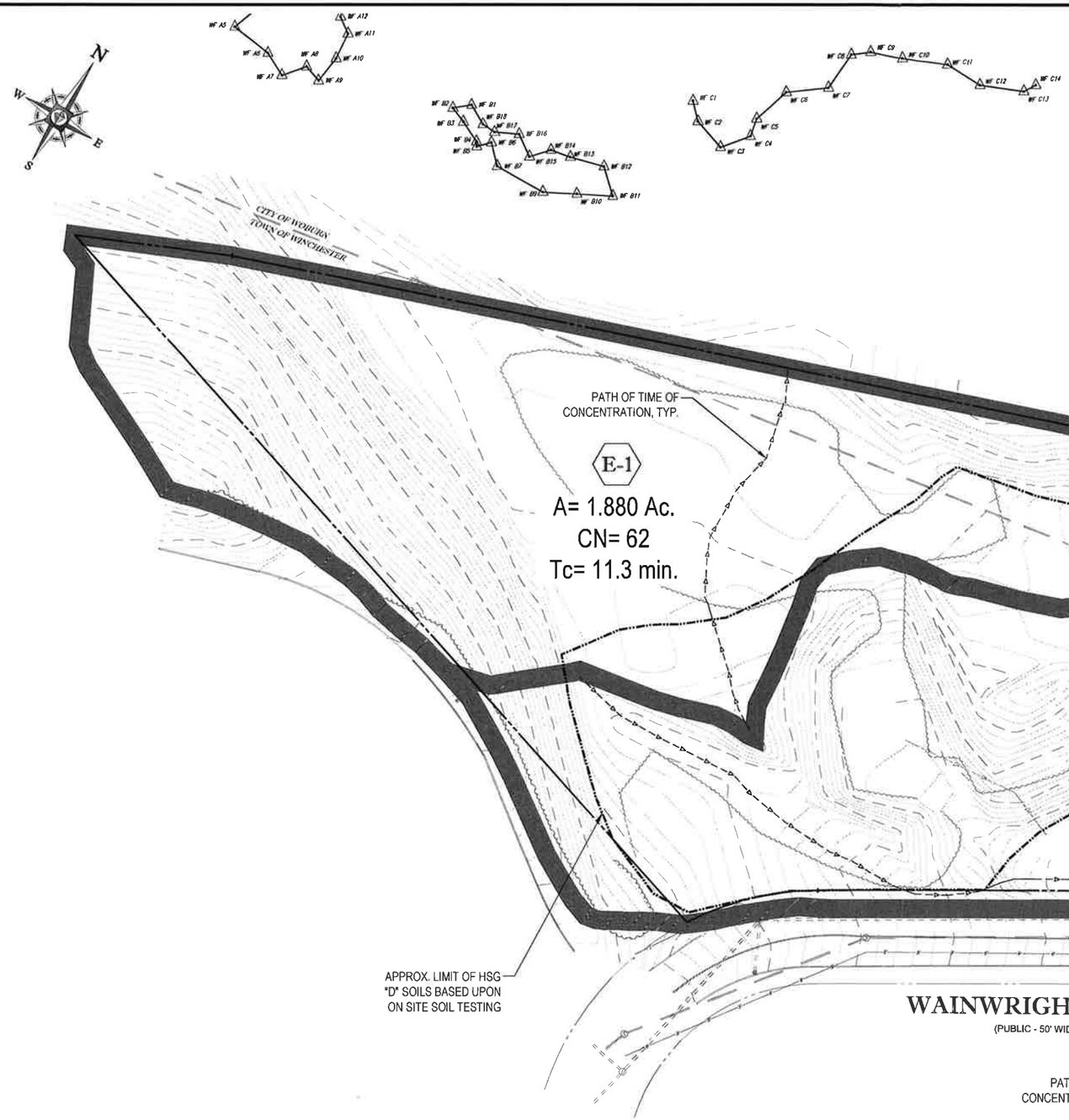
| Depth | Soil Horizon | Soil Texture | Soil Color | Other: Structures; Stones; Boulders; Consistency; % gravel |
|---|---|---|---|---|
| 0-80 | Fill | --- | --- | fractured rock & boulders mixed w/ soil |
| 80-86 | Ab | Sandy Loam | 10YR 3/3 | gr, mvfr, <2% gravel |
| 86-94 | Bb | Sandy Loam | 10YR 5/6 | abk, mfr, 5% gravel |
| 94-120 | C | Silt-Loam | 2.5Y 7/3 | m, fr, 5% gravel |
| | | | | |
| | | | | |

| | | | |
|---|---|---|---|
| Parent Material (geologic): | Glacial Till | Depth to Bedrock: | >120" |
| Depth to Groundwater: | Standing Water in Hole: | N/A | |
| | Weeping From Pit Face: | 100" | |
| | Estimated Seasonal High Groundwater: | | 92" |

DETERMINATION FOR SEASONAL HIGH WATER TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Method used: | | Depth observed standing in obs. hole: | | | N/A | | |
| | | Depth to weeping from side of obs. hole: | | | N/A | | |
| | | Depth to soil mottles, description: | | | 92" 5Y 5/1 | | |
| | | Groundwater adjustment: | | | N/A | | |
| Index Well #: | N/A | Reading Date: | N/A | Index Well Level: | N/A | Adj. Factor: | N/A |
| Adj. ground water level: | | N/A | | | | | |
| Notes: | | | | | | | |

# APPENDIX C
# PRE AND POST-DEVELOPMENT WATERSHED MAPS

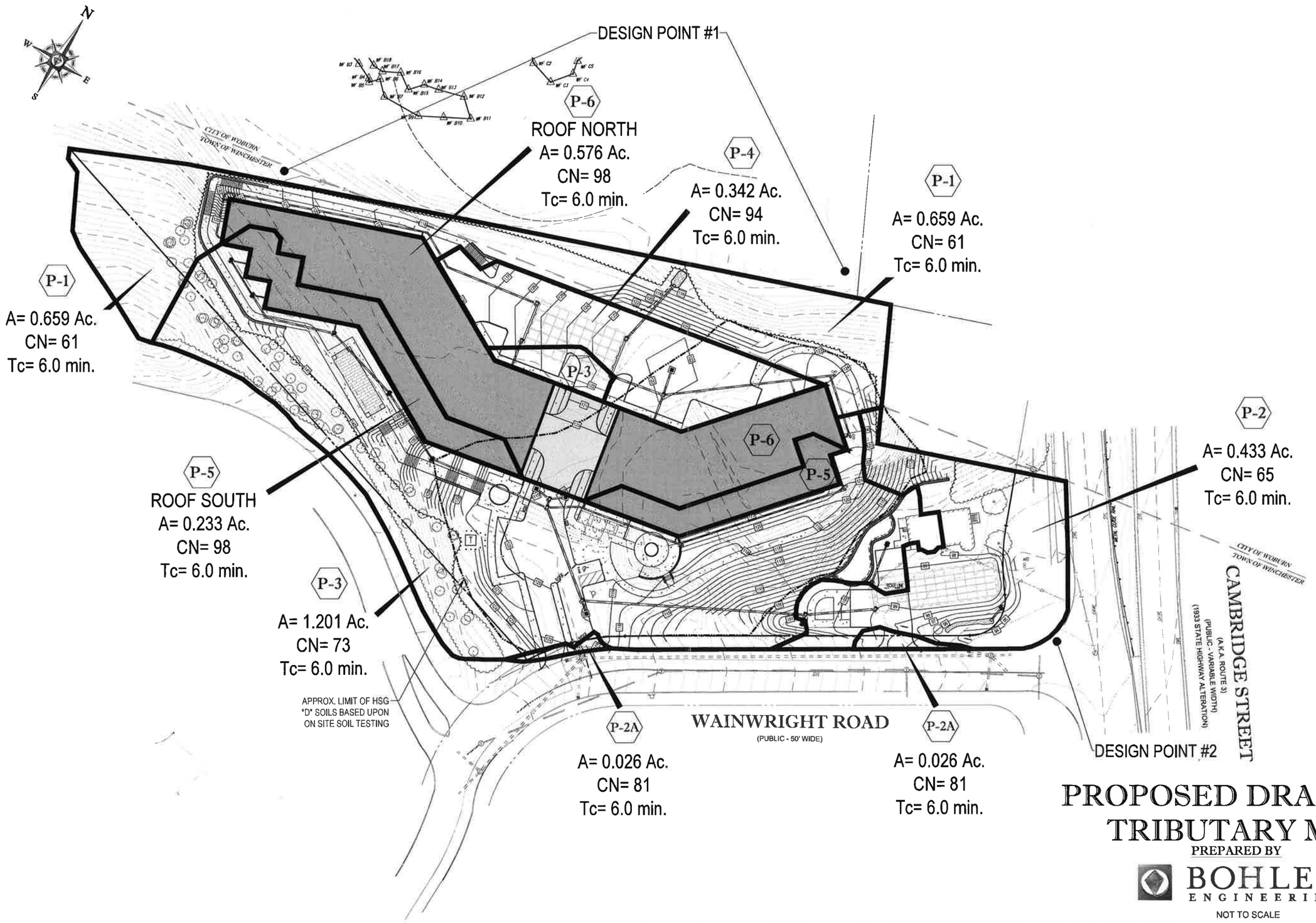



# EXISTING DRAINAGE TRIBUTARY MAP

PREPARED BY

BOHLER ENGINEERING

NOT TO SCALE



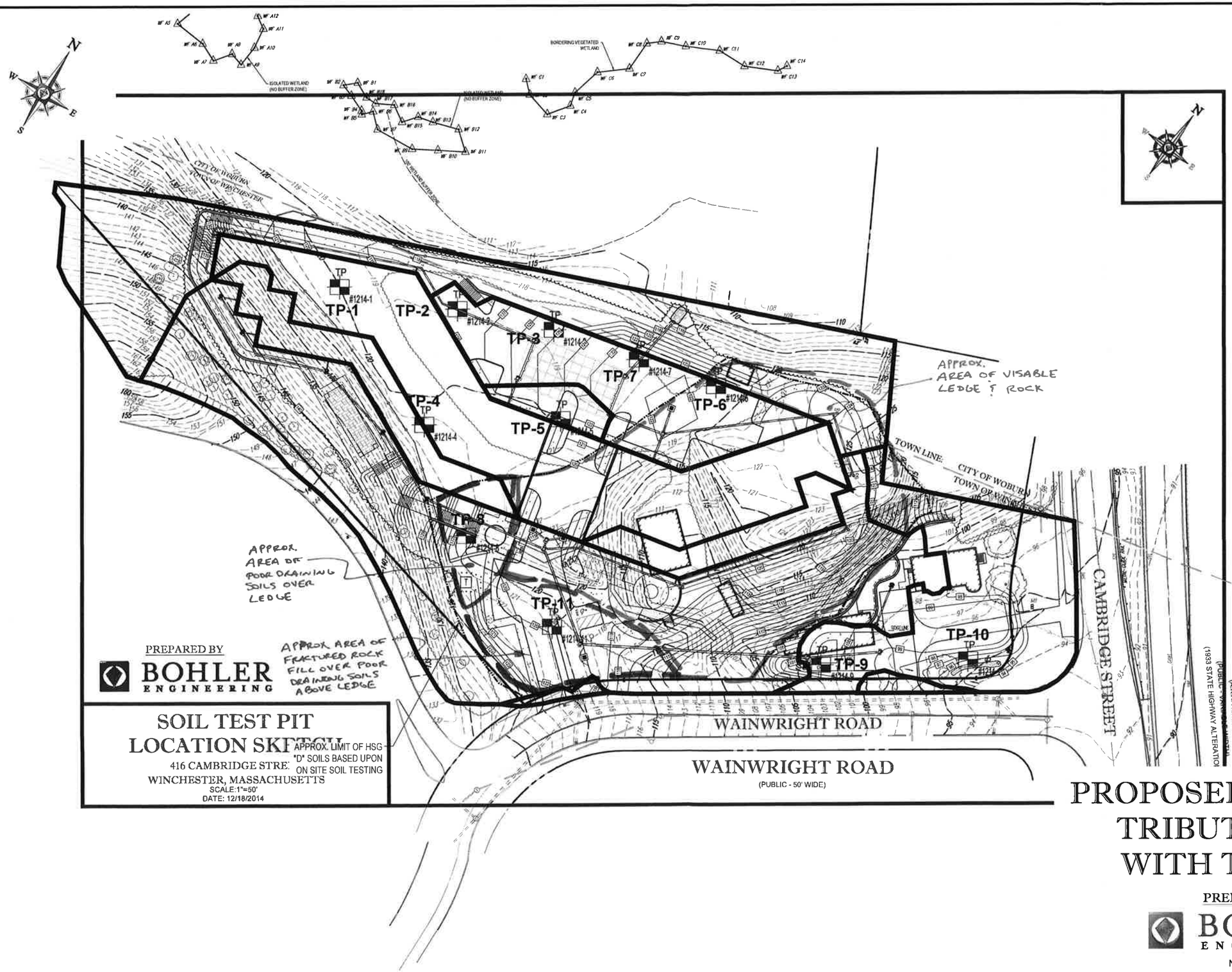

# PROPOSED DRAINAGE TRIBUTARY MAP

PREPARED BY

BOHLER ENGINEERING

NOT TO SCALE

P:\14W\14116\DWG\W14116ss1.dwg, 11/18/2015 11:27:42 AM




PREPARED BY

BOHLER ENGINEERING

## SOIL TEST PIT LOCATION SKETCH

416 CAMBRIDGE STRE
WINCHESTER, MASSACHUSETTS
SCALE:1"=50'
DATE: 12/18/2014

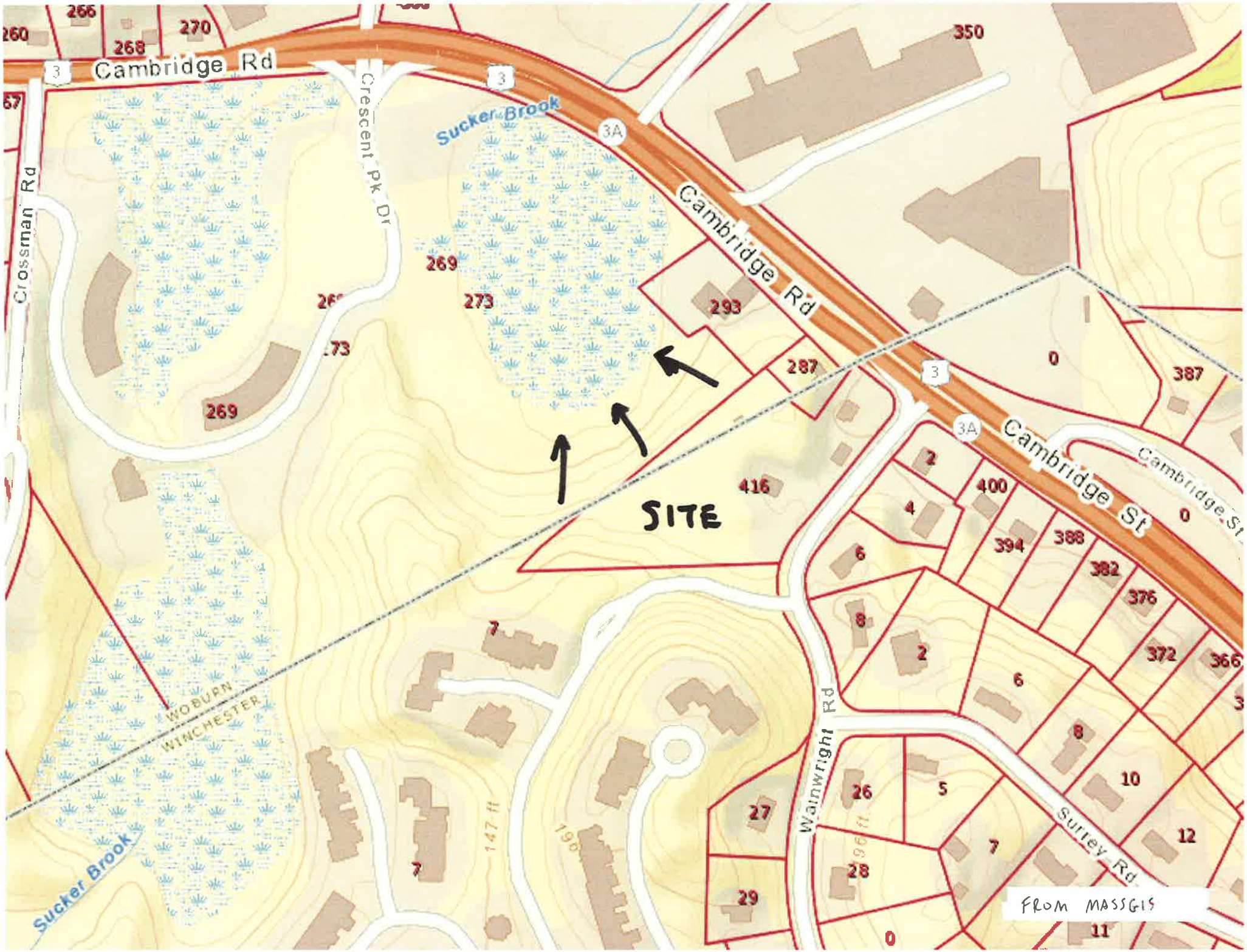
# PROPOSED DRAINAGE TRIBUTARY MAP WITH TEST PITS

PREPARED BY

BOHLER ENGINEERING

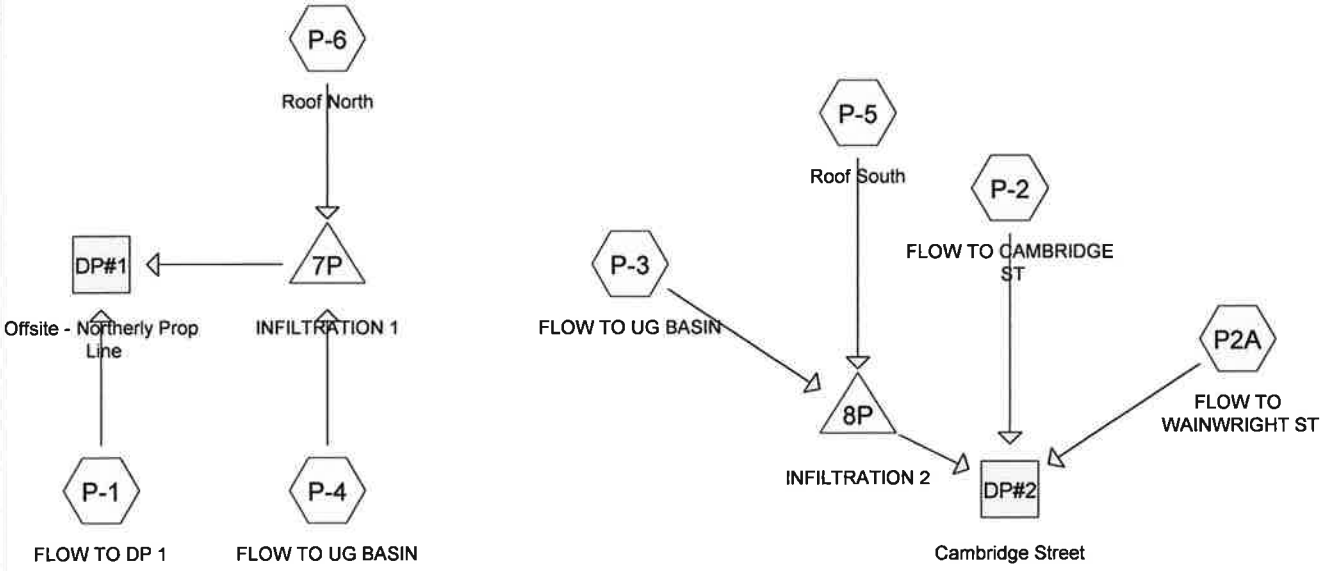
NOT TO SCALE

P:\14W141161\DWG\W141161ss1.dwg, 11/18/2015 11:28:30 AM


Cambridge Rd
Crossman Rd
Crescent Pk Dr
Sucker Brook
Cambridge Rd
Cambridge St
Cambridge St
Wainwright Rd
Surrey Rd
WOBURN
WINCHESTER
Sucker Brook
SITE
FROM MASSGIS

# APPENDIX D
# PRE AND POST DEVELOPMENT HYDROLOGIC CALCULATIONS

HYDROCAD SUMMARY OUTPUT




Subcat Reach Pond Link

**Routing Diagram for W141161-POST 11-16-15**
Prepared by Bohler Engineering, Printed 11/18/2015

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=0.40"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=0.18 cfs 0.022 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=0.55"
Tc=6.0 min CN=65 Runoff=0.21 cfs 0.020 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=0.92"
Tc=6.0 min CN=73 Runoff=1.18 cfs 0.092 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=2.45"
Tc=6.0 min CN=94 Runoff=0.92 cfs 0.070 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=2.87"
Tc=6.0 min CN=98 Runoff=0.68 cfs 0.056 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=2.87"
Tc=6.0 min CN=98 Runoff=1.69 cfs 0.138 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=1.39"
Tc=6.0 min CN=81 Runoff=0.04 cfs 0.003 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=0.48 cfs 0.104 af
Outflow=0.48 cfs 0.104 af

