PARE PROJECT NO. 17044.03

# STORMWATER MANAGEMENT REPORT

# ASHLAND PUBLIC SAFETY COMPLEX
# UNION STREET
# ASHLAND, MA

**Assessors Map 15, Lot 76, 77, & 78**

**Town of Ashland, MA**
**Ashland, MA**

**Prepared for**:

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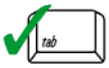
**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection - Wetlands Program

# Checklist for Stormwater Report

## A. Introduction

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





A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection - Wetlands Program

# Checklist for Stormwater Report

## B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

## Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

## Checklist

**Project Type:** Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

# Checklist for Stormwater Report

## Checklist (continued)

**LID Measures:** Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of “country drainage” versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☒ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☒ Green Roof
- ☐ Other (describe): _____

**Standard 1: No New Untreated Discharges**

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 2: Peak Rate Attenuation**

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

**Standard 3: Recharge**

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 3: Recharge** (continued)

☒ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

**Standard 4: Water Quality**

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 4: Water Quality** (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

**Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)**

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

**Standard 6: Critical Areas**

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable**

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

**Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control**

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control** (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

**Standard 9: Operation and Maintenance Plan**

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

**Standard 10: Prohibition of Illicit Discharges**

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

## PURPOSE

Pare Corporation (Pare) has prepared this report to summarize the stormwater management system for a proposed Public Safety Complex located in Ashland, MA. The new facility will be located at 12-16 Union Street in Ashland, MA. The project will include construction of a new public safety building, parking areas and access drives, pedestrian walkways, stormwater management systems, and other associated site improvements. The project is proposed on a 3.82 +/- acre parcel once partially disturbed as part of a previous uncompleted development project.

The parcel which is owned by the Town of Ashland, was subdivided in 2019 through an ANR process. The parcel includes portions of parcels previously designated on the Town of Ashland Assessor's Map 15, Lot 76 and 77, and the entire parcel previously designated on the Assessor's Map 15, Lot 78.

The following sections of the report discuss the existing conditions, proposed development, methodology employed to evaluate stormwater runoff for existing and proposed conditions, and design elements for the proposed stormwater management system components. Supporting documentation is provided in the attached appendices.

## PROJECT DESCRIPTION

The study area, hereby referred to as the "Site", included in this hydrologic study comprises approximately 3.99 +/- acres of land including the aforementioned parcel. Most of the Site is included within the parcel (3.82 acres) except for utility trenching and minor modifications to the intersection within the right-of-way (0.17 acres). Within the Site, the Limit of Disturbance (LOD) for development is approximately 2.86 acres. The Site is bounded to the northwest by Union Street, residential properties to the northeast, Ashland High School property to the southeast, and privately owned property which is currently forested area to the southwest.

Wetland resource areas were defined and delineated in the vicinity of the Site on September 11 & 12, 2019. Wetland resource areas were defined and delineated in Wetland resource areas in the vicinity of the proposed Ashland Public Safety Complex project on Union Street in Ashland were defined and delineated in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00, referred to as the WPA Regulations) and the Ashland Wetlands Protection Bylaw (the Bylaw), and the methodology specified in the publications entitled Delineating Bordering Vegetated Wetlands under the Massachusetts Wetlands Protection Act (Jackson, 1995) and The Regional Supplement to the Corps of Engineers Wetland Delineation Manual: North Central and Northeast Region (U.S. Army Corps of Engineers, 2012). Wetland resource areas on or around the Site include Bordering Vegetated Wetlands,

Isolated Land Subject to Flooding, Isolated Freshwater Wetlands, and Bordering Land Subject to Flooding. The wetland areas are depicted on the proposed site plans.

There are no NHESP Priority Habitats, Certified Vernal Pools, or Potential Vernal Pools onsite as mapped by MassGIS. The Site is not located in a Zone II Wellhead Protection Area, Interim Wellhead Protection Area, or Zone I Wellhead Protection Area. Additionally, the Site is not located in a Zone A, B, or C Surface Water Protection Area.

According to the FEMA Flood Insurance Rate Map for Middlesex County, Massachusetts (Community-Panel 25017C0514F, revision date July 7, 2014), included in Appendix A of this report, the project Site is located entirely within FEMA Zone X, or "areas determined to be outside the 0.2% annual chance floodplain."

The existing topography of the site generally slopes to the southwest of the project area, where the wetland is located. Runoff is ultimately captured in an inlet within the right-of-way and in the wetland at the southwest of the Site.

## GEOTECHNICAL INVESTIGATIONS AND SOIL DATA

NRCS Soil mapping indicated that natural soil in the vicinity of the Site is comprised of Narragansett Silt Loam with varying slopes. This soil is classified as a Hydrologic Soil Group (HSG) rating A. A type soils have a high rate of water transmission. NRCS Hydrologic Soil Report for the Site are provided in Appendix A.

A subsurface investigation, inclusive of (8) test pits, ten (10) soil borings, and twenty-six (26) rock probes were conducted to evaluate soil conditions at the Site. Test pit, boring, and rock probe logs from the investigation are provided in Appendix A.

The soil profile varies across the site but generally consists of sand and gravel glacial deposits over bedrock. In some investigations across the site a layer of topsoil and/or fill material was encountered at the surface above the glacial deposits. Bedrock was found across the Site. The depth to bedrock varies between 6' (RP-5) and >15' (RP19-1 & RP19-12) below the existing surface elevation. Depth to ground water also varies throughout the Site between el. 173.3' (RP19-1) and el. 216.6' (B19-10). The water table is likely perched on the bedrock formations found on the Site.

For most of the site, depth to bedrock and groundwater precludes the feasibility of infiltration on the Site. At the southeast corner of the site adjacent to the right of way, the bedrock depth and groundwater depth is at its deepest relative to proposed grades. The investigation used to establish Estimated Seasonal High Groundwater in the vicinity of the proposed infiltration site is B19-1. Groundwater was observed at elevation 180.8. observed water elevation in nearby investigations TP-1 and RP19-1 indicate groundwater deeper than el. 179.5, indicating that the use of the data in B19-1 is conservative. At the start of construction, Pare will observe a test pit excavated by the contractor to verify soil and groundwater conditions within the limits of the proposed infiltration system.

Soil disturbance onsite will include the construction of the foundation for the proposed building, construction of the proposed parking areas and access drives, and excavation for all proposed utilities and drainage features. Erosion control wattles will be used to limit movement of soil offsite, and water will be sprayed as necessary to control dust. Existing catch basins in the vicinity of the site will require inlet protection.

## METHODOLOGY

Hydrologic calculations for existing and proposed conditions were performed using HydroCAD Version 10.00 software, which uses TR-55 methodology to calculate runoff and TR-20 methodology for storm routing through the stormwater detention facilities. Site hydrology was evaluated for the 1" storm event as well as the 2-year, 10-year, and 100-year frequency storms in accordance with the guidelines of the Massachusetts Stormwater Handbook. Existing and Proposed Watershed Maps, indicating the subwatersheds and associated stormwater flow paths may be found in Appendix D.

The hydraulic design calculations were completed using the Rational Method to calculate the accumulated flows to each structure. The stormwater conveyance system was designed using Manning's Equation. Autodesk Storm and Sanitary Analysis software was used to perform the design calculations. The stormwater conveyance system was designed to handle the runoff generated by a 25-year design storm.

## EXISTING CONDITIONS OF STUDY AREA

The Site, although previously cleared as part of a different development project, is currently considered undeveloped with woods covering the majority of the Site. Under existing conditions, the composite

curve number are 45, 63, and 54 for the three subcatchment areas: EDA-1A, EDA-1B, and EDA-1C (described below), respectively meaning there is relatively little runoff from the Site. Stormwater runoff that is generated from the Site generally flows overland to the southwest of the Site where most of the runoff is captured in two catch basin inlets within the right-of-way. The remaining runoff from the Site flows overland into wetlands that exist at the south of the Site along the southern/southwestern edge of the property. Both the catch basins in the right-of-way and the southwestern wetland series discharge to a culvert beneath Union Street flowing west towards the open water connected to Framingham Reservoir #2.

The existing Site contains approximately 0.20 acres of impervious area within the hydrologic boundary, which consists of a gravel access drive, a walkway parallel to the right-of-way, and portions of the paved right-of-way. The remaining portions of the Site are grass, woods, and wetlands areas. The existing surface covers were modeled as paved parking, gravel surface, woods/grass combination (in fair condition) in the hydrologic analysis. Wetland conditions on the Site are assumed have similar hydrologic characteristics to pasture/grassland/range, poor and are modeled as such.

The Site was considered one analysis area based on existing drainage patterns. Stormwater from the existing Site ultimately flows to a single design point: "DP-1 Culvert."

Under existing conditions, two subwatersheds were analyzed. The Existing Hydrology Plan, XBT-1, included in Appendix D, depicts the limits of the Existing Drainage Areas (EDA), described below:

- **EDA-1A**: EDA-1A is comprised of woods, wetlands, gravel drive, and paved walkways in the middle of the Site. Stormwater runoff discharges to the existing drainage system on Union Street via overland flow into catch basins.

- **EDA-1B**: EDA-1B is comprised of woods, gravel drive, and paved walkways at the north of the Site. Stormwater runoff discharges to the existing drainage system on Union Street via overland flow into the right-of-way and along the curb line into catch basins.

- **EDA-1C**: EDA-1C is comprised of woods and wetlands located at the south of the Site. Stormwater runoff flows overland to the wetlands on Site.

## PROPOSED CONDITIONS OF STUDY AREA

The proposed improvements to the Site include construction of a new building, carport, firing range structure, parking areas, walls, stormwater management systems including two detention systems and an infiltration system, pedestrian walkways, and other associated site improvements. The proposed

condition has approximately 1.89 acres of impervious surface within the hydrologic boundary, resulting in a net increase of 1.69 acres of impervious area.

The main entrance to the Site is provided by an access drive to the southwest of the Site via Union Street. Another access drive is located at the north of the site at the existing signalized intersection which provides access to the Fire Department apparatus bay. Parking is spread out throughout the site in a parking lot at the front of the Site, along the access drive at the south of the Site, and at the rear of the building. Walkways help to provide connections from parking to the building at the front and rear of the Site.

The proposed project will require stormwater management systems to handle the increase in stormwater runoff and pollutant loading to the design point. All new stormwater collection, storage, and treatment systems will be designed and constructed in accordance with the guidelines of the Massachusetts Stormwater Handbook prepared by the Massachusetts Department of Environmental Protection (MADEP). Pre-development runoff rates will be maintained or reduced and released into existing drainage paths downstream of proposed improvements. Most proposed impervious areas will be treated prior to leaving the site in accordance with the handbook.

The grading scheme is designed to shed water as in the existing conditions to the maximum extent possible. Grades generally slope away from the building so to protect the building from stormwater runoff. Stormwater is conveyed to best management practices (BMP's) via overland flow and a stormwater conveyance system consisting of catch basins, manholes, and HDPE piping.

The drainage system is designed to incorporate features that address flow-rate, quantity of runoff, and quality of runoff from the developed Site. Runoff from the site flows overland into catch basins or tree box filters (via flush curbed inlets). Where runoff is captured in catch basins, a water quality structure is provided as treatment. Where tree box filters capture runoff, catch basin inlets are provided as an overflow for larger storm events. Water is conveyed from the upstream treatment systems into two different detention systems on the Site via a piped drainage system. Roof runoff is partially treated by a green roof system prior to discharging to the Site's drainage system. Water from the detention system, additional tree box filters, and the roof are piped to an infiltration system at the southwest of the Site. Overflow from the infiltration system is controlled by an outlet control structure. Overflow from the infiltration system is connected via a pipe outlet to the drainage system within Union Street. An emergency overflow has been provided at the west of the infiltration system which discharges via a

flared end section at the existing wetland located at the southwest of the Site. The features implemented on the Site include:

- **Source Control and Maintenance**: Properly maintaining sources of pollutants promotes a site that produces higher quality stormwater runoff than sites that do not control sources of pollutants. An example of source control includes the removal of sediment buildup from best management practices during regular maintenance per the Long-Term Operations & Maintenance Plan.

- **Tree Box Filter without Exfiltration**: The tree box filters (TBF) have been designed in accordance with the Massachusetts Stormwater Handbook requirements to promote water quality. The tree box filters are comprised of filter media (comprised of sand and compost) and topped with 4" of mulch. Runoff will enter the tree box filters via overland flow. The stormwater will then pass through the mulch and into the filter media. Tree box filters have been designed as closed systems that do not provide exfiltration. The catch basin overflow outlet is elevated to store the water quality volume for 24-hours while it slowly drains through the underdrain system following the storm event. During larger storm events, excess runoff will exit the system through a raised outlet pipe or bypass the system and continue along the curb line into a deep sump catch basin overflow.

  Pare Corporation has spoken with Robert Roseen from the University of New Hampshire Stormwater Center several times about their research and design of the Tree Box Filters. Since the start of the research facility, in 2004, UNH Stormwater Center has been testing the tree box filter in many different situations. UNH Stormwater Center 2012 Bi-Annual Report states that the TBF is "effective for removing many pollutants and consistently exceeds EPA's recommended level of removal for total suspended solids." The design is based upon the successful design implemented at UNH.

  The sizing of the tree box filters is completed in accordance with the UNH Stormwater Center with the design accounting for the proposed filter media to be composed of 80 percent sand and 20 percent compost. Per UNH, the mix was designed to maximize permeability while providing enough organic content to sustain vegetation and maintain a high infiltration rate of 100 feet per day. To be conservative, a k value of 30 ft/day was used for the sizing calculations of the tree box filters.

  UNH has been at the forefront of stormwater design and is a credible source of stormwater data for the northeastern United States. UNH is an authority on tree box filters because they annually

maintain, operate, and study a tree box filter on campus. The total suspended solids removal and other water quality benefits are recorded and published bi-annually. The data shows that with the UNH design, tree box filters are capable of meeting water quality requirements through the sizing method presented.

- **Hydrodynamic Separator**: The hydrodynamic separator is a proprietary water quality structure (WQS) that has been designed in accordance with the Massachusetts Stormwater Handbook requirements to promote water quality. The system is sized to treat the water quality flow passing through the system and is also sized to bypass flows during a 25-year storm event. Sizing calculations for the system are included in Appendix C.

- **Green Roof**: The green roof is a constructed system designed to capture roof runoff at the source and has been designed in accordance with the Massachusetts Stormwater Handbook requirements to promote water quality. The two proposed green roofs are sized to treat a portion of the water quality volume generated by the roof system. Treatment calculations for the systems are included in Appendix C.

- **Underground Infiltration System**: The underground infiltration system (UGIS) has been designed in accordance with the Massachusetts Stormwater Handbook requirements to promote exfiltration and recharge. The system outlets into an outlet control structure that connects into the stormwater drainage system within the right-of-way. The weir within the outlet control structure is elevated to exfiltrate the entire WQv and provide flow control downstream. The UGIS is designed to keep greater than 2' from the bottom of the system to ESHGWT. Considering the existing soil characteristics, an infiltration rate of 2.41 in/hr was used. The system has less than 4' clearance to groundwater, therefore a mounding analysis for the system is included as part of Appendix C. The mounding analysis shows that the groundwater mound that forms will not break out above the land, per the requirements of the handbook.

Construction will include filling a portion of the onsite wetland resource areas as well as work within the 25' no disturbance zone and the 100' buffer zone. Paving, grading, and retaining wall construction will be done in the 25' no disturbance zone. Construction of a portion of the proposed public safety building falls within the 100' buffer zone as well. Wetland replication as mitigation is anticipated to be undertaken at an offsite location and plans for mitigation are under development.

Under proposed conditions, five subwatersheds were analyzed. The Proposed Hydrology Plan, XBT-2, included in Appendix D, depicts the limits of the Proposed Drainage Areas (PDA), described below:

- **PDA-1A**: PDA-1A is comprised of a portion of the building, a majority of paved parking at the south of the Site, paved walkways, and grassed areas. Runoff from this drainage area flows overland into tree box filters and ultimately piped to the infiltration system. Runoff from the portion of the building included in this drainage area is partially treated by two separate green roof systems prior to discharging into the infiltration system.

- **PDA-1B**: PDA-1B is comprised of a paved Fire Department apparatus bay apron, northern portion of the building, and a small grassed area. Runoff from this drainage area flows overland into catch basins where it is piped to a hydrodynamic separator. Ultimately, runoff is piped to the infiltration system.

- **PDA-1C**: PDA-1C is comprised of the majority of the back parking lot at the east of the Site, eastern portion of the building, carport & shooting range structures, and grassed areas at the northeast of the Site. Runoff from this drainage area flows overland into tree box filters and ultimately piped to the infiltration system.

- **PDA-1D**: PDA-1D is comprised of a grassed are at the north of the Site, the driveway aprons, a portion of the paved walkway at the west of the site, and work within the right-of-way. Runoff from this drainage area is untreated. Runoff flows overland into the right-of-way and along the curb line to the south where it is captured in inlets within the right-of-way.

- **PDA-1E**: PDA-1E is comprised of grassed areas, woodland, and wetlands at the south of the Site. A majority of this area will remain undisturbed. Runoff from this drainage area flows overland into the wetland system at the south of the Site. The infiltration system has an emergency overflow that discharges at a flared end section within this drainage area.

## STORMWATER MANAGEMENT STANDARDS

This proposed stormwater management system complies with the current regulations of the Massachusetts Department of Environmental Protection (DEP) and the Town of Ashland Conservation Commission requirements. Compliance and applicability of the ten (10) Stormwater Management Standards are discussed below.

### STANDARD #1 – NO NEW UNTREATED DISCHARGES

No new point discharges of untreated stormwater are proposed for the project. Water quality is achieved by source control and conveying stormwater from impervious areas through the proposed best management practices. Stormwater throughout the Site is treated using a green roof, tree box filters, a water quality structure, and an underground infiltration system. Portions of the site within, and directly adjacent to, existing roadways will remain untreated as in the existing condition.

**STANDARD #2 – POST-DEVELOPMENT PEAK DISCHARGE RATES**

MassDEP Stormwater Standard #2 states that runoff rates from the developed Site must not exceed existing runoff rates for the 2-year and 10-year, 24-hour storm events. Standard 2 states that the 100-year, 24-hour storm event must also be evaluated to demonstrate that there will be no increased flooding impacts off-site.

The proposed stormwater management system is designed to reduce runoff rates from the 2-, 10-, and 100-year, 24-hour storm events. This is achieved by controlling runoff using the proposed underground detention systems and infiltration system and their associated outlet control structures.

Existing and proposed peak runoff rates from the Site were generated for the rainfall events having a return rate of 2-year, 10-year, and 100-year using the SCS TR-20 Method (refer to Appendix B for hydrology calculations). Runoff hydrographs were developed for the existing and proposed conditions for each of the design points of the Site. Results for each storm event and the net difference in pre- and post-development flows are shown in Table 1 below; a negative number indicates flows are decreased in the proposed condition.

Table 1: - Peak Stormwater Runoff Flow Rate (CFS)

| Design Point | 2-Year Event 3.10” | 10-Year Event 4.50” | 100-year Event 6.50” |
|---|---|---|---|
| DP-1 - Culvert Existing | 0.14 | 0.79 | 2.72 |
| DP-1 - Culvert Proposed | 0.10 | 0.65 | 2.31 |
| Change | -0.04 | -0.14 | -0.41 |

**STANDARD #3 – RECHARGE TO GROUNDWATER**

Stormwater Standard #3 states that loss of groundwater recharge from the proposed development shall be eliminated or minimized and at a minimum, the recharge volume, which is dependent on soil type, shall be recharged to the groundwater. The intent of this standard is to ensure that the infiltration volume of precipitation into the ground under post-development conditions is at least as much as the infiltration volume under pre-development conditions. Per the Handbook, a recharge rate of 0.60 inches of runoff is required for A type soils. The required recharge volume is 3,680 CF and the provided recharge volume is 10,716 CF. Calculations documenting compliance with this requirement are provided in Appendix C.

**STANDARD #4 – TSS REMOVAL**

Stormwater Standard #4 requires that stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). Based on the Site's infiltration rate of greater than 2.41 in/hr, the required water quality volume is 1.0 inch. Water quality control for the site is described below and supporting calculations are provided in Appendix C.

At least 80% TSS treatment is achieved using a treatment train consisting of tree box filters or a hydrodynamic separator and the infiltration system. See Appendix C for calculations for the stormwater facilities.

**STANDARD #5 – LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS (LUHPPL)**

Standard #5 specifies that LUHPPLs appropriately reduce and control potential pollutants from entering groundwater or waterways. The site is not classified by the Handbook as a LUHPPL and therefore this standard does not apply.

**STANDARD #6 – PROTECTION OF CRITICAL AREAS**

The proposed development is not located within a Zone II or Interim Wellhead Protection Area. Standard #6 is not applicable to this project.

**STANDARD #7 – REDEVELOPMENT PROJECTS**

The project is proposed as a mix of new development and redevelopment, with redevelopment area being limited to the existing gravel parking lot and access drive. The project is required by the Handbook to meet the Stormwater Standards to the full extent for the net increase in impervious area, required to meet Standards 2, 3, 4, 5, and 6 only to the maximum extent practicable and improve existing conditions for the existing impervious area.

**STANDARD #8 – EROSION & SEDIMENT CONTROL PLAN**

The project proposes to disturb greater than 1 acre of land and is required to develop a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) Construction General Permit (CGP) for discharges from construction activities. The SWPPP will include means and methods at the discretion of the Contractor to comply with the NPDES CGP. The SWPPP and the Notice of Intent under the CGP will be required to be prepared and submitted by the Contractor as the Operator of the Site. The SWPPP is required to be submitted to the town prior to the start of earth disturbing activities.

Minimum erosion and sediment control features, including perimeter silt fencing, filter socks, and inlet protection are shown on the Project Plans.

**STANDARD #9 – OPERATIONS AND MAINTENANCE PLAN**

The Town of Ashland will be responsible for the Operation and Maintenance of the Stormwater Management System post-construction. The Stormwater Operation and Maintenance Plan is included under separate cover.

**STANDARD #10 – ILLICIT DISCHARGES**

The Stormwater Management System has been designed to route stormwater through and treated by a series of stormwater best-management practices prior to discharge. To Pare Corporation's knowledge, based on the best-available information and in-field reviews of the current Site, there are no known non-stormwater discharges that will be connected to the proposed stormwater collection system that would convey pollutants directly to groundwater or surface waters.

## PROPOSED DRAINAGE CONVEYANCE SYSTEM

The proposed stormwater conveyance system includes drain manholes, catch basins, detention systems, and an underground infiltration system. The proposed system has been designed for a 25-year 24-hour storm event utilizing the Rational Method. The Manning equation was used to model the stormwater conveyance system and perform the hydraulic analysis of the system. The following criteria were used to design the conveyance system:

- Manholes are provided at all directional changes, connections, and conduit size increases.
- Pipes are designed to convey the 25-year stormwater event.
- All conduit is HDPE pipe sized 12" diameter or larger.
- Minimum pipe velocity is 2 feet per second.
- Maximum pipe velocity is 12 feet per second.

All pipes are modeled in the hydraulic calculations in Appendix B of this report.

## SUMMARY

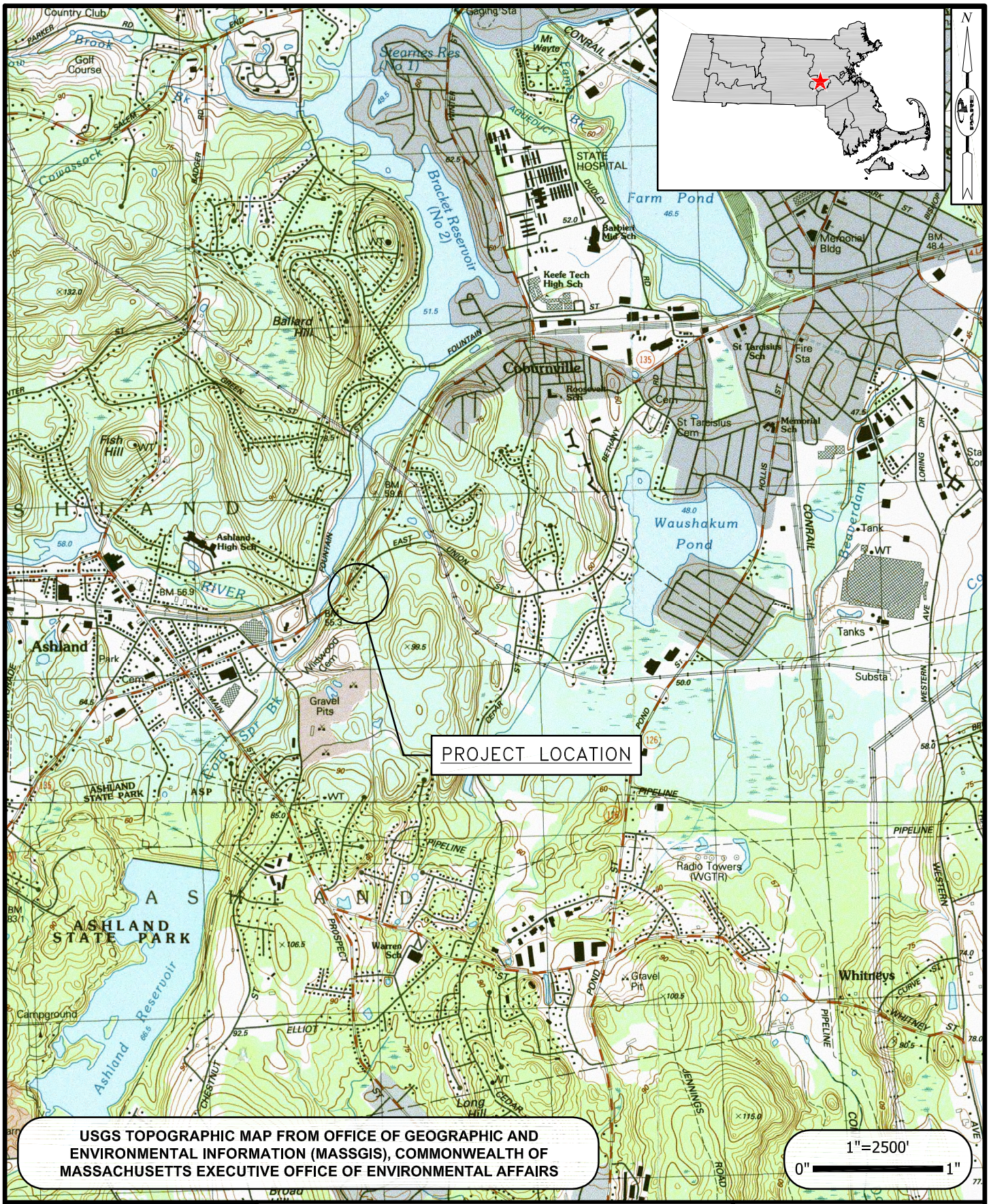
The post-development stormwater management system has been designed in accordance with the Massachusetts Stormwater Handbook requirements. The proposed stormwater management system addresses both the quantity and quality of the stormwater runoff. The stormwater management system promotes recharge and ultimately provides reductions in peak runoff rate within the hydrologic analysis

area for the design storm events. TSS loading from the site is managed through source control and best management practices. The development of the property is proposed to improve existing conditions and the stormwater discharges to the area's natural resources.

## APPENDIX A

Existing Conditions & Soils Information

*Site Locus and Aerial Map*
*Zoning Map*
*Test Pit Logs*
*Boring Logs*
*Rock Probe Logs*
*Soils Map*
*FEMA Firmette*
*IDF Curve*
*TR-55 Curve numbers*
*Design Storms*




USGS TOPOGRAPHIC MAP FROM OFFICE OF GEOGRAPHIC AND ENVIRONMENTAL INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

PARE CORPORATION

# ASHLAND PUBLIC SAFETY COMPLEX

12 UNION STREET

ASHLAND, MASSACHUSETTS

## LOCUS PLAN

SEPTEMBER 2019 FIGURE 1


PARE CORPORATION

# ASHLAND PUBLIC SAFETY COMPLEX

12 UNION STREET
ASHLAND, MASSACHUSETTS

## AERIAL PLAN

SEPTEMBER 2019 FIGURE 2

Town of Ashland, Mass.
Incorporated March 16, 1846

## ZONING DISTRICTS

**RESIDENTIAL**
- RESIDENTIAL A RA
- RESIDENTIAL B RB
- RESIDENTIAL MULTI_FAMILY RM

**COMMERCIAL**
- ADD -"A" OVERLAY
- ADD - "B"
- ADD - "C"
- DOWNTOWN COMMERCE CD
- HIGHWAY COMMERCE CH
- OFFICE COMMERCE CO
- VILLAGE COMMERCE CV
- NEIGHBORHOOD COMMERCE CN

**INDUSTRIAL**
- INDUSTRIAL

**RAIL TRANSIT DISTRICT**
- RTD "A"
- RTD "B"
- RTD "C"
- RTD "D"
- RTD "E"
- RTD "F"

**WILDWOOD MIXED USE DISTRICT**
- WMUSD "A"
- WMUSD "B"
- WMUSD "C"
- WMUSD "D"
- WMUSD "E"
- WMUSD "BUFFER"
- QUARRY REMEDIATION DISTRICT

**OTHER**
- POND ST MIXED USE OVERLAY
- GROUNDWATER PROTECTION OVERLAY
- SOLAR OVERLAY
- SURFACE WATER BODY
- RIVER
- TRAIN LINE
- TRAIN RIGHT OF WAY
- EASEMENT
- BUILDINGS
- PARCELS

| | | |
|---|---|---|
| 09 | 10 | |
| 14 | 15 | 16 |
| 20 | 21 | 22 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 01 | 02 | | | | |
| | 03 | 04 | 05 | | | |
| 06 | 07 | 08 | 09 | 10 | | |
| 11 | 12 | 13 | 14 | 15 | 16 | |
| 17 | 18 | 19 | 20 | 21 | 22 | |
| | | 23 | 24 | 25 | 26 | |
| | | 27 | 28 | 29 | 30 | |

ASHLAND GIS INITIATIVE

0 100 200 400 600 800 1,000 Feet

N W E S

# TOWN OF ASHLAND - ZONING & TAX PARCEL FY 2014

Information shown on this map is from the Ashland GIS database. The Town of Ashland does not guarantee the accuracy of the information. Users are responsible for determining its suitability for their intended use or purpose. Parcel lines depict approximate boundaries of land ownership and should not be used to support any legal determination of boundaries related to rights or interests in real property.

May, 2014

**15**

Test pits observed by Pare Corporation on 2017-11-02.

**Elevations listed in the logs were recorded prior to receiving the most current survey and therefore the elevations listed on the logs are not on the same datum as the survey for the site.*

Pare Corporation
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# TEST PIT NUMBER TP17-1



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 188 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** 9.00 ft / Elev 179.00 ft
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | D | A-C | 1 | | | Dry, brown DEBRIS (concrete, metal, rr rail, brick, CMU), some fine to coarse sand, some fine to coarse gravel, some boulders, trace silt. (FILL) | |
| 5 | 6 | D | A&B | 2 | ¥ | | Moist, tan, fine to coarse SAND and fine to coarse GRAVEL, some boulders, trace silt. (GLACIAL DEPOSITS) | |
| 10 | | | | | | | Bottom of test pit at 12.0 feet. | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | 8 | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | 11 | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | VOLUME = CU.YDS | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | PERCENT BY WEIGHT | |
| | | | | | F-C | FINE TO COARSE | | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. 4-6" Topsoil.
2. Black layer at 6' depth before native soils, orange color tinge to safe, 6-7' depth then tan.

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# TEST PIT NUMBER TP17-2



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 199 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** ---
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | E | A | | | | Dry, black/orange/brown, fine to coarse SAND, some little coarse gravel, some boulder, trace silt, trace roots/grass. (TOPSOIL) | |
| | 1 | D | A-C | | | | Dry, brown/tan COBBLES and BOULDERS, some fine to coarse sand, some fine to coarse gravel, trace silt, trace roots. (FILL) | |
| | 3 | D | A-C | 1, 2 | NE | | Dry, dark brown BOULDERS and COBBLES, some fine to coarse sand, some gravel, trace silt, trace brick, trace plastic, trace roots. (FILL) | |
| 5 | | | | | | | | |
| | 7 | D | A-C | 3, 4 | | | Dry, brown BOULDERS and COBBLES, some fine to coarse sand, little gravel, trace silt, trace roots. (GLACIAL DEPOSITS) | |
| 10 | | | | | | | Bottom of test pit at 10.0 feet. | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | 5.5 | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | 10 | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | VOLUME = CU.YDS | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | | |
| | | | | | F-C | FINE TO COARSE | PERCENT BY WEIGHT | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. Large tree trunk at 4-6'.
2. At 7' several "C" boulders.
3. Granite stone.
4. 12' deep on hillside.

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# TEST PIT NUMBER TP17-3



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 205 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** 9.50 ft / Elev 195.50 ft
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | E | - | | | | Dry, fine to coarse SAND and GRAVEL, trace silt, trace grass/roots. (TOPSOIL) | |
| | 0.5 | M | A | | | | Dry, gray, fine to coarse SAND and GRAVEL and DEBRIS (8' minus brick, concrete, plastic, wood). (FILL) | |
| | 2 | M-D | A-B | 1, 2 | | | Dry, moist, tan/brown, fine to coarse SAND, some gravel, little cobble/boulders, trace silt. (GLACIAL DEPOSITS) | |
| 5 | | | | | | | | |
| 10 | | | | 3 | ¥ | | Bottom of test pit at 10.0 feet. | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | 7 / 12 | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | VOLUME = CU.YDS | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | | |
| | | | | | F-C | FINE TO COARSE | PERCENT BY WEIGHT | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. At 5' down, orange layer sand (1.5' thick).
2. Large boulder northwest side pit (36"+).
3. Potential bedrock at 10'.

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# TEST PIT NUMBER TP17-4



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 217 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** ---
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | E | - | | | | Dry, fine to coarse SAND, little silt, little organics, trace roots. (TOPSOIL) | |
| | 0.25 | D | A-C | | | | Dry, tan/light brown BOULDERS and COBBLES, some fine to coarse sand, some fine to coarse gravel. (GLACIAL DEPOSITS) | |
| 5 | 5 | D | A-B | 1, 2 | NE | | Moist, orange/tan COBBLES and fine to coarse SAND and fine to coarse GRAVEL, trace silt. (GLACIAL DEPOSITS) | |
| | | | | 3 | | | Bottom of test pit at 8.0 feet. | |
| 10 | | | | | | | | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | 8 | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | 15 | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | VOLUME = CU.YDS | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | PERCENT BY WEIGHT | |
| | | | | | F-C | FINE TO COARSE | | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. Orange soil at 5' deep.
2. Partial bedrock at 8' deep.
3. Mottled hard packed soil and silt clumps.

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# TEST PIT NUMBER TP17-5



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 208 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
▽ **AT TIME OF EXCAVATION** 8.00 ft / Elev 200.00 ft
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | M | A | | | | Dry, black/dark brown, fine to coarse SAND and GRAVEL, some boulders/cobbles, trace silt, trace roots (up to 1.5" thick). (TOPSOIL) | |
| | 3 | M | A | | | | Moist, tan/gray, fine to coarse SAND and GRAVEL, some cobbles, some boulders, trace silt. (GLACIAL DEPOSITS) | |
| 5 | 8 | D | A | 1 | ¥ | | Wet, fine to coarse SAND, some gravel, trace silt, trace cobbles/boulders, trace weathered rock. (GLACIAL DEPOSITS) | |
| 10 | | | | | | | Bottom of test pit at 11.0 feet. | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | 6 / 13 | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | VOLUME = CU.YDS | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | PERCENT BY WEIGHT | |
| | | | | | F-C | FINE TO COARSE | | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. **Wet side walls and very weathered rock at 8' deep.**

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# TEST PIT NUMBER TP17-6



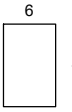
**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 218 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** 7.00 ft / Elev 211.00 ft
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | E | A | | | | Dry, dark brown/black, some fine to coarse SAND, some gravel, little boulders/cobbles, trace roots (up to 2" dia.). (TOPSOIL) | |
| | 2.5 | M-D | A | 1, 2 | | | Moist, gray/tan, fine to coarse SAND and fine to coarse GRAVEL, trace silt, little cobbles. (FILL) | |
| 5 | 6 | D | A | 2 | ¥ | | Wet, maroon, fine to coarse SAND and coarse GRAVEL, some cobbles, some boulders, trace silt. (GLACIAL DEPOSITS) | |
| | | | | 3 | | | Bottom of test pit at 8.0 feet. | |
| 10 | | | | | | | | |
| 15 | | | | | | | | |

**BOULDER CLASS**

| DESTINATION | SIZE |
|---|---|
| A | 6" TO 18" |
| B | 18" TO 36" |
| C | 36" & UP |

**TEST PIT PLAN**




VOLUME = CU.YDS

**EXCAVATION EFFORT**

| | |
|---|---|
| E | EASY |
| M | MODERATE |
| D | DIFFICULT |

**ABBREVIATIONS**

| | |
|---|---|
| F | FINE |
| M | MEDIUM |
| C | COARSE |
| V | VERY |
| F-M | FINE TO MEDIUM |
| F-C | FINE TO COARSE |
| NE | NOT ENCOUNTERED |

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**REMARKS:**
1. Tire and trace plastic at 2'.
2. Mottled soils 1-3' deep. Orange staining at 4'.
3. Potential bedrock at 8'.

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# TEST PIT NUMBER TP17-7



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 203 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** 7.00 ft / Elev 196.00 ft
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | E | - | | | | Loam, little fine to coarse SAND, little gravel, little silt. (TOPSOIL) | |
| | 0.5 | D | A&B | | | | Dry, brown, fine to coarse SAND and GRAVEL and BOULDERS/COBBLES, trace silt. (FILL) | |
| | 3.5 | E | - | | | | Moist, black, organic SILT, little fine sand, trace roots. (SILT) | |
| 5 | 4.5 | D | A | 1 | ¥ | | Wet, orange/blue/gray, fine to coarse SAND and GRAVEL, some cobbles, some boulders, trace silt. (GLACIAL DEPOSITS) | |
| 10 | | | | 2 | | | Bottom of test pit at 10.0 feet. | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | | |
| | | VOLUME = CU.YDS | | | F-C | FINE TO COARSE | PERCENT BY WEIGHT | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. 1' gray, 1' orange and then blue gray soils.
2. Potential weathered rock at 10'.

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# TEST PIT NUMBER TP17-8



**CLIENT** HKT Architects, Inc.
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.01
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 11/02/17 **COMPLETED** 11/02/17
**GROUND ELEVATION** 195 ft
**EXCAVATION CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**EXCAVATION METHOD** Komatsu PC 120, 8 Ton, 12' Reach
**AT TIME OF EXCAVATION** 3.50 ft / Elev 191.50 ft
**LOGGED BY** D. Caouette **CHECKED BY**
**AT END OF EXCAVATION** ---
**BORING LOCATION** SEE FIGURE 2

| DEPTH (ft) | DEPTH (FT) | EXCAVATION EFFORT | BOULDERS CNT/CLASS | REMARKS | GROUNDWATER ELEVATION | GRAPHIC LOG | SAMPLE DESCRIPTION | PID READING |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | E | - | | | | Moist, brown/black LOAM. (TOPSOIL) | |
| | 1 | M | A | | | | Moist, brown, fine to coarse SAND and GRAVEL, some cobbles, little boulders, trace silt. (GLACIAL DEPOSITS) | |
| | 3 | M-D | A | | ¥ | | Wet, orange, fine to medium SAND, some gravel, some boulders. (GLACIAL DEPOSITS) | |
| 5 | 4.5 | D | A | | | | Wet, brown, fine to coarse SAND and GRAVEL, little boulders, little cobbles, trace silt. (GLACIAL DEPOSITS) | |
| 10 | | | | | | | Bottom of test pit at 9.5 feet. | |
| 15 | | | | | | | | |

| BOULDER CLASS | | TEST PIT PLAN | EXCAVATION EFFORT | | ABBREVIATIONS | | BURMISTER CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| DESTINATION | SIZE | | E | EASY | F | FINE | TRACE | 0 -10% |
| A | 6" TO 18" | | M | MODERATE | M | MEDIUM | LITTLE | 10 - 20% |
| B | 18" TO 36" | | D | DIFFICULT | C | COARSE | SOME | 20 - 35% |
| C | 36" & UP | | | | V | VERY | AND | 35 - 50% |
| | | | | | F-M | FINE TO MEDIUM | | |
| | | VOLUME = CU.YDS | | | F-C | FINE TO COARSE | PERCENT BY WEIGHT | |
| | | | | | NE | NOT ENCOUNTERED | | |

**REMARKS:**
1. **Potential bedrock at 9.5'.**
2. **Orange soils at 3' deep.**

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# BORING NUMBER B19-1



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/19/19 **COMPLETED** 9/19/19
**GROUND ELEVATION** 186.5 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 5.70 ft / Elev 180.8 ft
**BORING LOCATION** 2920106.201°N, 669660.455°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 14 / 24 | 0 - 2 | 22-18-13-9 (31) | | | Moist, dense, brown, fine to medium SAND, some fine to coarse gravel, trace coarse sand, trace silt. | FILL |
| | | S-2 | 15 / 24 | 2 - 4 | 4-3-3-3 (6) | | | Moist, loose, brown to black, fine SAND, some silt, trace medium sand. | |
| 5 | | S-3 | 7 / 24 | 4 - 6 | 2-0-0-6 (0) | | | Wet, very loose, dark brown, fine SAND, some silt, little fine to coarse gravel, trace medium to coarse sand. | |
| | | S-4 | 0 / 0 | 6 - 6 | 50/0" | | | Boulder | BOULDER |
| 10 | | S-5 | 9 / 24 | 8 - 10 | 4-8-10-24 (18) | | | Wet, medium dense, brown, fine to medium SAND and fine to coarse GRAVEL, trace coarse sand, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | | | | | | | Bottom of borehole at 10.0 feet. | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Driller indicated boulder between 6'-8'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-2



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/19/19 **COMPLETED** 9/19/19
**GROUND ELEVATION** 188.9 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 3.60 ft / Elev 185.3 ft
**BORING LOCATION** 2920105.018°N, 669747.892°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 12 / 24 | 0 - 2 | 4-5-8-16 (13) | | | 1A: Moist, medium dense, dark brown, fine SAND and SILT, trace fine to coarse gravel, trace roots (4"). 1B: Moist, medium dense, brown, fine to medium SAND, some fine to coarse gravel, trace coarse sand, trace silt (8"). | 3"-4" TOPSOIL |
| | | S-2 | 14 / 15 | 2 - 3.3 | 19-19-50/3" | | | Moist, very dense, brown, fine to medium SAND, trace fine to coarse gravel, trace coarse sand, trace silt. | |
| 5 | | S-3 | 11 / 24 | 4 - 6 | 24-41-25-58 (66) | | | Moist, very dense, brown, fine to medium SAND, some fine to coarse gravel, trace coarse sand, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | S-4 | 13 / 24 | 6 - 8 | 14-22-22-24 (44) | | | Wet, dense, brown, fine to medium SAND and fine to coarse GRAVEL, trace coarse sand, trace silt. | |
| 10 | | S-5 | 15 / 24 | 8 - 10 | 27-25-25-21 (50) | | | Wet, dense, brown to light gray, fine to medium SAND and fine to coarse GRAVEL, trace coarse sand, trace silt. | |
| 15 | | | | | | | | Possible bedrock at 11'. Rollerbit to 15' to confirm bedrock. | POSSIBLE BEDROCK |
| 20 | | | | | | | | Bottom of borehole at 15.0 feet. | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Driller indicated possible bedrock at approximately 11'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-3



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/17/19 **COMPLETED** 9/18/19
**GROUND ELEVATION** 197.0 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 8.40 ft / Elev 188.6 ft
**BORING LOCATION** 2920095.749°N, 669836.273°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 8 / 24 | 0 - 2 | 4-10-12-31 (22) | | | Moist, medium dense, brown, fine SAND and fine to coarse GRAVEL, trace medium to coarse sand, trace silt, trace roots. | 1" TOPSOIL |
| | | S-2 | 18 / 24 | 2 - 4 | 19-54-55-49 (109) | | | 2A: Moist, very dense, brown, fine to medium SAND, some fine to coarse gravel, trace coarse sand, trace silt (10").<br>2B: Moist, very dense, black, fine SAND, trace silt. | FILL |
| 5 | | S-3 | 19 / 24 | 4 - 6 | 30-69-75-71 (144) | | | Moist, very dense, dark brown/black, fine to medium SAND and fine to coarse GRAVEL, trace silt. | |
| | | S-4 | 4 / 9 | 6 - 6.7 | 24-53/3" | | | Wet, very dense, dark brown/black, fine to medium SAND, some fine to coarse gravel, trace coarse sand, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | S-5 | 5 / 7 | 8 - 8.6 | 22-37/1" | | | Wet, very dense, fine to coarse SAND, little fine gravel, trace silt. | |
| 10 | | | | | | | | Possible bedrock at approximately 8.6'. Rollerbit down to 15' to confirm. | POSSIBLE BEDROCK |
| 15 | | | | | | | | Bottom of borehole at 15.0 feet. | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1. Wash color brown, changed to dark brown/black at approximately 3.5', changed back to brown at approximately 6'.
2. A monitoring well was installed (10' screen). Please see well piezometer installation sketch for more details.
3. Driller indicated possible bedrock at 8.6'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-4



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/18/19 **COMPLETED** 9/18/19
**GROUND ELEVATION** 199.0 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 2.10 ft / Elev 196.9 ft
**BORING LOCATION** 2920050.035°N, 669872.611°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 12 / 24 | 0 - 2 | 3-5-8-4 (13) | | | Moist, medium dense, brown, fine SAND, some fine to coarse gravel, little silt, trace coarse sand. | 3" TOPSOIL |
| | | S-2 | 13 / 24 | 2 - 4 | 8-20-21-17 (41) | | | Moist, dense, brown to gray, fine to medium SAND, little fine to coarse gravel, trace coarse sand, trace silt. | |
| 5 | | S-3 | 8 / 24 | 4 - 6 | 27-27-43-31 (70) | | | Wet, very dense, light gray, fine to coarse SAND and fine to coarse GRAVEL, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | S-4 | 6 / 24 | 6 - 8 | 24-25-19-18 (44) | | | Wet, dense, light gray, fine to coarse GRAVEL, some fine to coarse sand, trace silt. | |
| 10 | | S-5 | 13 / 24 | 8 - 10 | 25-25-21-28 (46) | | | Wet, dense, light gray, fine to coarse GRAVEL, some fine sand, trace silt. | |
| 15 | | | | | | | | Driller indicated possible bedrock encountered at 11.5'. Driller rollerbitted to 15' to confirm bedrock. | POSSIBLE BEDROCK |
| 20 | | | | | | | | Bottom of borehole at 15.0 feet. | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Wash color brown.
2.Driller indicated possible bedrock at approximately 11.5'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-5



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/17/19 **COMPLETED** 9/17/19
**GROUND ELEVATION** 215.3 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 3.10 ft / Elev 212.2 ft
**BORING LOCATION** 2920120.763°N, 670003.641°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 13 / 24 | 0 - 2 | 3-3-11-27 (14) | | | Moist, medium dense, brown to tan, fine to coarse GRAVEL and fine SAND, trace medium to coarse sand, trace silt. | 2" TOPSOIL |
| | | S-2 | 8 / 9 | 2 - 2.7 | 69-50/3" | | | Moist, very dense, light brown, fine to medium SAND and fine to coarse GRAVEL, trace coarse sand, trace silt. Boulder between 2.7'-4'. | BOULDER |
| 5 | | S-3 | 10 / 24 | 4 - 6 | 25-9-8-11 (17) | | | Wet, medium dense, brown to tan to gray, fine to coarse GRAVEL and fine to coarse SAND, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | S-4 | 20 / 24 | 6 - 8 | 47-28-20-17 (48) | | | 4A: Wet, dense, brown, fine to coarse SAND, little fine to coarse gravel, trace silt (10"). 4B: Wet, dense, gray, fine to coarse GRAVEL, some fine to coarse sand, trace silt (10"). | |
| 10 | | S-5 | 11 / 24 | 8 - 10 | 13-21-37-18 (58) | | | Wet, very dense, gray, fine to coarse GRAVEL and fine to coarse SAND, trace silt. | |
| | | | | | | | | Possible bedrock encountered at approximately 10.5'. Rollerbit to 14' to confirm bedrock. | POSSIBLE BEDROCK |
| 15 | | | | | | | | Bottom of borehole at 14.0 feet. | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Wash color light brown changed to gray at approximately 8'.
2.Driller indicated possible boulder/bedrock encountered at approximately 10.5'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-6



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/18/19 **COMPLETED** 9/18/19
**GROUND ELEVATION** 204.7 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 12.40 ft / Elev 192.3 ft
**BORING LOCATION** 2920204.123°N, 669863.098°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 0 / 24 | 0 - 2 | 6-9-18-18 (27) | | | No Recovery. | GLACIAL STRATIFIED DEPOSITS |
| | | S-2 | 19 / 24 | 2 - 4 | 13-7-5-13 (12) | | | Moist, medium dense, light brown, fine SAND and SILT, trace fine to coarse gravel, trace coarse sand, trace roots. | |
| 5 | | S-3 | 15 / 23 | 4 - 5.9 | 14-15-31-62/5" | | | Moist, dense, light brown, fine SAND, little fine to coarse gravel, trace silt. | |
| | | S-4 | 14 / 24 | 6 - 8 | 42-51-43-44 (94) | | | Wet, very dense, light brown, fine to coarse SAND, some fine to coarse gravel, trace silt. | |
| 10 | | S-5 | 14 / 24 | 8 - 10 | 27-66-80-46 (146) | | | Wet, very dense, light brown, fine to medium SAND and fine to coarse GRAVEL, trace coarse sand, trace silt. | |
| | | | | | | | | Boulder at 10.5'. | BOULDER |
| | | | | | | | | | GLACIAL STRATIFIED DEPOSITS |
| 15 | | | | | | | | Possible bedrock encountered at approximately 12.5'. Rollerbit to 15' to confirm bedrock. | POSSIBLE BEDROCK/BOULDER |
| | | | | | | | | Bottom of borehole at 15.0 feet. | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Wash color brown.
2.Boulder at 10.5'.
3.Possible bedrock/boulder at 12.5'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-7



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/16/19 **COMPLETED** 9/17/19
**GROUND ELEVATION** 217.2 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 9.30 ft / Elev 207.9 ft
**BORING LOCATION** 2920232.888°N, 669970.615°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 6 / 24 | 0 - 2 | 2-7-10-13 (17) | | | Moist, medium dense, brown, fine SAND and SILT, trace coarse gravel, trace coarse sand, trace organics (roots, leaves). | 2' TOPSOIL |
| | | S-2 | 21 / 24 | 2 - 4 | 13-17-15-15 (32) | | | Moist, dense, brown to light gray, fine SAND and SILT. | GLACIAL STRATIFIED DEPOSITS |
| 5 | | S-3 | 10 / 14 | 4 - 5.1 | 17-44-50/2" | | | Moist, very dense, brown, fine SAND, little medium to coarse sand, trace fine gravel, trace silt. | |
| | | | | | | | | | COBBLES |
| | | S-4 | 1 / 4 | 6 - 6.3 | 40/4" | | | Moist, very dense, brown, fine to coarse GRAVEL and fine SAND, trace medium to coarse sand, trace silt. Boulder | BOULDER |
| 10 | | S-5 | 16 / 24 | 8 - 10 | 22-24-31-39 (55) | | | Wet, very dense, brown, fine to medium SAND, little fine to coarse gravel, trace coarse sand, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | S-6 | 7 / 8 | 13 - 13.7 | 10-35/2" | | | Wet, very dense, gray, fine SAND, trace silt. | |
| 15 | | | | | | | | Split spoon refusal at approximately 13.7'. Driller rollerbitted to 15.1' to confirm bedrock and started coring at 15.1'. | |
| | | C-1 | 57 / 60 | 15.1 - 20.1 | | 7.3<br>7.5<br>3.8<br>3.5<br>4.3 | | Strong, light gray/white GRANITE, massive, slightly weathered to fresh.<br>REC = 97% RQD = 83% | GRANITE |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Wash color brown.
2.Iron staining throughout sample S-2 and S-3.
3.Cobbles from 5.1'-6'.
4.Boulders from 6.3'-7.4'.
5.Driller switched to 3' casing at approximately 10' to prepare for rock coring.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

*(Continued Next Page)*

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# BORING NUMBER B19-7



**CLIENT** HKT Architects **PROJECT NAME** Ashland Public Safety Complex

**PROJECT NUMBER** 17044.03 **PROJECT LOCATION** Ashland, MA

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 20 | | C-2 | 56 / 58 | 20.1 - 24.9 | | 8.5<br>7.7<br>10.0<br>12.0<br>6.5 | | Strong, white GRANITE, massive, slightly weathered to fresh.<br>REC = 97% RQD = 78% | GRANITE |
| 25 | | | | | | | | Bottom of borehole at 24.9 feet. | |
| 30 | | | | | | | | | |
| 35 | | | | | | | | | |
| 40 | | | | | | | | | |
| 45 | | | | | | | | | |