**Reach DP#2: Cambridge Street** Inflow=0.85 cfs 0.089 af
Outflow=0.85 cfs 0.089 af

**Pond 7P: INFILTRATION 1** Peak Elev=117.39' Storage=3,889 cf Inflow=2.61 cfs 0.207 af
Discarded=0.07 cfs 0.126 af Primary=0.37 cfs 0.081 af Outflow=0.43 cfs 0.207 af

**Pond 8P: INFILTRATION 2** Peak Elev=95.68' Storage=1,749 cf Inflow=1.86 cfs 0.148 af
Discarded=0.05 cfs 0.082 af Primary=0.71 cfs 0.066 af Outflow=0.76 cfs 0.148 af

**Total Runoff Area = 3.470 ac Runoff Volume = 0.400 af Average Runoff Depth = 1.38"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=1.08"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=0.72 cfs 0.059 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=1.33"
Tc=6.0 min CN=65 Runoff=0.62 cfs 0.048 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=1.90"
Tc=6.0 min CN=73 Runoff=2.58 cfs 0.190 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=3.82"
Tc=6.0 min CN=94 Runoff=1.40 cfs 0.109 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=4.26"
Tc=6.0 min CN=98 Runoff=1.00 cfs 0.083 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=4.26"
Tc=6.0 min CN=98 Runoff=2.47 cfs 0.205 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=2.55"
Tc=6.0 min CN=81 Runoff=0.08 cfs 0.006 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=1.15 cfs 0.230 af
Outflow=1.15 cfs 0.230 af

**Reach DP#2: Cambridge Street** Inflow=2.84 cfs 0.232 af
Outflow=2.84 cfs 0.232 af

**Pond 7P: INFILTRATION 1** Peak Elev=118.49' Storage=6,111 cf Inflow=3.87 cfs 0.313 af
Discarded=0.07 cfs 0.143 af Primary=0.58 cfs 0.170 af Outflow=0.64 cfs 0.313 af

**Pond 8P: INFILTRATION 2** Peak Elev=96.20' Storage=2,576 cf Inflow=3.58 cfs 0.273 af
Discarded=0.05 cfs 0.094 af Primary=2.31 cfs 0.179 af Outflow=2.36 cfs 0.273 af

**Total Runoff Area = 3.470 ac Runoff Volume = 0.699 af Average Runoff Depth = 2.42"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=1.55"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=1.09 cfs 0.085 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=1.86"
Tc=6.0 min CN=65 Runoff=0.89 cfs 0.067 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=2.52"
Tc=6.0 min CN=73 Runoff=3.46 cfs 0.252 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=4.60"
Tc=6.0 min CN=94 Runoff=1.67 cfs 0.131 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=5.06"
Tc=6.0 min CN=98 Runoff=1.18 cfs 0.098 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=5.06"
Tc=6.0 min CN=98 Runoff=2.92 cfs 0.243 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=3.25"
Tc=6.0 min CN=81 Runoff=0.10 cfs 0.007 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=1.61 cfs 0.310 af
Outflow=1.61 cfs 0.310 af

**Reach DP#2: Cambridge Street** Inflow=3.93 cfs 0.327 af
Outflow=3.93 cfs 0.327 af

**Pond 7P: INFILTRATION 1** Peak Elev=119.24' Storage=7,383 cf Inflow=4.59 cfs 0.374 af
Discarded=0.07 cfs 0.150 af Primary=0.68 cfs 0.224 af Outflow=0.75 cfs 0.374 af

**Pond 8P: INFILTRATION 2** Peak Elev=96.50' Storage=3,020 cf Inflow=4.64 cfs 0.350 af
Discarded=0.05 cfs 0.097 af Primary=3.14 cfs 0.253 af Outflow=3.19 cfs 0.350 af

**Total Runoff Area = 3.470 ac Runoff Volume = 0.884 af Average Runoff Depth = 3.06"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=2.35"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=1.72 cfs 0.129 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=2.72"
Tc=6.0 min CN=65 Runoff=1.34 cfs 0.098 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=3.51"
Tc=6.0 min CN=73 Runoff=4.84 cfs 0.351 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=5.79"
Tc=6.0 min CN=94 Runoff=2.07 cfs 0.165 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=6.26"
Tc=6.0 min CN=98 Runoff=1.45 cfs 0.122 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=6.26"
Tc=6.0 min CN=98 Runoff=3.58 cfs 0.301 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=4.34"
Tc=6.0 min CN=81 Runoff=0.13 cfs 0.009 af

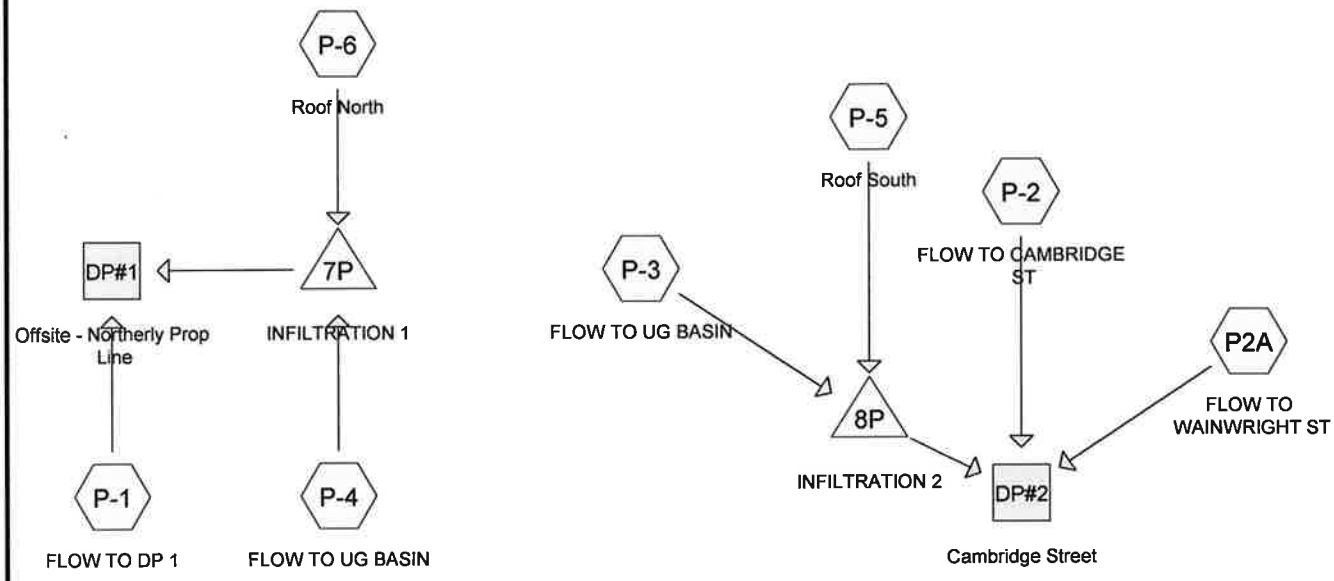
**Reach DP#1: Offsite - Northerly Prop Line** Inflow=3.54 cfs 0.437 af
Outflow=3.54 cfs 0.437 af

**Reach DP#2: Cambridge Street** Inflow=5.44 cfs 0.479 af
Outflow=5.44 cfs 0.479 af

**Pond 7P: INFILTRATION 1** Peak Elev=119.78' Storage=8,057 cf Inflow=5.66 cfs 0.466 af
Discarded=0.07 cfs 0.157 af Primary=2.63 cfs 0.308 af Outflow=2.70 cfs 0.466 af

**Pond 8P: INFILTRATION 2** Peak Elev=96.98' Storage=3,666 cf Inflow=6.29 cfs 0.473 af
Discarded=0.05 cfs 0.102 af Primary=4.28 cfs 0.371 af Outflow=4.33 cfs 0.473 af

**Total Runoff Area = 3.470 ac Runoff Volume = 1.175 af Average Runoff Depth = 4.06"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**




Subcat Reach Pond Link

**Routing Diagram for W141161-POST 11-16-15**
Prepared by Bohler Engineering, Printed 11/18/2015

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=0.40"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=0.18 cfs 0.022 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=0.55"
Tc=6.0 min CN=65 Runoff=0.21 cfs 0.020 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=0.92"
Tc=6.0 min CN=73 Runoff=1.18 cfs 0.092 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=2.45"
Tc=6.0 min CN=94 Runoff=0.92 cfs 0.070 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=2.87"
Tc=6.0 min CN=98 Runoff=0.68 cfs 0.056 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=2.87"
Tc=6.0 min CN=98 Runoff=1.69 cfs 0.138 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=1.39"
Tc=6.0 min CN=81 Runoff=0.04 cfs 0.003 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=0.48 cfs 0.104 af
Outflow=0.48 cfs 0.104 af

**Reach DP#2: Cambridge Street** Inflow=0.85 cfs 0.089 af
Outflow=0.85 cfs 0.089 af

**Pond 7P: INFILTRATION 1** Peak Elev=117.39' Storage=3,889 cf Inflow=2.61 cfs 0.207 af
Discarded=0.07 cfs 0.126 af Primary=0.37 cfs 0.081 af Outflow=0.43 cfs 0.207 af

**Pond 8P: INFILTRATION 2** Peak Elev=95.68' Storage=1,749 cf Inflow=1.86 cfs 0.148 af
Discarded=0.05 cfs 0.082 af Primary=0.71 cfs 0.066 af Outflow=0.76 cfs 0.148 af

**Total Runoff Area = 3.470 ac Runoff Volume = 0.400 af Average Runoff Depth = 1.38"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

## Summary for Subcatchment P-1: FLOW TO DP 1

Runoff = 0.18 cfs @ 12.14 hrs, Volume= 0.022 af, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.181 | 61 | >75% Grass cover, Good, HSG B |
| 0.058 | 80 | >75% Grass cover, Good, HSG D |
| 0.390 | 55 | Woods, Good, HSG B |
| 0.030 | 98 | Paved parking, HSG B |
| 0.659 | 61 | Weighted Average |
| 0.629 | | 95.45% Pervious Area |
| 0.030 | | 4.55% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.2900 | 0.19 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10" |
| 0.4 | 72 | 0.2900 | 2.69 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.3 | | | | | **Direct Entry, To make min. allowable** |
| 6.0 | 122 | Total | | | |

## Summary for Subcatchment P-2: FLOW TO CAMBRIDGE ST

Runoff = 0.21 cfs @ 12.11 hrs, Volume= 0.020 af, Depth= 0.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.050 | 98 | Paved parking, HSG D |
| 0.365 | 61 | >75% Grass cover, Good, HSG B |
| 0.018 | 55 | Woods, Good, HSG B |
| 0.433 | 65 | Weighted Average |
| 0.383 | | 88.45% Pervious Area |
| 0.050 | | 11.55% Impervious Area |

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

## Summary for Subcatchment P-3: FLOW TO UG BASIN

Runoff = 1.18 cfs @ 12.10 hrs, Volume= 0.092 af, Depth= 0.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.369 | 80 | >75% Grass cover, Good, HSG D |
| 0.242 | 98 | Paved parking, HSG D |
| 0.226 | 55 | Woods, Good, HSG B |
| 0.364 | 61 | >75% Grass cover, Good, HSG B |
| 1.201 | 73 | Weighted Average |
| 0.959 | | 79.85% Pervious Area |
| 0.242 | | 20.15% Impervious Area |

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

## Summary for Subcatchment P-4: FLOW TO UG BASIN

Runoff = 0.92 cfs @ 12.09 hrs, Volume= 0.070 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.034 | 61 | >75% Grass cover, Good, HSG B |
| * 0.308 | 98 | Paved parking |
| 0.342 | 94 | Weighted Average |
| 0.034 | | 9.94% Pervious Area |
| 0.308 | | 90.06% Impervious Area |

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

## Summary for Subcatchment P-5: Roof South

Runoff = 0.68 cfs @ 12.09 hrs, Volume= 0.056 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.233 | 98 | Roofs, HSG B |
| 0.233 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P-6: Roof North

Runoff = 1.69 cfs @ 12.09 hrs, Volume= 0.138 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.576 | 98 | Roofs, HSG B |
| 0.576 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P2A: FLOW TO WAINWRIGHT ST

Runoff = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af, Depth= 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.014 | 98 | Paved parking, HSG B |
| 0.012 | 61 | >75% Grass cover, Good, HSG B |
| 0.026 | 81 | Weighted Average |
| 0.012 | | 46.15% Pervious Area |
| 0.014 | | 53.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowable** |

## Summary for Reach DP#1: Offsite - Northerly Prop Line

Inflow Area = 1.577 ac, 57.96% Impervious, Inflow Depth = 0.79" for 2-year event
Inflow = 0.48 cfs @ 12.36 hrs, Volume= 0.104 af
Outflow = 0.48 cfs @ 12.36 hrs, Volume= 0.104 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Reach DP#2: Cambridge Street

Inflow Area = 1.893 ac, 28.47% Impervious, Inflow Depth = 0.57" for 2-year event
Inflow = 0.85 cfs @ 12.35 hrs, Volume= 0.089 af
Outflow = 0.85 cfs @ 12.35 hrs, Volume= 0.089 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Pond 7P: INFILTRATION 1

Inflow Area = 0.918 ac, 96.30% Impervious, Inflow Depth = 2.71" for 2-year event
Inflow = 2.61 cfs @ 12.09 hrs, Volume= 0.207 af
Outflow = 0.43 cfs @ 12.56 hrs, Volume= 0.207 af, Atten= 83%, Lag= 28.3 min
Discarded = 0.07 cfs @ 9.60 hrs, Volume= 0.126 af
Primary = 0.37 cfs @ 12.56 hrs, Volume= 0.081 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 117.39' @ 12.56 hrs Surf.Area= 2,755 sf Storage= 3,889 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 205.3 min ( 972.8 - 767.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 115.25' | 4,020 cf | **37.08'W x 74.30'L x 5.50'H Field A**<br>15,153 cf Overall - 5,104 cf Embedded = 10,050 cf x 40.0% Voids |
| #2A | 116.00' | 5,104 cf | **ADS_StormTech MC-3500 c +Cap** x 45 Inside #1<br>Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf<br>Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap<br>Cap Storage= +15.6 cf x 2 x 5 rows = 156.0 cf |
| | | 9,124 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.75' | **12.0" Round Culvert**<br>L= 48.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 115.75' / 114.79' S= 0.0200 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Device 1 | 116.45' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 119.50' | **4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #4 | Discarded | 115.25' | **1.020 in/hr Exfiltration Loamy Sand Rawl's Rate over Surface area** |

**Discarded OutFlow** Max=0.07 cfs @ 9.60 hrs HW=115.31' (Free Discharge)
↑**4=Exfiltration Loamy Sand Rawl's Rate** (Exfiltration Controls 0.07 cfs)

**Primary OutFlow** Max=0.37 cfs @ 12.56 hrs HW=117.39' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Passes 0.37 cfs of 4.03 cfs potential flow)
↑**2=Orifice/Grate** (Orifice Controls 0.37 cfs @ 4.22 fps)
**3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 8P: INFILTRATION 2

Inflow Area = 1.434 ac, 33.12% Impervious, Inflow Depth = 1.24" for 2-year event
Inflow = 1.86 cfs @ 12.10 hrs, Volume= 0.148 af
Outflow = 0.76 cfs @ 12.37 hrs, Volume= 0.148 af, Atten= 59%, Lag= 16.5 min
Discarded = 0.05 cfs @ 11.45 hrs, Volume= 0.082 af
Primary = 0.71 cfs @ 12.37 hrs, Volume= 0.066 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 95.68' @ 12.37 hrs Surf.Area= 2,140 sf Storage= 1,749 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 132.7 min ( 958.6 - 825.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 94.40' | 1,980 cf | **25.25'W x 84.76'L x 3.50'H Field A**<br>7,491 cf Overall - 2,541 cf Embedded = 4,950 cf x 40.0% Voids |
| #2A | 94.90' | 2,541 cf | **ADS_StormTech SC-740** x 55 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>Row Length Adjustment= +0.44' x 6.45 sf x 5 rows |
| | | 4,521 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 95.20' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 95.20' / 95.10' S= 0.0125 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Primary | 97.30' | **24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |
| #3 | Discarded | 94.40' | **1.020 in/hr Exfiltration- Sandy Loam Rawls Rate over Surface area** |

**Discarded OutFlow** Max=0.05 cfs @ 11.45 hrs HW=94.44' (Free Discharge)
└**3=Exfiltration- Sandy Loam Rawls Rate** (Exfiltration Controls 0.05 cfs)

**Primary OutFlow** Max=0.71 cfs @ 12.37 hrs HW=95.68' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Barrel Controls 0.71 cfs @ 2.80 fps)
└**2=Orifice/Grate** ( Controls 0.00 cfs)

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=1.08"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=0.72 cfs 0.059 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=1.33"
Tc=6.0 min CN=65 Runoff=0.62 cfs 0.048 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=1.90"
Tc=6.0 min CN=73 Runoff=2.58 cfs 0.190 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=3.82"
Tc=6.0 min CN=94 Runoff=1.40 cfs 0.109 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=4.26"
Tc=6.0 min CN=98 Runoff=1.00 cfs 0.083 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=4.26"
Tc=6.0 min CN=98 Runoff=2.47 cfs 0.205 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=2.55"
Tc=6.0 min CN=81 Runoff=0.08 cfs 0.006 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=1.15 cfs 0.230 af
Outflow=1.15 cfs 0.230 af

**Reach DP#2: Cambridge Street** Inflow=2.84 cfs 0.232 af
Outflow=2.84 cfs 0.232 af

**Pond 7P: INFILTRATION 1** Peak Elev=118.49' Storage=6,111 cf Inflow=3.87 cfs 0.313 af
Discarded=0.07 cfs 0.143 af Primary=0.58 cfs 0.170 af Outflow=0.64 cfs 0.313 af

**Pond 8P: INFILTRATION 2** Peak Elev=96.20' Storage=2,576 cf Inflow=3.58 cfs 0.273 af
Discarded=0.05 cfs 0.094 af Primary=2.31 cfs 0.179 af Outflow=2.36 cfs 0.273 af

**Total Runoff Area = 3.470 ac Runoff Volume = 0.699 af Average Runoff Depth = 2.42"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

## Summary for Subcatchment P-1: FLOW TO DP 1

Runoff = 0.72 cfs @ 12.11 hrs, Volume= 0.059 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.181 | 61 | >75% Grass cover, Good, HSG B |
| 0.058 | 80 | >75% Grass cover, Good, HSG D |
| 0.390 | 55 | Woods, Good, HSG B |
| 0.030 | 98 | Paved parking, HSG B |
| 0.659 | 61 | Weighted Average |
| 0.629 | | 95.45% Pervious Area |
| 0.030 | | 4.55% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.2900 | 0.19 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10" |
| 0.4 | 72 | 0.2900 | 2.69 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.3 | | | | | **Direct Entry, To make min. allowable** |
| 6.0 | 122 | Total | | | |

## Summary for Subcatchment P-2: FLOW TO CAMBRIDGE ST

Runoff = 0.62 cfs @ 12.10 hrs, Volume= 0.048 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.050 | 98 | Paved parking, HSG D |
| 0.365 | 61 | >75% Grass cover, Good, HSG B |
| 0.018 | 55 | Woods, Good, HSG B |
| 0.433 | 65 | Weighted Average |
| 0.383 | | 88.45% Pervious Area |
| 0.050 | | 11.55% Impervious Area |

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

## Summary for Subcatchment P-3: FLOW TO UG BASIN

Runoff = 2.58 cfs @ 12.10 hrs, Volume= 0.190 af, Depth= 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.369 | 80 | >75% Grass cover, Good, HSG D |
| 0.242 | 98 | Paved parking, HSG D |
| 0.226 | 55 | Woods, Good, HSG B |
| 0.364 | 61 | >75% Grass cover, Good, HSG B |
| 1.201 | 73 | Weighted Average |
| 0.959 | | 79.85% Pervious Area |
| 0.242 | | 20.15% Impervious Area |

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

## Summary for Subcatchment P-4: FLOW TO UG BASIN

Runoff = 1.40 cfs @ 12.09 hrs, Volume= 0.109 af, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.034 | 61 | >75% Grass cover, Good, HSG B |
| * 0.308 | 98 | Paved parking |
| 0.342 | 94 | Weighted Average |
| 0.034 | | 9.94% Pervious Area |
| 0.308 | | 90.06% Impervious Area |

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

## Summary for Subcatchment P-5: Roof South

Runoff = 1.00 cfs @ 12.09 hrs, Volume= 0.083 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.233 | 98 | Roofs, HSG B |
| 0.233 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P-6: Roof North

Runoff = 2.47 cfs @ 12.09 hrs, Volume= 0.205 af, Depth= 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.576 | 98 | Roofs, HSG B |
| 0.576 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P2A: FLOW TO WAINWRIGHT ST

Runoff = 0.08 cfs @ 12.09 hrs, Volume= 0.006 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.014 | 98 | Paved parking, HSG B |
| 0.012 | 61 | >75% Grass cover, Good, HSG B |
| 0.026 | 81 | Weighted Average |
| 0.012 | | 46.15% Pervious Area |
| 0.014 | | 53.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowable** |

## Summary for Reach DP#1: Offsite - Northerly Prop Line

Inflow Area = 1.577 ac, 57.96% Impervious, Inflow Depth = 1.75" for 10-year event
Inflow = 1.15 cfs @ 12.12 hrs, Volume= 0.230 af
Outflow = 1.15 cfs @ 12.12 hrs, Volume= 0.230 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Reach DP#2: Cambridge Street