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# BORING NUMBER B19-8



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/13/19 **COMPLETED** 9/16/19
**GROUND ELEVATION** 204.6 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** 10.00 ft / Elev 194.6 ft
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 10.00 ft / Elev 194.6 ft
**BORING LOCATION** 2920270.735°N, 669844.555°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 4 / 7 | 0 - 0.6 | 30-60/1" | | | Dry, dense, brown, fine SAND and SILT, trace medium to coarse sand, trace fine gravel. | 2" TOPSOIL |
| | | | | | | | | Boulder | BOULDER |
| | | S-2 | 12 / 24 | 2 - 4 | 25-23-15-19 (38) | | | Dry, dense, brown, fine to coarse GRAVEL, some silt, little fine to coarse sand. | GLACIAL STRATIFIED DEPOSITS |
| 5 | | S-3 | 9 / 13 | 4 - 5.1 | 25-51-37/1" | | | Moist, very dense, brown, fine SAND, some fine to coarse gravel, some silt, little medium to coarse sand. | |
| | | | | | | | | Boulder | BOULDER |
| | | S-4 | 12 / 19 | 6 - 7.6 | 58-83-110-35/1" | | | Moist, very dense, brown, fine to coarse GRAVEL (max. 2.5"), some fine to coarse sand, trace silt. | |
| | | S-5 | 13 / 15 | 8 - 9.3 | 39-71-55/3" | | | Moist, very dense, brown, fine to coarse SAND and fine to coarse GRAVEL, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| 10 | | S-6 | 5 / 9 | 10 - 10.7 | 64-58/3" | | | Wet, very dense, brown, fine to coarse SAND, some fine to coarse gravel, trace silt. | |
| | | | | | | 4.8 | | Strong, light gray/white GRANITE, massive, slightly weathered to fresh. | GRANITE |
| | | | | | | 7.1 | | REC =93% RQD = 88% | |
| 15 | | C-1 | 55 / 59 | 12.5 - 17.4 | | 7.2 | | | |
| | | | | | | 5.2 | | | |
| | | | | | | 5.5 | | | |
| | | | | | | 7.1 | | Strong, light gray/white GRANITE, massive, slightly weathered to fresh. | |
| | | C-2 | 37 / 40 | 17.4 - 20.7 | | 5.2 | | REC = 93% RQD = 55% | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1. Driller hand dug boulders from approximately 0.6'-2'.
2. Wash color light brown.
3. 1' boulder from approximately 5.1'-6'.
4. Driller indicated bedrock at approximately 12.5'.
5. A monitoring well was installed at this location. Depth of well 20.4' (10' screen). Please see well/piezometer installation sketch for more details.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

*(Continued Next Page)*

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# BORING NUMBER B19-8



**CLIENT** HKT Architects **PROJECT NAME** Ashland Public Safety Complex

**PROJECT NUMBER** 17044.03 **PROJECT LOCATION** Ashland, MA

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 20 | | | | | | 5.9 | | | GRANITE |
| | | | | | | 5.5/4" | | Bottom of borehole at 20.7 feet. | |
| 25 | | | | | | | | | |
| 30 | | | | | | | | | |
| 35 | | | | | | | | | |
| 40 | | | | | | | | | |
| 45 | | | | | | | | | |

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# BORING NUMBER B19-9



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/16/19 **COMPLETED** 9/16/19
**GROUND ELEVATION** 216.9 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 9.90 ft / Elev 207.0 ft
**BORING LOCATION** 2920293.566°N, 69947.109°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 13 / 24 | 0 - 2 | 6-9-14-26 (23) | | | Moist, medium dense, brown, fine to medium SAND and fine to coarse GRAVEL, trace coarse sand, trace silt. | 1" TOPSOIL<br>GLACIAL STRATIFIED DEPOSITS |
| | | S-2 | 5 / 7 | 2 - 2.6 | 33-36/1" | | | Moist, very dense, brown, fine to medium SAND, some fine to coarse gravel, trace coarse sand, trace silt.<br>Boulder | BOULDER<br>GLACIAL STRATIFIED DEPOSITS |
| 5 | | S-3 | 0 / 3 | 4 - 4.3 | 39/3" | | | Refusal. Fine to coarse gravel in spoon tip. Driller advanced rollerbit to 6'. | |
| | | S-4 | 0 / 0 | 6 - 8.3 | 6/0" | | | Spoon bounced back/refusal. Driller advanced rollerbit to 8.3'. | BOULDER |
| 10 | | S-5 | 1 / 3 | 8.3 - 8.6 | 39/3" | | | Wet, very dense, brown, fine to medium SAND, trace coarse sand, trace fine gravel, trace silt.<br>Boulder | GLACIAL STRATIFIED DEPOSITS<br>BOULDER |
| | | S-6 | 10 / 14 | 10 - 11.2 | 15-16-35/2" | | | Wet, very dense, brown, fine to medium SAND, trace gravel, trace coarse sand, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| 15 | | | | | | | | Bottom of borehole at 11.2 feet. | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.Wash color light brown.
2.1' boulder between 2.6'-3.6'.
3.Possible boulders between 4.3'-8.0'.
4.Possible boulders/bedrock from 8.6'-9.8'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# BORING NUMBER B19-10



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/17/19 **COMPLETED** 9/17/19
**GROUND ELEVATION** 218.6 ft **HOLE SIZE** 4 in.
**DRILLING CONTRACTOR** Northern Drill Service, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** Wash & Drive
**AT TIME OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** RKM
**AT END OF DRILLING** 2.00 ft / Elev 216.6 ft
**BORING LOCATION** 290184.307°N, 670085.847°E

| DEPTH (ft) | CASING (bl/ft) | SAMPLE TYPE NUMBER | RECOVERY/PEN. (in) | DEPTH (FT) | BLOW COUNTS/6" | MIN/FT | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 0 | | S-1 | 2 / 24 | 0 - 2 | 10-13-10-7 (23) | | | Moist, medium dense, brown, fine SAND and SILT, trace fine gravel, trace coarse sand, trace organics. (roots). | 2" TOPSOIL |
| | | S-2 | 15 / 24 | 2 - 4 | 13-13-22-20 (35) | | | Moist, dense, light brown, fine SAND, little fine to coarse gravel, trace medium to coarse sand, trace silt. | |
| 5 | | S-3 | 17 / 24 | 4 - 6 | 30-32-40-35 (72) | | | Wet, very dense, light brown, fine to coarse GRAVEL and fine to medium SAND, trace coarse sand, trace silt. | GLACIAL STRATIFIED DEPOSITS |
| | | S-4 | 16 / 24 | 6 - 8 | 26-23-20-17 (43) | | | Wet, dense, light brown/light gray/tan, fine to coarse SAND, some fine to coarse gravel, trace silt. | |
| | | S-5 | 9 / 16 | 8 - 9.3 | 18-22-39/4" | | | Wet, very dense, light brown to light gray, fine to coarse GRAVEL, some fine to coarse sand, trace silt. | |
| 10 | | | | | | | | Bottom of borehole at 9.3 feet. | |
| 15 | | | | | | | | | |
| 20 | | | | | | | | | |

**GRANULAR SOILS**

| BLOWS/FT | DENSITY |
|---|---|
| 0 - 4 | V. LOOSE |
| 4 -10 | LOOSE |
| 10 - 30 | M. DENSE |
| 30 - 50 | DENSE |
| >50 | V. DENSE |

**COHESIVE SOILS**

| BLOWS/FT | CONSIST. |
|---|---|
| <2 | V. SOFT |
| 2 - 4 | SOFT |
| 4 - 8 | M. STIFF |
| 8 - 15 | STIFF |
| 15 - 30 | V. STIFF |
| >30 | HARD |

**REMARKS:**
1.S-3: Iron staining at approximately 5'-6'.

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-1



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 188.3 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920136.038°N, 669719.805°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 12 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| | P-2 | 12 - 14 | | Boulders | BOULDERS |
| 15 | P-3 | 14 - 15 | | SAND and GRAVEL | SAND & GRAVEL |

Bottom of probe at 15.0 feet.

20

**REMARKS:**

1. **Easy drilling.**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-2



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 196.6 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920207.155°N, 669783.388°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 14 | | SAND & GRAVEL | SAND & GRAVEL |
| 15 | P-2 | 14 - 15 | | Bedrock | BEDROCK |

Bottom of probe at 15.0 feet.

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-3



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 210.9 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920317.164°N, 669897.627°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 7 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | P-2 | 7 - 15 | | Bedrock | BEDROCK |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

1. **Driller indicated very hard bedrock encountered at 7'.**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-4



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 217.9 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920288.875°N, 669966.625°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 8 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | P-2 | 8 - 15 | | Bedrock | BEDROCK |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-5



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 218.3 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920249.308°N, 670030.383°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 6 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | P-2 | 6 - 15 | | Bedrock | BEDROCK |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-6



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 219.9 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 213.9 ft (Approximate)
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2920222.099°N, 670085.778°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 9 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | P-2 | 9 - 15 | | Bedrock | BEDROCK |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-7



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 218.1 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920100.896°N, 670071.042°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 13 | | SAND and GRAVEL | SAND & GRAVEL |
| 15 | P-2 | 13 - 15 | | Bedrock | BEDROCK |

Bottom of probe at 15.0 feet.

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-8



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 218.5 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** 8.00 ft / Elev 210.5 ft (Approximate)
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920014.355°N, 670115.414°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

1. **Driller indicated bedrock was encountered at approximately 15'.**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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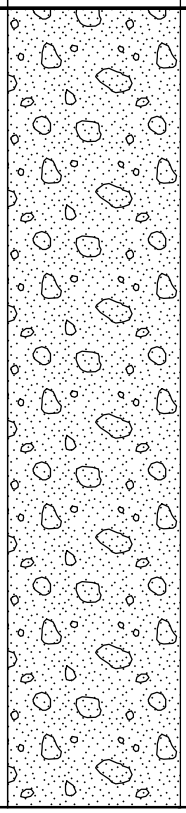
# PROBE NUMBER RP19-9



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 219.0 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2919968.883°N, 670171.847°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 |  | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-10



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 220.0 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** 3.00 ft / Elev 217.0 ft (Approximate)
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2919903.676°N, 670164.508°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-11



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 214.5 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2919995.959°N, 670047.507°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND & GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-12



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 211.1 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2919945.997°N, 670007.375°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-13



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 202.9 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 196.9 ft (Approximate)
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2919979.928°N, 669926.536°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-14



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 207.0 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 201.0 ft
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2920075.685°N, 669936.080°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-15



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 199.1 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 193.1 ft (Approximate)
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2920084.125°N, 669866.131°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | Moist, gray to brown SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-16



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 197.0 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 191.0 ft (Approximate)
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2920152.885°N, 669828.453°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 2 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-2 | 2 - 5 | | Boulder | BOULDER |
| 5 | P-3 | 5 - 11 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | P-4 | 11 - 15 | | Bedrock | BEDROCK |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-17



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 204.6 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920137.269°N, 669918.446°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 8 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | P-2 | 8 - 15 | | Bedrock | BEDROCK |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

1. **Driller indicated soft bedrock encountered at 8'.**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-18



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 213.2 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920170.433°N, 669961.064°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 12 | | SAND and GRAVEL | SAND & GRAVEL |
| 15 | P-2 | 12 - 15 | | Bedrock | BEDROCK |
| | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-19



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 217.2 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920246.647°N, 669956.337°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 2 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-2 | 2 - 3 | | Boulder | BOULDER |
| | P-3 | 3 - 5 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | P-4 | 5 - 6 | | Boulder | BOULDER |
| | P-5 | 6 - 7 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-6 | 7 - 9 | | Boulder | BOULDER |
| | P-7 | 9 - 14 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | | | | | |
| | P-8 | 14 - 15 | | Bedrock | BEDROCK |
| 15 | | | | | |
| | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-20



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 207.5 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920207.379°N, 669881.289°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 2 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-2 | 2 - 5 | | Boulder | BOULDER |
| 5 | P-3 | 5 - 8 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-4 | 8 - 15 | | Bedrock | BEDROCK |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-21



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 210.7 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920041.816°N, 669976.284°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-22



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 206.6 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920019.328°N, 669953.749°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 15 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-23



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 213.9 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920111.636°N, 669984.824°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 1 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-2 | 1 - 3 | | Boulder | BOULDER |
| | P-3 | 3 - 5 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | P-4 | 5 - 7 | | Boulder | BOULDER |
| | P-5 | 7 - 14 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | | | | | |
| 15 | P-6 | 14 - 15 | | Bedrock | BEDROCK |
| 20 | | | | Bottom of probe at 15.0 feet. | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-24



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 217.4 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
**AT TIME OF DRILLING** --- Not Encountered
**LOGGED BY** MLP **CHECKED BY** SJM
**AT END OF DRILLING** ---
**BORING LOCATION** 2920121.463°N, 670048.808°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 2 | | SAND and GRAVEL | SAND & GRAVEL |
| | P-2 | 2 - 4 | | Boulder | BOULDER |
| 5 | P-3 | 4 - 9 | | SAND and GRAVEL | SAND & GRAVEL |
| 10 | P-4 | 9 - 15 | | Bedrock | BEDROCK |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-25



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 217.9 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 211.9 ft (Approximate)
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2920218.903°N, 670041.408°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 12 | | SAND and GRAVEL | SAND & GRAVEL |
| 5 | | | | | |
| 10 | | | | | |
| | P-2 | 12 - 15 | | Bedrock | BEDROCK |
| 15 | | | | Bottom of probe at 15.0 feet. | |
| 20 | | | | | |

**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**

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# PROBE NUMBER RP19-26



**CLIENT** HKT Architects
**PROJECT NAME** Ashland Public Safety Complex
**PROJECT NUMBER** 17044.03
**PROJECT LOCATION** Ashland, MA
**DATE STARTED** 9/4/19 **COMPLETED** 9/4/19
**GROUND ELEVATION** 218.6 ft **HOLE SIZE** 2 1/2 inches
**DRILLING CONTRACTOR** South Street Drilling & Blasting
**GROUND WATER LEVELS:**
**DRILLING METHOD** Air track
▽ **AT TIME OF DRILLING** 6.00 ft / Elev 212.6 ft (Approximate)
**AT END OF DRILLING** ---
**LOGGED BY** MLP **CHECKED BY** SJM
**BORING LOCATION** 2920139.194°N, 670101.278°E

| DEPTH (ft) | SAMPLE TYPE NUMBER | DEPTH (FT) | GRAPHIC LOG | SAMPLE DESCRIPTION | STRATUM DESCRIPTION |
|---|---|---|---|---|---|
| 0 | P-1 | 0 - 13 | | Moist, brown to gray SAND and GRAVEL | SAND & GRAVEL |
| 15 | P-2 | 13 - 15 | | Bedrock | BEDROCK |
| 20 | | | | Bottom of probe at 15.0 feet. | |

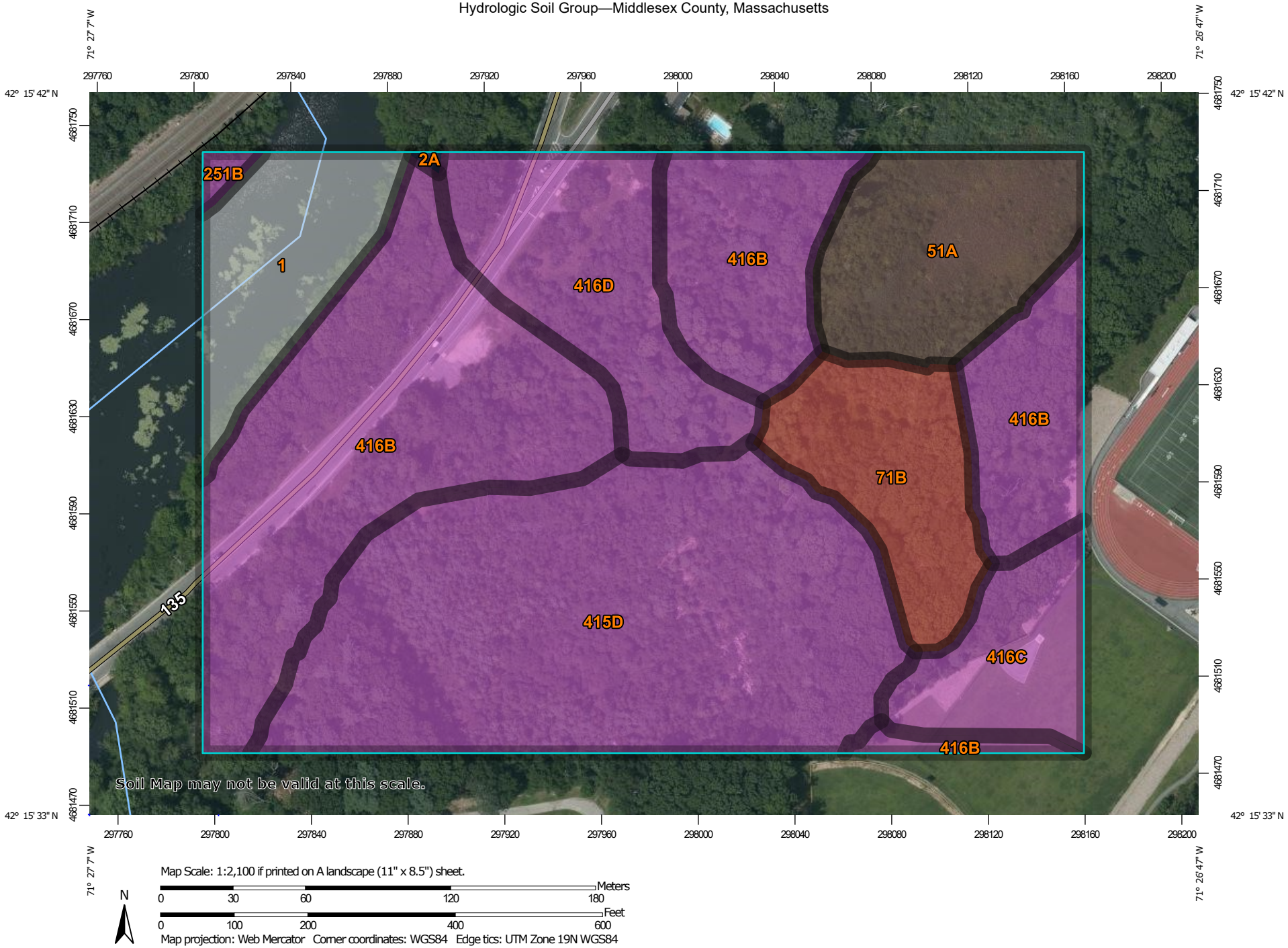
**REMARKS:**

**BURMISTER CLASSIFICATION**

| | |
|---|---|
| TRACE | 0 -10% |
| LITTLE | 10 - 20% |
| SOME | 20 - 35% |
| AND | 35 - 50% |

PERCENT BY WEIGHT

**NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.**
**2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.**




Map Scale: 1:2,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Lines**

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Soil Rating Points**

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

**Water Features**

- Streams and Canals

**Transportation**

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**

- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 19, Sep 12, 2019

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

Date(s) aerial images were photographed: Jul 28, 2019—Aug 15, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 1 | Water | | 1.5 | 6.6% |
| 2A | Pootatuck fine sandy loam, 0 to 3 percent slopes | B | 0.0 | 0.1% |
| 51A | Swansea muck, 0 to 1 percent slopes | B/D | 2.0 | 8.7% |
| 71B | Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony | D | 1.7 | 7.5% |
| 251B | Haven silt loam, 3 to 8 percent slopes | A | 0.1 | 0.4% |
| 415D | Narragansett silt loam, 15 to 25 percent slopes | A | 6.5 | 29.2% |
| 416B | Narragansett silt loam, 3 to 8 percent slopes, very stony | A | 7.3 | 32.7% |
| 416C | Narragansett silt loam, 8 to 15 percent slopes, very stony | A | 1.2 | 5.3% |
| 416D | Narragansett silt loam, 15 to 25 percent slopes, very stony | A | 2.2 | 9.6% |
| **Totals for Area of Interest** | | | **22.4** | **100.0%** |

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

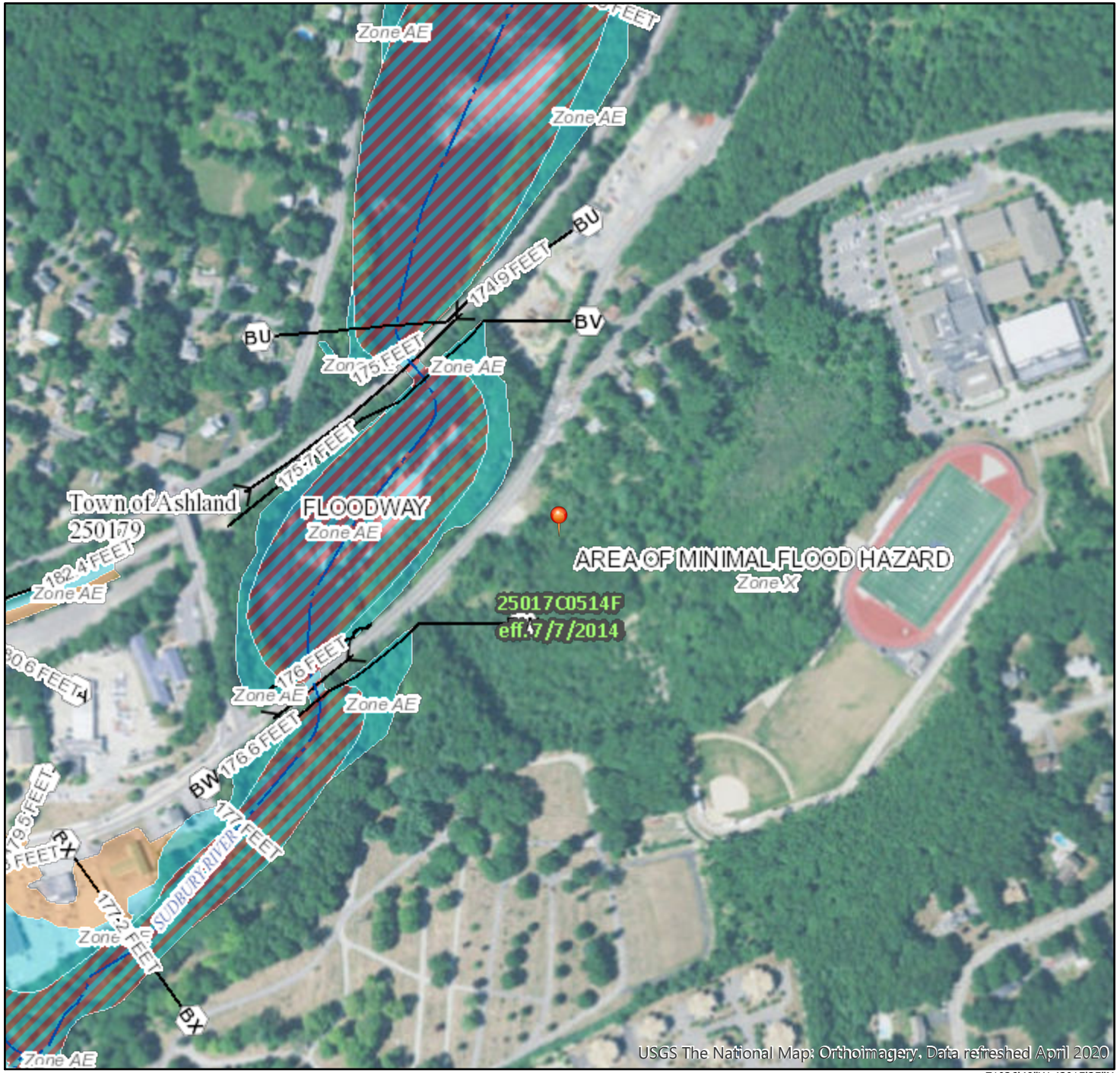
*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# National Flood Hazard Layer FIRMette

71°27'18"W 42°15'52"N




71°26'40"W 42°15'25"N

Feet

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

1:6,000

## Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/22/2020 at 2:02 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

# NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Massachusetts State Plane Mainland Zone (FIPS zone 2001). The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

**Base map** information shown on this FIRM was derived from orthophotography provided by MassGIS at a scale of 1:500 from photography dated April 2008.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

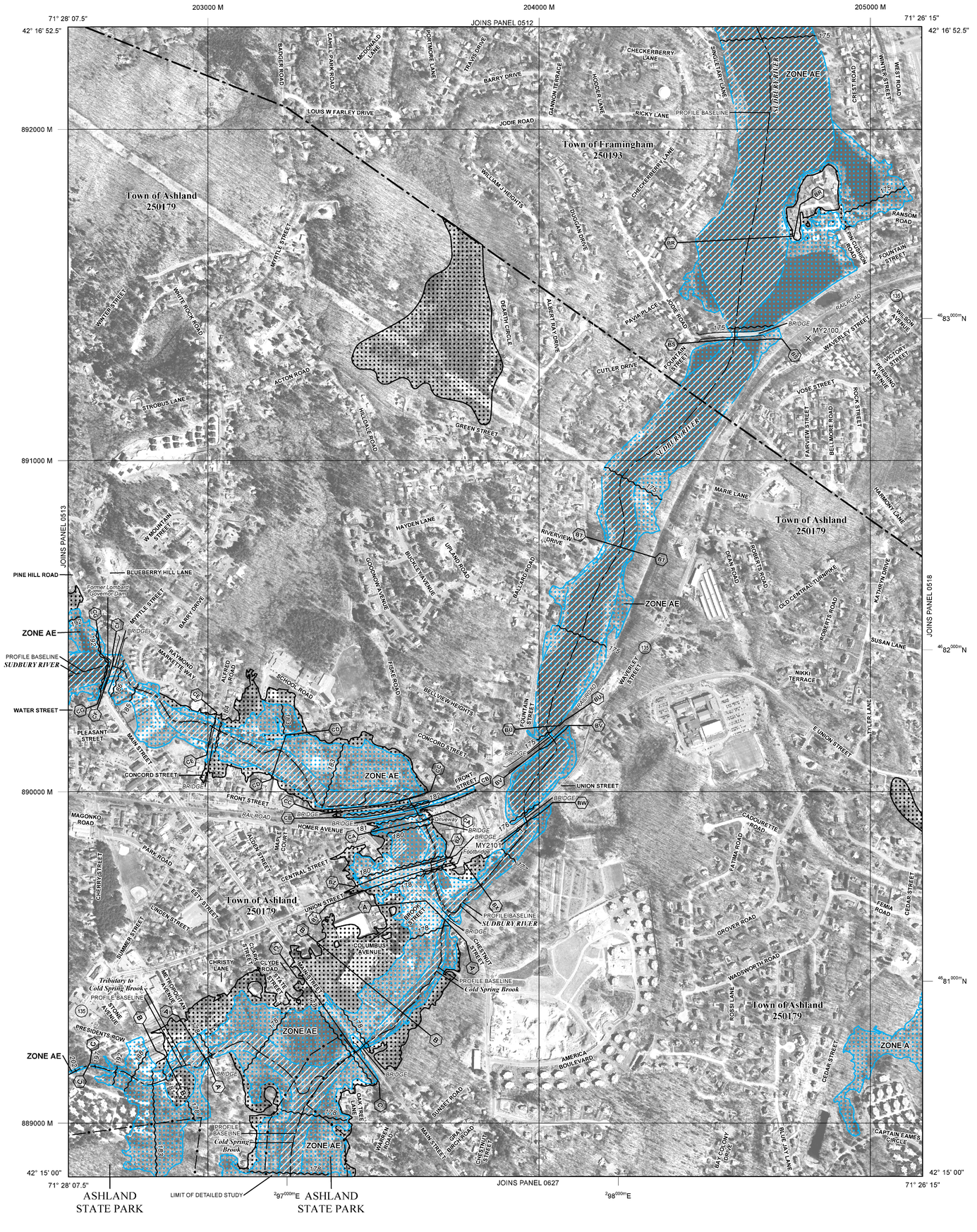
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.




# LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

**ZONE A** No Base Flood Elevations determined.

**ZONE AE** Base Flood Elevations determined.

**ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

**ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

**ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

**ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

**ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

**ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

**ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

**ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.

**ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% Annual Chance Floodplain Boundary
- 0.2% Annual Chance Floodplain Boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A — A — Cross section line
- 23 — 23 — Transect line
- 45° 02' 08", 93° 02' 12" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
- 4989000 M — 1000-meter ticks: Massachusetts State Plane Mainland Zone (FIPS Zone 2001), Lambert Conformal Conic projection
- 4683000mN — 1000-meter Universal Transverse Mercator grid values, zone 19
- DX5510 × — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
June 4, 2010

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

July 7, 2014 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0514F

# FIRM

## FLOOD INSURANCE RATE MAP

## MIDDLESEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

**PANEL 514 OF 656**
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

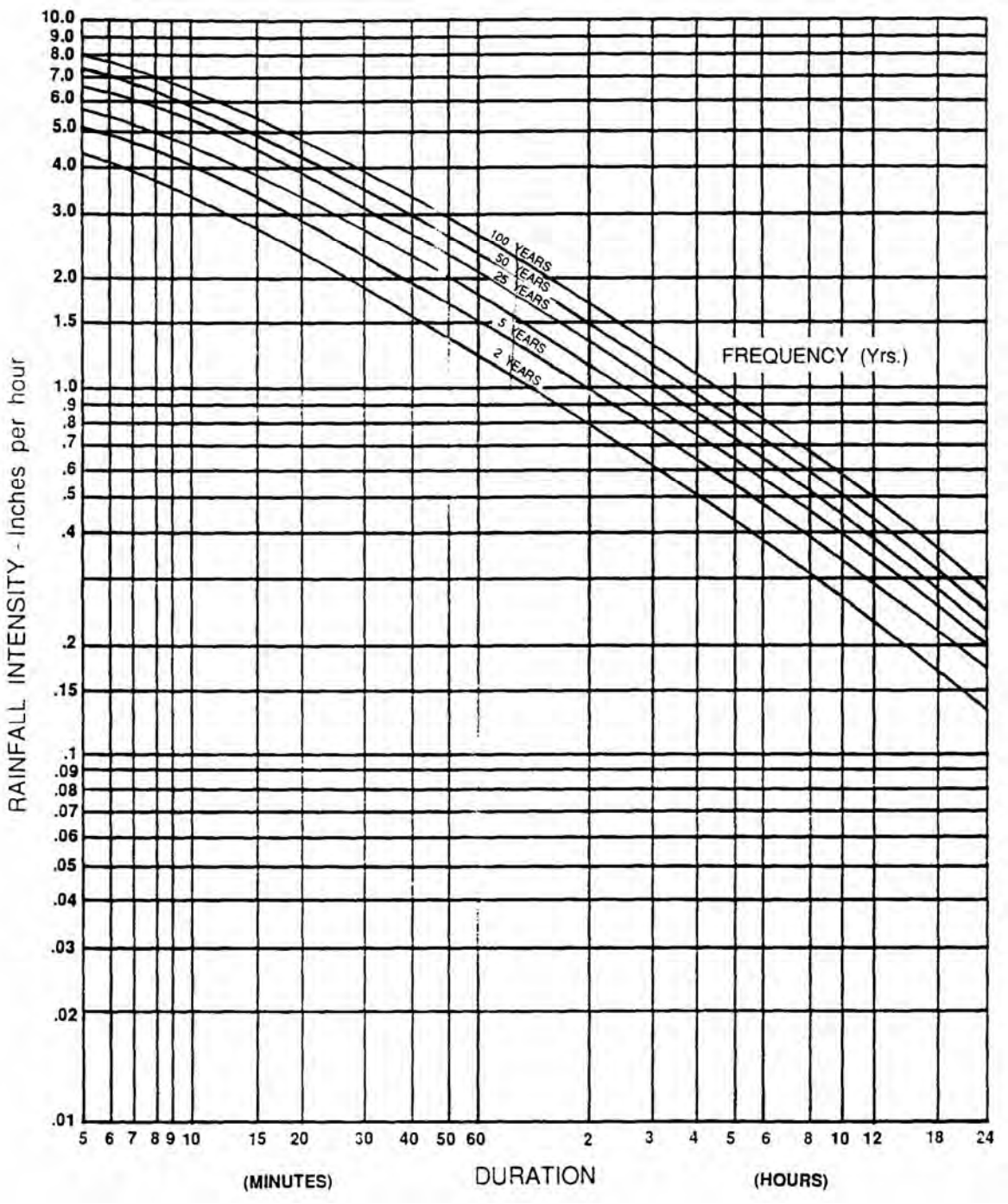
| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ASHLAND, TOWN OF | 250179 | 0514 | F |
| FRAMINGHAM, TOWN OF | 250193 | 0514 | F |

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

**MAP NUMBER**
**25017C0514F**
**MAP REVISED**
**JULY 7, 2014**

Federal Emergency Management Agency

**Exhibit 8-14**
**Intensity – Duration – Frequency Curve for Worcester, MA**




Source: TR55 - Urban Hydrology for Small Wetlands, NRCS

Table 2-2a Runoff curve numbers for urban areas [1]

| Cover description: Cover type and hydrologic condition | Average percent impervious area [2] | Curve numbers for hydrologic soil group: A | B | C | D |
|---|---|---|---|---|---|
| *Fully developed urban areas (vegetation established)* | | | | | |
| Open space (lawns, parks, golf courses, cemeteries, etc.) [3]: | | | | | |
| Poor condition (grass cover < 50%) | | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | | 49 | 69 | 79 | 84 |
| Good condition (grass cover > 75%) | | 39 | 61 | 74 | 80 |
| Impervious areas: | | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Streets and roads: | | | | | |
| Paved; curbs and storm sewers (excluding right-of-way) | | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | | 72 | 82 | 87 | 89 |
| Western desert urban areas: | | | | | |
| Natural desert landscaping (pervious areas only) [4] | | 63 | 77 | 85 | 88 |
| Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders) | | 96 | 96 | 96 | 96 |
| Urban districts: | | | | | |
| Commercial and business | 85 | 89 | 92 | 94 | 95 |
| Industrial | 72 | 81 | 88 | 91 | 93 |
| Residential districts by average lot size: | | | | | |
| 1/8 acre or less (town houses) | 65 | 77 | 85 | 90 | 92 |
| 1/4 acre | 38 | 61 | 75 | 83 | 87 |
| 1/3 acre | 30 | 57 | 72 | 81 | 86 |
| 1/2 acre | 25 | 54 | 70 | 80 | 85 |
| 1 acre | 20 | 51 | 68 | 79 | 84 |
| 2 acres | 12 | 46 | 65 | 77 | 82 |
| *Developing urban areas* | | | | | |
| Newly graded areas (pervious areas only, no vegetation) [5] | | 77 | 86 | 91 | 94 |
| Idle lands (CN's are determined using cover types similar to those in table 2-2c). | | | | | |

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

## F-1. Rainfall Data for Massachusetts from *Rainfall Frequency Atlas of the United States* (TP-40)

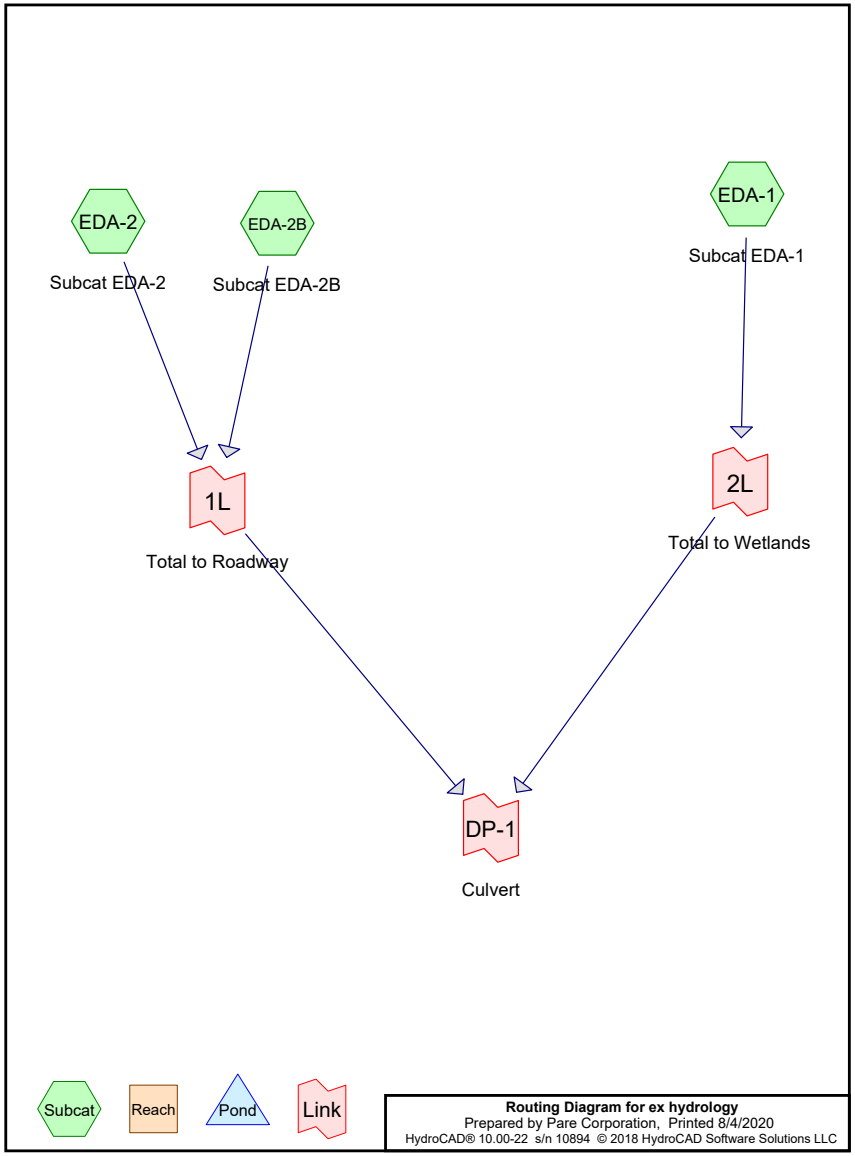
- Users of this Handbook should note that current MA DEP written guidance (see DEP Waterlines newsletter -- Fall 2000) requires the use of TP-40 Rainfall Data for calculations under the Wetlands Protection Regulations and the Stormwater Management Policy. More stringent design storms may be used under a local bylaw or ordinance. However, DEP will continue to require the use of TP-40 in any case it reviews under the Wetlands Protection Act and Stormwater Management Policy.

*Adjusted Technical Paper 40 Design Storms for 24-hour Event by County*

| County Name | 1-yr 24-hr | 2-yr 24-hr | 5-yr 24-hr | 10-yr 24-hr | 25-yr 24-hr | 50-yr 24-hr | 100-yr 24-hr |
|---|---|---|---|---|---|---|---|
| Barnstable | 2.5 | 3.6 | 4.5 | 4.8 | 5.7 | 6.4 | 7.1 |
| Berkshire | 2.5 | 2.9 | 3.8 | 4.4 | 5.1 | 5.9 | 6.4 |
| Bristol | 2.5 | 3.4 | 4.3 | 4.8 | 5.6 | 6.3 | 7.0 |
| Dukes | 2.5 | 3.6 | 4.6 | 4.9 | 5.8 | 6.5 | 7.2 |
| Essex | 2.5 | 3.1 | 3.9 | 4.5 | 5.4 | 5.9 | 6.5 |
| Franklin | 2.5 | 2.9 | 3.8 | 4.3 | 5.1 | 5.8 | 6.2 |
| Hampden | 2.5 | 3.0 | 4.0 | 4.6 | 5.3 | 6.0 | 6.5 |
| Hampshire | 2.5 | 3.0 | 3.9 | 4.5 | 5.2 | 5.9 | 6.4 |
| Middlesex | 2.5 | 3.1 | 4.0 | 4.5 | 5.3 | 5.9 | 6.5 |
| Nantucket | 2.5 | 3.6 | 4.6 | 4.9 | 5.8 | 6.5 | 7.2 |
| Norfolk | 2.5 | 3.2 | 4.1 | 4.7 | 5.5 | 6.1 | 6.7 |
| Plymouth | 2.5 | 3.4 | 4.3 | 4.7 | 5.6 | 6.2 | 7.0 |
| Suffolk | 2.5 | 3.2 | 4.0 | 4.6 | 5.5 | 6.0 | 6.6 |
| Worcester | 2.5 | 3.0 | 4.0 | 4.5 | 5.3 | 5.9 | 6.5 |

# APPENDIX B

Hydrologic Calculations – Existing and Proposed Conditions
Hydraulic Design Table






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

**SubcatchmentEDA-1: Subcat EDA-1** Runoff Area=0.701 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=54 Runoff=0.05 cfs 0.011 af

**SubcatchmentEDA-2: Subcat EDA-2** Runoff Area=2.907 ac 0.08% Impervious Runoff Depth=0.03"
Flow Length=507' Tc=22.1 min CN=45 Runoff=0.01 cfs 0.008 af

**SubcatchmentEDA-2B: Subcat EDA-2B** Runoff Area=0.382 ac 31.06% Impervious Runoff Depth=0.48"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=63 Runoff=0.14 cfs 0.015 af

**Link 1L: Total to Roadway** Inflow=0.14 cfs 0.023 af
Primary=0.14 cfs 0.023 af

**Link 2L: Total to Wetlands** Inflow=0.05 cfs 0.011 af
Primary=0.05 cfs 0.011 af

**Link DP-1: Culvert** Inflow=0.14 cfs 0.035 af
Primary=0.14 cfs 0.035 af

**Total Runoff Area = 3.991 ac Runoff Volume = 0.035 af Average Runoff Depth = 0.10"**
**96.97% Pervious = 3.870 ac 3.03% Impervious = 0.121 ac**

## Summary for Subcatchment EDA-1: Subcat EDA-1

Runoff = 0.05 cfs @ 12.42 hrs, Volume= 0.011 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.048 | 43 | Woods/grass comb., Fair, HSG A |
| 0.356 | 43 | Woods/grass comb., Fair, HSG A |
| 0.016 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.281 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.701 | 54 | Weighted Average |
| 0.701 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.9 | 50 | 0.0600 | 0.10 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 0.9 | 210 | 0.0600 | 3.94 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 8.8 | 260 | Total | | | |



## Summary for Subcatchment EDA-2: Subcat EDA-2

Runoff = 0.01 cfs @ 15.89 hrs, Volume= 0.008 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 2.718 | 43 | Woods/grass comb., Fair, HSG A |
| 0.000 | 43 | Woods/grass comb., Fair, HSG A |
| 0.028 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.068 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.036 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.055 | 96 | Gravel surface, HSG A |
| 0.000 | 98 | Paved parking, HSG A |
| 0.000 | 98 | Paved parking, HSG A |
| 0.002 | 98 | Paved parking, HSG A |
| 2.907 | 45 | Weighted Average |
| 2.905 | | 99.92% Pervious Area |
| 0.002 | | 0.08% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.3 | 50 | 0.0100 | 0.05 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.8 | 112 | 0.0450 | 1.06 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.7 | 80 | 0.1500 | 1.94 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.9 | 42 | 0.0240 | 0.77 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.4 | 51 | 0.1570 | 1.98 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.4 | 87 | 0.0460 | 1.07 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.6 | 85 | 0.0210 | 2.33 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 22.1 | 507 | Total | | | |

## Summary for Subcatchment EDA-2B: Subcat EDA-2B

Runoff = 0.14 cfs @ 12.14 hrs, Volume= 0.015 af, Depth= 0.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (ac) | CN | Description |
|---|---|---|
| 0.164 | 43 | Woods/grass comb., Fair, HSG A |
| 0.042 | 43 | Woods/grass comb., Fair, HSG A |
| 0.027 | 43 | Woods/grass comb., Fair, HSG A |
| 0.008 | 43 | Woods/grass comb., Fair, HSG A |
| 0.023 | 96 | Gravel surface, HSG A |
| 0.017 | 98 | Paved parking, HSG A |
| 0.102 | 98 | Paved parking, HSG A |
| 0.382 | 63 | Weighted Average |
| 0.264 | | 68.94% Pervious Area |
| 0.119 | | 31.06% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.4 | 50 | 0.1040 | 0.13 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 121 | 0.1040 | 1.61 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 7.7 | 171 | Total | | | |



## Summary for Link 1L: Total to Roadway

Inflow Area = 3.290 ac, 3.68% Impervious, Inflow Depth = 0.08" for 2-Year event
Inflow = 0.14 cfs @ 12.14 hrs, Volume= 0.023 af
Primary = 0.14 cfs @ 12.14 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

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

## Summary for Link 2L: Total to Wetlands

Inflow Area = 0.701 ac, 0.00% Impervious, Inflow Depth = 0.20" for 2-Year event
Inflow = 0.05 cfs @ 12.42 hrs, Volume= 0.011 af
Primary = 0.05 cfs @ 12.42 hrs, Volume= 0.011 af, Atten= 0%, Lag= 0.0 min

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



## Summary for Link DP-1: Culvert

Inflow Area = 3.991 ac, 3.03% Impervious, Inflow Depth = 0.10" for 2-Year event
Inflow = 0.14 cfs @ 12.16 hrs, Volume= 0.035 af
Primary = 0.14 cfs @ 12.16 hrs, Volume= 0.035 af, Atten= 0%, Lag= 0.0 min

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

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

**Subcatchment EDA-1: Subcat EDA-1** Runoff Area=0.701 ac 0.00% Impervious Runoff Depth=1.73"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=54 Runoff=1.16 cfs 0.101 af

**Subcatchment EDA-2: Subcat EDA-2** Runoff Area=2.907 ac 0.08% Impervious Runoff Depth=1.01"
Flow Length=507' Tc=22.1 min CN=45 Runoff=1.58 cfs 0.245 af

**Subcatchment EDA-2B: Subcat EDA-2B** Runoff Area=0.382 ac 31.06% Impervious Runoff Depth=2.53"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=63 Runoff=1.04 cfs 0.081 af

**Link 1L: Total to Roadway** Inflow=2.04 cfs 0.325 af
Primary=2.04 cfs 0.325 af

**Link 2L: Total to Wetlands** Inflow=1.16 cfs 0.101 af
Primary=1.16 cfs 0.101 af

**Link DP-1: Culvert** Inflow=2.72 cfs 0.426 af
Primary=2.72 cfs 0.426 af

**Total Runoff Area = 3.991 ac Runoff Volume = 0.426 af Average Runoff Depth = 1.28"**
**96.97% Pervious = 3.870 ac 3.03% Impervious = 0.121 ac**



## Summary for Subcatchment EDA-1: Subcat EDA-1

Runoff = 1.16 cfs @ 12.14 hrs, Volume= 0.101 af, Depth= 1.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.048 | 43 | Woods/grass comb., Fair, HSG A |
| 0.356 | 43 | Woods/grass comb., Fair, HSG A |
| 0.016 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.281 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.701 | 54 | Weighted Average |
| 0.701 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.9 | 50 | 0.0600 | 0.10 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 0.9 | 210 | 0.0600 | 3.94 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 8.8 | 260 | Total | | | |

## Summary for Subcatchment EDA-2: Subcat EDA-2

Runoff = 1.58 cfs @ 12.40 hrs, Volume= 0.245 af, Depth= 1.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 2.718 | 43 | Woods/grass comb., Fair, HSG A |
| 0.000 | 43 | Woods/grass comb., Fair, HSG A |
| 0.028 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.068 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.036 | 68 | Pasture/grassland/range, Poor, HSG A |
| 0.055 | 96 | Gravel surface, HSG A |
| 0.000 | 98 | Paved parking, HSG A |
| 0.000 | 98 | Paved parking, HSG A |
| 0.002 | 98 | Paved parking, HSG A |
| 2.907 | 45 | Weighted Average |
| 2.905 | | 99.92% Pervious Area |
| 0.002 | | 0.08% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 16.3 | 50 | 0.0100 | 0.05 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.8 | 112 | 0.0450 | 1.06 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.7 | 80 | 0.1500 | 1.94 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.9 | 42 | 0.0240 | 0.77 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.4 | 51 | 0.1570 | 1.98 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 1.4 | 87 | 0.0460 | 1.07 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 0.6 | 85 | 0.0210 | 2.33 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 22.1 | 507 | Total | | | |



## Summary for Subcatchment EDA-2B: Subcat EDA-2B

Runoff = 1.04 cfs @ 12.12 hrs, Volume= 0.081 af, Depth= 2.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (ac) | CN | Description |
|---|---|---|
| 0.164 | 43 | Woods/grass comb., Fair, HSG A |
| 0.042 | 43 | Woods/grass comb., Fair, HSG A |
| 0.027 | 43 | Woods/grass comb., Fair, HSG A |
| 0.008 | 43 | Woods/grass comb., Fair, HSG A |
| 0.023 | 96 | Gravel surface, HSG A |
| 0.017 | 98 | Paved parking, HSG A |
| 0.102 | 98 | Paved parking, HSG A |
| 0.382 | 63 | Weighted Average |
| 0.264 | | 68.94% Pervious Area |
| 0.119 | | 31.06% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.4 | 50 | 0.1040 | 0.13 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 121 | 0.1040 | 1.61 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 7.7 | 171 | Total | | | |

## Summary for Link 1L: Total to Roadway

Inflow Area = 3.290 ac, 3.68% Impervious, Inflow Depth = 1.19" for 100-Year event
Inflow = 2.04 cfs @ 12.37 hrs, Volume= 0.325 af
Primary = 2.04 cfs @ 12.37 hrs, Volume= 0.325 af, Atten= 0%, Lag= 0.0 min

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



## Summary for Link 2L: Total to Wetlands

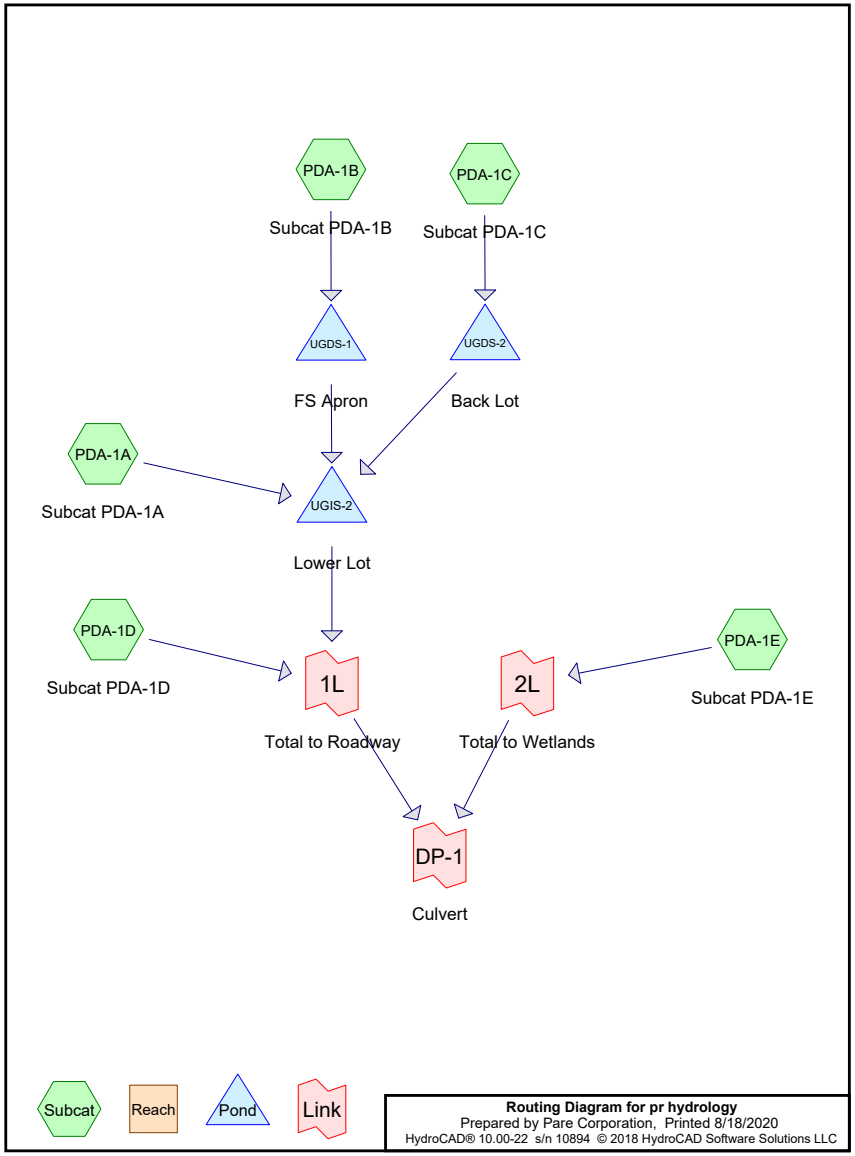
Inflow Area = 0.701 ac, 0.00% Impervious, Inflow Depth = 1.73" for 100-Year event
Inflow = 1.16 cfs @ 12.14 hrs, Volume= 0.101 af
Primary = 1.16 cfs @ 12.14 hrs, Volume= 0.101 af, Atten= 0%, Lag= 0.0 min