Inflow Area = 1.893 ac, 28.47% Impervious, Inflow Depth = 1.47" for 10-year event
Inflow = 2.84 cfs @ 12.17 hrs, Volume= 0.232 af
Outflow = 2.84 cfs @ 12.17 hrs, Volume= 0.232 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Pond 7P: INFILTRATION 1

Inflow Area = 0.918 ac, 96.30% Impervious, Inflow Depth = 4.10" for 10-year event
Inflow = 3.87 cfs @ 12.09 hrs, Volume= 0.313 af
Outflow = 0.64 cfs @ 12.56 hrs, Volume= 0.313 af, Atten= 83%, Lag= 28.3 min
Discarded = 0.07 cfs @ 8.35 hrs, Volume= 0.143 af
Primary = 0.58 cfs @ 12.56 hrs, Volume= 0.170 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 118.49' @ 12.56 hrs Surf.Area= 2,755 sf Storage= 6,111 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 191.1 min ( 950.2 - 759.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 115.25' | 4,020 cf | **37.08'W x 74.30'L x 5.50'H Field A**<br>15,153 cf Overall - 5,104 cf Embedded = 10,050 cf x 40.0% Voids |
| #2A | 116.00' | 5,104 cf | **ADS_StormTech MC-3500 c +Cap** x 45 Inside #1<br>Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf<br>Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap<br>Cap Storage= +15.6 cf x 2 x 5 rows = 156.0 cf |
| | | 9,124 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.75' | **12.0" Round Culvert**<br>L= 48.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 115.75' / 114.79' S= 0.0200 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Device 1 | 116.45' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 119.50' | **4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #4 | Discarded | 115.25' | **1.020 in/hr Exfiltration Loamy Sand Rawl's Rate over Surface area** |

**Discarded OutFlow** Max=0.07 cfs @ 8.35 hrs HW=115.31' (Free Discharge)
└**4=Exfiltration Loamy Sand Rawl's Rate** (Exfiltration Controls 0.07 cfs)

**Primary OutFlow** Max=0.58 cfs @ 12.56 hrs HW=118.49' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.58 cfs of 5.66 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.58 cfs @ 6.60 fps)
  └**3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 8P: INFILTRATION 2

Inflow Area = 1.434 ac, 33.12% Impervious, Inflow Depth = 2.28" for 10-year event
Inflow = 3.58 cfs @ 12.09 hrs, Volume= 0.273 af
Outflow = 2.36 cfs @ 12.20 hrs, Volume= 0.273 af, Atten= 34%, Lag= 6.3 min
Discarded = 0.05 cfs @ 10.35 hrs, Volume= 0.094 af
Primary = 2.31 cfs @ 12.20 hrs, Volume= 0.179 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 96.20' @ 12.20 hrs Surf.Area= 2,140 sf Storage= 2,576 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 91.7 min ( 908.1 - 816.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 94.40' | 1,980 cf | **25.25'W x 84.76'L x 3.50'H Field A**<br>7,491 cf Overall - 2,541 cf Embedded = 4,950 cf x 40.0% Voids |
| #2A | 94.90' | 2,541 cf | **ADS_StormTech SC-740** x 55 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>Row Length Adjustment= +0.44' x 6.45 sf x 5 rows |
| | | 4,521 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 95.20' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 95.20' / 95.10' S= 0.0125 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Primary | 97.30' | **24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |
| #3 | Discarded | 94.40' | **1.020 in/hr Exfiltration- Sandy Loam Rawls Rate over Surface area** |

**Discarded OutFlow** Max=0.05 cfs @ 10.35 hrs HW=94.44' (Free Discharge)
└**3=Exfiltration- Sandy Loam Rawls Rate** (Exfiltration Controls 0.05 cfs)

**Primary OutFlow** Max=2.31 cfs @ 12.20 hrs HW=96.20' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Barrel Controls 2.31 cfs @ 3.67 fps)
└**2=Orifice/Grate** ( Controls 0.00 cfs)

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=1.55"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=1.09 cfs 0.085 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=1.86"
Tc=6.0 min CN=65 Runoff=0.89 cfs 0.067 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=2.52"
Tc=6.0 min CN=73 Runoff=3.46 cfs 0.252 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=4.60"
Tc=6.0 min CN=94 Runoff=1.67 cfs 0.131 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=5.06"
Tc=6.0 min CN=98 Runoff=1.18 cfs 0.098 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=5.06"
Tc=6.0 min CN=98 Runoff=2.92 cfs 0.243 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=3.25"
Tc=6.0 min CN=81 Runoff=0.10 cfs 0.007 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=1.61 cfs 0.310 af
Outflow=1.61 cfs 0.310 af

**Reach DP#2: Cambridge Street** Inflow=3.93 cfs 0.327 af
Outflow=3.93 cfs 0.327 af

**Pond 7P: INFILTRATION 1** Peak Elev=119.24' Storage=7,383 cf Inflow=4.59 cfs 0.374 af
Discarded=0.07 cfs 0.150 af Primary=0.68 cfs 0.224 af Outflow=0.75 cfs 0.374 af

**Pond 8P: INFILTRATION 2** Peak Elev=96.50' Storage=3,020 cf Inflow=4.64 cfs 0.350 af
Discarded=0.05 cfs 0.097 af Primary=3.14 cfs 0.253 af Outflow=3.19 cfs 0.350 af

**Total Runoff Area = 3.470 ac Runoff Volume = 0.884 af Average Runoff Depth = 3.06"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

## Summary for Subcatchment P-1: FLOW TO DP 1

Runoff = 1.09 cfs @ 12.10 hrs, Volume= 0.085 af, Depth= 1.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.181 | 61 | >75% Grass cover, Good, HSG B |
| 0.058 | 80 | >75% Grass cover, Good, HSG D |
| 0.390 | 55 | Woods, Good, HSG B |
| 0.030 | 98 | Paved parking, HSG B |
| 0.659 | 61 | Weighted Average |
| 0.629 | | 95.45% Pervious Area |
| 0.030 | | 4.55% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.2900 | 0.19 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10" |
| 0.4 | 72 | 0.2900 | 2.69 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.3 | | | | | **Direct Entry, To make min. allowable** |
| 6.0 | 122 | Total | | | |

## Summary for Subcatchment P-2: FLOW TO CAMBRIDGE ST

Runoff = 0.89 cfs @ 12.10 hrs, Volume= 0.067 af, Depth= 1.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.050 | 98 | Paved parking, HSG D |
| 0.365 | 61 | >75% Grass cover, Good, HSG B |
| 0.018 | 55 | Woods, Good, HSG B |
| 0.433 | 65 | Weighted Average |
| 0.383 | | 88.45% Pervious Area |
| 0.050 | | 11.55% Impervious Area |

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

## Summary for Subcatchment P-3: FLOW TO UG BASIN

Runoff = 3.46 cfs @ 12.09 hrs, Volume= 0.252 af, Depth= 2.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.369 | 80 | >75% Grass cover, Good, HSG D |
| 0.242 | 98 | Paved parking, HSG D |
| 0.226 | 55 | Woods, Good, HSG B |
| 0.364 | 61 | >75% Grass cover, Good, HSG B |
| 1.201 | 73 | Weighted Average |
| 0.959 | | 79.85% Pervious Area |
| 0.242 | | 20.15% Impervious Area |

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

## Summary for Subcatchment P-4: FLOW TO UG BASIN

Runoff = 1.67 cfs @ 12.09 hrs, Volume= 0.131 af, Depth= 4.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.034 | 61 | >75% Grass cover, Good, HSG B |
| * 0.308 | 98 | Paved parking |
| 0.342 | 94 | Weighted Average |
| 0.034 | | 9.94% Pervious Area |
| 0.308 | | 90.06% Impervious Area |

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

## Summary for Subcatchment P-5: Roof South

Runoff = 1.18 cfs @ 12.09 hrs, Volume= 0.098 af, Depth= 5.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.233 | 98 | Roofs, HSG B |
| 0.233 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P-6: Roof North

Runoff = 2.92 cfs @ 12.09 hrs, Volume= 0.243 af, Depth= 5.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.576 | 98 | Roofs, HSG B |
| 0.576 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P2A: FLOW TO WAINWRIGHT ST

Runoff = 0.10 cfs @ 12.09 hrs, Volume= 0.007 af, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.30"

| Area (ac) | CN | Description |
|---|---|---|
| 0.014 | 98 | Paved parking, HSG B |
| 0.012 | 61 | >75% Grass cover, Good, HSG B |
| 0.026 | 81 | Weighted Average |
| 0.012 | | 46.15% Pervious Area |
| 0.014 | | 53.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowable** |

## Summary for Reach DP#1: Offsite - Northerly Prop Line

Inflow Area = 1.577 ac, 57.96% Impervious, Inflow Depth = 2.36" for 25-year event
Inflow = 1.61 cfs @ 12.11 hrs, Volume= 0.310 af
Outflow = 1.61 cfs @ 12.11 hrs, Volume= 0.310 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Reach DP#2: Cambridge Street

Inflow Area = 1.893 ac, 28.47% Impervious, Inflow Depth = 2.07" for 25-year event
Inflow = 3.93 cfs @ 12.15 hrs, Volume= 0.327 af
Outflow = 3.93 cfs @ 12.15 hrs, Volume= 0.327 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Pond 7P: INFILTRATION 1

Inflow Area = 0.918 ac, 96.30% Impervious, Inflow Depth = 4.89" for 25-year event
Inflow = 4.59 cfs @ 12.09 hrs, Volume= 0.374 af
Outflow = 0.75 cfs @ 12.56 hrs, Volume= 0.374 af, Atten= 84%, Lag= 28.5 min
Discarded = 0.07 cfs @ 7.65 hrs, Volume= 0.150 af
Primary = 0.68 cfs @ 12.56 hrs, Volume= 0.224 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 119.24' @ 12.56 hrs Surf.Area= 2,755 sf Storage= 7,383 cf
vs 120.75'
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 187.9 min ( 943.6 - 755.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 115.25' | 4,020 cf | **37.08'W x 74.30'L x 5.50'H Field A**<br>15,153 cf Overall - 5,104 cf Embedded = 10,050 cf x 40.0% Voids |
| #2A | 116.00' | 5,104 cf | **ADS_StormTech MC-3500 c +Cap** x 45 Inside #1<br>Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf<br>Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap<br>Cap Storage= +15.6 cf x 2 x 5 rows = 156.0 cf |
| | | 9,124 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.75' | **12.0" Round Culvert**<br>L= 48.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 115.75' / 114.79' S= 0.0200 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Device 1 | 116.45' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 119.50' | **4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #4 | Discarded | 115.25' | **1.020 in/hr Exfiltration Loamy Sand Rawl's Rate over Surface area** |

**Discarded OutFlow** Max=0.07 cfs @ 7.65 hrs HW=115.31' (Free Discharge)
↑—**4=Exfiltration Loamy Sand Rawl's Rate** (Exfiltration Controls 0.07 cfs)

**Primary OutFlow** Max=0.68 cfs @ 12.56 hrs HW=119.24' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.68 cfs of 6.54 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 0.68 cfs @ 7.80 fps)
—**3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 8P: INFILTRATION 2

Inflow Area = 1.434 ac, 33.12% Impervious, Inflow Depth = 2.93" for 25-year event
Inflow = 4.64 cfs @ 12.09 hrs, Volume= 0.350 af
Outflow = 3.19 cfs @ 12.18 hrs, Volume= 0.350 af, Atten= 31%, Lag= 5.5 min
Discarded = 0.05 cfs @ 9.75 hrs, Volume= 0.097 af
Primary = 3.14 cfs @ 12.18 hrs, Volume= 0.253 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 96.50' @ 12.19 hrs Surf.Area= 2,140 sf Storage= 3,020 cf
vs 97.90
Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 77.2 min ( 889.0 - 811.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 94.40' | 1,980 cf | **25.25'W x 84.76'L x 3.50'H Field A**<br>7,491 cf Overall - 2,541 cf Embedded = 4,950 cf x 40.0% Voids |
| #2A | 94.90' | 2,541 cf | **ADS_StormTech SC-740** x 55 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>Row Length Adjustment= +0.44' x 6.45 sf x 5 rows |
| | | 4,521 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 95.20' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 95.20' / 95.10' S= 0.0125 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Primary | 97.30' | **24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |
| #3 | Discarded | 94.40' | **1.020 in/hr Exfiltration- Sandy Loam Rawls Rate over Surface area** |

**Discarded OutFlow** Max=0.05 cfs @ 9.75 hrs HW=94.44' (Free Discharge)
└**3=Exfiltration- Sandy Loam Rawls Rate** (Exfiltration Controls 0.05 cfs)

**Primary OutFlow** Max=3.12 cfs @ 12.18 hrs HW=96.49' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Barrel Controls 3.12 cfs @ 4.02 fps)
└**2=Orifice/Grate** ( Controls 0.00 cfs)

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: FLOW TO DP 1** Runoff Area=0.659 ac 4.55% Impervious Runoff Depth=2.35"
Flow Length=122' Slope=0.2900 '/' Tc=6.0 min CN=61 Runoff=1.72 cfs 0.129 af

**Subcatchment P-2: FLOW TO CAMBRIDGE** Runoff Area=0.433 ac 11.55% Impervious Runoff Depth=2.72"
Tc=6.0 min CN=65 Runoff=1.34 cfs 0.098 af

**Subcatchment P-3: FLOW TO UG BASIN** Runoff Area=1.201 ac 20.15% Impervious Runoff Depth=3.51"
Tc=6.0 min CN=73 Runoff=4.84 cfs 0.351 af

**Subcatchment P-4: FLOW TO UG BASIN** Runoff Area=0.342 ac 90.06% Impervious Runoff Depth=5.79"
Tc=6.0 min CN=94 Runoff=2.07 cfs 0.165 af

**Subcatchment P-5: Roof South** Runoff Area=0.233 ac 100.00% Impervious Runoff Depth=6.26"
Tc=6.0 min CN=98 Runoff=1.45 cfs 0.122 af

**Subcatchment P-6: Roof North** Runoff Area=0.576 ac 100.00% Impervious Runoff Depth=6.26"
Tc=6.0 min CN=98 Runoff=3.58 cfs 0.301 af

**Subcatchment P2A: FLOW TO** Runoff Area=0.026 ac 53.85% Impervious Runoff Depth=4.34"
Tc=6.0 min CN=81 Runoff=0.13 cfs 0.009 af

**Reach DP#1: Offsite - Northerly Prop Line** Inflow=3.54 cfs 0.437 af
Outflow=3.54 cfs 0.437 af

**Reach DP#2: Cambridge Street** Inflow=5.44 cfs 0.479 af
Outflow=5.44 cfs 0.479 af

**Pond 7P: INFILTRATION 1** Peak Elev=119.78' Storage=8,057 cf Inflow=5.66 cfs 0.466 af
Discarded=0.07 cfs 0.157 af Primary=2.63 cfs 0.308 af Outflow=2.70 cfs 0.466 af

**Pond 8P: INFILTRATION 2** Peak Elev=96.98' Storage=3,666 cf Inflow=6.29 cfs 0.473 af
Discarded=0.05 cfs 0.102 af Primary=4.28 cfs 0.371 af Outflow=4.33 cfs 0.473 af

**Total Runoff Area = 3.470 ac Runoff Volume = 1.175 af Average Runoff Depth = 4.06"**
**58.13% Pervious = 2.017 ac 41.87% Impervious = 1.453 ac**

## Summary for Subcatchment P-1: FLOW TO DP 1

Runoff = 1.72 cfs @ 12.10 hrs, Volume= 0.129 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.181 | 61 | >75% Grass cover, Good, HSG B |
| 0.058 | 80 | >75% Grass cover, Good, HSG D |
| 0.390 | 55 | Woods, Good, HSG B |
| 0.030 | 98 | Paved parking, HSG B |
| 0.659 | 61 | Weighted Average |
| 0.629 | | 95.45% Pervious Area |
| 0.030 | | 4.55% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.2900 | 0.19 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10" |
| 0.4 | 72 | 0.2900 | 2.69 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.3 | | | | | **Direct Entry, To make min. allowable** |
| 6.0 | 122 | Total | | | |

## Summary for Subcatchment P-2: FLOW TO CAMBRIDGE ST

Runoff = 1.34 cfs @ 12.10 hrs, Volume= 0.098 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.050 | 98 | Paved parking, HSG D |
| 0.365 | 61 | >75% Grass cover, Good, HSG B |
| 0.018 | 55 | Woods, Good, HSG B |
| 0.433 | 65 | Weighted Average |
| 0.383 | | 88.45% Pervious Area |
| 0.050 | | 11.55% Impervious Area |

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

## Summary for Subcatchment P-3: FLOW TO UG BASIN

Runoff = 4.84 cfs @ 12.09 hrs, Volume= 0.351 af, Depth= 3.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.369 | 80 | >75% Grass cover, Good, HSG D |
| 0.242 | 98 | Paved parking, HSG D |
| 0.226 | 55 | Woods, Good, HSG B |
| 0.364 | 61 | >75% Grass cover, Good, HSG B |
| 1.201 | 73 | Weighted Average |
| 0.959 | | 79.85% Pervious Area |
| 0.242 | | 20.15% Impervious Area |

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

## Summary for Subcatchment P-4: FLOW TO UG BASIN

Runoff = 2.07 cfs @ 12.09 hrs, Volume= 0.165 af, Depth= 5.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.034 | 61 | >75% Grass cover, Good, HSG B |
| * 0.308 | 98 | Paved parking |
| 0.342 | 94 | Weighted Average |
| 0.034 | | 9.94% Pervious Area |
| 0.308 | | 90.06% Impervious Area |

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

## Summary for Subcatchment P-5: Roof South

Runoff = 1.45 cfs @ 12.09 hrs, Volume= 0.122 af, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.233 | 98 | Roofs, HSG B |
| 0.233 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P-6: Roof North

Runoff = 3.58 cfs @ 12.09 hrs, Volume= 0.301 af, Depth= 6.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.576 | 98 | Roofs, HSG B |
| 0.576 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowed** |

## Summary for Subcatchment P2A: FLOW TO WAINWRIGHT ST

Runoff = 0.13 cfs @ 12.09 hrs, Volume= 0.009 af, Depth= 4.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.014 | 98 | Paved parking, HSG B |
| 0.012 | 61 | >75% Grass cover, Good, HSG B |
| 0.026 | 81 | Weighted Average |
| 0.012 | | 46.15% Pervious Area |
| 0.014 | | 53.85% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, Min. allowable** |

## Summary for Reach DP#1: Offsite - Northerly Prop Line

Inflow Area = 1.577 ac, 57.96% Impervious, Inflow Depth = 3.33" for 100-year event
Inflow = 3.54 cfs @ 12.27 hrs, Volume= 0.437 af
Outflow = 3.54 cfs @ 12.27 hrs, Volume= 0.437 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Reach DP#2: Cambridge Street

Inflow Area = 1.893 ac, 28.47% Impervious, Inflow Depth = 3.03" for 100-year event
Inflow = 5.44 cfs @ 12.14 hrs, Volume= 0.479 af
Outflow = 5.44 cfs @ 12.14 hrs, Volume= 0.479 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Pond 7P: INFILTRATION 1

Inflow Area = 0.918 ac, 96.30% Impervious, Inflow Depth = 6.09" for 100-year event
Inflow = 5.66 cfs @ 12.09 hrs, Volume= 0.466 af
Outflow = 2.70 cfs @ 12.27 hrs, Volume= 0.466 af, Atten= 52%, Lag= 11.2 min
Discarded = 0.07 cfs @ 6.80 hrs, Volume= 0.157 af
Primary = 2.63 cfs @ 12.27 hrs, Volume= 0.308 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 119.78' @ 12.27 hrs Surf.Area= 2,755 sf Storage= 8,057 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 171.2 min ( 923.1 - 751.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 115.25' | 4,020 cf | **37.08'W x 74.30'L x 5.50'H Field A**<br>15,153 cf Overall - 5,104 cf Embedded = 10,050 cf x 40.0% Voids |
| #2A | 116.00' | 5,104 cf | **ADS_StormTech MC-3500 c +Cap** x 45 Inside #1<br>Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf<br>Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap<br>Cap Storage= +15.6 cf x 2 x 5 rows = 156.0 cf |
| | | 9,124 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 115.75' | **12.0" Round Culvert**<br>L= 48.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 115.75' / 114.79' S= 0.0200 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Device 1 | 116.45' | **4.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 119.50' | **4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #4 | Discarded | 115.25' | **1.020 in/hr Exfiltration Loamy Sand Rawl's Rate over Surface area** |

**Discarded OutFlow** Max=0.07 cfs @ 6.80 hrs HW=115.31' (Free Discharge)
↑**4=Exfiltration Loamy Sand Rawl's Rate** (Exfiltration Controls 0.07 cfs)

**Primary OutFlow** Max=2.45 cfs @ 12.27 hrs HW=119.76' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Passes 2.45 cfs of 7.08 cfs potential flow)
↑**2=Orifice/Grate** (Orifice Controls 0.74 cfs @ 8.54 fps)
**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.70 cfs @ 1.66 fps)