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

## Summary for Link DP-1: Culvert

Inflow Area = 3.991 ac, 3.03% Impervious, Inflow Depth = 1.28" for 100-Year event
Inflow = 2.72 cfs @ 12.33 hrs, Volume= 0.426 af
Primary = 2.72 cfs @ 12.33 hrs, Volume= 0.426 af, Atten= 0%, Lag= 0.0 min

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






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

**SubcatchmentPDA-1A: Subcat PDA-1A** Runoff Area=53,729 sf 72.55% Impervious Runoff Depth=1.46"
Tc=5.0 min CN=82 Runoff=2.18 cfs 0.150 af

**SubcatchmentPDA-1B: Subcat PDA-1B** Runoff Area=29,296 sf 49.57% Impervious Runoff Depth=0.72"
Tc=5.0 min CN=69 Runoff=0.51 cfs 0.041 af

**SubcatchmentPDA-1C: Subcat PDA-1C** Runoff Area=25,540 sf 88.56% Impervious Runoff Depth=2.16"
Tc=5.0 min CN=91 Runoff=1.52 cfs 0.106 af

**SubcatchmentPDA-1D: Subcat PDA-1D** Runoff Area=16,652 sf 35.03% Impervious Runoff Depth=0.40"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=61 Runoff=0.10 cfs 0.013 af

**SubcatchmentPDA-1E: Subcat PDA-1E** Runoff Area=48,632 sf 0.62% Impervious Runoff Depth=0.11"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=50 Runoff=0.02 cfs 0.010 af

**Pond UGDS-1: FS Apron** Peak Elev=192.44' Storage=0.008 af Inflow=0.51 cfs 0.041 af
Outflow=0.22 cfs 0.041 af

**Pond UGDS-2: Back Lot** Peak Elev=200.69' Storage=0.043 af Inflow=1.52 cfs 0.106 af
Outflow=0.24 cfs 0.106 af

**Pond UGIS-2: Lower Lot** Peak Elev=184.04' Storage=0.107 af Inflow=2.48 cfs 0.296 af
Discarded=0.28 cfs 0.296 af Primary=0.00 cfs 0.000 af Outflow=0.28 cfs 0.296 af

**Link 1L: Total to Roadway** Inflow=0.10 cfs 0.013 af
Primary=0.10 cfs 0.013 af

**Link 2L: Total to Wetlands** Inflow=0.02 cfs 0.010 af
Primary=0.02 cfs 0.010 af

**Link DP-1: Culvert** Inflow=0.10 cfs 0.023 af
Primary=0.10 cfs 0.023 af

**Total Runoff Area = 3.991 ac Runoff Volume = 0.319 af Average Runoff Depth = 0.96"**
**52.69% Pervious = 2.103 ac 47.31% Impervious = 1.888 ac**

## Summary for Subcatchment PDA-1A: Subcat PDA-1A

Runoff = 2.18 cfs @ 12.08 hrs, Volume= 0.150 af, Depth= 1.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 38,686 | 98 | Paved parking, HSG A |
| 277 | 98 | Paved parking, HSG A |
| 20 | 98 | Paved parking, HSG A |
| 2,711 | 39 | >75% Grass cover, Good, HSG A |
| 212 | 39 | >75% Grass cover, Good, HSG A |
| 2,692 | 39 | >75% Grass cover, Good, HSG A |
| 2,224 | 39 | >75% Grass cover, Good, HSG A |
| 112 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 39 | >75% Grass cover, Good, HSG A |
| 83 | 39 | >75% Grass cover, Good, HSG A |
| 262 | 39 | >75% Grass cover, Good, HSG A |
| 692 | 39 | >75% Grass cover, Good, HSG A |
| 3,866 | 39 | >75% Grass cover, Good, HSG A |
| 261 | 39 | >75% Grass cover, Good, HSG A |
| 1,632 | 39 | >75% Grass cover, Good, HSG A |
| 53,729 | 82 | Weighted Average |
| 14,747 | | 27.45% Pervious Area |
| 38,982 | | 72.55% Impervious Area |

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



## Summary for Subcatchment PDA-1B: Subcat PDA-1B

Runoff = 0.51 cfs @ 12.09 hrs, Volume= 0.041 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 14,344 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 7 | 98 | Paved parking, HSG A |
| 170 | 98 | Paved parking, HSG A |
| 4,546 | 43 | Woods/grass comb., Fair, HSG A |
| 3,042 | 43 | Woods/grass comb., Fair, HSG A |
| 7 | 39 | >75% Grass cover, Good, HSG A |
| 3 | 39 | >75% Grass cover, Good, HSG A |
| 12 | 39 | >75% Grass cover, Good, HSG A |
| 7,165 | 39 | >75% Grass cover, Good, HSG A |
| 29,296 | 69 | Weighted Average |
| 14,775 | | 50.43% Pervious Area |
| 14,521 | | 49.57% Impervious Area |

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

## Summary for Subcatchment PDA-1C: Subcat PDA-1C

Runoff = 1.52 cfs @ 12.07 hrs, Volume= 0.106 af, Depth= 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 223 | 39 | >75% Grass cover, Good, HSG A |
| 1,316 | 39 | >75% Grass cover, Good, HSG A |
| 1,383 | 39 | >75% Grass cover, Good, HSG A |
| 22,618 | 98 | Paved parking, HSG A |
| 25,540 | 91 | Weighted Average |
| 2,921 | | 11.44% Pervious Area |
| 22,618 | | 88.56% Impervious Area |

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



## Summary for Subcatchment PDA-1D: Subcat PDA-1D

Runoff = 0.10 cfs @ 12.15 hrs, Volume= 0.013 af, Depth= 0.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 5,831 | 98 | Paved parking, HSG A |
| 1 | 98 | Paved parking, HSG A |
| 1 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 5,546 | 43 | Woods/grass comb., Fair, HSG A |
| 3,244 | 39 | >75% Grass cover, Good, HSG A |
| 1,811 | 39 | >75% Grass cover, Good, HSG A |
| 214 | 39 | >75% Grass cover, Good, HSG A |
| 4 | 39 | >75% Grass cover, Good, HSG A |
| 16,652 | 61 | Weighted Average |
| 10,819 | | 64.97% Pervious Area |
| 5,833 | | 35.03% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.4 | 50 | 0.1040 | 0.13 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 121 | 0.1040 | 1.61 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 7.7 | 171 | Total | | | |

## Summary for Subcatchment PDA-1E: Subcat PDA-1E

Runoff = 0.02 cfs @ 13.68 hrs, Volume= 0.010 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 1 | 98 | Paved parking, HSG A |
| 128 | 98 | Paved parking, HSG A |
| 114 | 98 | Paved parking, HSG A |
| 2 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 34 | 98 | Paved parking, HSG A |
| 22 | 98 | Paved parking, HSG A |
| 11,355 | 43 | Woods/grass comb., Fair, HSG A |
| 13,508 | 43 | Woods/grass comb., Fair, HSG A |
| 1,584 | 68 | Pasture/grassland/range, Poor, HSG A |
| 11,504 | 68 | Pasture/grassland/range, Poor, HSG A |
| 701 | 68 | Pasture/grassland/range, Poor, HSG A |
| 9,680 | 39 | >75% Grass cover, Good, HSG A |
| 48,632 | 50 | Weighted Average |
| 48,332 | | 99.38% Pervious Area |
| 300 | | 0.62% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.9 | 50 | 0.0600 | 0.10 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 0.9 | 210 | 0.0600 | 3.94 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 8.8 | 260 | Total | | | |



## Summary for Pond UGDS-1: FS Apron

Inflow Area = 0.673 ac, 49.57% Impervious, Inflow Depth = 0.72" for 2-Year event
Inflow = 0.51 cfs @ 12.09 hrs, Volume= 0.041 af
Outflow = 0.22 cfs @ 12.39 hrs, Volume= 0.041 af, Atten= 57%, Lag= 18.0 min
Primary = 0.22 cfs @ 12.39 hrs, Volume= 0.041 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 192.44' @ 12.39 hrs Surf.Area= 0.020 ac Storage= 0.008 af

Plug-Flow detention time= 43.6 min calculated for 0.041 af (100% of inflow)
Center-of-Mass det. time= 43.6 min ( 924.6 - 881.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 192.00' | 0.000 af | **30.27'W x 28.71'L x 3.00'H Field A**<br>0.060 af Overall - 0.060 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 192.00' | 0.043 af | **StormTrap ST2 SingleTrap 2-6** x 2 Inside #1<br>Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf<br>Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf<br>2 Rows of 1 Chambers<br>16.96' x 15.40' Core + 6.66' Border = 30.27' x 28.71' System |
| | | 0.043 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 192.00' | **12.0" Round Culvert** L= 193.0' Ke= 0.500<br>Inlet / Outlet Invert= 192.00' / 186.64' S= 0.0278 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 194.45' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 192.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.22 cfs @ 12.39 hrs HW=192.44' TW=183.58' (Dynamic Tailwater)
↑└**1=Culvert** (Passes 0.22 cfs of 0.76 cfs potential flow)
↑└**2=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)
└**3=Orifice/Grate** (Orifice Controls 0.22 cfs @ 2.53 fps)

## Pond UGDS-1: FS Apron - Chamber Wizard Field A

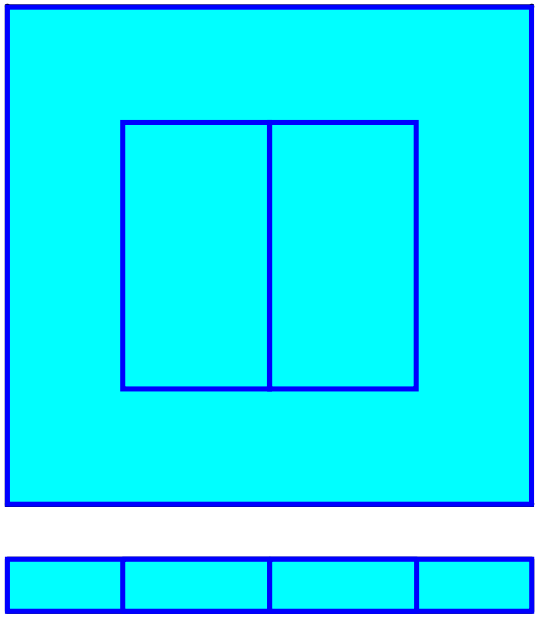
**Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

1 Chambers/Row x 15.40' Long = 15.40' Row Length +79.9" Border x 2 = 28.71' Base Length
2 Rows x 101.7" Wide + 79.9" Side Border x 2 = 30.27' Base Width
36.0" Chamber Height = 3.00' Field Height

2 Chambers x 289.8 cf + 1,300.8 cf Border = 1,880.4 cf Chamber Storage
2 Chambers x 391.6 cf + 1,823.8 cf Border = 2,607.1 cf Displacement

Chamber Storage = 1,880.4 cf = 0.043 af
Overall Storage Efficiency = 72.1%
Overall System Size = 28.71' x 30.27' x 3.00'

2 Chambers (plus border)
96.6 cy Field





## Stage-Discharge for Pond UGDS-1: FS Apron

| Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) |
|---|---|---|---|---|---|
| 192.00 | 0.00 | 193.02 | 0.39 | 194.04 | 0.58 |
| 192.02 | 0.00 | 193.04 | 0.39 | 194.06 | 0.58 |
| 192.04 | 0.00 | 193.06 | 0.40 | 194.08 | 0.58 |
| 192.06 | 0.01 | 193.08 | 0.40 | 194.10 | 0.58 |
| 192.08 | 0.02 | 193.10 | 0.41 | 194.12 | 0.59 |
| 192.10 | 0.02 | 193.12 | 0.41 | 194.14 | 0.59 |
| 192.12 | 0.03 | 193.14 | 0.41 | 194.16 | 0.59 |
| 192.14 | 0.04 | 193.16 | 0.42 | 194.18 | 0.60 |
| 192.16 | 0.06 | 193.18 | 0.42 | 194.20 | 0.60 |
| 192.18 | 0.07 | 193.20 | 0.43 | 194.22 | 0.60 |
| 192.20 | 0.08 | 193.22 | 0.43 | 194.24 | 0.61 |
| 192.22 | 0.10 | 193.24 | 0.44 | 194.26 | 0.61 |
| 192.24 | 0.11 | 193.26 | 0.44 | 194.28 | 0.61 |
| 192.26 | 0.13 | 193.28 | 0.44 | 194.30 | 0.61 |
| 192.28 | 0.14 | 193.30 | 0.45 | 194.32 | 0.62 |
| 192.30 | 0.15 | 193.32 | 0.45 | 194.34 | 0.62 |
| 192.32 | 0.17 | 193.34 | 0.46 | 194.36 | 0.62 |
| 192.34 | 0.17 | 193.36 | 0.46 | 194.38 | 0.63 |
| 192.36 | 0.18 | 193.38 | 0.46 | 194.40 | 0.63 |
| 192.38 | 0.19 | 193.40 | 0.47 | 194.42 | 0.63 |
| 192.40 | 0.20 | 193.42 | 0.47 | 194.44 | 0.63 |
| 192.42 | 0.21 | 193.44 | 0.47 | 194.46 | 0.65 |
| 192.44 | 0.22 | 193.46 | 0.48 | 194.48 | 0.72 |
| 192.46 | 0.23 | 193.48 | 0.48 | 194.50 | 0.82 |
| 192.48 | 0.24 | 193.50 | 0.49 | 194.52 | 0.95 |
| 192.50 | 0.24 | 193.52 | 0.49 | 194.54 | 1.09 |
| 192.52 | 0.25 | 193.54 | 0.49 | 194.56 | 1.24 |
| 192.54 | 0.26 | 193.56 | 0.50 | 194.58 | 1.42 |
| 192.56 | 0.26 | 193.58 | 0.50 | 194.60 | 1.60 |
| 192.58 | 0.27 | 193.60 | 0.50 | 194.62 | 1.80 |
| 192.60 | 0.28 | 193.62 | 0.51 | 194.64 | 2.00 |
| 192.62 | 0.28 | 193.64 | 0.51 | 194.66 | 2.22 |
| 192.64 | 0.29 | 193.66 | 0.51 | 194.68 | 2.45 |
| 192.66 | 0.30 | 193.68 | 0.52 | 194.70 | 2.69 |
| 192.68 | 0.30 | 193.70 | 0.52 | 194.72 | 2.94 |
| 192.70 | 0.31 | 193.72 | 0.52 | 194.74 | 3.20 |
| 192.72 | 0.31 | 193.74 | 0.53 | 194.76 | 3.46 |
| 192.74 | 0.32 | 193.76 | 0.53 | 194.78 | 3.74 |
| 192.76 | 0.32 | 193.78 | 0.53 | 194.80 | 4.02 |
| 192.78 | 0.33 | 193.80 | 0.54 | 194.82 | 4.31 |
| 192.80 | 0.33 | 193.82 | 0.54 | 194.84 | 4.61 |
| 192.82 | 0.34 | 193.84 | 0.54 | 194.86 | 4.91 |
| 192.84 | 0.34 | 193.86 | 0.55 | 194.88 | 5.22 |
| 192.86 | 0.35 | 193.88 | 0.55 | 194.90 | 5.54 |
| 192.88 | 0.35 | 193.90 | 0.55 | 194.92 | 5.87 |
| 192.90 | 0.36 | 193.92 | 0.56 | 194.94 | 5.91 |
| 192.92 | 0.36 | 193.94 | 0.56 | 194.96 | 5.93 |
| 192.94 | 0.37 | 193.96 | 0.56 | 194.98 | 5.96 |
| 192.96 | 0.37 | 193.98 | 0.57 | 195.00 | **5.98** |
| 192.98 | 0.38 | 194.00 | 0.57 | | |
| 193.00 | 0.38 | 194.02 | 0.57 | | |

## Stage-Area-Storage for Pond UGDS-1: FS Apron

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|---|---|
| 192.00 | 0.000 | 193.02 | 0.018 | 194.04 | 0.035 |
| 192.02 | 0.000 | 193.04 | 0.018 | 194.06 | 0.036 |
| 192.04 | 0.001 | 193.06 | 0.018 | 194.08 | 0.036 |
| 192.06 | 0.001 | 193.08 | 0.019 | 194.10 | 0.036 |
| 192.08 | 0.001 | 193.10 | 0.019 | 194.12 | 0.037 |
| 192.10 | 0.002 | 193.12 | 0.019 | 194.14 | 0.037 |
| 192.12 | 0.002 | 193.14 | 0.020 | 194.16 | 0.037 |
| 192.14 | 0.002 | 193.16 | 0.020 | 194.18 | 0.038 |
| 192.16 | 0.003 | 193.18 | 0.020 | 194.20 | 0.038 |
| 192.18 | 0.003 | 193.20 | 0.021 | 194.22 | 0.038 |
| 192.20 | 0.003 | 193.22 | 0.021 | 194.24 | 0.039 |
| 192.22 | 0.004 | 193.24 | 0.021 | 194.26 | 0.039 |
| 192.24 | 0.004 | 193.26 | 0.022 | 194.28 | 0.039 |
| 192.26 | 0.004 | 193.28 | 0.022 | 194.30 | 0.040 |
| 192.28 | 0.005 | 193.30 | 0.022 | 194.32 | 0.040 |
| 192.30 | 0.005 | 193.32 | 0.023 | 194.34 | 0.040 |
| 192.32 | 0.006 | 193.34 | 0.023 | 194.36 | 0.041 |
| 192.34 | 0.006 | 193.36 | 0.023 | 194.38 | 0.041 |
| 192.36 | 0.006 | 193.38 | 0.024 | 194.40 | 0.041 |
| 192.38 | 0.007 | 193.40 | 0.024 | 194.42 | 0.042 |
| 192.40 | 0.007 | 193.42 | 0.025 | 194.44 | 0.042 |
| 192.42 | 0.007 | 193.44 | 0.025 | 194.46 | 0.042 |
| 192.44 | 0.008 | 193.46 | 0.025 | 194.48 | 0.043 |
| 192.46 | 0.008 | 193.48 | 0.026 | 194.50 | 0.043 |
| 192.48 | 0.008 | 193.50 | 0.026 | 194.52 | 0.043 |
| 192.50 | 0.009 | 193.52 | 0.026 | 194.54 | 0.043 |
| 192.52 | 0.009 | 193.54 | 0.027 | 194.56 | 0.043 |
| 192.54 | 0.009 | 193.56 | 0.027 | 194.58 | 0.043 |
| 192.56 | 0.010 | 193.58 | 0.027 | 194.60 | **0.043** |
| 192.58 | 0.010 | 193.60 | 0.028 | 194.62 | 0.043 |
| 192.60 | 0.010 | 193.62 | 0.028 | 194.64 | 0.043 |
| 192.62 | 0.011 | 193.64 | 0.028 | 194.66 | 0.043 |
| 192.64 | 0.011 | 193.66 | 0.029 | 194.68 | 0.043 |
| 192.66 | 0.011 | 193.68 | 0.029 | 194.70 | 0.043 |
| 192.68 | 0.012 | 193.70 | 0.029 | 194.72 | 0.043 |
| 192.70 | 0.012 | 193.72 | 0.030 | 194.74 | 0.043 |
| 192.72 | 0.012 | 193.74 | 0.030 | 194.76 | 0.043 |
| 192.74 | 0.013 | 193.76 | 0.030 | 194.78 | 0.043 |
| 192.76 | 0.013 | 193.78 | 0.031 | 194.80 | 0.043 |
| 192.78 | 0.013 | 193.80 | 0.031 | 194.82 | 0.043 |
| 192.80 | 0.014 | 193.82 | 0.031 | 194.84 | 0.043 |
| 192.82 | 0.014 | 193.84 | 0.032 | 194.86 | 0.043 |
| 192.84 | 0.015 | 193.86 | 0.032 | 194.88 | 0.043 |
| 192.86 | 0.015 | 193.88 | 0.032 | 194.90 | 0.043 |
| 192.88 | 0.015 | 193.90 | 0.033 | 194.92 | 0.043 |
| 192.90 | 0.016 | 193.92 | 0.033 | 194.94 | 0.043 |
| 192.92 | 0.016 | 193.94 | 0.033 | 194.96 | 0.043 |
| 192.94 | 0.016 | 193.96 | 0.034 | 194.98 | 0.043 |
| 192.96 | 0.017 | 193.98 | 0.034 | 195.00 | 0.043 |
| 192.98 | 0.017 | 194.00 | 0.035 | | |
| 193.00 | 0.017 | 194.02 | 0.035 | | |



## Summary for Pond UGDS-2: Back Lot

Inflow Area = 0.586 ac, 88.56% Impervious, Inflow Depth = 2.16" for 2-Year event
Inflow = 1.52 cfs @ 12.07 hrs, Volume= 0.106 af
Outflow = 0.24 cfs @ 12.54 hrs, Volume= 0.106 af, Atten= 84%, Lag= 28.3 min
Primary = 0.24 cfs @ 12.54 hrs, Volume= 0.106 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 200.69' @ 12.54 hrs Surf.Area= 0.041 ac Storage= 0.043 af

Plug-Flow detention time= 114.0 min calculated for 0.106 af (100% of inflow)
Center-of-Mass det. time= 113.1 min ( 915.9 - 802.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 199.50' | 0.000 af | **30.27'W x 59.50'L x 3.50'H Field A**<br>0.145 af Overall - 0.145 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 199.50' | 0.109 af | **StormTrap ST2 SingleTrap 3-0**x 6 Inside #1<br>Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf<br>Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf<br>2 Rows of 3 Chambers<br>16.96' x 46.19' Core + 6.66' Border = 30.27' x 59.50' System |
| | | 0.109 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 199.50' | **12.0" Round Culvert** L= 390.0' Ke= 0.500<br>Inlet / Outlet Invert= 199.50' / 186.63' S= 0.0330 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 202.40' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 201.00' | **3.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 199.50' | **3.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.24 cfs @ 12.54 hrs HW=200.69' TW=183.68' (Dynamic Tailwater)
- **1=Culvert** (Passes 0.24 cfs of 3.14 cfs potential flow)
  - **2=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)
  - **3=Orifice/Grate** ( Controls 0.00 cfs)
  - **4=Orifice/Grate** (Orifice Controls 0.24 cfs @ 4.97 fps)

## Pond UGDS-2: Back Lot - Chamber Wizard Field A

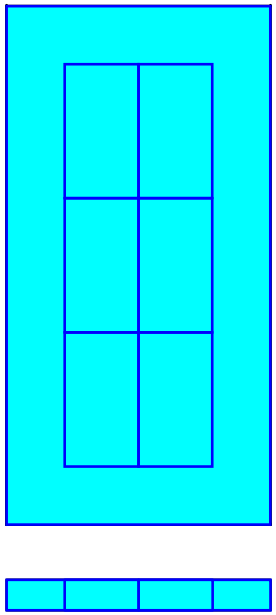
**Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

3 Chambers/Row x 15.40' Long = 46.19' Row Length +79.9" Border x 2 = 59.50' Base Length
2 Rows x 101.7" Wide + 79.9" Side Border x 2 = 30.27' Base Width
42.0" Chamber Height = 3.50' Field Height

6 Chambers x 354.0 cf + 2,645.3 cf Border = 4,769.2 cf Chamber Storage
6 Chambers x 456.9 cf + 3,562.5 cf Border = 6,303.9 cf Displacement

Chamber Storage = 4,769.2 cf = 0.109 af
Overall Storage Efficiency = 75.7%
Overall System Size = 59.50' x 30.27' x 3.50'

6 Chambers (plus border)
233.5 cy Field





## Stage-Discharge for Pond UGDS-2: Back Lot

| Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) |
|---|---|---|---|---|---|---|---|
| 199.50 | 0.00 | 200.52 | 0.22 | 201.54 | 0.48 | 202.56 | 1.73 |
| 199.52 | 0.00 | 200.54 | 0.23 | 201.56 | 0.48 | 202.58 | 1.93 |
| 199.54 | 0.00 | 200.56 | 0.23 | 201.58 | 0.49 | 202.60 | 2.15 |
| 199.56 | 0.01 | 200.58 | 0.23 | 201.60 | 0.50 | 202.62 | 2.37 |
| 199.58 | 0.01 | 200.60 | 0.23 | 201.62 | 0.50 | 202.64 | 2.61 |
| 199.60 | 0.02 | 200.62 | 0.24 | 201.64 | 0.51 | 202.66 | 2.85 |
| 199.62 | 0.03 | 200.64 | 0.24 | 201.66 | 0.51 | 202.68 | 3.10 |
| 199.64 | 0.04 | 200.66 | 0.24 | 201.68 | 0.51 | 202.70 | 3.37 |
| 199.66 | 0.05 | 200.68 | 0.24 | 201.70 | 0.52 | 202.72 | 3.64 |
| 199.68 | 0.05 | 200.70 | 0.25 | 201.72 | 0.52 | 202.74 | 3.91 |
| 199.70 | 0.06 | 200.72 | 0.25 | 201.74 | 0.53 | 202.76 | 4.20 |
| 199.72 | 0.07 | 200.74 | 0.25 | 201.76 | 0.53 | 202.78 | 4.50 |
| 199.74 | 0.08 | 200.76 | 0.25 | 201.78 | 0.54 | 202.80 | 4.80 |
| 199.76 | 0.09 | 200.78 | 0.25 | 201.80 | 0.54 | 202.82 | 5.11 |
| 199.78 | 0.09 | 200.80 | 0.26 | 201.82 | 0.55 | 202.84 | 5.42 |
| 199.80 | 0.10 | 200.82 | 0.26 | 201.84 | 0.55 | 202.86 | 5.74 |
| 199.82 | 0.10 | 200.84 | 0.26 | 201.86 | 0.56 | 202.88 | 6.07 |
| 199.84 | 0.11 | 200.86 | 0.26 | 201.88 | 0.56 | 202.90 | 6.41 |
| 199.86 | 0.11 | 200.88 | 0.26 | 201.90 | 0.56 | 202.92 | 6.46 |
| 199.88 | 0.12 | 200.90 | 0.27 | 201.92 | 0.57 | 202.94 | 6.48 |
| 199.90 | 0.12 | 200.92 | 0.27 | 201.94 | 0.57 | 202.96 | 6.51 |
| 199.92 | 0.13 | 200.94 | 0.27 | 201.96 | 0.58 | 202.98 | 6.53 |
| 199.94 | 0.13 | 200.96 | 0.27 | 201.98 | 0.58 | 203.00 | **6.55** |
| 199.96 | 0.14 | 200.98 | 0.28 | 202.00 | 0.59 | | |
| 199.98 | 0.14 | 201.00 | 0.28 | 202.02 | 0.59 | | |
| 200.00 | 0.14 | 201.02 | 0.28 | 202.04 | 0.59 | | |
| 200.02 | 0.15 | 201.04 | 0.28 | 202.06 | 0.60 | | |
| 200.04 | 0.15 | 201.06 | 0.29 | 202.08 | 0.60 | | |
| 200.06 | 0.16 | 201.08 | 0.30 | 202.10 | 0.61 | | |
| 200.08 | 0.16 | 201.10 | 0.31 | 202.12 | 0.61 | | |
| 200.10 | 0.16 | 201.12 | 0.32 | 202.14 | 0.61 | | |
| 200.12 | 0.17 | 201.14 | 0.33 | 202.16 | 0.62 | | |
| 200.14 | 0.17 | 201.16 | 0.34 | 202.18 | 0.62 | | |
| 200.16 | 0.17 | 201.18 | 0.35 | 202.20 | 0.62 | | |
| 200.18 | 0.18 | 201.20 | 0.36 | 202.22 | 0.63 | | |
| 200.20 | 0.18 | 201.22 | 0.37 | 202.24 | 0.63 | | |
| 200.22 | 0.18 | 201.24 | 0.38 | 202.26 | 0.64 | | |
| 200.24 | 0.19 | 201.26 | 0.39 | 202.28 | 0.64 | | |
| 200.26 | 0.19 | 201.28 | 0.40 | 202.30 | 0.64 | | |
| 200.28 | 0.19 | 201.30 | 0.40 | 202.32 | 0.65 | | |
| 200.30 | 0.19 | 201.32 | 0.41 | 202.34 | 0.65 | | |
| 200.32 | 0.20 | 201.34 | 0.42 | 202.36 | 0.65 | | |
| 200.34 | 0.20 | 201.36 | 0.43 | 202.38 | 0.66 | | |
| 200.36 | 0.20 | 201.38 | 0.43 | 202.40 | 0.66 | | |
| 200.38 | 0.21 | 201.40 | 0.44 | 202.42 | 0.71 | | |
| 200.40 | 0.21 | 201.42 | 0.45 | 202.44 | 0.80 | | |
| 200.42 | 0.21 | 201.44 | 0.45 | 202.46 | 0.91 | | |
| 200.44 | 0.21 | 201.46 | 0.46 | 202.48 | 1.04 | | |
| 200.46 | 0.22 | 201.48 | 0.46 | 202.50 | 1.19 | | |
| 200.48 | 0.22 | 201.50 | 0.47 | 202.52 | 1.36 | | |
| 200.50 | 0.22 | 201.52 | 0.47 | 202.54 | 1.54 | | |

## Stage-Area-Storage for Pond UGDS-2: Back Lot

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|
| 199.50 | 0.000 | 202.05 | 0.093 |
| 199.55 | 0.002 | 202.10 | 0.095 |
| 199.60 | 0.004 | 202.15 | 0.097 |
| 199.65 | 0.005 | 202.20 | 0.099 |
| 199.70 | 0.007 | 202.25 | 0.100 |
| 199.75 | 0.009 | 202.30 | 0.102 |
| 199.80 | 0.011 | 202.35 | 0.104 |
| 199.85 | 0.013 | 202.40 | 0.106 |
| 199.90 | 0.015 | 202.45 | 0.108 |
| 199.95 | 0.016 | 202.50 | **0.109** |
| 200.00 | 0.018 | 202.55 | **0.109** |
| 200.05 | 0.020 | 202.60 | 0.109 |
| 200.10 | 0.022 | 202.65 | 0.109 |
| 200.15 | 0.024 | 202.70 | 0.109 |
| 200.20 | 0.026 | 202.75 | 0.109 |
| 200.25 | 0.027 | 202.80 | 0.109 |
| 200.30 | 0.029 | 202.85 | 0.109 |
| 200.35 | 0.031 | 202.90 | 0.109 |
| 200.40 | 0.033 | 202.95 | 0.109 |
| 200.45 | 0.035 | 203.00 | 0.109 |
| 200.50 | 0.036 | | |
| 200.55 | 0.038 | | |
| 200.60 | 0.040 | | |
| 200.65 | 0.042 | | |
| 200.70 | 0.044 | | |
| 200.75 | 0.046 | | |
| 200.80 | 0.047 | | |
| 200.85 | 0.049 | | |
| 200.90 | 0.051 | | |
| 200.95 | 0.053 | | |
| 201.00 | 0.055 | | |
| 201.05 | 0.057 | | |
| 201.10 | 0.058 | | |
| 201.15 | 0.060 | | |
| 201.20 | 0.062 | | |
| 201.25 | 0.064 | | |
| 201.30 | 0.066 | | |
| 201.35 | 0.068 | | |
| 201.40 | 0.069 | | |
| 201.45 | 0.071 | | |
| 201.50 | 0.073 | | |
| 201.55 | 0.075 | | |
| 201.60 | 0.077 | | |
| 201.65 | 0.078 | | |
| 201.70 | 0.080 | | |
| 201.75 | 0.082 | | |
| 201.80 | 0.084 | | |
| 201.85 | 0.086 | | |
| 201.90 | 0.088 | | |
| 201.95 | 0.089 | | |
| 202.00 | 0.091 | | |



## Summary for Pond UGIS-2: Lower Lot

Inflow Area = 2.492 ac, 70.12% Impervious, Inflow Depth = 1.43" for 2-Year event
Inflow = 2.48 cfs @ 12.08 hrs, Volume= 0.296 af
Outflow = 0.28 cfs @ 11.84 hrs, Volume= 0.296 af, Atten= 89%, Lag= 0.0 min
Discarded = 0.28 cfs @ 11.84 hrs, Volume= 0.296 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 184.04' @ 15.46 hrs Surf.Area= 0.115 ac Storage= 0.107 af

Plug-Flow detention time= 165.4 min calculated for 0.296 af (100% of inflow)
Center-of-Mass det. time= 165.4 min ( 1,042.5 - 877.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 183.00' | 0.000 af | **55.71'W x 90.29'L x 4.00'H Field A**<br>0.462 af Overall - 0.462 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 183.00' | 0.359 af | **StormTrap ST2 SingleTrap 3-6**x 25 Inside #1<br>Inside= 101.7"W x 42.0"H => 26.77 sf x 15.40'L = 412.1 cf<br>Outside= 101.7"W x 48.0"H => 33.92 sf x 15.40'L = 522.2 cf<br>5 Rows of 5 Chambers<br>42.40' x 76.98' Core + 6.66' Border = 55.71' x 90.29' System |
| | | 0.359 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 185.00' | **12.0" Round Culvert** L= 26.0' Ke= 0.500<br>Inlet / Outlet Invert= 185.00' / 184.74' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 186.40' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Discarded | 183.00' | **2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01' |
| #4 | Primary | 185.40' | **6.0" Vert. Orifice/Grate** C= 0.600 |

**Discarded OutFlow** Max=0.28 cfs @ 11.84 hrs HW=183.04' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.28 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=183.00' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** ( Controls 0.00 cfs)
│ └**2=Sharp-Crested Rectangular Weir**( Controls 0.00 cfs)
└**4=Orifice/Grate** ( Controls 0.00 cfs)

## Pond UGIS-2: Lower Lot - Chamber Wizard Field A

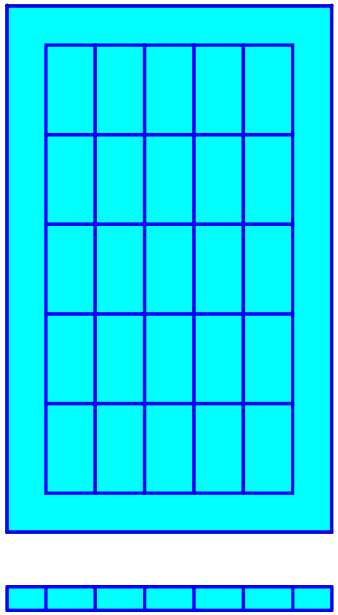
**Chamber Model = StormTrap ST2 SingleTrap 3-6 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 42.0"H => 26.77 sf x 15.40'L = 412.1 cf
Outside= 101.7"W x 48.0"H => 33.92 sf x 15.40'L = 522.2 cf

5 Chambers/Row x 15.40' Long = 76.98' Row Length +79.9" Border x 2 = 90.29' Base Length
5 Rows x 101.7" Wide + 79.9" Side Border x 2 = 55.71' Base Width
48.0" Chamber Height = 4.00' Field Height

25 Chambers x 412.1 cf + 5,349.6 cf Border = 15,652.9 cf Chamber Storage
25 Chambers x 522.2 cf + 7,065.6 cf Border = 20,120.0 cf Displacement

Chamber Storage = 15,652.9 cf = 0.359 af
Overall Storage Efficiency = 77.8%
Overall System Size = 90.29' x 55.71' x 4.00'

25 Chambers (plus border)
745.2 cy Field





## Stage-Discharge for Pond UGIS-2: Lower Lot

| Elevation (feet) | Discharge (cfs) | Discarded (cfs) | Primary (cfs) | Elevation (feet) | Discharge (cfs) | Discarded (cfs) | Primary (cfs) |
|---|---|---|---|---|---|---|---|
| 183.00 | 0.00 | **0.00** | 0.00 | 185.55 | 0.35 | 0.28 | 0.07 |
| 183.05 | 0.28 | **0.28** | 0.00 | 185.60 | 0.39 | 0.28 | 0.11 |
| 183.10 | 0.28 | 0.28 | 0.00 | 185.65 | 0.45 | 0.28 | 0.17 |
| 183.15 | 0.28 | 0.28 | 0.00 | 185.70 | 0.51 | 0.28 | 0.23 |
| 183.20 | 0.28 | 0.28 | 0.00 | 185.75 | 0.58 | 0.28 | 0.30 |
| 183.25 | 0.28 | 0.28 | 0.00 | 185.80 | 0.64 | 0.28 | 0.36 |
| 183.30 | 0.28 | 0.28 | 0.00 | 185.85 | 0.71 | 0.28 | 0.43 |
| 183.35 | 0.28 | 0.28 | 0.00 | 185.90 | 0.75 | 0.28 | 0.47 |
| 183.40 | 0.28 | 0.28 | 0.00 | 185.95 | 0.80 | 0.28 | 0.52 |
| 183.45 | 0.28 | 0.28 | 0.00 | 186.00 | 0.84 | 0.28 | 0.56 |
| 183.50 | 0.28 | 0.28 | 0.00 | 186.05 | 0.88 | 0.28 | 0.60 |
| 183.55 | 0.28 | 0.28 | 0.00 | 186.10 | 0.91 | 0.28 | 0.63 |
| 183.60 | 0.28 | 0.28 | 0.00 | 186.15 | 0.95 | 0.28 | 0.67 |
| 183.65 | 0.28 | 0.28 | 0.00 | 186.20 | 0.98 | 0.28 | 0.70 |
| 183.70 | 0.28 | 0.28 | 0.00 | 186.25 | 1.01 | 0.28 | 0.73 |
| 183.75 | 0.28 | 0.28 | 0.00 | 186.30 | 1.04 | 0.28 | 0.76 |
| 183.80 | 0.28 | 0.28 | 0.00 | 186.35 | 1.07 | 0.28 | 0.79 |
| 183.85 | 0.28 | 0.28 | 0.00 | 186.40 | 1.10 | 0.28 | 0.82 |
| 183.90 | 0.28 | 0.28 | 0.00 | 186.45 | 1.31 | 0.28 | 1.03 |
| 183.95 | 0.28 | 0.28 | 0.00 | 186.50 | 1.67 | 0.28 | 1.39 |
| 184.00 | 0.28 | 0.28 | 0.00 | 186.55 | 2.12 | 0.28 | 1.84 |
| 184.05 | 0.28 | 0.28 | 0.00 | 186.60 | 2.65 | 0.28 | 2.37 |
| 184.10 | 0.28 | 0.28 | 0.00 | 186.65 | 3.25 | 0.28 | 2.97 |
| 184.15 | 0.28 | 0.28 | 0.00 | 186.70 | 3.90 | 0.28 | 3.62 |
| 184.20 | 0.28 | 0.28 | 0.00 | 186.75 | 4.61 | 0.28 | 4.33 |
| 184.25 | 0.28 | 0.28 | 0.00 | 186.80 | 5.36 | 0.28 | 5.08 |
| 184.30 | 0.28 | 0.28 | 0.00 | 186.85 | 5.68 | 0.28 | 5.40 |
| 184.35 | 0.28 | 0.28 | 0.00 | 186.90 | 5.80 | 0.28 | 5.52 |
| 184.40 | 0.28 | 0.28 | 0.00 | 186.95 | 5.91 | 0.28 | 5.63 |
| 184.45 | 0.28 | 0.28 | 0.00 | 187.00 | **6.01** | 0.28 | **5.73** |
| 184.50 | 0.28 | 0.28 | 0.00 | | | | |
| 184.55 | 0.28 | 0.28 | 0.00 | | | | |
| 184.60 | 0.28 | 0.28 | 0.00 | | | | |
| 184.65 | 0.28 | 0.28 | 0.00 | | | | |
| 184.70 | 0.28 | 0.28 | 0.00 | | | | |
| 184.75 | 0.28 | 0.28 | 0.00 | | | | |
| 184.80 | 0.28 | 0.28 | 0.00 | | | | |
| 184.85 | 0.28 | 0.28 | 0.00 | | | | |
| 184.90 | 0.28 | 0.28 | 0.00 | | | | |
| 184.95 | 0.28 | 0.28 | 0.00 | | | | |
| 185.00 | 0.28 | 0.28 | 0.00 | | | | |
| 185.05 | 0.28 | 0.28 | 0.00 | | | | |
| 185.10 | 0.28 | 0.28 | 0.00 | | | | |
| 185.15 | 0.28 | 0.28 | 0.00 | | | | |
| 185.20 | 0.28 | 0.28 | 0.00 | | | | |
| 185.25 | 0.28 | 0.28 | 0.00 | | | | |
| 185.30 | 0.28 | 0.28 | 0.00 | | | | |
| 185.35 | 0.28 | 0.28 | 0.00 | | | | |
| 185.40 | 0.28 | 0.28 | 0.00 | | | | |
| 185.45 | 0.29 | 0.28 | 0.01 | | | | |
| 185.50 | 0.31 | 0.28 | 0.03 | | | | |

## Stage-Area-Storage for Pond UGIS-2: Lower Lot

| Elevation (feet) | Surface (acres) | Storage (acre-feet) | Elevation (feet) | Surface (acres) | Storage (acre-feet) |
|---|---|---|---|---|---|
| 183.00 | **0.115** | 0.000 | 185.55 | 0.115 | 0.262 |
| 183.05 | 0.115 | 0.005 | 185.60 | 0.115 | 0.267 |
| 183.10 | 0.115 | 0.010 | 185.65 | 0.115 | 0.272 |
| 183.15 | 0.115 | 0.015 | 185.70 | 0.115 | 0.277 |
| 183.20 | 0.115 | 0.021 | 185.75 | 0.115 | 0.282 |
| 183.25 | 0.115 | 0.026 | 185.80 | 0.115 | 0.287 |
| 183.30 | 0.115 | 0.031 | 185.85 | 0.115 | 0.293 |
| 183.35 | 0.115 | 0.036 | 185.90 | 0.115 | 0.298 |
| 183.40 | 0.115 | 0.041 | 185.95 | 0.115 | 0.303 |
| 183.45 | 0.115 | 0.046 | 186.00 | 0.115 | 0.308 |
| 183.50 | 0.115 | 0.051 | 186.05 | 0.115 | 0.313 |
| 183.55 | 0.115 | 0.056 | 186.10 | 0.115 | 0.318 |
| 183.60 | 0.115 | 0.062 | 186.15 | 0.115 | 0.323 |
| 183.65 | 0.115 | 0.067 | 186.20 | 0.115 | 0.329 |
| 183.70 | 0.115 | 0.072 | 186.25 | 0.115 | 0.334 |
| 183.75 | 0.115 | 0.077 | 186.30 | 0.115 | 0.339 |
| 183.80 | 0.115 | 0.082 | 186.35 | 0.115 | 0.344 |
| 183.85 | 0.115 | 0.087 | 186.40 | 0.115 | 0.349 |
| 183.90 | 0.115 | 0.092 | 186.45 | 0.115 | 0.354 |
| 183.95 | 0.115 | 0.098 | 186.50 | 0.115 | 0.359 |
| 184.00 | 0.115 | 0.103 | 186.55 | 0.115 | 0.359 |
| 184.05 | 0.115 | 0.108 | 186.60 | 0.115 | 0.359 |
| 184.10 | 0.115 | 0.113 | 186.65 | 0.115 | 0.359 |
| 184.15 | 0.115 | 0.118 | 186.70 | 0.115 | 0.359 |
| 184.20 | 0.115 | 0.123 | 186.75 | 0.115 | 0.359 |
| 184.25 | 0.115 | 0.128 | 186.80 | 0.115 | 0.359 |
| 184.30 | 0.115 | 0.133 | 186.85 | 0.115 | **0.359** |
| 184.35 | 0.115 | 0.139 | 186.90 | 0.115 | **0.359** |
| 184.40 | 0.115 | 0.144 | 186.95 | 0.115 | 0.359 |
| 184.45 | 0.115 | 0.149 | 187.00 | 0.115 | 0.359 |
| 184.50 | 0.115 | 0.154 | | | |
| 184.55 | 0.115 | 0.159 | | | |
| 184.60 | 0.115 | 0.164 | | | |
| 184.65 | 0.115 | 0.169 | | | |
| 184.70 | 0.115 | 0.175 | | | |
| 184.75 | 0.115 | 0.180 | | | |
| 184.80 | 0.115 | 0.185 | | | |
| 184.85 | 0.115 | 0.190 | | | |
| 184.90 | 0.115 | 0.195 | | | |
| 184.95 | 0.115 | 0.200 | | | |
| 185.00 | 0.115 | 0.205 | | | |
| 185.05 | 0.115 | 0.210 | | | |
| 185.10 | 0.115 | 0.216 | | | |
| 185.15 | 0.115 | 0.221 | | | |
| 185.20 | 0.115 | 0.226 | | | |
| 185.25 | 0.115 | 0.231 | | | |
| 185.30 | 0.115 | 0.236 | | | |
| 185.35 | 0.115 | 0.241 | | | |
| 185.40 | 0.115 | 0.246 | | | |
| 185.45 | 0.115 | 0.252 | | | |
| 185.50 | 0.115 | 0.257 | | | |



## Summary for Link 1L: Total to Roadway

Inflow Area = 2.875 ac, 65.45% Impervious, Inflow Depth = 0.05" for 2-Year event
Inflow = 0.10 cfs @ 12.15 hrs, Volume= 0.013 af
Primary = 0.10 cfs @ 12.15 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

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

## Summary for Link 2L: Total to Wetlands

Inflow Area = 1.116 ac, 0.62% Impervious, Inflow Depth = 0.11" for 2-Year event
Inflow = 0.02 cfs @ 13.68 hrs, Volume= 0.010 af
Primary = 0.02 cfs @ 13.68 hrs, Volume= 0.010 af, Atten= 0%, Lag= 0.0 min

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



## Summary for Link DP-1: Culvert

Inflow Area = 3.991 ac, 47.31% Impervious, Inflow Depth = 0.07" for 2-Year event
Inflow = 0.10 cfs @ 12.15 hrs, Volume= 0.023 af
Primary = 0.10 cfs @ 12.15 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

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

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

**Subcatchment EDA-1: Subcat EDA-1** Runoff Area=0.701 ac 0.00% Impervious Runoff Depth=0.69"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=54 Runoff=0.35 cfs 0.040 af

**Subcatchment EDA-2: Subcat EDA-2** Runoff Area=2.907 ac 0.08% Impervious Runoff Depth=0.30"
Flow Length=507' Tc=22.1 min CN=45 Runoff=0.25 cfs 0.072 af

**Subcatchment EDA-2B: Subcat EDA-2B** Runoff Area=0.382 ac 31.06% Impervious Runoff Depth=1.20"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=63 Runoff=0.46 cfs 0.038 af

**Link 1L: Total to Roadway** Inflow=0.46 cfs 0.110 af
Primary=0.46 cfs 0.110 af

**Link 2L: Total to Wetlands** Inflow=0.35 cfs 0.040 af
Primary=0.35 cfs 0.040 af

**Link DP-1: Culvert** Inflow=0.79 cfs 0.150 af
Primary=0.79 cfs 0.150 af

**Total Runoff Area = 3.991 ac Runoff Volume = 0.150 af Average Runoff Depth = 0.45"**
**96.97% Pervious = 3.870 ac 3.03% Impervious = 0.121 ac**



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

**Subcatchment EDA-1: Subcat EDA-1** Runoff Area=0.701 ac 0.00% Impervious Runoff Depth=1.73"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=54 Runoff=1.16 cfs 0.101 af

**Subcatchment EDA-2: Subcat EDA-2** Runoff Area=2.907 ac 0.08% Impervious Runoff Depth=1.01"
Flow Length=507' Tc=22.1 min CN=45 Runoff=1.58 cfs 0.245 af

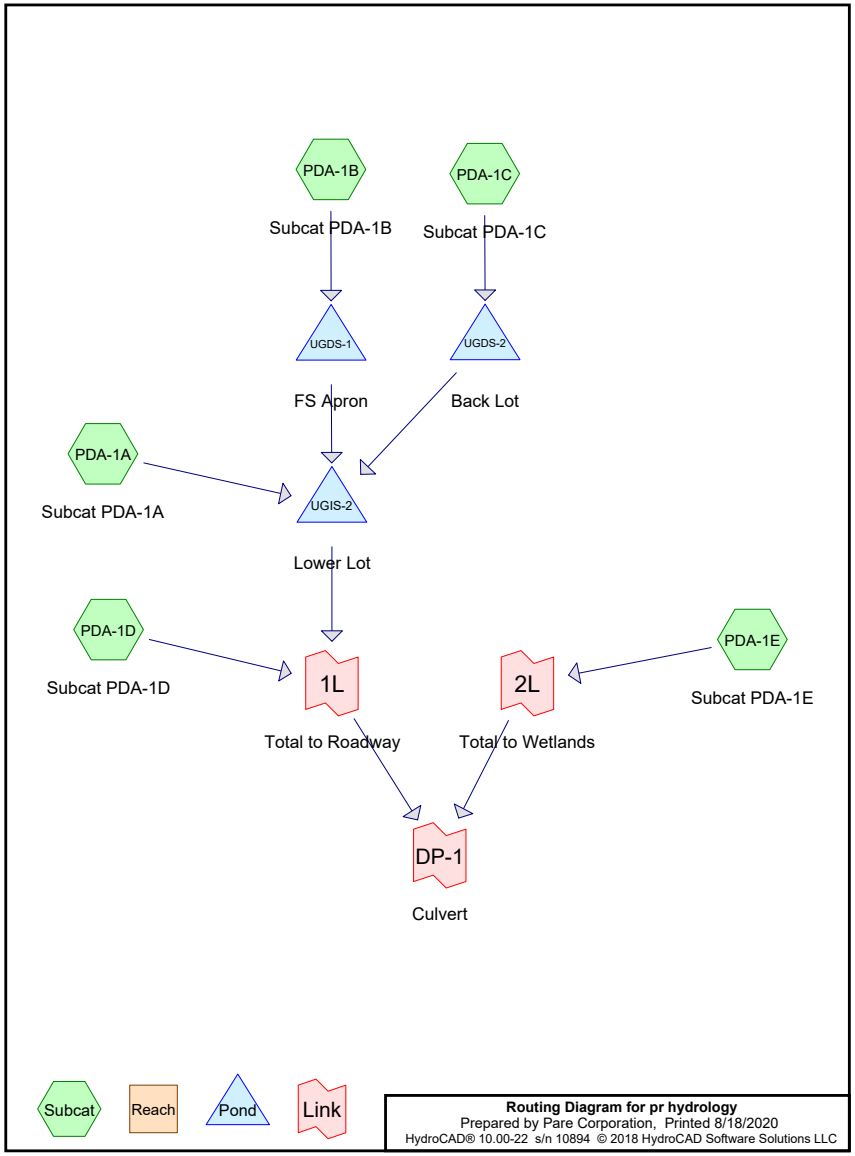
**Subcatchment EDA-2B: Subcat EDA-2B** Runoff Area=0.382 ac 31.06% Impervious Runoff Depth=2.53"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=63 Runoff=1.04 cfs 0.081 af

**Link 1L: Total to Roadway** Inflow=2.04 cfs 0.325 af
Primary=2.04 cfs 0.325 af

**Link 2L: Total to Wetlands** Inflow=1.16 cfs 0.101 af
Primary=1.16 cfs 0.101 af

**Link DP-1: Culvert** Inflow=2.72 cfs 0.426 af
Primary=2.72 cfs 0.426 af

**Total Runoff Area = 3.991 ac Runoff Volume = 0.426 af Average Runoff Depth = 1.28"**
**96.97% Pervious = 3.870 ac 3.03% Impervious = 0.121 ac**






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

**SubcatchmentPDA-1A: Subcat PDA-1A** Runoff Area=53,729 sf 72.55% Impervious Runoff Depth=2.64"
Tc=5.0 min CN=82 Runoff=3.95 cfs 0.271 af

**SubcatchmentPDA-1B: Subcat PDA-1B** Runoff Area=29,296 sf 49.57% Impervious Runoff Depth=1.60"
Tc=5.0 min CN=69 Runoff=1.26 cfs 0.090 af

**SubcatchmentPDA-1C: Subcat PDA-1C** Runoff Area=25,540 sf 88.56% Impervious Runoff Depth=3.50"
Tc=5.0 min CN=91 Runoff=2.40 cfs 0.171 af

**SubcatchmentPDA-1D: Subcat PDA-1D** Runoff Area=16,652 sf 35.03% Impervious Runoff Depth=1.08"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=61 Runoff=0.40 cfs 0.034 af

**SubcatchmentPDA-1E: Subcat PDA-1E** Runoff Area=48,632 sf 0.62% Impervious Runoff Depth=0.50"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=50 Runoff=0.29 cfs 0.047 af