## Summary for Pond 8P: INFILTRATION 2

Inflow Area = 1.434 ac, 33.12% Impervious, Inflow Depth = 3.96" for 100-year event
Inflow = 6.29 cfs @ 12.09 hrs, Volume= 0.473 af
Outflow = 4.33 cfs @ 12.18 hrs, Volume= 0.473 af, Atten= 31%, Lag= 5.5 min
Discarded = 0.05 cfs @ 9.00 hrs, Volume= 0.102 af
Primary = 4.28 cfs @ 12.18 hrs, Volume= 0.371 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 96.98' @ 12.18 hrs Surf.Area= 2,140 sf Storage= 3,666 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 63.5 min ( 869.5 - 806.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 94.40' | 1,980 cf | **25.25'W x 84.76'L x 3.50'H Field A**<br>7,491 cf Overall - 2,541 cf Embedded = 4,950 cf x 40.0% Voids |
| #2A | 94.90' | 2,541 cf | **ADS_StormTech SC-740** x 55 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>Row Length Adjustment= +0.44' x 6.45 sf x 5 rows |
| | | 4,521 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 95.20' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 95.20' / 95.10' S= 0.0125 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Primary | 97.30' | **24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |
| #3 | Discarded | 94.40' | **1.020 in/hr Exfiltration- Sandy Loam Rawls Rate over Surface area** |

**Discarded OutFlow** Max=0.05 cfs @ 9.00 hrs HW=94.44' (Free Discharge)
└**3=Exfiltration- Sandy Loam Rawls Rate** (Exfiltration Controls 0.05 cfs)

**Primary OutFlow** Max=4.25 cfs @ 12.18 hrs HW=96.96' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Inlet Controls 4.25 cfs @ 5.41 fps)
└**2=Orifice/Grate** ( Controls 0.00 cfs)

# APPENDIX E
# WATER QUALITY CALCULATIONS

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

*Version 1, Automated: Mar. 4, 2008*

Location: CB-1 & CB-4 (Stormceptors)

## TSS Removal Calculation Worksheet

| B<br>BMP[1] | C<br>TSS Removal Rate[1] | D<br>Starting TSS Load* | E<br>Amount Removed (C*D) | F<br>Remaining Load (D-E) |
|---|---|---|---|---|
| **Proprietary Treatment Practice** | **0.65** | **1.00** | **0.65** | **0.35** |
| **Infiltration Basin** | **0.80** | **0.35** | **0.28** | **0.07** |
| | **0.00** | **0.07** | **0.00** | **0.07** |
| | **0.00** | **0.07** | **0.00** | **0.07** |
| | **0.00** | **0.07** | **0.00** | **0.07** |

**Total TSS Removal =** **93%**

**Separate Form Needs to be Completed for Each Outlet or BMP Train**

Project: W141161
Prepared By: AWP
Date: 7/10/2015

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

*Version 1, Automated: Mar. 4, 2008*

Location: CB-2 & CB-3

## TSS Removal Calculation Worksheet

| B<br>BMP[1] | C<br>TSS Removal Rate[1] | D<br>Starting TSS Load* | E<br>Amount Removed (C*D) | F<br>Remaining Load (D-E) |
|---|---|---|---|---|
| **Deep Sump and Hooded Catch Basin** | **0.25** | **1.00** | **0.25** | **0.75** |
| **Proprietary Treatment Practice** | **0.65** | **0.75** | **0.49** | **0.26** |
| **Infiltration Basin** | **0.80** | **0.26** | **0.21** | **0.05** |
| | **0.00** | **0.05** | **0.00** | **0.05** |
| | **0.00** | **0.05** | **0.00** | **0.05** |

**Total TSS Removal =** **95%**

**Separate Form Needs to be Completed for Each Outlet or BMP Train**

Project: W141161
Prepared By: AWP
Date: 7/10/2015

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

W141161
Calculated by AWP
Date: 11/17/15

Water Quality Flow (Drainage to proposed CB-1)

Impervious area draining to hydrodynamic separator= 13,416 sf (0.308 Ac.)

Time of concentration= 5 min. (0.16 hr)

$Q_{0.5}$ = (qu)(A)(WQV) A = 13,416 SF x $\frac{1\ Ac}{43{,}560\ SF}$ x $\frac{1\ mi^2}{640\ Ac}$ = 0.000481 Ac

WQV = 1/2" qu = 773

$Q_{0.5}$ = 773 x 0.000481 x 0.5

$Q_{0.5}$ = 0.37 cfs

---

Water Quality Flow (Drainage to proposed STC-1)

Impervious area draining to hydrodynamic separator= 8,663 sf (0.199 Ac.)

Time of concentration= 5 min. (0.16 hr)

$Q_{0.5}$ = (qu)(A)(WQV) A = 7,813 SF x $\frac{1\ Ac}{43{,}560\ SF}$ x $\frac{1\ mi^2}{640\ Ac}$ = 0.00028 Ac

WQV = 1/2" qu = 773

$Q_{0.5}$ = 773 x 0.00028 x 0.5

$Q_{0.5}$ = 0.11 cfs

---

Water Quality Flow (Drainage to proposed CB-1)

Impervious area draining to hydrodynamic separator= 1,439 sf (0.033 Ac.)

Time of concentration= 5 min. (0.16 hr)

$Q_{0.5}$ = (qu)(A)(WQV) A = 1,439 SF x $\frac{1\ Ac}{43{,}560\ SF}$ x $\frac{1\ mi^2}{640\ Ac}$ = 0.000052 Ac

WQV = 1/2" qu = 773

$Q_{0.5}$ = 773 x 0.000052 x 0.5

$Q_{0.5}$ = 0.02 cfs

Groundwater Recharge Required

Existing Impervious Area= 0.20 Ac.

Proposed Impervious Area=1.482 Ac.

Increase in Impervious Area= 1.282 Ac. (55,844 sf)

Impervious area to be infiltrated= 1.359 Ac. (59,198 sf)

1.359/1.482 = 92%, >65%, no infiltration adjustment factor required

Use type B soils to be conservative (ignore D soils, which have a lower recharge rate requirement)

0.35 inch x 55,844 sf / 12 in/ft = 1,629 cf required

2,788 cf provided (see next pages)

Water Quality Volume Calculations

Proposed impervious area to Design Point #1 (off-site wetlands to the north) = 0.914 Ac.

Proposed impervious area to Design Point #2 (Cambridge St / Wainwright Rd) = 0.540 Ac.

WQV at D.P. #1 = 0.914 x 43,560 sf/ac x 0.5 in / 12 in/ft = 1,659 cf

WQV at D.P. #2 = 0.540 x 43,560 sf/ac x 0.5 in / 12 in/ft = 980 cf

See next pages demonstrating that the required WQVs are provided within the infiltration basins

Basin Drawdown Times

Basin #1: Storage below lowest outlet= 1,842 cf

Bottom area= 2,755 sf

Infiltration rate= 1.02 in/hr

Drawdown time= 1,842 / 2,755 x 12 in/ft / 1.02 in/hr = 8 hrs

Basin #2: Storage below lowest outlet= 946 cf

Bottom area= 2,140 sf

Infiltration rate= 1.02 in/hr

Drawdown time= 946 / 2,140 x 12 in/ft / 1.02 in/hr = 5 hrs

Weighted TSS Removal Rate:

TSS removal rates are for driveway and parking lot impervious areas only and exclude roofs and sidewalks in lawn areas.

$$\frac{(0.329 \times 0.93) + (0.179 \times 0.95) + (0.045 \times 0.00)}{(0.329 + 0.179 + 0.045)} = \mathbf{86.1\%}$$

## Stage-Area-Storage for Pond 7P: INFILTRATION 1

| Elevation (feet) | Surface (sq-ft) | Storage (cubic-feet) |
|---|---|---|
| 115.25 | **2,755** | 0 |
| 115.35 | 2,755 | 110 |
| 115.45 | 2,755 | 220 |
| 115.55 | 2,755 | 331 |
| 115.65 | 2,755 | 441 |
| 115.75 | 2,755 | 551 |
| 115.85 | 2,755 | 661 |
| 115.95 | 2,755 | 771 |
| 116.05 | 2,755 | 940 |
| 116.15 | 2,755 | 1,167 |
| 116.25 | 2,755 | 1,393 |
| 116.35 | 2,755 | 1,618 |
| 116.45 | 2,755 | 1,842 |
| 116.55 | 2,755 | 2,065 |
| 116.65 | 2,755 | 2,287 |
| 116.75 | 2,755 | 2,509 |
| 116.85 | 2,755 | 2,729 |
| 116.95 | 2,755 | 2,948 |
| 117.05 | 2,755 | 3,165 |
| 117.15 | 2,755 | 3,382 |
| 117.25 | 2,755 | 3,597 |
| 117.35 | 2,755 | 3,810 |
| 117.45 | 2,755 | 4,022 |
| 117.55 | 2,755 | 4,232 |
| 117.65 | 2,755 | 4,441 |
| 117.75 | 2,755 | 4,647 |
| 117.85 | 2,755 | 4,852 |
| 117.95 | 2,755 | 5,054 |
| 118.05 | 2,755 | 5,254 |
| 118.15 | 2,755 | 5,452 |
| 118.25 | 2,755 | 5,647 |
| 118.35 | 2,755 | 5,839 |
| 118.45 | 2,755 | 6,028 |
| 118.55 | 2,755 | 6,214 |
| 118.65 | 2,755 | 6,396 |
| 118.75 | 2,755 | 6,575 |
| 118.85 | 2,755 | 6,749 |
| 118.95 | 2,755 | 6,919 |
| 119.05 | 2,755 | 7,084 |
| 119.15 | 2,755 | 7,244 |
| 119.25 | 2,755 | 7,396 |
| 119.35 | 2,755 | 7,538 |
| 119.45 | 2,755 | 7,669 |
| 119.55 | 2,755 | 7,791 |
| 119.65 | 2,755 | 7,909 |
| 119.75 | 2,755 | 8,022 |
| 119.85 | 2,755 | 8,132 |
| 119.95 | 2,755 | 8,242 |
| 120.05 | 2,755 | 8,352 |
| 120.15 | 2,755 | 8,462 |
| 120.25 | 2,755 | 8,573 |
| 120.35 | 2,755 | 8,683 |
| 120.45 | 2,755 | 8,793 |
| 120.55 | 2,755 | 8,903 |
| 120.65 | 2,755 | 9,013 |
| 120.75 | 2,755 | **9,124** |

LOWEST OUTLET

TOTAL GW RECHARGE:

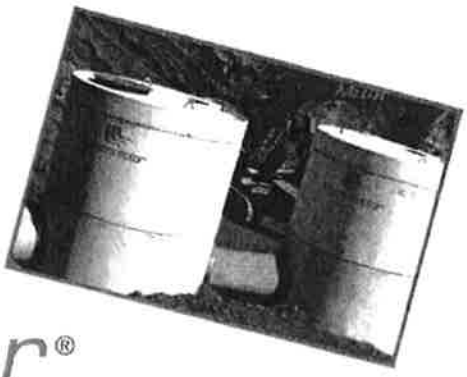
1842 CF BASIN #1
946 CF BASIN #2

2,788 CF TOTAL

## Stage-Area-Storage for Pond 8P: INFILTRATION 2

| Elevation (feet) | Surface (sq-ft) | Storage (cubic-feet) |
|---|---|---|
| 94.40 | **2,140** | 0 |
| 94.45 | 2,140 | 43 |
| 94.50 | 2,140 | 86 |
| 94.55 | 2,140 | 128 |
| 94.60 | 2,140 | 171 |
| 94.65 | 2,140 | 214 |
| 94.70 | 2,140 | 257 |
| 94.75 | 2,140 | 300 |
| 94.80 | 2,140 | 342 |
| 94.85 | 2,140 | 385 |
| 94.90 | 2,140 | 428 |
| 94.95 | 2,140 | 515 |
| 95.00 | 2,140 | 601 |
| 95.05 | 2,140 | 688 |
| 95.10 | 2,140 | 774 |
| 95.15 | 2,140 | 860 |
| 95.20 | 2,140 | 946 |
| 95.25 | 2,140 | 1,032 |
| 95.30 | 2,140 | 1,117 |
| 95.35 | 2,140 | 1,202 |
| 95.40 | 2,140 | 1,287 |
| 95.45 | 2,140 | 1,371 |
| 95.50 | 2,140 | 1,455 |
| 95.55 | 2,140 | 1,538 |
| 95.60 | 2,140 | 1,621 |
| 95.65 | 2,140 | 1,704 |
| 95.70 | 2,140 | 1,786 |
| 95.75 | 2,140 | 1,868 |
| 95.80 | 2,140 | 1,949 |
| 95.85 | 2,140 | 2,030 |
| 95.90 | 2,140 | 2,110 |
| 95.95 | 2,140 | 2,190 |
| 96.00 | 2,140 | 2,270 |
| 96.05 | 2,140 | 2,348 |
| 96.10 | 2,140 | 2,426 |
| 96.15 | 2,140 | 2,504 |
| 96.20 | 2,140 | 2,581 |
| 96.25 | 2,140 | 2,657 |
| 96.30 | 2,140 | 2,732 |
| 96.35 | 2,140 | 2,807 |
| 96.40 | 2,140 | 2,881 |
| 96.45 | 2,140 | 2,955 |
| 96.50 | 2,140 | 3,027 |
| 96.55 | 2,140 | 3,099 |
| 96.60 | 2,140 | 3,169 |
| 96.65 | 2,140 | 3,239 |
| 96.70 | 2,140 | 3,307 |
| 96.75 | 2,140 | 3,374 |
| 96.80 | 2,140 | 3,441 |
| 96.85 | 2,140 | 3,506 |
| 96.90 | 2,140 | 3,569 |
| 96.95 | 2,140 | 3,632 |
| 97.00 | 2,140 | 3,692 |
| 97.05 | 2,140 | 3,751 |
| 97.10 | 2,140 | 3,807 |
| 97.15 | 2,140 | 3,860 |
| 97.20 | 2,140 | 3,911 |
| 97.25 | 2,140 | 3,958 |
| 97.30 | 2,140 | 4,004 |
| 97.35 | 2,140 | 4,049 |
| 97.40 | 2,140 | 4,093 |
| 97.45 | 2,140 | 4,136 |
| 97.50 | 2,140 | 4,178 |
| 97.55 | 2,140 | 4,221 |
| 97.60 | 2,140 | 4,264 |
| 97.65 | 2,140 | 4,307 |
| 97.70 | 2,140 | 4,350 |
| 97.75 | 2,140 | 4,392 |
| 97.80 | 2,140 | 4,435 |
| 97.85 | 2,140 | 4,478 |
| 97.90 | 2,140 | **4,521** |

LOWEST OUTLET



# Stormceptor® STC

Stormceptor® is an underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention. With thousands of systems operating worldwide, Stormceptor delivers protection every day in every storm.

With patented technology, optimal treatment occurs by allowing free oil to rise and sediment to settle. The Stormceptor design prohibits scour and release of previously captured pollutants, ensuring superior treatment and protection during even the most extreme storm events.

Stormceptor is very easy to design and provides flexibility under varying site constraints such as tight right-of-ways, zero lot lines and retrofit projects. Design flexibility allows for a cost-effective approach to stormwater treatment. Stormceptor has proven performance backed by the longest record of lab and field verification in the industry.

## Tested Performance

- Fine particle capture
- Prevents scour or release
- 95%+ Oil removal

## Massachusetts – Water Quality (Q) Flow Rate

| Stormceptor STC Model | Inside Diameter (ft) | Typical Depth Below Inlet Pipe Invert [1] (in) | Water Quality Flow Rate Q [2] (cfs) | Peak Conveyance Flow Rate [3] (cfs) | Hydrocarbon Capacity [4] (Gallons) | Maximum Sediment Capacity [4] ($ft^3$) |
|---|---|---|---|---|---|---|
| STC 450i | 4 | 68 | 0.40 | 5.5 | 86 | 46 |
| STC 900 | 6 | 63 | 0.89 | 22 | 251 | 89 |
| STC 2400 | 8 | 104 | 1.58 | 22 | 840 | 205 |
| STC 4800 | 10 | 140 | 2.47 | 22 | 909 | 543 |
| STC 7200 | 12 | 148 | 3.56 | 22 | 1,059 | 839 |
| STC 11000 | 2 x 10 | 142 | 4.94 | 48 | 2,792 | 1,086 |
| STC 16000 | 2 x 12 | 148 | 7.12 | 48 | 3,055 | 1,677 |

[1] Depth Below Pipe Inlet Invert to the Bottom of Base Slab, and Maximum Sediment Capacity can vary to accommodate specific site designs and pollutant loads. Depths can vary to accommodate special designs or site conditions. Contact your local representative for assistance.
[2] Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the OK110 particle size distribution.
[3] Peak Conveyance Flow Rate is based upon ideal velocity of 3 feet per second and outlet pipe diameters of 18-inch, 36-inch, and 54-inch diameters.
[4] Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.

Stormceptor®
www.stormceptor.com

Rinker MATERIALS™
www.rinkerstormceptor.com
Manufacturing Plant: Westfield, MA
Phone: (413) 562-3647
11-22-13-R13-802 MDEP

BOHLER ENGINEERING

| | |
|---|---|
| JOB NO. | STORMTECH VOLUMES |
| SHEET NO. | OF |
| CALCULATED BY | AWP |
| DATE | 11/16/15 |
| CHECK BY | |
| DATE | |
| SCALE | |
| OF | |

BASIN #1 VOLUME

45 MC 3500 UNITS IN 5 ROWS OF 9 UNITS EACH

CHAMBER STORAGE = 109.9 CF / CHAMBER
END CAP STORAGE = 14.9 CF / CAP

TOTAL CHAMBER & END CAP STORAGE = 109.9 x 45 + 10 x 14.9 = 5,095 CF

STONE PRISMATOID VOLUME = 74.30 x 37.08 x 5.50 = 15,152 CF

STONE - CHAMBERS = 15,152 - 5095 = 10,057 CF x 40% VOIDS = 4023 CF

TOTAL VOLUME = 5,095 + 4,023 = 9,118 CF

BASIN #2 VOLUME

55 SC-740 UNITS IN 5 ROWS OF 11 UNITS EACH

CHAMBER STORAGE = 45.9 CF / CHAMBER
END CAPS = 10

TOTAL CHAMBER STORAGE = 45.9 CF x 55 = 2,525 CF

STONE PRISMATOID VOLUME = 84.76' x 25.25' x 3.5' = 7491 CF

STONE - CHAMBERS = 7,491 - 2525 = 4966 CF x 40% VOIDS = 1,986 CF

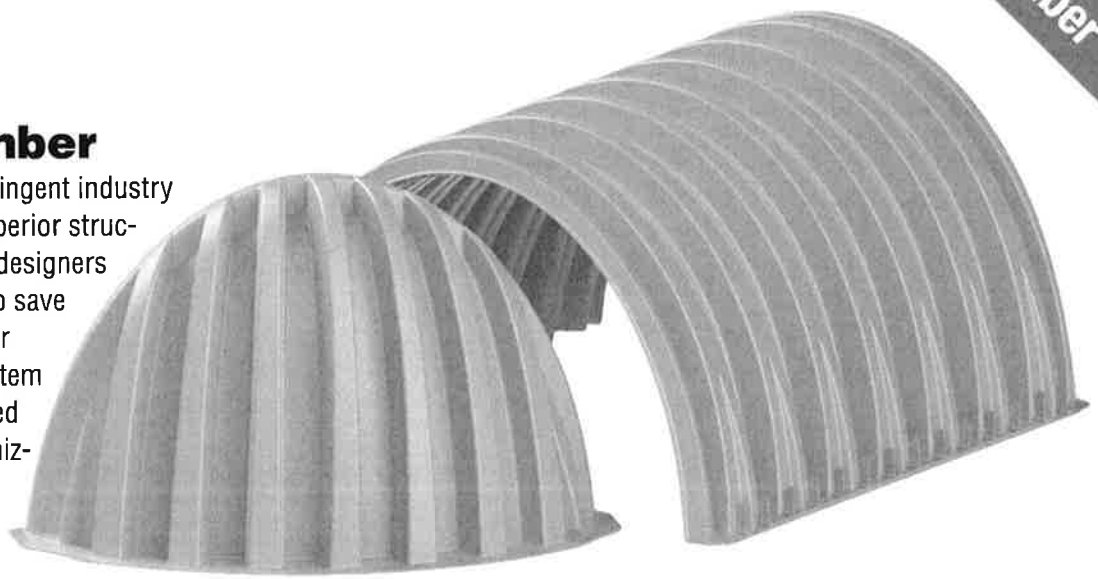
TOTAL VOLUME = 2525 + 1,986 = 4,511 CF

StormTech®
*Detention • Retention • Water Quality*

MC-3500 Chamber

# StormTech MC-3500 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.



**StormTech MC-3500 Chamber** (not to scale)

Nominal Chamber Specifications

| | |
|---|---|
| Size (L x W x H) | 90" (2286 mm) x 77" (1956 mm) x 45" (1143 mm) |
| Chamber Storage | 109.9 ft³ (3.11 m³) |
| Min. Installed Storage* | 178.9 ft³ (5.06 m³) |
| Weight | 134 lbs (60.8 kg) |

* This assumes a minimum of 12" (305 mm) of stone above, 9" (229 mm) of stone below chambers, 9" (229 mm) of row spacing, and 40% stone porosity.