**Pond UGDS-1: FS Apron** Peak Elev=193.24' Storage=0.021 af Inflow=1.26 cfs 0.090 af
Outflow=0.43 cfs 0.090 af

**Pond UGDS-2: Back Lot** Peak Elev=201.41' Storage=0.070 af Inflow=2.40 cfs 0.171 af
Outflow=0.44 cfs 0.171 af

**Pond UGIS-2: Lower Lot** Peak Elev=185.56' Storage=0.263 af Inflow=4.51 cfs 0.532 af
Discarded=0.28 cfs 0.516 af Primary=0.08 cfs 0.015 af Outflow=0.36 cfs 0.532 af

**Link 1L: Total to Roadway** Inflow=0.40 cfs 0.050 af
Primary=0.40 cfs 0.050 af

**Link 2L: Total to Wetlands** Inflow=0.29 cfs 0.047 af
Primary=0.29 cfs 0.047 af

**Link DP-1: Culvert** Inflow=0.65 cfs 0.096 af
Primary=0.65 cfs 0.096 af

**Total Runoff Area = 3.991 ac Runoff Volume = 0.613 af Average Runoff Depth = 1.84"**
**52.69% Pervious = 2.103 ac 47.31% Impervious = 1.888 ac**

## Summary for Subcatchment PDA-1A: Subcat PDA-1A

Runoff = 3.95 cfs @ 12.07 hrs, Volume= 0.271 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 38,686 | 98 | Paved parking, HSG A |
| 277 | 98 | Paved parking, HSG A |
| 20 | 98 | Paved parking, HSG A |
| 2,711 | 39 | >75% Grass cover, Good, HSG A |
| 212 | 39 | >75% Grass cover, Good, HSG A |
| 2,692 | 39 | >75% Grass cover, Good, HSG A |
| 2,224 | 39 | >75% Grass cover, Good, HSG A |
| 112 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 39 | >75% Grass cover, Good, HSG A |
| 83 | 39 | >75% Grass cover, Good, HSG A |
| 262 | 39 | >75% Grass cover, Good, HSG A |
| 692 | 39 | >75% Grass cover, Good, HSG A |
| 3,866 | 39 | >75% Grass cover, Good, HSG A |
| 261 | 39 | >75% Grass cover, Good, HSG A |
| 1,632 | 39 | >75% Grass cover, Good, HSG A |
| 53,729 | 82 | Weighted Average |
| 14,747 | | 27.45% Pervious Area |
| 38,982 | | 72.55% Impervious Area |

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



## Summary for Subcatchment PDA-1B: Subcat PDA-1B

Runoff = 1.26 cfs @ 12.08 hrs, Volume= 0.090 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 14,344 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 7 | 98 | Paved parking, HSG A |
| 170 | 98 | Paved parking, HSG A |
| 4,546 | 43 | Woods/grass comb., Fair, HSG A |
| 3,042 | 43 | Woods/grass comb., Fair, HSG A |
| 7 | 39 | >75% Grass cover, Good, HSG A |
| 3 | 39 | >75% Grass cover, Good, HSG A |
| 12 | 39 | >75% Grass cover, Good, HSG A |
| 7,165 | 39 | >75% Grass cover, Good, HSG A |
| 29,296 | 69 | Weighted Average |
| 14,775 | | 50.43% Pervious Area |
| 14,521 | | 49.57% Impervious Area |

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

## Summary for Subcatchment PDA-1C: Subcat PDA-1C

Runoff = 2.40 cfs @ 12.07 hrs, Volume= 0.171 af, Depth= 3.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 223 | 39 | >75% Grass cover, Good, HSG A |
| 1,316 | 39 | >75% Grass cover, Good, HSG A |
| 1,383 | 39 | >75% Grass cover, Good, HSG A |
| 22,618 | 98 | Paved parking, HSG A |
| 25,540 | 91 | Weighted Average |
| 2,921 | | 11.44% Pervious Area |
| 22,618 | | 88.56% Impervious Area |

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



## Summary for Subcatchment PDA-1D: Subcat PDA-1D

Runoff = 0.40 cfs @ 12.12 hrs, Volume= 0.034 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 5,831 | 98 | Paved parking, HSG A |
| 1 | 98 | Paved parking, HSG A |
| 1 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 5,546 | 43 | Woods/grass comb., Fair, HSG A |
| 3,244 | 39 | >75% Grass cover, Good, HSG A |
| 1,811 | 39 | >75% Grass cover, Good, HSG A |
| 214 | 39 | >75% Grass cover, Good, HSG A |
| 4 | 39 | >75% Grass cover, Good, HSG A |
| 16,652 | 61 | Weighted Average |
| 10,819 | | 64.97% Pervious Area |
| 5,833 | | 35.03% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.4 | 50 | 0.1040 | 0.13 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 121 | 0.1040 | 1.61 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 7.7 | 171 | Total | | | |

## Summary for Subcatchment PDA-1E: Subcat PDA-1E

Runoff = 0.29 cfs @ 12.21 hrs, Volume= 0.047 af, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 1 | 98 | Paved parking, HSG A |
| 128 | 98 | Paved parking, HSG A |
| 114 | 98 | Paved parking, HSG A |
| 2 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 34 | 98 | Paved parking, HSG A |
| 22 | 98 | Paved parking, HSG A |
| 11,355 | 43 | Woods/grass comb., Fair, HSG A |
| 13,508 | 43 | Woods/grass comb., Fair, HSG A |
| 1,584 | 68 | Pasture/grassland/range, Poor, HSG A |
| 11,504 | 68 | Pasture/grassland/range, Poor, HSG A |
| 701 | 68 | Pasture/grassland/range, Poor, HSG A |
| 9,680 | 39 | >75% Grass cover, Good, HSG A |
| 48,632 | 50 | Weighted Average |
| 48,332 | | 99.38% Pervious Area |
| 300 | | 0.62% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.9 | 50 | 0.0600 | 0.10 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 0.9 | 210 | 0.0600 | 3.94 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 8.8 | 260 | Total | | | |



## Summary for Pond UGDS-1: FS Apron

Inflow Area = 0.673 ac, 49.57% Impervious, Inflow Depth = 1.60" for 10-Year event
Inflow = 1.26 cfs @ 12.08 hrs, Volume= 0.090 af
Outflow = 0.43 cfs @ 12.41 hrs, Volume= 0.090 af, Atten= 66%, Lag= 19.8 min
Primary = 0.43 cfs @ 12.41 hrs, Volume= 0.090 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 193.24' @ 12.41 hrs Surf.Area= 0.020 ac Storage= 0.021 af

Plug-Flow detention time= 36.6 min calculated for 0.090 af (100% of inflow)
Center-of-Mass det. time= 36.4 min ( 891.7 - 855.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 192.00' | 0.000 af | **30.27'W x 28.71'L x 3.00'H Field A**<br>0.060 af Overall - 0.060 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 192.00' | 0.043 af | **StormTrap ST2 SingleTrap 2-6** x 2 Inside #1<br>Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf<br>Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf<br>2 Rows of 1 Chambers<br>16.96' x 15.40' Core + 6.66' Border = 30.27' x 28.71' System |
| | | 0.043 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 192.00' | **12.0" Round Culvert** L= 193.0' Ke= 0.500<br>Inlet / Outlet Invert= 192.00' / 186.64' S= 0.0278 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 194.45' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 192.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.43 cfs @ 12.41 hrs HW=193.24' TW=184.30' (Dynamic Tailwater)
↑└─**1=Culvert** (Passes 0.43 cfs of 3.25 cfs potential flow)
↑└─**2=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)
└─**3=Orifice/Grate** (Orifice Controls 0.43 cfs @ 4.98 fps)

## Pond UGDS-1: FS Apron - Chamber Wizard Field A

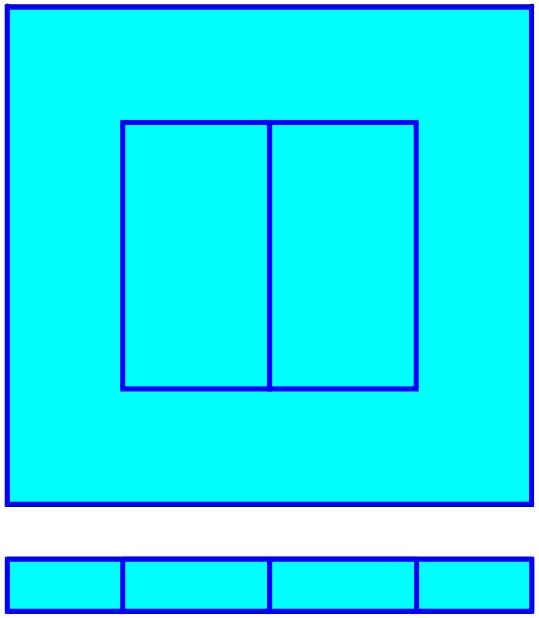
**Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

1 Chambers/Row x 15.40' Long = 15.40' Row Length +79.9" Border x 2 = 28.71' Base Length
2 Rows x 101.7" Wide + 79.9" Side Border x 2 = 30.27' Base Width
36.0" Chamber Height = 3.00' Field Height

2 Chambers x 289.8 cf + 1,300.8 cf Border = 1,880.4 cf Chamber Storage
2 Chambers x 391.6 cf + 1,823.8 cf Border = 2,607.1 cf Displacement

Chamber Storage = 1,880.4 cf = 0.043 af
Overall Storage Efficiency = 72.1%
Overall System Size = 28.71' x 30.27' x 3.00'

2 Chambers (plus border)
96.6 cy Field





## Stage-Discharge for Pond UGDS-1: FS Apron

| Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) |
|---|---|---|---|---|---|
| 192.00 | 0.00 | 193.02 | 0.39 | 194.04 | 0.58 |
| 192.02 | 0.00 | 193.04 | 0.39 | 194.06 | 0.58 |
| 192.04 | 0.00 | 193.06 | 0.40 | 194.08 | 0.58 |
| 192.06 | 0.01 | 193.08 | 0.40 | 194.10 | 0.58 |
| 192.08 | 0.02 | 193.10 | 0.41 | 194.12 | 0.59 |
| 192.10 | 0.02 | 193.12 | 0.41 | 194.14 | 0.59 |
| 192.12 | 0.03 | 193.14 | 0.41 | 194.16 | 0.59 |
| 192.14 | 0.04 | 193.16 | 0.42 | 194.18 | 0.60 |
| 192.16 | 0.06 | 193.18 | 0.42 | 194.20 | 0.60 |
| 192.18 | 0.07 | 193.20 | 0.43 | 194.22 | 0.60 |
| 192.20 | 0.08 | 193.22 | 0.43 | 194.24 | 0.61 |
| 192.22 | 0.10 | 193.24 | 0.44 | 194.26 | 0.61 |
| 192.24 | 0.11 | 193.26 | 0.44 | 194.28 | 0.61 |
| 192.26 | 0.13 | 193.28 | 0.44 | 194.30 | 0.61 |
| 192.28 | 0.14 | 193.30 | 0.45 | 194.32 | 0.62 |
| 192.30 | 0.15 | 193.32 | 0.45 | 194.34 | 0.62 |
| 192.32 | 0.17 | 193.34 | 0.46 | 194.36 | 0.62 |
| 192.34 | 0.17 | 193.36 | 0.46 | 194.38 | 0.63 |
| 192.36 | 0.18 | 193.38 | 0.46 | 194.40 | 0.63 |
| 192.38 | 0.19 | 193.40 | 0.47 | 194.42 | 0.63 |
| 192.40 | 0.20 | 193.42 | 0.47 | 194.44 | 0.63 |
| 192.42 | 0.21 | 193.44 | 0.47 | 194.46 | 0.65 |
| 192.44 | 0.22 | 193.46 | 0.48 | 194.48 | 0.72 |
| 192.46 | 0.23 | 193.48 | 0.48 | 194.50 | 0.82 |
| 192.48 | 0.24 | 193.50 | 0.49 | 194.52 | 0.95 |
| 192.50 | 0.24 | 193.52 | 0.49 | 194.54 | 1.09 |
| 192.52 | 0.25 | 193.54 | 0.49 | 194.56 | 1.24 |
| 192.54 | 0.26 | 193.56 | 0.50 | 194.58 | 1.42 |
| 192.56 | 0.26 | 193.58 | 0.50 | 194.60 | 1.60 |
| 192.58 | 0.27 | 193.60 | 0.50 | 194.62 | 1.80 |
| 192.60 | 0.28 | 193.62 | 0.51 | 194.64 | 2.00 |
| 192.62 | 0.28 | 193.64 | 0.51 | 194.66 | 2.22 |
| 192.64 | 0.29 | 193.66 | 0.51 | 194.68 | 2.45 |
| 192.66 | 0.30 | 193.68 | 0.52 | 194.70 | 2.69 |
| 192.68 | 0.30 | 193.70 | 0.52 | 194.72 | 2.94 |
| 192.70 | 0.31 | 193.72 | 0.52 | 194.74 | 3.20 |
| 192.72 | 0.31 | 193.74 | 0.53 | 194.76 | 3.46 |
| 192.74 | 0.32 | 193.76 | 0.53 | 194.78 | 3.74 |
| 192.76 | 0.32 | 193.78 | 0.53 | 194.80 | 4.02 |
| 192.78 | 0.33 | 193.80 | 0.54 | 194.82 | 4.31 |
| 192.80 | 0.33 | 193.82 | 0.54 | 194.84 | 4.61 |
| 192.82 | 0.34 | 193.84 | 0.54 | 194.86 | 4.91 |
| 192.84 | 0.34 | 193.86 | 0.55 | 194.88 | 5.22 |
| 192.86 | 0.35 | 193.88 | 0.55 | 194.90 | 5.54 |
| 192.88 | 0.35 | 193.90 | 0.55 | 194.92 | 5.87 |
| 192.90 | 0.36 | 193.92 | 0.56 | 194.94 | 5.91 |
| 192.92 | 0.36 | 193.94 | 0.56 | 194.96 | 5.93 |
| 192.94 | 0.37 | 193.96 | 0.56 | 194.98 | 5.96 |
| 192.96 | 0.37 | 193.98 | 0.57 | 195.00 | **5.98** |
| 192.98 | 0.38 | 194.00 | 0.57 | | |
| 193.00 | 0.38 | 194.02 | 0.57 | | |

## Stage-Area-Storage for Pond UGDS-1: FS Apron

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|---|---|
| 192.00 | 0.000 | 193.02 | 0.018 | 194.04 | 0.035 |
| 192.02 | 0.000 | 193.04 | 0.018 | 194.06 | 0.036 |
| 192.04 | 0.001 | 193.06 | 0.018 | 194.08 | 0.036 |
| 192.06 | 0.001 | 193.08 | 0.019 | 194.10 | 0.036 |
| 192.08 | 0.001 | 193.10 | 0.019 | 194.12 | 0.037 |
| 192.10 | 0.002 | 193.12 | 0.019 | 194.14 | 0.037 |
| 192.12 | 0.002 | 193.14 | 0.020 | 194.16 | 0.037 |
| 192.14 | 0.002 | 193.16 | 0.020 | 194.18 | 0.038 |
| 192.16 | 0.003 | 193.18 | 0.020 | 194.20 | 0.038 |
| 192.18 | 0.003 | 193.20 | 0.021 | 194.22 | 0.038 |
| 192.20 | 0.003 | 193.22 | 0.021 | 194.24 | 0.039 |
| 192.22 | 0.004 | 193.24 | 0.021 | 194.26 | 0.039 |
| 192.24 | 0.004 | 193.26 | 0.022 | 194.28 | 0.039 |
| 192.26 | 0.004 | 193.28 | 0.022 | 194.30 | 0.040 |
| 192.28 | 0.005 | 193.30 | 0.022 | 194.32 | 0.040 |
| 192.30 | 0.005 | 193.32 | 0.023 | 194.34 | 0.040 |
| 192.32 | 0.006 | 193.34 | 0.023 | 194.36 | 0.041 |
| 192.34 | 0.006 | 193.36 | 0.023 | 194.38 | 0.041 |
| 192.36 | 0.006 | 193.38 | 0.024 | 194.40 | 0.041 |
| 192.38 | 0.007 | 193.40 | 0.024 | 194.42 | 0.042 |
| 192.40 | 0.007 | 193.42 | 0.025 | 194.44 | 0.042 |
| 192.42 | 0.007 | 193.44 | 0.025 | 194.46 | 0.042 |
| 192.44 | 0.008 | 193.46 | 0.025 | 194.48 | 0.043 |
| 192.46 | 0.008 | 193.48 | 0.026 | 194.50 | 0.043 |
| 192.48 | 0.008 | 193.50 | 0.026 | 194.52 | 0.043 |
| 192.50 | 0.009 | 193.52 | 0.026 | 194.54 | 0.043 |
| 192.52 | 0.009 | 193.54 | 0.027 | 194.56 | 0.043 |
| 192.54 | 0.009 | 193.56 | 0.027 | 194.58 | 0.043 |
| 192.56 | 0.010 | 193.58 | 0.027 | 194.60 | **0.043** |
| 192.58 | 0.010 | 193.60 | 0.028 | 194.62 | 0.043 |
| 192.60 | 0.010 | 193.62 | 0.028 | 194.64 | 0.043 |
| 192.62 | 0.011 | 193.64 | 0.028 | 194.66 | 0.043 |
| 192.64 | 0.011 | 193.66 | 0.029 | 194.68 | 0.043 |
| 192.66 | 0.011 | 193.68 | 0.029 | 194.70 | 0.043 |
| 192.68 | 0.012 | 193.70 | 0.029 | 194.72 | 0.043 |
| 192.70 | 0.012 | 193.72 | 0.030 | 194.74 | 0.043 |
| 192.72 | 0.012 | 193.74 | 0.030 | 194.76 | 0.043 |
| 192.74 | 0.013 | 193.76 | 0.030 | 194.78 | 0.043 |
| 192.76 | 0.013 | 193.78 | 0.031 | 194.80 | 0.043 |
| 192.78 | 0.013 | 193.80 | 0.031 | 194.82 | 0.043 |
| 192.80 | 0.014 | 193.82 | 0.031 | 194.84 | 0.043 |
| 192.82 | 0.014 | 193.84 | 0.032 | 194.86 | 0.043 |
| 192.84 | 0.015 | 193.86 | 0.032 | 194.88 | 0.043 |
| 192.86 | 0.015 | 193.88 | 0.032 | 194.90 | 0.043 |
| 192.88 | 0.015 | 193.90 | 0.033 | 194.92 | 0.043 |
| 192.90 | 0.016 | 193.92 | 0.033 | 194.94 | 0.043 |
| 192.92 | 0.016 | 193.94 | 0.033 | 194.96 | 0.043 |
| 192.94 | 0.016 | 193.96 | 0.034 | 194.98 | 0.043 |
| 192.96 | 0.017 | 193.98 | 0.034 | 195.00 | 0.043 |
| 192.98 | 0.017 | 194.00 | 0.035 | | |
| 193.00 | 0.017 | 194.02 | 0.035 | | |



## Summary for Pond UGDS-2: Back Lot

Inflow Area = 0.586 ac, 88.56% Impervious, Inflow Depth = 3.50" for 10-Year event
Inflow = 2.40 cfs @ 12.07 hrs, Volume= 0.171 af
Outflow = 0.44 cfs @ 12.51 hrs, Volume= 0.171 af, Atten= 82%, Lag= 26.3 min
Primary = 0.44 cfs @ 12.51 hrs, Volume= 0.171 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 201.41' @ 12.51 hrs Surf.Area= 0.041 ac Storage= 0.070 af

Plug-Flow detention time= 116.8 min calculated for 0.171 af (100% of inflow)
Center-of-Mass det. time= 116.2 min ( 905.7 - 789.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 199.50' | 0.000 af | **30.27'W x 59.50'L x 3.50'H Field A**<br>0.145 af Overall - 0.145 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 199.50' | 0.109 af | **StormTrap ST2 SingleTrap 3-0**x 6 Inside #1<br>Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf<br>Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf<br>2 Rows of 3 Chambers<br>16.96' x 46.19' Core + 6.66' Border = 30.27' x 59.50' System |
| | | 0.109 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 199.50' | **12.0" Round Culvert** L= 390.0' Ke= 0.500<br>Inlet / Outlet Invert= 199.50' / 186.63' S= 0.0330 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 202.40' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 201.00' | **3.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 199.50' | **3.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.44 cfs @ 12.51 hrs HW=201.41' TW=184.43' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.44 cfs of 4.49 cfs potential flow)
—**2=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)
—**3=Orifice/Grate** (Orifice Controls 0.13 cfs @ 2.57 fps)
—**4=Orifice/Grate** (Orifice Controls 0.32 cfs @ 6.43 fps)

## Pond UGDS-2: Back Lot - Chamber Wizard Field A

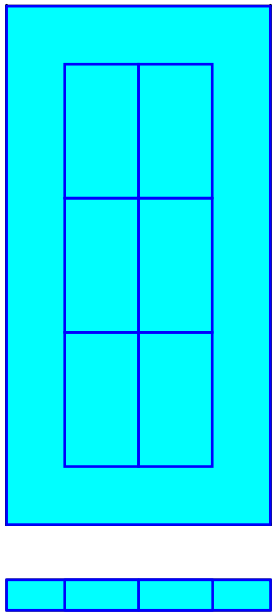
**Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

3 Chambers/Row x 15.40' Long = 46.19' Row Length +79.9" Border x 2 = 59.50' Base Length
2 Rows x 101.7" Wide + 79.9" Side Border x 2 = 30.27' Base Width
42.0" Chamber Height = 3.50' Field Height

6 Chambers x 354.0 cf + 2,645.3 cf Border = 4,769.2 cf Chamber Storage
6 Chambers x 456.9 cf + 3,562.5 cf Border = 6,303.9 cf Displacement

Chamber Storage = 4,769.2 cf = 0.109 af
Overall Storage Efficiency = 75.7%
Overall System Size = 59.50' x 30.27' x 3.50'

6 Chambers (plus border)
233.5 cy Field





## Stage-Discharge for Pond UGDS-2: Back Lot

| Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) |
|---|---|---|---|---|---|---|---|
| 199.50 | 0.00 | 200.52 | 0.22 | 201.54 | 0.48 | 202.56 | 1.73 |
| 199.52 | 0.00 | 200.54 | 0.23 | 201.56 | 0.48 | 202.58 | 1.93 |
| 199.54 | 0.00 | 200.56 | 0.23 | 201.58 | 0.49 | 202.60 | 2.15 |
| 199.56 | 0.01 | 200.58 | 0.23 | 201.60 | 0.50 | 202.62 | 2.37 |
| 199.58 | 0.01 | 200.60 | 0.23 | 201.62 | 0.50 | 202.64 | 2.61 |
| 199.60 | 0.02 | 200.62 | 0.24 | 201.64 | 0.51 | 202.66 | 2.85 |
| 199.62 | 0.03 | 200.64 | 0.24 | 201.66 | 0.51 | 202.68 | 3.10 |
| 199.64 | 0.04 | 200.66 | 0.24 | 201.68 | 0.51 | 202.70 | 3.37 |
| 199.66 | 0.05 | 200.68 | 0.24 | 201.70 | 0.52 | 202.72 | 3.64 |
| 199.68 | 0.05 | 200.70 | 0.25 | 201.72 | 0.52 | 202.74 | 3.91 |
| 199.70 | 0.06 | 200.72 | 0.25 | 201.74 | 0.53 | 202.76 | 4.20 |
| 199.72 | 0.07 | 200.74 | 0.25 | 201.76 | 0.53 | 202.78 | 4.50 |
| 199.74 | 0.08 | 200.76 | 0.25 | 201.78 | 0.54 | 202.80 | 4.80 |
| 199.76 | 0.09 | 200.78 | 0.25 | 201.80 | 0.54 | 202.82 | 5.11 |
| 199.78 | 0.09 | 200.80 | 0.26 | 201.82 | 0.55 | 202.84 | 5.42 |
| 199.80 | 0.10 | 200.82 | 0.26 | 201.84 | 0.55 | 202.86 | 5.74 |
| 199.82 | 0.10 | 200.84 | 0.26 | 201.86 | 0.56 | 202.88 | 6.07 |
| 199.84 | 0.11 | 200.86 | 0.26 | 201.88 | 0.56 | 202.90 | 6.41 |
| 199.86 | 0.11 | 200.88 | 0.26 | 201.90 | 0.56 | 202.92 | 6.46 |
| 199.88 | 0.12 | 200.90 | 0.27 | 201.92 | 0.57 | 202.94 | 6.48 |
| 199.90 | 0.12 | 200.92 | 0.27 | 201.94 | 0.57 | 202.96 | 6.51 |
| 199.92 | 0.13 | 200.94 | 0.27 | 201.96 | 0.58 | 202.98 | 6.53 |
| 199.94 | 0.13 | 200.96 | 0.27 | 201.98 | 0.58 | 203.00 | **6.55** |
| 199.96 | 0.14 | 200.98 | 0.28 | 202.00 | 0.59 | | |
| 199.98 | 0.14 | 201.00 | 0.28 | 202.02 | 0.59 | | |
| 200.00 | 0.14 | 201.02 | 0.28 | 202.04 | 0.59 | | |
| 200.02 | 0.15 | 201.04 | 0.28 | 202.06 | 0.60 | | |
| 200.04 | 0.15 | 201.06 | 0.29 | 202.08 | 0.60 | | |
| 200.06 | 0.16 | 201.08 | 0.30 | 202.10 | 0.61 | | |
| 200.08 | 0.16 | 201.10 | 0.31 | 202.12 | 0.61 | | |
| 200.10 | 0.16 | 201.12 | 0.32 | 202.14 | 0.61 | | |
| 200.12 | 0.17 | 201.14 | 0.33 | 202.16 | 0.62 | | |
| 200.14 | 0.17 | 201.16 | 0.34 | 202.18 | 0.62 | | |
| 200.16 | 0.17 | 201.18 | 0.35 | 202.20 | 0.62 | | |
| 200.18 | 0.18 | 201.20 | 0.36 | 202.22 | 0.63 | | |
| 200.20 | 0.18 | 201.22 | 0.37 | 202.24 | 0.63 | | |
| 200.22 | 0.18 | 201.24 | 0.38 | 202.26 | 0.64 | | |
| 200.24 | 0.19 | 201.26 | 0.39 | 202.28 | 0.64 | | |
| 200.26 | 0.19 | 201.28 | 0.40 | 202.30 | 0.64 | | |
| 200.28 | 0.19 | 201.30 | 0.40 | 202.32 | 0.65 | | |
| 200.30 | 0.19 | 201.32 | 0.41 | 202.34 | 0.65 | | |
| 200.32 | 0.20 | 201.34 | 0.42 | 202.36 | 0.65 | | |
| 200.34 | 0.20 | 201.36 | 0.43 | 202.38 | 0.66 | | |
| 200.36 | 0.20 | 201.38 | 0.43 | 202.40 | 0.66 | | |
| 200.38 | 0.21 | 201.40 | 0.44 | 202.42 | 0.71 | | |
| 200.40 | 0.21 | 201.42 | 0.45 | 202.44 | 0.80 | | |
| 200.42 | 0.21 | 201.44 | 0.45 | 202.46 | 0.91 | | |
| 200.44 | 0.21 | 201.46 | 0.46 | 202.48 | 1.04 | | |
| 200.46 | 0.22 | 201.48 | 0.46 | 202.50 | 1.19 | | |
| 200.48 | 0.22 | 201.50 | 0.47 | 202.52 | 1.36 | | |
| 200.50 | 0.22 | 201.52 | 0.47 | 202.54 | 1.54 | | |