**StormTech MC-3500 End Cap** (not to scale)

Nominal End Cap Specifications

| | |
|---|---|
| Size (L x W x H) | 25.7" (653 mm) x 75" (1905 mm) x 45" (1143 mm) |
| End Cap Storage | 14.9 ft³ (0.42 m³) |
| Min. Installed Storage* | 46.0 ft³ (1.30 m³) |
| Weight | 49 lbs (22.2 kg) |

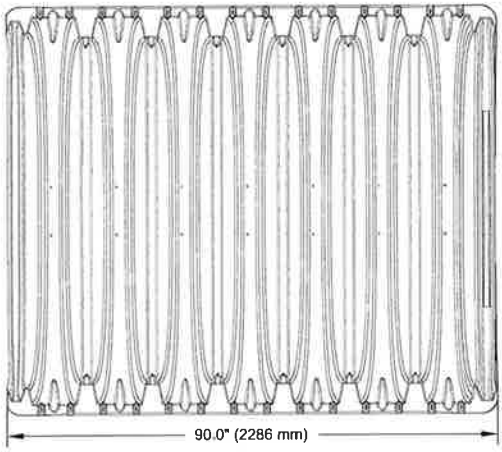
* This assumes a minimum of 12" (305mm) of stone above, 9" (229 mm) of stone below, 9" (229 mm) row spacing, 6" (152 mm) of stone perimeter, and 40% stone porosity.

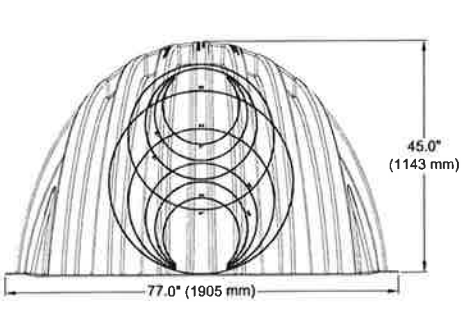
Shipping

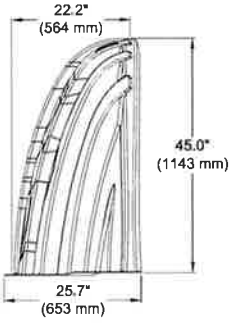
15 chambers/pallet

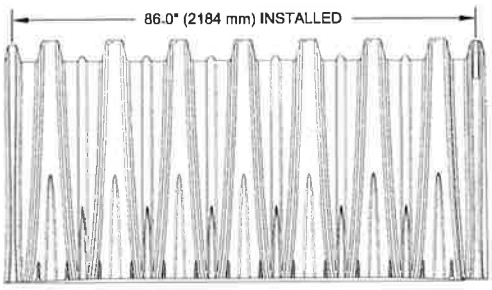
7 end caps/pallet

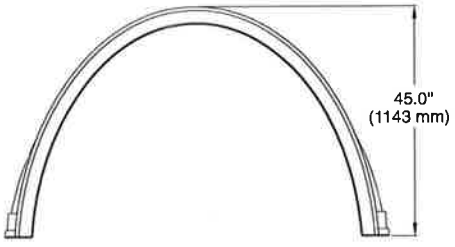
7 pallets/truck



### Storage Volume Per Chamber/End Cap ft³ (m³)

| | Bare Unit Storage | Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm) | | | |
|---|---|---|---|---|---|
| | ft³ (m³) | 9 (229) | 12 (305) | 15 (381) | 18 (457) |
| **MC-3500 Chamber** | 109.9 (3.11) | 178.9 (5.06) | 184.0 (5.21) | 189.2 (5.36) | 194.3 (5.5) |
| **MC-3500 End Cap** | 14.9 (0.42) | 46.0 (1.33) | 47.7 (1.35) | 49.4 (1.40) | 51.1 (1.45) |

*NOTE: Assumes 40% porosity for the stone plus the chamber/end cap volume. End Cap volume assumes 6" (152mm) stone perimeter.*

### Volume of Excavation Per Chamber/End Cap in yd³ (m³)

| | Stone Foundation Depth in. (mm) | | | |
|---|---|---|---|---|
| | 9 (229) | 12 (305) | 15 (381) | 18 (457) |
| **MC-3500** | 12.4 (9.5) | 12.8 (9.8) | 13.3 (10.2) | 13.8 (10.5) |
| **End Cap** | 4.1 (3.1) | 4.2 (3.2) | 4.4 (3.3) | 4.5 (3.5) |

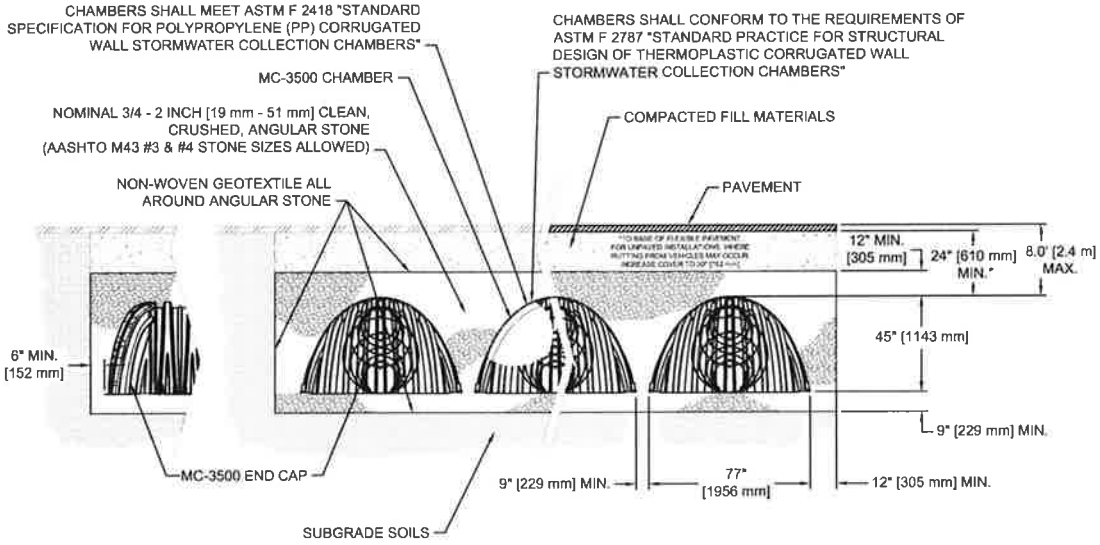
*NOTE: Assumes 9" (229 mm) of separation between chamber rows, 6" (152 mm) of perimeter in front of end caps, and 24" (610 mm) of cover. The volume of excavation will vary as depth of cover increases.*

### Amount of Stone Per Chamber

| ENGLISH tons (yd³) | Stone Foundation Depth | | | |
|---|---|---|---|---|
| | 9 in. | 12 in. | 15 in. | 18 in. |
| **MC-3500** | 9.1 (6.4) | 9.7 (6.9) | 10.4 (7.3) | 11.1 (7.8) |
| **End Cap** | 4.1 (2.9) | 4.3 (3.0) | 4.5 (3.2) | 4.7 (3.3) |
| METRIC kg (m³) | **229 mm** | **305 mm** | **381 mm** | **457 mm** |
| **MC-3500** | 8220 (4.9) | 8831 (5.3) | 9443 (5.6) | 10054 (6.0) |
| **End Cap** | 3699 (2.2) | 3900 (2.3) | 4100 (2.4) | 4301 (2.6) |

*NOTE: Assumes 12" (305 mm) of stone above, and 9" (229 mm) row spacing, and 6" (152mm) of perimeter stone in front of end caps.*

### General Cross Section




NOTES:
1. THIS CROSS SECTION PROVIDES GENERAL INFORMATION FOR THE MC-3500 CHAMBER. STORMTECH MC-3500 CHAMBERS MUST BE DESIGNED AND INSTALLED IN ACCORDANCE WITH THE MC-3500 DESIGN MANUAL AND MC-3500 CONSTRUCTION GUIDE.
2. PROPERLY INSTALLED MC-3500 CHAMBERS PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR EARTH AND LIVE LOADS WITH CONSIDERATION FOR IMPACT AND MULTIPLE PRESENCES.
3. PERIMETER STONE MUST ALWAYS BE BROUGHT UP EVENLY WITH BACKFILL OF BED. PERIMETER STONE MUST EXTEND HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH STRAIGHT OR SLOPED SIDEWALLS.


StormTech®
Detention • Retention • Water Quality
A division of ADS
70 Inwood Road, Suite 3 | Rocky Hill | Connecticut | 06067
860.529.8188 | 888.892.2694 | fax 866.328.8401 | fax 860-529-8040 | www.stormtech.com




S150909 03/2014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## Stage-Area-Storage for Pond 7P: INFILTRATION 1

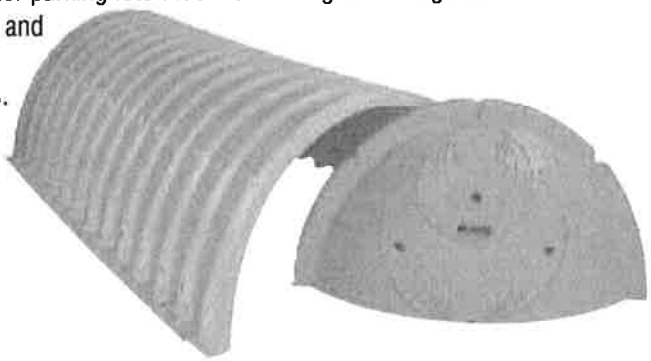
| Elevation (feet) | Surface (sq-ft) | Storage (cubic-feet) |
|---|---|---|
| 115.25 | **2,755** | 0 |
| 115.35 | 2,755 | 110 |
| 115.45 | 2,755 | 220 |
| 115.55 | 2,755 | 331 |
| 115.65 | 2,755 | 441 |
| 115.75 | 2,755 | 551 |
| 115.85 | 2,755 | 661 |
| 115.95 | 2,755 | 771 |
| 116.05 | 2,755 | 940 |
| 116.15 | 2,755 | 1,167 |
| 116.25 | 2,755 | 1,393 |
| 116.35 | 2,755 | 1,618 |
| 116.45 | 2,755 | 1,842 |
| 116.55 | 2,755 | 2,065 |
| 116.65 | 2,755 | 2,287 |
| 116.75 | 2,755 | 2,509 |
| 116.85 | 2,755 | 2,729 |
| 116.95 | 2,755 | 2,948 |
| 117.05 | 2,755 | 3,165 |
| 117.15 | 2,755 | 3,382 |
| 117.25 | 2,755 | 3,597 |
| 117.35 | 2,755 | 3,810 |
| 117.45 | 2,755 | 4,022 |
| 117.55 | 2,755 | 4,232 |
| 117.65 | 2,755 | 4,441 |
| 117.75 | 2,755 | 4,647 |
| 117.85 | 2,755 | 4,852 |
| 117.95 | 2,755 | 5,054 |
| 118.05 | 2,755 | 5,254 |
| 118.15 | 2,755 | 5,452 |
| 118.25 | 2,755 | 5,647 |
| 118.35 | 2,755 | 5,839 |
| 118.45 | 2,755 | 6,028 |
| 118.55 | 2,755 | 6,214 |
| 118.65 | 2,755 | 6,396 |
| 118.75 | 2,755 | 6,575 |
| 118.85 | 2,755 | 6,749 |
| 118.95 | 2,755 | 6,919 |
| 119.05 | 2,755 | 7,084 |
| 119.15 | 2,755 | 7,244 |
| 119.25 | 2,755 | 7,396 |
| 119.35 | 2,755 | 7,538 |
| 119.45 | 2,755 | 7,669 |
| 119.55 | 2,755 | 7,791 |
| 119.65 | 2,755 | 7,909 |
| 119.75 | 2,755 | 8,022 |
| 119.85 | 2,755 | 8,132 |
| 119.95 | 2,755 | 8,242 |
| 120.05 | 2,755 | 8,352 |
| 120.15 | 2,755 | 8,462 |
| 120.25 | 2,755 | 8,573 |
| 120.35 | 2,755 | 8,683 |
| 120.45 | 2,755 | 8,793 |
| 120.55 | 2,755 | 8,903 |
| 120.65 | 2,755 | 9,013 |
| 120.75 | 2,755 | **9,124** |

TOTAL VOLUME

# StormTech SC-740 Chamber

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal applications.

StormTech®
*Detention • Retention • Recharge*
Subsurface Stormwater Management℠



**StormTech SC-740 Chamber**
(not to scale)

Nominal Chamber Specifications

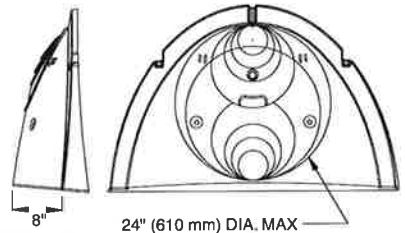
**Size** (L x W x H)
85.4" x 51.0" x 30.0"
(2170 x 1295 x 762 mm)

**Chamber Storage**
45.9 ft³ (1.30 m³)

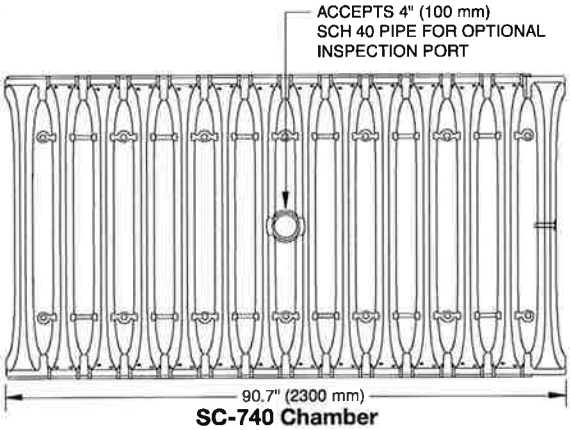
**Minimum Installed Storage***
74.9 ft³ (2.12 m³)

**Weight**
74.0 lbs (33.6 kg)

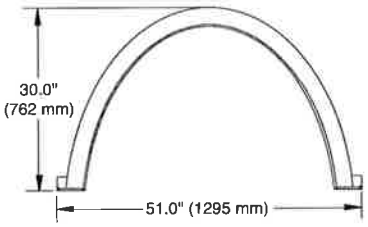
**Shipping**
30 chambers/pallet
60 end caps/pallet
12 pallets/truck

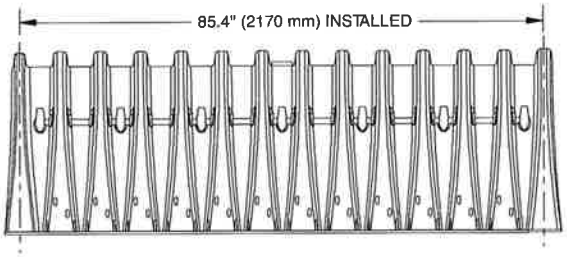



**SC-740 End Cap**

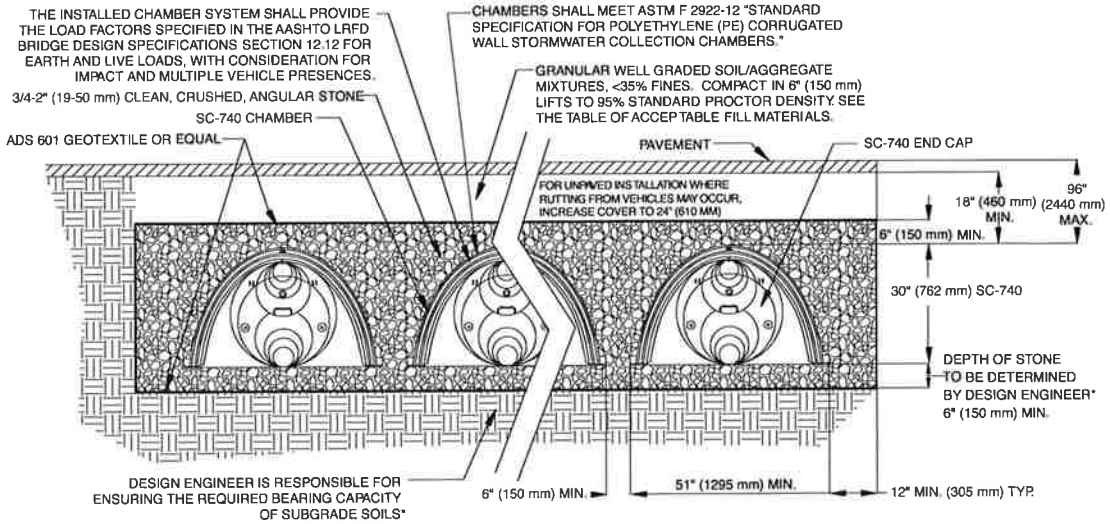



**SC-740 Chamber**




**Typical Cross Section Detail**
(not to scale)




THIS CROSS SECTION DETAILS THE REQUIREMENTS NECESSARY TO SATISFY THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS USING STORMTECH CHAMBERS

MADE IN THE U.S.A.

**SC-740 Cumulative Storage Volumes Per Chamber**

*Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (152 mm) Stone Base Under the Chambers.*

| Depth of Water in System Inches (mm) | Cumulative Chamber Storage Ft³ (m³) | Total System Cumulative Storage Ft³ (m³) |
|---|---|---|
| 42 (1067) | 45.90 (1.300) | 74.90 (2.121) |
| 41 (1041) | 45.90 (1.300) | 73.77 (2.089) |
| 40 (1016) | Stone 45.90 (1.300) | 72.64 (2.057) |
| 39 (991) | Cover 45.90 (1.300) | 71.52 (2.025) |
| 38 (965) | 45.90 (1.300) | 70.39 (1.993) |
| 37 (948) | 45.90 (1.300) | 69.26 (1.961) |
| 36 (914) | 45.90 (1.300) | 68.14 (1.929) |
| 35 (889) | 45.85 (1.298) | 66.98 (1.897) |
| 34 (864) | 45.69 (1.294) | 65.75 (1.862) |
| 33 (838) | 45.41 (1.286) | 64.46 (1.825) |
| 32 (813) | 44.81 (1.269) | 62.97 (1.783) |
| 31 (787) | 44.01 (1.246) | 61.36 (1.737) |
| 30 (762) | 43.06 (1.219) | 59.66 (1.689) |
| 29 (737) | 41.98 (1.189) | 57.89 (1.639) |
| 28 (711) | 40.80 (1.155) | 56.05 (1.587) |
| 27 (686) | 39.54 (1.120) | 54.17 (1.534) |
| 26 (660) | 38.18 (1.081) | 52.23 (1.479) |
| 25 (635) | 36.74 (1.040) | 50.23 (1.422) |
| 24 (610) | 35.22 (0.977) | 48.19 (1.365) |
| 23 (584) | 33.64 (0.953) | 46.11 (1.306) |
| 22 (559) | 31.99 (0.906) | 44.00 (1.246) |
| 21 (533) | 30.29 (0.858) | 41.85 (1.185) |
| 20 (508) | 28.54 (0.808) | 39.67 (1.123) |
| 19 (483) | 26.74 (0.757) | 37.47 (1.061) |
| 18 (457) | 24.89 (0.705) | 35.23 (0.997) |
| 17 (432) | 23.00 (0.651) | 32.96 (0.939) |
| 16 (406) | 21.06 (0.596) | 30.68 (0.869) |
| 15 (381) | 19.09 (0.541) | 28.36 (0.803) |
| 14 (356) | 17.08 (0.484) | 26.03 (0.737) |
| 13 (330) | 15.04 (0.426) | 23.68 (0.670) |
| 12 (305) | 12.97 (0.367) | 21.31 (0.608) |
| 11 (279) | 10.87 (0.309) | 18.92 (0.535) |
| 10 (254) | 8.74 (0.247) | 16.51 (0.468) |
| 9 (229) | 6.58 (0.186) | 14.09 (0.399) |
| 8 (203) | 4.41 (0.125) | 11.66 (0.330) |
| 7 (178) | 2.21 (0.063) | 9.21 (0.264) |
| 6 (152) | 0 | 6.76 (0.191) |
| 5 (127) | 0 | 5.63 (0.160) |
| 4 (102) | Stone Foundation 0 | 4.51 (0.125) |
| 3 (76) | 0 | 3.38 (0.095) |
| 2 (51) | 0 | 2.25 (0.064) |
| 1 (25) | 0 | 1.13 (0.032) |

*Note: Add 1.13 cu. ft. (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.*

**Storage Volume Per Chamber**

| | Bare Chamber Storage | Chamber and Stone Foundation Depth in. (mm) | | |
|---|---|---|---|---|
| | ft³ (m³) | 6 (150) | 12 (305) | 18 (460) |
| **StormTech SC-740** | 45.9 (1.3) | 74.9 (2.1) | 81.7 (2.3) | 88.4 (2.5) |

*Note: Storage volumes are in cubic feet per chamber. Assumes 40% porosity for the stone plus the chamber volume.*

**Amount of Stone Per Chamber**

| | Stone Foundation Depth | | |
|---|---|---|---|
| ENGLISH TONS (CUBIC YARDS) | 6" | 12" | 18" |
| **StormTech SC-740** | 3.8 (2.8 yd³) | 4.6 (3.3 yd³) | 5.5 (3.9 yd³) |
| METRIC KILOGRAMS (METER³) | **150 mm** | **305 mm** | **460 mm** |
| **StormTech SC-740** | 3450 (2.1 m³) | 4170 (2.5 m³) | 4490 (3.0 m³) |

*Note: Assumes 6" (150 mm) of stone above, and between chambers.*

**Volume of Excavation Per Chamber**

| | Stone Foundation Depth | | |
|---|---|---|---|
| | 6" (150 mm) | 12" (305 mm) | 18" (460 mm) |
| **StormTech SC-740** | 5.5 (4.2) | 6.2 (4.7) | 6.8 (5.2) |

*Note: Volumes are in cubic yards (cubic meters) per chamber. Assumes 6" (150 mm) of separation between chamber rows and 18" (460 mm) of cover. The volume of excavation will vary as the depth of the cover increases.*

**STANDARD LIMITED WARRANTY OF STORMTECH LLC ("STORMTECH"): PRODUCTS**

(A) This Limited Warranty applies solely to the StormTech chambers and endplates manufactured by StormTech and sold to the original purchaser (the "Purchaser"). The chambers and endplates are collectively referred to as the "Products."

(B) The structural integrity of the Products, when installed strictly in accordance with StormTech's written installation instructions at the time of installation, are warranted to the Purchaser against defective materials and workmanship for one (1) year from the date of purchase. Should a defect appear in the Limited Warranty period, the Purchaser shall provide StormTech with written notice of the alleged defect at StormTech's corporate headquarters within ten (10) days of the discovery of the defect. The notice shall describe the alleged defect in reasonable detail. StormTech agrees to supply replacements for those Products determined by StormTech to be defective and covered by this Limited Warranty. The supply of replacement products is the sole remedy of the Purchaser for breaches of this Limited Warranty. StormTech's liability specifically excludes the cost of removal and/or installation of the Products.

(C) **THIS LIMITED WARRANTY IS EXCLUSIVE. THERE ARE NO OTHER WARRANTIES WITH RESPECT TO THE PRODUCTS, INCLUDING NO IMPLIED WARRANTIES OF MERCHANT-ABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.**

(D) This Limited Warranty only applies to the Products when the Products are installed in a single layer. **UNDER NO CIRCUMSTANCES, SHALL THE PRODUCTS BE INSTALLED IN A MULTI-LAYER CONFIGURATION.**

(E) No representative of StormTech has the authority to change this Limited Warranty in any manner or to extend this Limited Warranty. This Limited Warranty does not apply to any person other than to the Purchaser.

(F) Under no circumstances shall StormTech be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the Products, or the cost of other goods or services related to the purchase and installation of the Products. For this Limited Warranty to apply, the Products must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and StormTech's written installation instructions.

(G) **THE LIMITED WARRANTY DOES NOT EXTEND TO INCIDENTAL, CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES. STORMTECH SHALL NOT BE LIABLE FOR PENALTIES OR LIQUIDATED DAMAGES, INCLUDING LOSS OF PRODUCTION AND PROFITS; LABOR AND MATERIALS; OVERHEAD COSTS; OR OTHER LOSS OR EXPENSE INCURRED BY THE PURCHASER OR ANY THIRD PARTY. SPECIFICALLY EXCLUDED FROM LIMITED WARRANTY COVERAGE ARE DAMAGE TO THE PRODUCTS ARISING FROM ORDINARY WEAR AND TEAR; ALTERATION, ACCIDENT, MISUSE, ABUSE OR NEGLECT; THE PRODUCTS BEING SUBJECTED TO VEHICLE TRAFFIC OR OTHER CONDITIONS WHICH ARE NOT PERMITTED BY STORMTECH'S WRITTEN SPECIFICATIONS OR INSTALLATION INSTRUCTIONS; FAILURE TO MAINTAIN THE MINIMUM GROUND COVERS SET FORTH IN THE INSTALLATION INSTRUCTIONS; THE PLACEMENT OF IMPROPER MATERIALS INTO THE PRODUCTS; FAILURE OF THE PRODUCTS DUE TO IMPROPER SITING OR IMPROPER SIZING; OR ANY OTHER EVENT NOT CAUSED BY STORMTECH. THIS LIMITED WARRANTY REPRESENTS STORMTECH'S SOLE LIABILITY TO THE PURCHASER FOR CLAIMS RELATED TO THE PRODUCTS, WHETHER THE CLAIM IS BASED UPON CONTRACT, TORT, OR OTHER LEGAL THEORY.**

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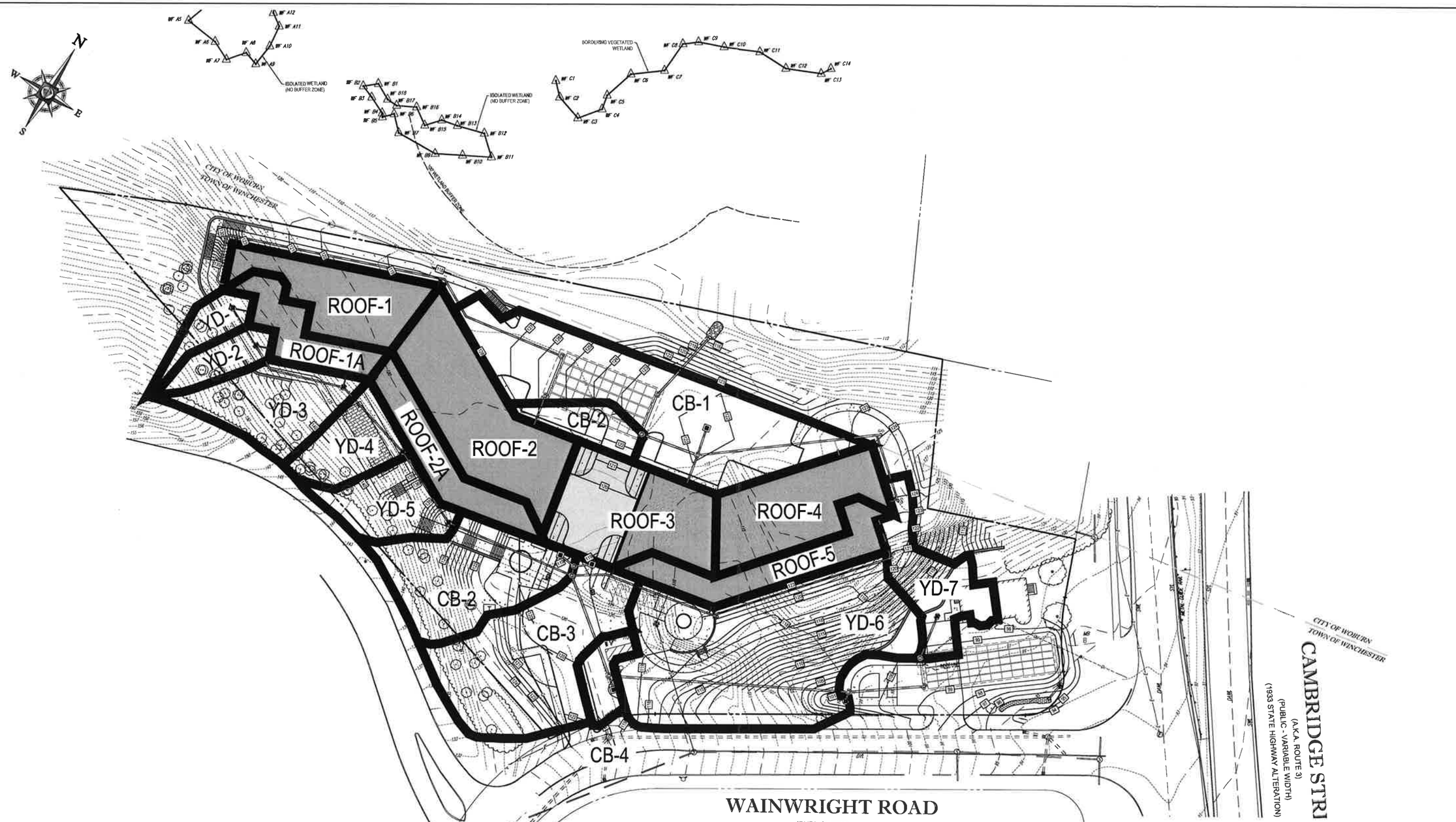
## Stage-Area-Storage for Pond 8P: INFILTRATION 2

| Elevation (feet) | Surface (sq-ft) | Storage (cubic-feet) |
|---|---|---|
| 94.40 | **2,140** | 0 |
| 94.45 | 2,140 | 43 |
| 94.50 | 2,140 | 86 |
| 94.55 | 2,140 | 128 |
| 94.60 | 2,140 | 171 |
| 94.65 | 2,140 | 214 |
| 94.70 | 2,140 | 257 |
| 94.75 | 2,140 | 300 |
| 94.80 | 2,140 | 342 |
| 94.85 | 2,140 | 385 |
| 94.90 | 2,140 | 428 |
| 94.95 | 2,140 | 515 |
| 95.00 | 2,140 | 601 |
| 95.05 | 2,140 | 688 |
| 95.10 | 2,140 | 774 |
| 95.15 | 2,140 | 860 |
| 95.20 | 2,140 | 946 |
| 95.25 | 2,140 | 1,032 |
| 95.30 | 2,140 | 1,117 |
| 95.35 | 2,140 | 1,202 |
| 95.40 | 2,140 | 1,287 |
| 95.45 | 2,140 | 1,371 |
| 95.50 | 2,140 | 1,455 |
| 95.55 | 2,140 | 1,538 |
| 95.60 | 2,140 | 1,621 |
| 95.65 | 2,140 | 1,704 |
| 95.70 | 2,140 | 1,786 |
| 95.75 | 2,140 | 1,868 |
| 95.80 | 2,140 | 1,949 |
| 95.85 | 2,140 | 2,030 |
| 95.90 | 2,140 | 2,110 |
| 95.95 | 2,140 | 2,190 |
| 96.00 | 2,140 | 2,270 |
| 96.05 | 2,140 | 2,348 |
| 96.10 | 2,140 | 2,426 |
| 96.15 | 2,140 | 2,504 |
| 96.20 | 2,140 | 2,581 |
| 96.25 | 2,140 | 2,657 |
| 96.30 | 2,140 | 2,732 |
| 96.35 | 2,140 | 2,807 |
| 96.40 | 2,140 | 2,881 |
| 96.45 | 2,140 | 2,955 |
| 96.50 | 2,140 | 3,027 |
| 96.55 | 2,140 | 3,099 |
| 96.60 | 2,140 | 3,169 |
| 96.65 | 2,140 | 3,239 |
| 96.70 | 2,140 | 3,307 |
| 96.75 | 2,140 | 3,374 |
| 96.80 | 2,140 | 3,441 |
| 96.85 | 2,140 | 3,506 |
| 96.90 | 2,140 | 3,569 |
| 96.95 | 2,140 | 3,632 |
| 97.00 | 2,140 | 3,692 |
| 97.05 | 2,140 | 3,751 |
| 97.10 | 2,140 | 3,807 |
| 97.15 | 2,140 | 3,860 |
| 97.20 | 2,140 | 3,911 |
| 97.25 | 2,140 | 3,958 |
| 97.30 | 2,140 | 4,004 |
| 97.35 | 2,140 | 4,049 |
| 97.40 | 2,140 | 4,093 |
| 97.45 | 2,140 | 4,136 |
| 97.50 | 2,140 | 4,178 |
| 97.55 | 2,140 | 4,221 |
| 97.60 | 2,140 | 4,264 |
| 97.65 | 2,140 | 4,307 |
| 97.70 | 2,140 | 4,350 |
| 97.75 | 2,140 | 4,392 |
| 97.80 | 2,140 | 4,435 |
| 97.85 | 2,140 | 4,478 |
| 97.90 | 2,140 | **4,521** TOTAL VOLUME |

# APPENDIX F
# STORM SEWER CALCULATIONS




# PROPOSED CATCH BASIN DRAINAGE TRIBUTARY MAP

PREPARED BY

BOHLER ENGINEERING

NOT TO SCALE

P:\14W14116\DWG\W14116ss2.dwg, 11/17/2015 10:49:43 AM

# Results



| Line No. | Line ID | Inlet Time (min) | Tc (min) | i Inlet (in/hr) | Drng Area (ac) | Runoff Coeff (C) | Q Capt (cfs) | Total CxA | Known Q (cfs) | Line Length (ft) | Line Slope (%) | Line Size (in) | Flow Rate (cfs) | Capac Full (cfs) | Vel Ave (ft/s) | Invert Up (ft) | Invert Dn (ft) | Gnd/Rim El Up (ft) | HGL Up (ft) | Cover Up (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MHG-MHH | 0.0 | 10.0 | 0.00 | 0.00 | 0.00 | .... | 0.76 | 0.00 | 54.00 | 1.00 | 15 | 4.57 | 6.46 | 4.84 | 95.95 | 95.41 | 100.30 | 96.81 | 3.10 |
| 2 | MHF-MHG | 0.0 | 9.1 | 0.00 | 0.00 | 0.00 | .... | 0.61 | 0.00 | 165.00 | 10.00 | 15 | 3.68 | 20.42 | 4.05 | 112.55 | 96.05 | 120.10 | 113.32 | 6.30 |
| 3 | MHE-MHF | 0.0 | 8.7 | 0.00 | 0.00 | 0.00 | .... | 0.59 | 0.00 | 60.00 | 1.50 | 15 | 3.52 | 7.91 | 5.40 | 114.40 | 113.50 | 119.15 | 115.15 | 3.50 |
| 4 | YD6-MHG | 5.0 | 5.0 | 6.00 | 0.37 | 0.40 | 0.89 | 0.15 | 0.00 | 5.00 | 2.00 | 8 | 0.89 | 1.71 | 2.54 | 96.15 | 96.05 | 100.15 | 97.14 | 3.33 |
| 5 | RF5-MHE | 5.0 | 5.0 | 6.00 | 0.09 | 0.90 | 0.49 | 0.08 | 0.00 | 250.00 | 2.10 | 8 | 0.49 | 1.75 | 3.55 | 121.00 | 115.75 | 123.00 | 121.33 | 1.33 |
| 6 | STC1-MHE | 0.0 | 5.2 | 0.00 | 0.00 | 0.00 | .... | 0.23 | 0.00 | 4.00 | 1.00 | 12 | 1.40 | 3.56 | 1.90 | 114.54 | 114.50 | 119.10 | 115.41 | 3.56 |
| 7 | CB3-STC1 | 5.0 | 5.0 | 6.00 | 0.22 | 0.58 | 0.77 | 0.13 | 0.00 | 11.00 | 1.00 | 12 | 0.77 | 3.56 | 1.50 | 114.90 | 114.79 | 118.89 | 115.47 | 2.99 |
| 8 | CB2-STC1 | 5.0 | 5.0 | 6.00 | 0.20 | 0.53 | 0.64 | 0.11 | 0.00 | 11.00 | 1.00 | 12 | 0.64 | 3.56 | 1.21 | 114.90 | 114.79 | 118.90 | 115.48 | 3.00 |
| 9 | YD5-MHE | 5.0 | 8.0 | 6.00 | 0.08 | 0.56 | 0.27 | 0.27 | 0.00 | 88.00 | 10.20 | 12 | 1.64 | 11.38 | 6.98 | 124.20 | 115.22 | 129.20 | 124.74 | 4.00 |
| 10 | YD4-YD5 | 5.0 | 7.5 | 6.00 | 0.07 | 0.55 | 0.23 | 0.23 | 0.00 | 52.00 | 10.02 | 12 | 1.37 | 11.27 | 6.58 | 131.42 | 126.21 | 134.50 | 131.92 | 2.08 |
| 11 | YD3-YD4 | 5.0 | 6.5 | 6.00 | 0.11 | 0.35 | 0.23 | 0.12 | 0.00 | 56.00 | 5.00 | 12 | 0.70 | 7.96 | 2.03 | 134.22 | 131.42 | 139.00 | 134.58 | 3.78 |
| 12 | YD2-YD3 | 5.0 | 5.6 | 6.00 | 0.04 | 0.35 | 0.08 | 0.08 | 0.00 | 70.00 | 1.00 | 8 | 0.47 | 1.21 | 2.35 | 134.92 | 134.22 | 138.20 | 135.24 | 2.61 |
| 13 | YD1-YD2 | 5.0 | 5.2 | 6.00 | 0.03 | 0.36 | 0.06 | 0.06 | 0.00 | 28.00 | 1.00 | 8 | 0.39 | 1.21 | 2.13 | 135.20 | 134.92 | 138.20 | 135.49 | 2.33 |
| 14 | RF1A-YD1 | 5.0 | 5.0 | 6.00 | 0.06 | 0.90 | 0.32 | 0.05 | 0.00 | 12.00 | 2.08 | 8 | 0.32 | 1.74 | 2.00 | 135.45 | 135.20 | 140.00 | 135.72 | 3.88 |
| 15 | RF2A-YD3 | 5.0 | 5.0 | 6.00 | 0.08 | 0.90 | 0.43 | 0.07 | 0.00 | 12.00 | 2.00 | 8 | 0.43 | 1.71 | 3.38 | 134.48 | 134.24 | 140.00 | 134.79 | 4.85 |
| 16 | CB4-MHF | 5.0 | 5.0 | 6.00 | 0.03 | 0.90 | 0.16 | 0.03 | 0.00 | 6.00 | 1.67 | 12 | 0.16 | 4.60 | 2.26 | 115.50 | 115.40 | 118.90 | 115.67 | 2.40 |
| 17 | YD7-MHI | 5.0 | 5.0 | 6.00 | 0.09 | 0.41 | 0.22 | 0.04 | 0.00 | 26.00 | 1.00 | 8 | 0.22 | 1.21 | 2.02 | 95.20 | 94.94 | 98.50 | 95.42 | 2.63 |
| 18 | RF1-MHD | 5.0 | 5.0 | 6.00 | 0.11 | 0.90 | 0.59 | 0.10 | 0.00 | 304.00 | 0.50 | 12 | 0.59 | 2.52 | 2.50 | 123.16 | 121.64 | 140.00 | 123.49 | 15.84 |
| 19 | RF2-MHC | 5.0 | 5.0 | 6.00 | 0.18 | 0.90 | 0.97 | 0.16 | 0.00 | 20.00 | 5.00 | 12 | 0.97 | 7.96 | 2.94 | 121.00 | 120.00 | 124.00 | 121.42 | 2.00 |
| 20 | MHB-MHA | 0.0 | 6.4 | 0.00 | 0.00 | 0.00 | .... | 0.53 | 0.00 | 8.00 | 1.25 | 12 | 3.17 | 3.98 | 4.03 | 117.72 | 117.62 | 121.90 | 119.71 | 3.18 |
| 21 | RF3-MHB | 5.0 | 5.0 | 6.00 | 0.16 | 0.90 | 0.86 | 0.14 | 0.00 | 18.00 | 1.00 | 8 | 0.86 | 1.21 | 2.48 | 118.00 | 117.82 | 121.00 | 120.22 | 2.33 |

Project File: W141161.stm | Number of lines: 23 | Date: 11-30-2015

NOTES: Intensity = 45.72 / (Inlet time + 11.30) ^ 0.73 -- Return period = 25 Yrs. ; ** Critical depth ; System flows limited to inlet captured flows.

# Results



| Line No. | Line ID | Inlet Time (min) | Tc (min) | i Inlet (in/hr) | Drng Area (ac) | Runoff Coeff (C) | Q Capt (cfs) | Total CxA | Known Q (cfs) | Line Length (ft) | Line Slope (%) | Line Size (in) | Flow Rate (cfs) | Capac Full (cfs) | Vel Ave (ft/s) | Invert Up (ft) | Invert Dn (ft) | Gnd/Rim El Up (ft) | HGL Up (ft) | Cover Up (ft) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | CB1-MHB | 5.0 | 5.0 | 6.00 | 0.30 | 0.89 | 1.60 | 0.27 | 0.00 | 16.00 | 1.00 | 12 | 1.60 | 3.56 | 2.04 | 118.00 | 117.84 | 121.25 | 120.19 | 2.25 | |
| 23 | RF4-MHB | 5.0 | 5.0 | 6.00 | 0.13 | 0.90 | 0.70 | 0.12 | 0.00 | 168.00 | 1.00 | 8 | 0.70 | 1.21 | 2.64 | 121.00 | 119.32 | 124.00 | 121.39 | 2.33 | |

Project File: W141161.stm | Number of lines: 23 | Date: 11-30-2015

NOTES: Intensity = 45.72 / (Inlet time + 11.30) ^ 0.73 -- Return period = 25 Yrs. ; ** Critical depth ; System flows limited to inlet captured flows.

# Results



| Line No. | Line ID | Inlet Time (min) | Tc (min) | i Inlet (in/hr) | Drng Area (ac) | Runoff Coeff (C) | Q Capt (cfs) | Total CxA | Known Q (cfs) | Line Length (ft) | Line Slope (%) | Line Size (in) | Flow Rate (cfs) | Capac Full (cfs) | Vel Ave (ft/s) | Invert Up (ft) | Invert Dn (ft) | Gnd/Rim El Up (ft) | HGL Up (ft) | Cover Up (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MHG-MHH | 0.0 | 9.1 | 0.00 | 0.00 | 0.00 | .... | 0.76 | 0.00 | 54.00 | 1.00 | 15 | 5.64 | 6.46 | 5.63 | 95.95 | 95.41 | 100.30 | 96.90 | 3.10 |
| 2 | MHF-MHG | 0.0 | 8.3 | 0.00 | 0.00 | 0.00 | .... | 0.61 | 0.00 | 165.00 | 10.00 | 15 | 4.54 | 20.42 | 4.49 | 112.55 | 96.05 | 120.10 | 113.40 | 6.30 |
| 3 | MHE-MHF | 0.0 | 8.0 | 0.00 | 0.00 | 0.00 | .... | 0.59 | 0.00 | 60.00 | 1.50 | 15 | 4.34 | 7.91 | 5.79 | 114.40 | 113.50 | 119.15 | 115.23 | 3.50 |
| 4 | YD6-MHG | 5.0 | 5.0 | 7.40 | 0.37 | 0.40 | 1.09 | 0.15 | 0.00 | 5.00 | 2.00 | 8 | 1.09 | 1.71 | 3.14 | 96.15 | 96.05 | 100.15 | 97.28 | 3.33 |
| 5 | RF5-MHE | 5.0 | 5.0 | 7.40 | 0.09 | 0.90 | 0.60 | 0.08 | 0.00 | 250.00 | 2.10 | 8 | 0.60 | 1.75 | 3.79 | 121.00 | 115.75 | 123.00 | 121.36 | 1.33 |
| 6 | STC1-MHE | 0.0 | 5.2 | 0.00 | 0.00 | 0.00 | .... | 0.23 | 0.00 | 4.00 | 1.00 | 12 | 1.73 | 3.56 | 2.20 | 114.54 | 114.50 | 119.10 | 115.54 | 3.56 |
| 7 | CB3-STC1 | 5.0 | 5.0 | 7.40 | 0.22 | 0.58 | 0.94 | 0.13 | 0.00 | 11.00 | 1.00 | 12 | 0.94 | 3.56 | 1.41 | 114.90 | 114.79 | 118.89 | 115.64 | 2.99 |
| 8 | CB2-STC1 | 5.0 | 5.0 | 7.40 | 0.20 | 0.53 | 0.78 | 0.11 | 0.00 | 11.00 | 1.00 | 12 | 0.78 | 3.56 | 1.16 | 114.90 | 114.79 | 118.90 | 115.65 | 3.00 |
| 9 | YD5-MHE | 5.0 | 7.5 | 7.40 | 0.08 | 0.56 | 0.33 | 0.27 | 0.00 | 88.00 | 10.20 | 12 | 2.02 | 11.38 | 7.15 | 124.20 | 115.22 | 129.20 | 124.80 | 4.00 |
| 10 | YD4-YD5 | 5.0 | 7.1 | 7.40 | 0.07 | 0.55 | 0.28 | 0.23 | 0.00 | 52.00 | 10.02 | 12 | 1.68 | 11.27 | 7.03 | 131.42 | 126.21 | 134.50 | 131.97 | 2.08 |
| 11 | YD3-YD4 | 5.0 | 6.2 | 7.40 | 0.11 | 0.35 | 0.28 | 0.12 | 0.00 | 56.00 | 5.00 | 12 | 0.87 | 7.96 | 2.18 | 134.22 | 131.42 | 139.00 | 134.62 | 3.78 |
| 12 | YD2-YD3 | 5.0 | 5.5 | 7.40 | 0.04 | 0.35 | 0.10 | 0.08 | 0.00 | 70.00 | 1.00 | 8 | 0.58 | 1.21 | 2.57 | 134.92 | 134.22 | 138.20 | 135.28 | 2.61 |
| 13 | YD1-YD2 | 5.0 | 5.2 | 7.40 | 0.03 | 0.36 | 0.08 | 0.06 | 0.00 | 28.00 | 1.00 | 8 | 0.48 | 1.21 | 2.31 | 135.20 | 134.92 | 138.20 | 135.53 | 2.33 |
| 14 | RF1A-YD1 | 5.0 | 5.0 | 7.40 | 0.06 | 0.90 | 0.40 | 0.05 | 0.00 | 12.00 | 2.08 | 8 | 0.40 | 1.74 | 2.16 | 135.45 | 135.20 | 140.00 | 135.75 | 3.88 |
| 15 | RF2A-YD3 | 5.0 | 5.0 | 7.40 | 0.08 | 0.90 | 0.53 | 0.07 | 0.00 | 12.00 | 2.00 | 8 | 0.53 | 1.71 | 3.60 | 134.48 | 134.24 | 140.00 | 134.83 | 4.85 |
| 16 | CB4-MHF | 5.0 | 5.0 | 7.40 | 0.03 | 0.90 | 0.20 | 0.03 | 0.00 | 6.00 | 1.67 | 12 | 0.20 | 4.60 | 2.40 | 115.50 | 115.40 | 118.90 | 115.69 | 2.40 |
| 17 | YD7-MHI | 5.0 | 5.0 | 7.40 | 0.09 | 0.41 | 0.27 | 0.04 | 0.00 | 26.00 | 1.00 | 8 | 0.27 | 1.21 | 2.31 | 95.20 | 94.94 | 98.50 | 95.45 | 2.63 |
| 18 | RF1-MHD | 5.0 | 5.0 | 7.40 | 0.11 | 0.90 | 0.73 | 0.10 | 0.00 | 304.00 | 0.50 | 12 | 0.73 | 2.52 | 2.78 | 123.16 | 121.64 | 140.00 | 123.54 | 15.84 |
| 19 | RF2-MHC | 5.0 | 5.0 | 7.40 | 0.18 | 0.90 | 1.20 | 0.16 | 0.00 | 20.00 | 5.00 | 12 | 1.20 | 7.96 | 3.36 | 121.00 | 120.00 | 124.00 | 121.46 | 2.00 |
| 20 | MHB-MHA | 0.0 | 6.1 | 0.00 | 0.00 | 0.00 | .... | 0.53 | 0.00 | 8.00 | 1.25 | 12 | 3.91 | 3.98 | 4.97 | 117.72 | 117.62 | 121.90 | 119.75 | 3.18 |
| 21 | RF3-MHB | 5.0 | 5.0 | 7.40 | 0.16 | 0.90 | 1.07 | 0.14 | 0.00 | 18.00 | 1.00 | 8 | 1.07 | 1.21 | 3.05 | 118.00 | 117.82 | 121.00 | 120.51 | 2.33 |

Project File: W141161.stm | Number of lines: 23 | Date: 11-30-2015

NOTES: Intensity = 44.87 / (Inlet time + 10.30) ^ 0.66 -- Return period = 100 Yrs. ** Critical depth ; System flows limited to inlet captured flows.

# Results

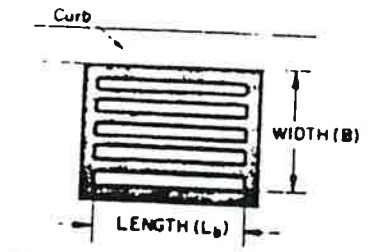


| Line No. | Line ID | Inlet Time (min) | Tc (min) | i Inlet (in/hr) | Drng Area (ac) | Runoff Coeff (C) | Q Capt (cfs) | Total CxA | Known Q (cfs) | Line Length (ft) | Line Slope (%) | Line Size (in) | Flow Rate (cfs) | Capac Full (cfs) | Vel Ave (ft/s) | Invert Up (ft) | Invert Dn (ft) | Gnd/Rim El Up (ft) | HGL Up (ft) | Cover Up (ft) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | CB1-MHB | 5.0 | 5.0 | 7.40 | 0.30 | 0.89 | 1.97 | 0.27 | 0.00 | 16.00 | 1.00 | 12 | 1.97 | 3.56 | 2.51 | 118.00 | 117.84 | 121.25 | 120.47 | 2.25 | |
| 23 | RF4-MHB | 5.0 | 5.0 | 7.40 | 0.13 | 0.90 | 0.87 | 0.12 | 0.00 | 168.00 | 1.00 | 8 | 0.87 | 1.21 | 2.98 | 121.00 | 119.32 | 124.00 | 121.45 | 2.33 | |

Project File: W141161.stm | Number of lines: 23 | Date: 11-30-2015

NOTES: Intensity = 44.87 / (Inlet time + 10.30) ^ 0.66 -- Return period = 100 Yrs. ; ** Critical depth ; System flows limited to inlet captured flows.

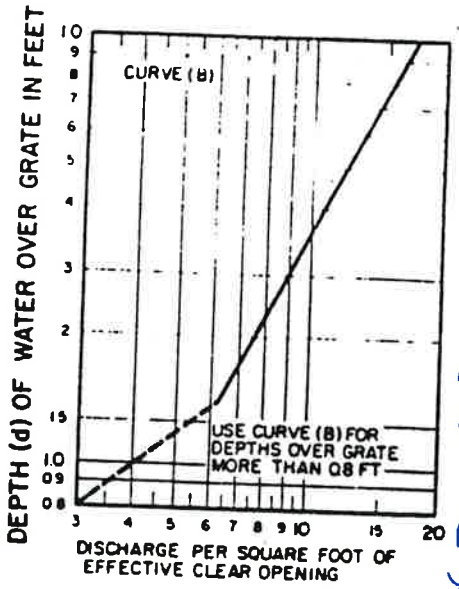
25 YEAR




$P = 2B + L_b$

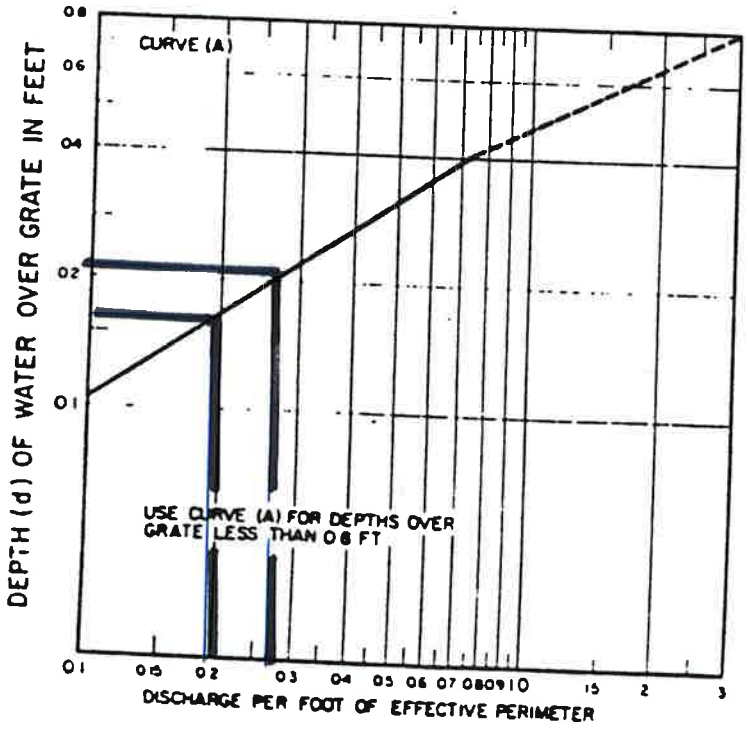
A = AREA OF CLEAR OPENING IN GRATE TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB $P = 2(B + L_b)$




MIN. PERIMETER OF CBs IN PAVED AREAS = 6'

PERIMETER OF 18" DIA. YARD DRAIN = $2 \times \pi \times 0.75'$ = 4.71'




MAX. FLOW TO A YARD DRAIN = 0.89 CFS (YD-6)

$Q/FT = 0.89/4.71 = 0.19$ CFS/FT

FROM CHART, NEED DEPTH OF 0.16' (2")

BUREAU OF PUBLIC ROADS
REV AUG 1968

HYDRAULIC CAPACITY OF GRATE INLET IN SUMP

MAX. FLOW TO A CB = 1.60 CFS (CB-1)

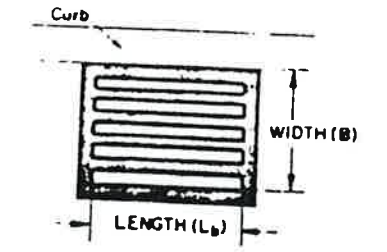
$Q/FT = 1.60/6 = 0.27$ CFS/FT

FROM CHART, NEED A DEPTH OF 0.22' (2.6")



A - 25

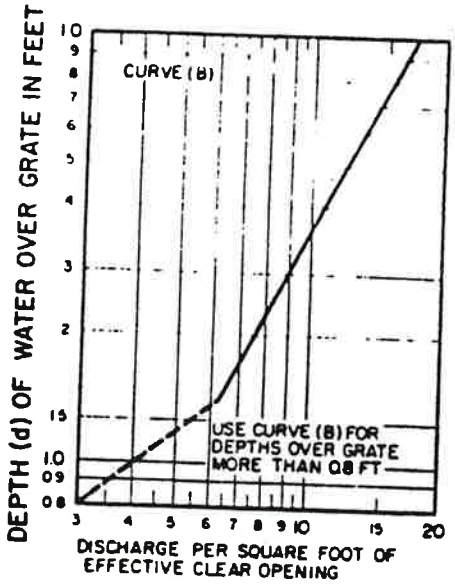
100 YR

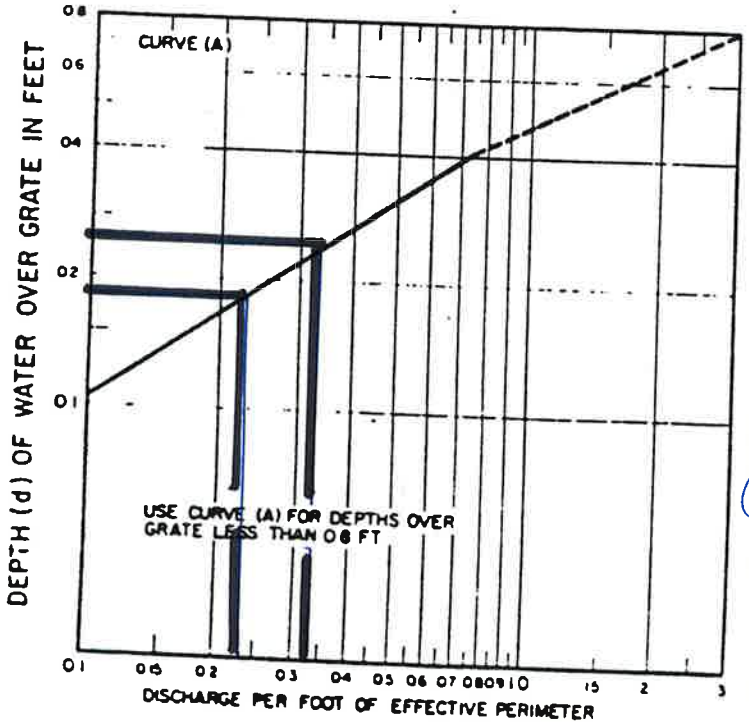



P = 2B + $L_b$

A = AREA OF CLEAR OPENING IN GRATE TO ALLOW FOR CLOGGING DIVIDE P OR A BY 2 BEFORE OBTAINING d.

WITHOUT CURB P = 2(B + $L_b$)




BUREAU OF PUBLIC ROADS
REV AUG 1968

**HYDRAULIC CAPACITY OF GRATE INLET IN SUMP**

MIN. PERIMETER OF CBs in PAVED AREAS = 6'

PERIMETER OF 18" DIA. YARD DRAIN = $2 \times \pi \times 0.75' = 4.71'$

MAX. FLOW TO A YARD DRAIN (YD-6) = 1.09 CFS

Q/FT = 1.09/4.71 = 0.23 CFS/FT

FROM CHART, NEED DEPTH OF 0.18' (2.2")



MAX. FLOW TO A CB = 1.97 CFS (CB-1)

Q/FT = 1.97/6 = 0.33 CFS/FT

FROM CHART, NEED A DEPTH OF 0.24' (3")

**CATCH BASIN DRAINAGE AREA SUMMARY**
**Proposed Apartments**
**Winchester, MA**

| | |
|---|---|
| c coefficient, grass= | 0.30 |
| c coefficient, impervious= | 0.90 |

| Drainage Area Name | Total Area (sf) | Grassed Area (sf) | "C" | Total Area (Ac.) |
|---|---|---|---|---|
| CB-1 | 13,078 | 198 | 0.89 | 0.30 |
| CB-2 | 8,820 | 5,472 | 0.53 | 0.20 |
| CB-3 | 9,560 | 5,095 | 0.58 | 0.22 |
| CB-4 | 1,439 | 0 | 0.90 | 0.03 |
| YD-1 | 1,518 | 1,356 | 0.36 | 0.03 |
| YD-2 | 1,702 | 1,550 | 0.35 | 0.04 |
| YD-3 | 4,696 | 4,321 | 0.35 | 0.11 |
| YD-4 | 3,079 | 1,777 | 0.55 | 0.07 |
| YD-5 | 3,371 | 1,886 | 0.56 | 0.08 |
| YD-6 | 16,285 | 13,621 | 0.40 | 0.37 |
| YD-7 | 3,962 | 3,248 | 0.41 | 0.09 |
| Roof-1 | 4,812 | 0 | 0.90 | 0.11 |
| Roof-1A | 2,792 | 0 | 0.90 | 0.06 |
| Roof-2 | 7,818 | 0 | 0.90 | 0.18 |
| Roof-2A | 3,390 | 0 | 0.90 | 0.08 |
| Roof-3 | 6,787 | 0 | 0.90 | 0.16 |
| Roof-4 | 5,545 | 0 | 0.90 | 0.13 |
| Roof-5 | 3,922 | 0 | 0.90 | 0.09 |

Empirical Preformed Scour Hole Equations:

Type 1: Scour Hole Depression = one-half pipe rise, m (ft)

$d_{50} = (0.0276\ R_p^2 /TW)\ (Q/R_p^{2.5})^{1.333}$ ( $d_{50} = (0.0125 R_p^2/TW)\ (Q/R_p^{2.5})^{1.333}$ ) **(11.35)**

Type 2: Scour Hole Depression = full pipe rise, m (ft)

$d_{50} = (0.0181\ R_p^2 /TW)\ (Q/R_p^{2.5})^{1.333}$ ( $d_{50} = (0.0082 R_p^2/TW)\ (Q/R_p^{2.5})^{1.333}$) **(11.36)**

$d_{50}$ = median stone size required, m (ft)

For variables $S_p$, $R_p$, TW and Q, see Section 11.13.5.

Type 1 and 2 preformed scour hole dimensions (See Figure 11-15)

| | | |
|---|---|---|
| $C = 3S_p + 6F$ | Basin Length m (ft) | |
| $B = 2S_p + 6F$ | Basin Inlet and Outlet Width m (ft) | **(11.37)** |
| $F = 0.5R_p$ (Type 1) or $R_p$ (Type 2) | Basin Depression m (ft) | |

Table 11-14 solves the above set of equations for Type 1 and 2 preformed scour holes for various pipe sizes.

The type of riprap required is as follows:

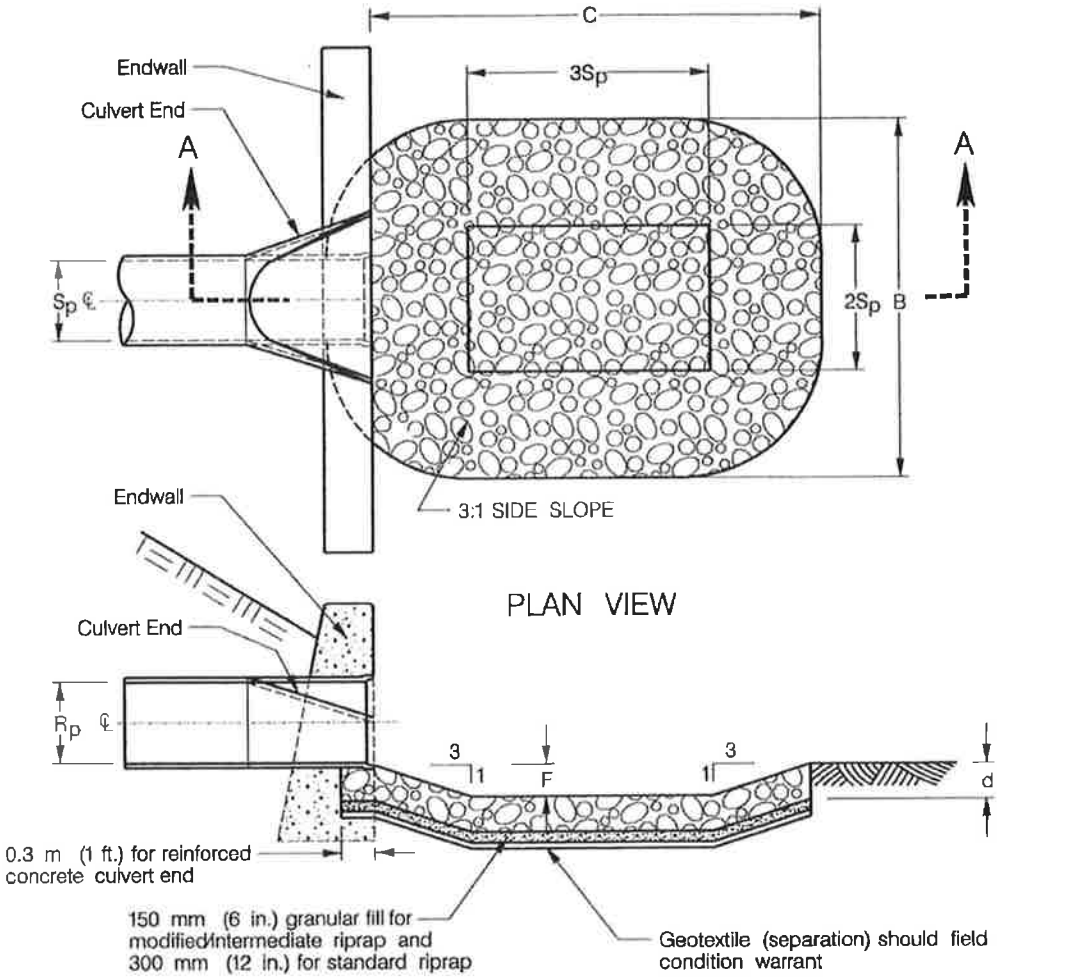
| | |
|---|---|
| Modified | $d_{50} < 0.13$m (0.42 ft) |
| Intermediate | 0.13m (0.42 ft) $< d_{50} <$ 0.20m (0.67 ft) |
| Standard | 0.20m (0.67 ft) $< d_{50} <$ 0.38m (1.25 ft) |
| Special Design | 0.38m (1.25 ft) $< d_{50}$ |

Reference: Report No. FHWA-RD-75-508 ("Culvert Outlet Protection Design: Computer Program Documentation")

**OUTLET PROTECTION**
**OUTLET VELOCITY > 14 feet/sec or Length of Apron exceeds limits shown on Tables 11-12.1 and 11-13.1**

| Preformed Scour Hole | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (See Figure 11-15) | PIPE DIAMETER OR SPAN (in) | | | | | | | | | |
| | 12 | 15 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 |
| **Type 1** | | | | | | | | | | |
| **B** | 5 | 6 | 8 | 10 | 13 | 15 | 18 | 20 | 23 | 25 |
| **C** | 6 | 8 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 |
| **d** | Depends on riprap type(see Figure 11-15) | | | | | | | | | |
| **$2S_p$** | 2.0 | 2.6 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 |
| **$3S_p$** | 3.0 | 3.9 | 4.5 | 6.0 | 7.5 | 9.0 | 10.5 | 12.0 | 13.5 | 15.0 |
| **$F = 0.5\ S_p$** | 0.5 | 0.625 | 0.75 | 1 | 1.25 | 1.5 | 1.75 | 2 | 2.25 | 2.5 |
| **Type 2** | | | | | | | | | | |
| **B** | 8 | 10 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 |
| **C** | 9 | 11 | 14 | 18 | 23 | 27 | 32 | 36 | 41 | 45 |
| **d** | Depends on riprap size (see Figure 11-15) | | | | | | | | | |
| **$2S_p$** | 2.0 | 2.6 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 |
| **$3S_p$** | 3.0 | 3.9 | 4.5 | 6.0 | 7.5 | 9.0 | 10.5 | 12.0 | 13.5 | 15.0 |
| **$F = S_p$** | 1.0 | 1.3 | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |

**Table 11-14.1 - Dimensions of Preformed Scour Hole (Feet)**




LEGEND

$S_p$ = { Max. inside pipe span (non-circular sections); Inside pipe diameter (circular sections) }

$R_p$ = { Max. inside pipe rise (non-circular sections); Inside pipe diameter (circular sections) }

d = { 300 mm (12 in.) Modified Riprap; 450 mm (18 in.) Intermediate Riprap; 900 mm (36 in.) Standard Riprap }

Type 1 $F = 0.5\ R_p$

Type 2 $F = R_p$

$C = 3S_p + 6F$

$B = 2S_p + 6F$

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

**Preformed Scour Hole**
**Riprap Sizing**
**25 Year Storm**
Based on Eq. 11.35 of ConnDOT Drainage Manual
for Type 1 Scour Holes

| FES # | Pipe Size (ft) | Q (cfs) | TW (ft) | $D_{50}$ (ft) |
|---|---|---|---|---|
| FES-1 | 1 | 0.79 | 0.3 | **0.03** |
| FES-2 | 1 | 3.09 | 0.3 | **0.19** |

* Assume 0.3' (4") tailwater at all FES

8" stone proposed at both outlets

# APPENDIX G
# LONG-TERM POLLUTION PREVENTION PLAN

Long-Term Pollution Prevention Plan

Winchester North

416 Cambridge Street

Winchester, Massachusetts

## 1. Good Housekeeping Practices

The Owner/Operator shall use good housekeeping practices by following the Operation and Maintenance plans as provided within this report.

## 2. Provisions for storing materials and waste products inside or under cover

Hazardous materials or wastes are not expected to be stored at the site. Any such materials or wastes will be stored and handled in accordance with all applicable local, state, and federal regulations. In the event of a significant spill of any hazardous material or waste, emergency contact numbers are listed below.

## 3. Vehicle washing controls

Vehicle washing is not anticipated to occur at this site.

## 4. Requirements for routine inspections and maintenance of stormwater BMPs

The Owner/Operator shall maintain the BMP's by following the Operation and Maintenance Plan.

## 5. Spill prevention and response plan

There is very limited risk of significant spills at this site. Any spill requiring action would most likely be associated with motor vehicles. In the event of a large spill contact the following:

Mass DEP 24 hour Spill Emergency Response Notification line: 888-304-1133.

**Regulatory Contacts**

Contact information for reporting oil and hazardous materials releases to the EPA, DEP, and local agencies are provided below.

| Agency | Telephone |
|---|---|
| Fire Department | 911 / (781) 729-1802 |
| Massachusetts Department Of Environmental Protection | 888-304-1133 |
| United States Environmental Protection Agency | (617) 918-1279 |

## 6. Provisions for maintenance of lawns, gardens, and other landscaped areas

The use of chemical fertilizers shall be minimized or avoided where possible.

## 7. Requirements for storage and use of fertilizers, herbicides, and pesticides

Fertilizers, herbicides, and pesticides will not be stored outdoors at the site.

## 8. Provisions for solid waste management

All solid waste management systems shall be inspected and maintained in accordance with all local, state and federal requirements.

# APPENDIX H
# OPERATION AND MAINTENANCE PLAN

# ***LONG-TERM STORMWATER SYSTEM OPERATION AND MAINTENANCE PLAN***

**The Stormwater Management Standards**

**Standard 9:** A Long-term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

The Long-term Operation and Maintenance Plan shall at a minimum identify:

1. Stormwater management system(s) owners;
2. The party or parties responsible for operation and maintenance, including how future property owners will be notified of the presence of the stormwater management system and the requirement for proper operation and maintenance;
3. The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks;
4. Plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point;
5. Description and delineation of public safety features; and
6. Estimated operations and maintenance budget.

The Operation and Maintenance Plan shall identify best management practices for implementing maintenance activities in a manner that minimizes impacts to wetland resource areas.

**The Proposal is for a private development.**

Stormwater Management System

Owner: FX Winchester, LLC

General Contractor: TBD

The General Contractor shall have all logs and reports as stated within the Stormwater Pollution Prevention Plan readily available at all times for inspection by the Town.

Method of recording for future Owners

☐ Deed
☐ Order of Conditions
☒ Other: Site Plan Approval

# DRAINAGE SYSTEM

**COMPONENT:** Stormwater Quality Unit (Stormceptor)

**RESPONSIBILITY:**
During Construction: General Contractor - TBD
Post Construction: Owner

**ACTION:** Inspection / cleaning

**FREQUENCY:** Per Manufacturer's Maintenance Guidelines or at least once per six months whichever is more restrictive depending on the rate of sediment accumulation.

**DESCRIPTION:** See attached Manufacturer's Maintenance Guidelines. All accumulated materials shall be disposed of in accordance with DEP regulations.

**BUDGET:** Inspection/cleaning- $1,000/ yr based on inspections and cleanings of twice a year.

**COMPONENT:** Infiltration Basins

**RESPONSIBILITY:**
During Construction: General Contractor - TBD
Post Construction: Owner

**ACTION:** Preventative Maintenance, Inspection & Mowing

**FREQUENCY:**
During Construction

1. Cleaning – As needed during construction or whenever the sediment depth is 6" deep.
2. Inspection – As needed during construction but once a month at a minimum.

Post Construction

1. Preventative Maintenance- Two times per year
2. Inspection to ensure proper functioning – After every major storm during the first 3 months of operation and twice a year thereafter.
3. Inspect and clean pretreatment devices- After every major storm during the first 3 months of operation and twice a year thereafter.

**DESCRIPTION:** The Infiltration basins shall be inspected a minimum of two times per year to ensure that they are operating as intended and that all components are stable and in working order. Inspections shall be by qualified personnel. The inlet to the basins shall be inspected for erosion and sedimentation, and shall be promptly repaired as needed. Sediment collecting in the basin bottom shall be inspected four times annually, and removal shall commence any time the sediment reaches a depth of six inches anywhere in the basin. Any sediments removed shall be disposed of in accordance with the latest DEP guidelines for stormwater sediment disposal.

Inspections:

- Inlet and Outlet condition
- Sediment Accumulation
- Oil/Gas Sheen in water
- General Inspection of basin

**BUDGET:** Inspection & Cleanings - $2500/ yr based on semi-annual inspections & cleanings

**COMPONENT:** Deep sump catch basins

**RESPONSIBILITY:**
**During Construction**: General Contractor - TBD
**Post Construction**: Owner

**ACTION:** Cleaning (Sediment removal / sump cleaning) and Inspection

**FREQUENCY:**
During Construction

1. Cleaning – As needed during construction or whenever the depth of deposits is greater than or equal to one half the depth from the bottom invert of the lowest pipe.
2. Inspection – Weekly during construction

Post Construction

1. Cleaning – Twice a year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom invert of the lowest pipe in the basin.
2. Inspection – Twice a year

**DESCRIPTION:** Basins are to be cleaned twice per year. The General Contractor will monitor sumps and remove sediments as necessary. The Lessee will monitor sumps post construction on an as needed basis. Precautions shall take place to maintain the integrity of the oil trapping hoods during cleaning. The hoods shall be inspected and repaired as necessary. Accumulated Hydrocarbon shall be collected separately from accumulated sediment. All material shall be disposed of in accordance with DEP regulations.

Inspections:

- Frame and Grate
- Inlet and Outlet condition
- Cracks and settlement & joint failure & leaking
- Sediment Accumulation
- Oil/Gas Sheen in water
- Condition of hood
- General Inspection of structure

**BUDGET:** Inspection/cleaning- $2500/ per basin per yr based on inspections and cleanings twice a year.

**COMPONENT:** Driveway and Parking Lot Pavement

**RESPONSIBILITY:**
**During Construction**: General Contractor - TBD
**Post Construction**: Owner

**ACTION:** Cleaning and Maintenance

**FREQUENCY:**
At least semi-annually

**DESCRIPTION:** Pavement is to be inspected a minimum of twice per year for signs of cracking and potholes. Damaged and cracked areas shall be repaired as necessary. The pavement is to be swept a minimum of once per year, with the time of sweeping to occur in the early spring to clean sand from winter plowing operations.

**COMPONENT:** Snow and Ice Removal

**RESPONSIBILITY:**
**During Construction**: General Contractor - TBD
**Post Construction**: Owner

**ACTION:** Snow and Ice Removal

**FREQUENCY:**
As needed

**DESCRIPTION:** Snow and ice are to be removed from the pavement and sidewalks to provide a safe surface for vehicular and pedestrian traffic.

**COMPONENT:** Vegetative Areas

**RESPONSIBILITY:**
**During Construction**: General Contractor - TBD
**Post Construction**: Owner

**ACTION:** Maintenance

**FREQUENCY:**
At least bi-weekly during growing seasons

**DESCRIPTION:** The vegetated areas containing grass and landscaped areas shall be maintained to provide a neat and well-maintained appearance. Lawns shall be moved at least once every other week, or as conditions warrant. The use of chemical fertilizers and weed killers shall be minimized where possible. Mulch shall be replaced annually and any dead or diseased plants shall be removed and replaced.

## *SAMPLE STORMWATER OPERATION & MAINTAINENCE ACTIVITY FORM*

**NOTE:** The owner is responsible for maintaining an accurate and complete log of inspection & maintenance activities, including but not limited to, inspections, cleanings & repairs.

| Inspection / Maintenance Activity | Contractor Name | Date | Observation / Action |
|---|---|---|---|
| | | | |
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# APPENDIX I
# GROUNDWATER MOUNDING ANALYSIS

# Groundwater Mound Beneath Rectangular Recharge Area

**by Glenn M. Duffield, President, HydroSOLVE, Inc.**



Hantush (1967) presented the following equations for predicting the maximum height of the water table beneath a rectangular recharge area:

$$h_m^2 - h_i^2 = Z_m(t) = (2w/K)vtS^*(0.5A/(4vt)^{1/2},0.5B/(4vt)^{1/2}) \ldots\ldots (1)$$

$$v = K\bar{b}/\varepsilon \ldots\ldots (2)$$

$$\bar{b} = 0.5[h_i(0) + h(t)] \ldots\ldots (3)$$

where $h_m$ is maximum height of mound above aquifer base (i.e., maximum saturated thickness of aquifer beneath recharge area); $h_i$ is initial height of water table above aquifer base (i.e., initial saturated thickness of aquifer); K and $\varepsilon$ are hydraulic conductivity and storativity (specific yield) of aquifer, respectively; w is constant rate of percolation from rectangular recharge area of length A and width B; $\bar{b}$ is a constant of linearization; and the function $S^*$ is an integral expression (see Hantush 1967). The aquifer is unconfined and assumed to have infinite extent.

If infiltration ends at time $t=t_0$, Hantush (1967) applied the principle of superposition to compute the decay of the mound as follows:

$$h_m^2 - h_i^2 = Z_m(t) - Z_m(t-t_0) \ldots\ldots (4)$$

Equation (1) is nonlinear owing to the definition of $\bar{b}$ in Equation (3); however, the solution is readily obtained by successive approximation.

**Results of Groundwater Mounding Calculation**

**Solution by Successive Approximation**

| Iteration | $\bar{b}$ | $h_m$* | % Change |
|---|---|---|---|
| 1 | 15 | 15.2808315045333 | 1.87221003022213 |
| 2 | 15.140415752266715.2816427463044 | | 5.30888499634674E-03 |
| 3 | 15.140821373152215.2816450742958 | | 1.52339078463015E-05 |

| K [L/T] | ε | $h_i$ [L] | A [L] | B [L] | w [L/T] | t [T] | $h_m$ [L] |
|---|---|---|---|---|---|---|---|
| .09 | .28 | 15 | 79 | 25 | .25 | 72 | 15.2816450742958 |

**maximum water-table rise ($h_m$ - $h_i$) at time t = 72 is**
0.281645074295755
**decay of mound computed after time t = 1**

Return to Groundwater Mounding Calculator

Click here for a benchmark for this calculator.

Hantush mounding calculations with contouring now available in AQTESOLV.

GROUNDWATER MOUNDING ANALYSIS PARAMETERS
PROPOSED APARTMENTS
WINCHESTER, MA

| Basin # | Basin Btm. Elev. (ft) | GW Elev. (ft) | Depth to GW (ft) | Mounding Analysis Needed? | Basin Length A (ft) | Basin Width B (ft) | Basin Btm. Area (sf) | 10 yr storm vol. (cf) | Time to 0 discharge (hr) | w (ft/hr) | Computed Mound (ft) | Distance from Btm. Of BMP to top of mound (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 115.25 | 109.33 | 5.92 | NO | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 2 | 94.4 | 92.33 | 2.07 | YES | 79 | 25 | 1,975 | 11,892 | 24 | 0.25 | 0.282 | 1.788 |

Notes
1. 10 yr storm volume from HydroCAD analysis converted from ac-ft to cf
2. Time to 0 discharge is from HydroCAD hydrographs, first time of 0 discharge
3. 72 hour calculation time based on DEP requirement to drain BMP in 72 hours
4. Hydraulic Conductivity = 0.9 ft/hr, converted from Rawls rate of 1.02 inches/hr
5. Specific yield for medium sand = 0.28
6. Initial Saturated Thickness Assumed to be a minimum of 15 feet based on test pit information

## Summary for Pond 8P: UG SYSTEM 2

Inflow Area = 1.434 ac, 33.12% Impervious, Inflow Depth = 2.28" for 10-year event
Inflow = 3.58 cfs @ 12.09 hrs, Volume= 0.273 af
Outflow = 2.50 cfs @ 12.18 hrs, Volume= 0.273 af, Atten= 30%, Lag= 5.5 min
Discarded = 0.04 cfs @ 10.20 hrs, Volume= 0.094 af
Primary = 2.45 cfs @ 12.18 hrs, Volume= 0.179 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 96.37' @ 12.19 hrs Surf.Area= 1,859 sf Storage= 2,506 cf

Plug-Flow detention time= 120.8 min calculated for 0.272 af (100% of inflow)
Center-of-Mass det. time= 121.5 min ( 937.8 - 816.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 94.40' | 1,679 cf | **25.25'W x 73.64'L x 3.50'H Field A**<br>6,508 cf Overall - 2,311 cf Embedded = 4,197 cf x 40.0% Voids |
| #2A | 94.90' | 2,311 cf | **ADS_StormTech SC-740** x 50 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>Row Length Adjustment= +0.44' x 6.45 sf x 5 rows |
| | | 3,990 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 93.70' | **12.0" Round Culvert**<br>L= 48.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 93.70' / 91.78' S= 0.0400 '/' Cc= 0.900<br>n= 0.012, Flow Area= 0.79 sf |
| #2 | Device 1 | 95.50' | **8.0" Vert. Orifice/Grate X 2.00** C= 0.600 |
| #3 | Device 1 | 97.40' | **4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #4 | Discarded | 94.40' | **1.020 in/hr Exfiltration- Sandy Loam Rawls Rate over Surface area** |

**Discarded OutFlow** Max=0.04 cfs @ 10.20 hrs HW=94.44' (Free Discharge)
↑└**4=Exfiltration- Sandy Loam Rawls Rate** (Exfiltration Controls 0.04 cfs)

**Primary OutFlow** Max=2.44 cfs @ 12.18 hrs HW=96.36' TW=0.00' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 2.44 cfs of 5.56 cfs potential flow)
↑ ├**2=Orifice/Grate** (Orifice Controls 2.44 cfs @ 3.49 fps)
└**3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Hydrograph for Pond 8P: UG SYSTEM 2

| Time (hours) | Inflow (cfs) | Storage (cubic-feet) | Elevation (feet) | Outflow (cfs) | Discarded (cfs) | Primary (cfs) | |
|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |
| 1.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |
| 2.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |
| 3.00 | 0.01 | 0 | 94.40 | 0.01 | 0.01 | 0.00 | |
| 4.00 | 0.01 | 0 | 94.40 | 0.01 | 0.01 | 0.00 | |
| 5.00 | 0.01 | 0 | 94.40 | 0.01 | 0.01 | 0.00 | |
| 6.00 | 0.01 | 0 | 94.40 | 0.01 | 0.01 | 0.00 | |
| 7.00 | 0.02 | 0 | 94.40 | 0.02 | 0.02 | 0.00 | |
| 8.00 | 0.02 | 0 | 94.40 | 0.02 | 0.02 | 0.00 | |
| 9.00 | 0.04 | 0 | 94.40 | 0.04 | 0.04 | 0.00 | |
| 10.00 | 0.06 | 13 | 94.42 | 0.04 | **0.04** | 0.00 | |
| 11.00 | 0.14 | 198 | 94.67 | 0.04 | **0.04** | 0.00 | |
| 12.00 | **2.10** | **1,742** | **95.81** | **0.66** | 0.04 | **0.61** | |
| 13.00 | **0.38** | **1,646** | **95.75** | **0.44** | 0.04 | **0.40** | |
| 14.00 | 0.25 | 1,550 | 95.68 | 0.26 | 0.04 | 0.22 | |
| 15.00 | 0.19 | 1,506 | 95.65 | 0.20 | 0.04 | 0.16 | |
| 16.00 | 0.13 | 1,464 | 95.62 | 0.15 | 0.04 | 0.10 | |
| 17.00 | 0.11 | 1,432 | 95.60 | 0.11 | 0.04 | 0.07 | |
| 18.00 | 0.08 | 1,405 | 95.58 | 0.09 | 0.04 | 0.05 | |
| 19.00 | 0.07 | 1,386 | 95.57 | 0.08 | 0.04 | 0.03 | |
| 20.00 | 0.07 | 1,374 | 95.56 | 0.07 | 0.04 | 0.03 | |
| 21.00 | 0.06 | 1,363 | 95.55 | 0.06 | 0.04 | 0.02 | |
| 22.00 | 0.06 | 1,352 | 95.55 | 0.06 | 0.04 | 0.02 | |
| 23.00 | 0.05 | 1,340 | 95.54 | 0.05 | 0.04 | 0.01 | |
| 24.00 | 0.04 | 1,324 | 95.53 | 0.05 | 0.04 | 0.01 | TIME TO ZERO DISCHARGE |
| 25.00 | 0.00 | 1,178 | 95.43 | 0.04 | 0.04 | 0.00 | |
| 26.00 | 0.00 | 1,020 | 95.32 | 0.04 | 0.04 | 0.00 | |
| 27.00 | 0.00 | 862 | 95.22 | 0.04 | 0.04 | 0.00 | |
| 28.00 | 0.00 | 704 | 95.12 | 0.04 | 0.04 | 0.00 | |
| 29.00 | 0.00 | 546 | 95.01 | 0.04 | 0.04 | 0.00 | |
| 30.00 | 0.00 | 388 | 94.91 | 0.04 | 0.04 | 0.00 | |
| 31.00 | 0.00 | 230 | 94.71 | 0.04 | 0.04 | 0.00 | |
| 32.00 | 0.00 | 72 | 94.50 | 0.04 | 0.04 | 0.00 | |
| 33.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |
| 34.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |
| 35.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |
| 36.00 | 0.00 | 0 | 94.40 | 0.00 | 0.00 | 0.00 | |