## Stage-Area-Storage for Pond UGDS-2: Back Lot

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|
| 199.50 | 0.000 | 202.05 | 0.093 |
| 199.55 | 0.002 | 202.10 | 0.095 |
| 199.60 | 0.004 | 202.15 | 0.097 |
| 199.65 | 0.005 | 202.20 | 0.099 |
| 199.70 | 0.007 | 202.25 | 0.100 |
| 199.75 | 0.009 | 202.30 | 0.102 |
| 199.80 | 0.011 | 202.35 | 0.104 |
| 199.85 | 0.013 | 202.40 | 0.106 |
| 199.90 | 0.015 | 202.45 | 0.108 |
| 199.95 | 0.016 | 202.50 | **0.109** |
| 200.00 | 0.018 | 202.55 | **0.109** |
| 200.05 | 0.020 | 202.60 | 0.109 |
| 200.10 | 0.022 | 202.65 | 0.109 |
| 200.15 | 0.024 | 202.70 | 0.109 |
| 200.20 | 0.026 | 202.75 | 0.109 |
| 200.25 | 0.027 | 202.80 | 0.109 |
| 200.30 | 0.029 | 202.85 | 0.109 |
| 200.35 | 0.031 | 202.90 | 0.109 |
| 200.40 | 0.033 | 202.95 | 0.109 |
| 200.45 | 0.035 | 203.00 | 0.109 |
| 200.50 | 0.036 | | |
| 200.55 | 0.038 | | |
| 200.60 | 0.040 | | |
| 200.65 | 0.042 | | |
| 200.70 | 0.044 | | |
| 200.75 | 0.046 | | |
| 200.80 | 0.047 | | |
| 200.85 | 0.049 | | |
| 200.90 | 0.051 | | |
| 200.95 | 0.053 | | |
| 201.00 | 0.055 | | |
| 201.05 | 0.057 | | |
| 201.10 | 0.058 | | |
| 201.15 | 0.060 | | |
| 201.20 | 0.062 | | |
| 201.25 | 0.064 | | |
| 201.30 | 0.066 | | |
| 201.35 | 0.068 | | |
| 201.40 | 0.069 | | |
| 201.45 | 0.071 | | |
| 201.50 | 0.073 | | |
| 201.55 | 0.075 | | |
| 201.60 | 0.077 | | |
| 201.65 | 0.078 | | |
| 201.70 | 0.080 | | |
| 201.75 | 0.082 | | |
| 201.80 | 0.084 | | |
| 201.85 | 0.086 | | |
| 201.90 | 0.088 | | |
| 201.95 | 0.089 | | |
| 202.00 | 0.091 | | |



## Summary for Pond UGIS-2: Lower Lot

Inflow Area = 2.492 ac, 70.12% Impervious, Inflow Depth = 2.56" for 10-Year event
Inflow = 4.51 cfs @ 12.08 hrs, Volume= 0.532 af
Outflow = 0.36 cfs @ 16.29 hrs, Volume= 0.532 af, Atten= 92%, Lag= 252.9 min
Discarded = 0.28 cfs @ 11.57 hrs, Volume= 0.516 af
Primary = 0.08 cfs @ 16.29 hrs, Volume= 0.015 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 185.56' @ 16.29 hrs Surf.Area= 0.115 ac Storage= 0.263 af

Plug-Flow detention time= 392.6 min calculated for 0.532 af (100% of inflow)
Center-of-Mass det. time= 392.6 min ( 1,252.2 - 859.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 183.00' | 0.000 af | **55.71'W x 90.29'L x 4.00'H Field A**<br>0.462 af Overall - 0.462 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 183.00' | 0.359 af | **StormTrap ST2 SingleTrap 3-6**x 25 Inside #1<br>Inside= 101.7"W x 42.0"H => 26.77 sf x 15.40'L = 412.1 cf<br>Outside= 101.7"W x 48.0"H => 33.92 sf x 15.40'L = 522.2 cf<br>5 Rows of 5 Chambers<br>42.40' x 76.98' Core + 6.66' Border = 55.71' x 90.29' System |
| | | 0.359 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 185.00' | **12.0" Round Culvert** L= 26.0' Ke= 0.500<br>Inlet / Outlet Invert= 185.00' / 184.74' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 186.40' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Discarded | 183.00' | **2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01' |
| #4 | Primary | 185.40' | **6.0" Vert. Orifice/Grate** C= 0.600 |

**Discarded OutFlow** Max=0.28 cfs @ 11.57 hrs HW=183.04' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.28 cfs)

**Primary OutFlow** Max=0.08 cfs @ 16.29 hrs HW=185.56' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Passes 0.00 cfs of 1.02 cfs potential flow)
│└**2=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)
└**4=Orifice/Grate** (Orifice Controls 0.08 cfs @ 1.37 fps)

## Pond UGIS-2: Lower Lot - Chamber Wizard Field A

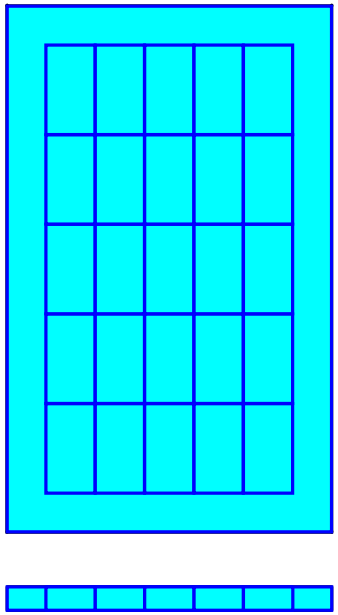
**Chamber Model = StormTrap ST2 SingleTrap 3-6 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 42.0"H => 26.77 sf x 15.40'L = 412.1 cf
Outside= 101.7"W x 48.0"H => 33.92 sf x 15.40'L = 522.2 cf

5 Chambers/Row x 15.40' Long = 76.98' Row Length +79.9" Border x 2 = 90.29' Base Length
5 Rows x 101.7" Wide + 79.9" Side Border x 2 = 55.71' Base Width
48.0" Chamber Height = 4.00' Field Height

25 Chambers x 412.1 cf + 5,349.6 cf Border = 15,652.9 cf Chamber Storage
25 Chambers x 522.2 cf + 7,065.6 cf Border = 20,120.0 cf Displacement

Chamber Storage = 15,652.9 cf = 0.359 af
Overall Storage Efficiency = 77.8%
Overall System Size = 90.29' x 55.71' x 4.00'

25 Chambers (plus border)
745.2 cy Field





## Stage-Discharge for Pond UGIS-2: Lower Lot

| Elevation (feet) | Discharge (cfs) | Discarded (cfs) | Primary (cfs) | Elevation (feet) | Discharge (cfs) | Discarded (cfs) | Primary (cfs) |
|---|---|---|---|---|---|---|---|
| 183.00 | 0.00 | **0.00** | 0.00 | 185.55 | 0.35 | 0.28 | 0.07 |
| 183.05 | 0.28 | **0.28** | 0.00 | 185.60 | 0.39 | 0.28 | 0.11 |
| 183.10 | 0.28 | 0.28 | 0.00 | 185.65 | 0.45 | 0.28 | 0.17 |
| 183.15 | 0.28 | 0.28 | 0.00 | 185.70 | 0.51 | 0.28 | 0.23 |
| 183.20 | 0.28 | 0.28 | 0.00 | 185.75 | 0.58 | 0.28 | 0.30 |
| 183.25 | 0.28 | 0.28 | 0.00 | 185.80 | 0.64 | 0.28 | 0.36 |
| 183.30 | 0.28 | 0.28 | 0.00 | 185.85 | 0.71 | 0.28 | 0.43 |
| 183.35 | 0.28 | 0.28 | 0.00 | 185.90 | 0.75 | 0.28 | 0.47 |
| 183.40 | 0.28 | 0.28 | 0.00 | 185.95 | 0.80 | 0.28 | 0.52 |
| 183.45 | 0.28 | 0.28 | 0.00 | 186.00 | 0.84 | 0.28 | 0.56 |
| 183.50 | 0.28 | 0.28 | 0.00 | 186.05 | 0.88 | 0.28 | 0.60 |
| 183.55 | 0.28 | 0.28 | 0.00 | 186.10 | 0.91 | 0.28 | 0.63 |
| 183.60 | 0.28 | 0.28 | 0.00 | 186.15 | 0.95 | 0.28 | 0.67 |
| 183.65 | 0.28 | 0.28 | 0.00 | 186.20 | 0.98 | 0.28 | 0.70 |
| 183.70 | 0.28 | 0.28 | 0.00 | 186.25 | 1.01 | 0.28 | 0.73 |
| 183.75 | 0.28 | 0.28 | 0.00 | 186.30 | 1.04 | 0.28 | 0.76 |
| 183.80 | 0.28 | 0.28 | 0.00 | 186.35 | 1.07 | 0.28 | 0.79 |
| 183.85 | 0.28 | 0.28 | 0.00 | 186.40 | 1.10 | 0.28 | 0.82 |
| 183.90 | 0.28 | 0.28 | 0.00 | 186.45 | 1.31 | 0.28 | 1.03 |
| 183.95 | 0.28 | 0.28 | 0.00 | 186.50 | 1.67 | 0.28 | 1.39 |
| 184.00 | 0.28 | 0.28 | 0.00 | 186.55 | 2.12 | 0.28 | 1.84 |
| 184.05 | 0.28 | 0.28 | 0.00 | 186.60 | 2.65 | 0.28 | 2.37 |
| 184.10 | 0.28 | 0.28 | 0.00 | 186.65 | 3.25 | 0.28 | 2.97 |
| 184.15 | 0.28 | 0.28 | 0.00 | 186.70 | 3.90 | 0.28 | 3.62 |
| 184.20 | 0.28 | 0.28 | 0.00 | 186.75 | 4.61 | 0.28 | 4.33 |
| 184.25 | 0.28 | 0.28 | 0.00 | 186.80 | 5.36 | 0.28 | 5.08 |
| 184.30 | 0.28 | 0.28 | 0.00 | 186.85 | 5.68 | 0.28 | 5.40 |
| 184.35 | 0.28 | 0.28 | 0.00 | 186.90 | 5.80 | 0.28 | 5.52 |
| 184.40 | 0.28 | 0.28 | 0.00 | 186.95 | 5.91 | 0.28 | 5.63 |
| 184.45 | 0.28 | 0.28 | 0.00 | 187.00 | **6.01** | 0.28 | **5.73** |
| 184.50 | 0.28 | 0.28 | 0.00 | | | | |
| 184.55 | 0.28 | 0.28 | 0.00 | | | | |
| 184.60 | 0.28 | 0.28 | 0.00 | | | | |
| 184.65 | 0.28 | 0.28 | 0.00 | | | | |
| 184.70 | 0.28 | 0.28 | 0.00 | | | | |
| 184.75 | 0.28 | 0.28 | 0.00 | | | | |
| 184.80 | 0.28 | 0.28 | 0.00 | | | | |
| 184.85 | 0.28 | 0.28 | 0.00 | | | | |
| 184.90 | 0.28 | 0.28 | 0.00 | | | | |
| 184.95 | 0.28 | 0.28 | 0.00 | | | | |
| 185.00 | 0.28 | 0.28 | 0.00 | | | | |
| 185.05 | 0.28 | 0.28 | 0.00 | | | | |
| 185.10 | 0.28 | 0.28 | 0.00 | | | | |
| 185.15 | 0.28 | 0.28 | 0.00 | | | | |
| 185.20 | 0.28 | 0.28 | 0.00 | | | | |
| 185.25 | 0.28 | 0.28 | 0.00 | | | | |
| 185.30 | 0.28 | 0.28 | 0.00 | | | | |
| 185.35 | 0.28 | 0.28 | 0.00 | | | | |
| 185.40 | 0.28 | 0.28 | 0.00 | | | | |
| 185.45 | 0.29 | 0.28 | 0.01 | | | | |
| 185.50 | 0.31 | 0.28 | 0.03 | | | | |

## Stage-Area-Storage for Pond UGIS-2: Lower Lot

| Elevation (feet) | Surface (acres) | Storage (acre-feet) | Elevation (feet) | Surface (acres) | Storage (acre-feet) |
|---|---|---|---|---|---|
| 183.00 | **0.115** | 0.000 | 185.55 | 0.115 | 0.262 |
| 183.05 | 0.115 | 0.005 | 185.60 | 0.115 | 0.267 |
| 183.10 | 0.115 | 0.010 | 185.65 | 0.115 | 0.272 |
| 183.15 | 0.115 | 0.015 | 185.70 | 0.115 | 0.277 |
| 183.20 | 0.115 | 0.021 | 185.75 | 0.115 | 0.282 |
| 183.25 | 0.115 | 0.026 | 185.80 | 0.115 | 0.287 |
| 183.30 | 0.115 | 0.031 | 185.85 | 0.115 | 0.293 |
| 183.35 | 0.115 | 0.036 | 185.90 | 0.115 | 0.298 |
| 183.40 | 0.115 | 0.041 | 185.95 | 0.115 | 0.303 |
| 183.45 | 0.115 | 0.046 | 186.00 | 0.115 | 0.308 |
| 183.50 | 0.115 | 0.051 | 186.05 | 0.115 | 0.313 |
| 183.55 | 0.115 | 0.056 | 186.10 | 0.115 | 0.318 |
| 183.60 | 0.115 | 0.062 | 186.15 | 0.115 | 0.323 |
| 183.65 | 0.115 | 0.067 | 186.20 | 0.115 | 0.329 |
| 183.70 | 0.115 | 0.072 | 186.25 | 0.115 | 0.334 |
| 183.75 | 0.115 | 0.077 | 186.30 | 0.115 | 0.339 |
| 183.80 | 0.115 | 0.082 | 186.35 | 0.115 | 0.344 |
| 183.85 | 0.115 | 0.087 | 186.40 | 0.115 | 0.349 |
| 183.90 | 0.115 | 0.092 | 186.45 | 0.115 | 0.354 |
| 183.95 | 0.115 | 0.098 | 186.50 | 0.115 | 0.359 |
| 184.00 | 0.115 | 0.103 | 186.55 | 0.115 | 0.359 |
| 184.05 | 0.115 | 0.108 | 186.60 | 0.115 | 0.359 |
| 184.10 | 0.115 | 0.113 | 186.65 | 0.115 | 0.359 |
| 184.15 | 0.115 | 0.118 | 186.70 | 0.115 | 0.359 |
| 184.20 | 0.115 | 0.123 | 186.75 | 0.115 | 0.359 |
| 184.25 | 0.115 | 0.128 | 186.80 | 0.115 | 0.359 |
| 184.30 | 0.115 | 0.133 | 186.85 | 0.115 | **0.359** |
| 184.35 | 0.115 | 0.139 | 186.90 | 0.115 | **0.359** |
| 184.40 | 0.115 | 0.144 | 186.95 | 0.115 | 0.359 |
| 184.45 | 0.115 | 0.149 | 187.00 | 0.115 | 0.359 |
| 184.50 | 0.115 | 0.154 | | | |
| 184.55 | 0.115 | 0.159 | | | |
| 184.60 | 0.115 | 0.164 | | | |
| 184.65 | 0.115 | 0.169 | | | |
| 184.70 | 0.115 | 0.175 | | | |
| 184.75 | 0.115 | 0.180 | | | |
| 184.80 | 0.115 | 0.185 | | | |
| 184.85 | 0.115 | 0.190 | | | |
| 184.90 | 0.115 | 0.195 | | | |
| 184.95 | 0.115 | 0.200 | | | |
| 185.00 | 0.115 | 0.205 | | | |
| 185.05 | 0.115 | 0.210 | | | |
| 185.10 | 0.115 | 0.216 | | | |
| 185.15 | 0.115 | 0.221 | | | |
| 185.20 | 0.115 | 0.226 | | | |
| 185.25 | 0.115 | 0.231 | | | |
| 185.30 | 0.115 | 0.236 | | | |
| 185.35 | 0.115 | 0.241 | | | |
| 185.40 | 0.115 | 0.246 | | | |
| 185.45 | 0.115 | 0.252 | | | |
| 185.50 | 0.115 | 0.257 | | | |



## Summary for Link 1L: Total to Roadway

Inflow Area = 2.875 ac, 65.45% Impervious, Inflow Depth = 0.21" for 10-Year event
Inflow = 0.40 cfs @ 12.12 hrs, Volume= 0.050 af
Primary = 0.40 cfs @ 12.12 hrs, Volume= 0.050 af, Atten= 0%, Lag= 0.0 min

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

## Summary for Link 2L: Total to Wetlands

Inflow Area = 1.116 ac, 0.62% Impervious, Inflow Depth = 0.50" for 10-Year event
Inflow = 0.29 cfs @ 12.21 hrs, Volume= 0.047 af
Primary = 0.29 cfs @ 12.21 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min

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



## Summary for Link DP-1: Culvert

Inflow Area = 3.991 ac, 47.31% Impervious, Inflow Depth = 0.29" for 10-Year event
Inflow = 0.65 cfs @ 12.15 hrs, Volume= 0.096 af
Primary = 0.65 cfs @ 12.15 hrs, Volume= 0.096 af, Atten= 0%, Lag= 0.0 min

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

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

**Subcatchment PDA-1A: Subcat PDA-1A** Runoff Area=53,729 sf 72.55% Impervious Runoff Depth=4.45"
Tc=5.0 min CN=82 Runoff=6.59 cfs 0.457 af

**Subcatchment PDA-1B: Subcat PDA-1B** Runoff Area=29,296 sf 49.57% Impervious Runoff Depth=3.11"
Tc=5.0 min CN=69 Runoff=2.53 cfs 0.174 af

**Subcatchment PDA-1C: Subcat PDA-1C** Runoff Area=25,540 sf 88.56% Impervious Runoff Depth=5.45"
Tc=5.0 min CN=91 Runoff=3.65 cfs 0.266 af

**Subcatchment PDA-1D: Subcat PDA-1D** Runoff Area=16,652 sf 35.03% Impervious Runoff Depth=2.35"
Flow Length=171' Slope=0.1040 '/' Tc=7.7 min CN=61 Runoff=0.96 cfs 0.075 af

**Subcatchment PDA-1E: Subcat PDA-1E** Runoff Area=48,632 sf 0.62% Impervious Runoff Depth=1.40"
Flow Length=260' Slope=0.0600 '/' Tc=8.8 min CN=50 Runoff=1.38 cfs 0.130 af

**Pond UGDS-1: FS Apron** Peak Elev=194.58' Storage=0.043 af Inflow=2.53 cfs 0.174 af
Outflow=1.40 cfs 0.174 af

**Pond UGDS-2: Back Lot** Peak Elev=202.44' Storage=0.107 af Inflow=3.65 cfs 0.266 af
Outflow=0.78 cfs 0.266 af

**Pond UGIS-2: Lower Lot** Peak Elev=186.45' Storage=0.354 af Inflow=7.55 cfs 0.898 af
Discarded=0.28 cfs 0.589 af Primary=1.03 cfs 0.308 af Outflow=1.31 cfs 0.898 af

**Link 1L: Total to Roadway** Inflow=1.12 cfs 0.383 af
Primary=1.12 cfs 0.383 af

**Link 2L: Total to Wetlands** Inflow=1.38 cfs 0.130 af
Primary=1.38 cfs 0.130 af

**Link DP-1: Culvert** Inflow=2.31 cfs 0.513 af
Primary=2.31 cfs 0.513 af

**Total Runoff Area = 3.991 ac Runoff Volume = 1.102 af Average Runoff Depth = 3.31"**
**52.69% Pervious = 2.103 ac 47.31% Impervious = 1.888 ac**



## Summary for Subcatchment PDA-1A: Subcat PDA-1A

Runoff = 6.59 cfs @ 12.07 hrs, Volume= 0.457 af, Depth= 4.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 38,686 | 98 | Paved parking, HSG A |
| 277 | 98 | Paved parking, HSG A |
| 20 | 98 | Paved parking, HSG A |
| 2,711 | 39 | >75% Grass cover, Good, HSG A |
| 212 | 39 | >75% Grass cover, Good, HSG A |
| 2,692 | 39 | >75% Grass cover, Good, HSG A |
| 2,224 | 39 | >75% Grass cover, Good, HSG A |
| 112 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 39 | >75% Grass cover, Good, HSG A |
| 83 | 39 | >75% Grass cover, Good, HSG A |
| 262 | 39 | >75% Grass cover, Good, HSG A |
| 692 | 39 | >75% Grass cover, Good, HSG A |
| 3,866 | 39 | >75% Grass cover, Good, HSG A |
| 261 | 39 | >75% Grass cover, Good, HSG A |
| 1,632 | 39 | >75% Grass cover, Good, HSG A |
| 53,729 | 82 | Weighted Average |
| 14,747 | | 27.45% Pervious Area |
| 38,982 | | 72.55% Impervious Area |

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

## Summary for Subcatchment PDA-1B: Subcat PDA-1B

Runoff = 2.53 cfs @ 12.08 hrs, Volume= 0.174 af, Depth= 3.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 14,344 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 7 | 98 | Paved parking, HSG A |
| 170 | 98 | Paved parking, HSG A |
| 4,546 | 43 | Woods/grass comb., Fair, HSG A |
| 3,042 | 43 | Woods/grass comb., Fair, HSG A |
| 7 | 39 | >75% Grass cover, Good, HSG A |
| 3 | 39 | >75% Grass cover, Good, HSG A |
| 12 | 39 | >75% Grass cover, Good, HSG A |
| 7,165 | 39 | >75% Grass cover, Good, HSG A |
| 29,296 | 69 | Weighted Average |
| 14,775 | | 50.43% Pervious Area |
| 14,521 | | 49.57% Impervious Area |

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



## Summary for Subcatchment PDA-1C: Subcat PDA-1C

Runoff = 3.65 cfs @ 12.07 hrs, Volume= 0.266 af, Depth= 5.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 223 | 39 | >75% Grass cover, Good, HSG A |
| 1,316 | 39 | >75% Grass cover, Good, HSG A |
| 1,383 | 39 | >75% Grass cover, Good, HSG A |
| 22,618 | 98 | Paved parking, HSG A |
| 25,540 | 91 | Weighted Average |
| 2,921 | | 11.44% Pervious Area |
| 22,618 | | 88.56% Impervious Area |

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

## Summary for Subcatchment PDA-1D: Subcat PDA-1D

Runoff = 0.96 cfs @ 12.12 hrs, Volume= 0.075 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 5,831 | 98 | Paved parking, HSG A |
| 1 | 98 | Paved parking, HSG A |
| 1 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 5,546 | 43 | Woods/grass comb., Fair, HSG A |
| 3,244 | 39 | >75% Grass cover, Good, HSG A |
| 1,811 | 39 | >75% Grass cover, Good, HSG A |
| 214 | 39 | >75% Grass cover, Good, HSG A |
| 4 | 39 | >75% Grass cover, Good, HSG A |
| 16,652 | 61 | Weighted Average |
| 10,819 | | 64.97% Pervious Area |
| 5,833 | | 35.03% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.4 | 50 | 0.1040 | 0.13 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 1.3 | 121 | 0.1040 | 1.61 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 7.7 | 171 | Total | | | |



## Summary for Subcatchment PDA-1E: Subcat PDA-1E

Runoff = 1.38 cfs @ 12.14 hrs, Volume= 0.130 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 1 | 98 | Paved parking, HSG A |
| 128 | 98 | Paved parking, HSG A |
| 114 | 98 | Paved parking, HSG A |
| 2 | 98 | Paved parking, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 34 | 98 | Paved parking, HSG A |
| 22 | 98 | Paved parking, HSG A |
| 11,355 | 43 | Woods/grass comb., Fair, HSG A |
| 13,508 | 43 | Woods/grass comb., Fair, HSG A |
| 1,584 | 68 | Pasture/grassland/range, Poor, HSG A |
| 11,504 | 68 | Pasture/grassland/range, Poor, HSG A |
| 701 | 68 | Pasture/grassland/range, Poor, HSG A |
| 9,680 | 39 | >75% Grass cover, Good, HSG A |
| 48,632 | 50 | Weighted Average |
| 48,332 | | 99.38% Pervious Area |
| 300 | | 0.62% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 7.9 | 50 | 0.0600 | 0.10 | | **Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20" |
| 0.9 | 210 | 0.0600 | 3.94 | | **Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps |
| 8.8 | 260 | Total | | | |

## Summary for Pond UGDS-1: FS Apron

Inflow Area = 0.673 ac, 49.57% Impervious, Inflow Depth = 3.11" for 100-Year event
Inflow = 2.53 cfs @ 12.08 hrs, Volume= 0.174 af
Outflow = 1.40 cfs @ 12.23 hrs, Volume= 0.174 af, Atten= 45%, Lag= 9.2 min
Primary = 1.40 cfs @ 12.23 hrs, Volume= 0.174 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 194.58' @ 12.23 hrs Surf.Area= 0.020 ac Storage= 0.043 af

Plug-Flow detention time= 36.6 min calculated for 0.174 af (100% of inflow)
Center-of-Mass det. time= 36.5 min ( 872.2 - 835.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 192.00' | 0.000 af | **30.27'W x 28.71'L x 3.00'H Field A**<br>0.060 af Overall - 0.060 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 192.00' | 0.043 af | **StormTrap ST2 SingleTrap 2-6** x 2 Inside #1<br>Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf<br>Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf<br>2 Rows of 1 Chambers<br>16.96' x 15.40' Core + 6.66' Border = 30.27' x 28.71' System |
| | | 0.043 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 192.00' | **12.0" Round Culvert** L= 193.0' Ke= 0.500<br>Inlet / Outlet Invert= 192.00' / 186.64' S= 0.0278 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 194.45' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 192.00' | **4.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=1.39 cfs @ 12.23 hrs HW=194.58' TW=185.04' (Dynamic Tailwater)
└1=**Culvert** (Passes 1.39 cfs of 5.45 cfs potential flow)
└2=**Sharp-Crested Rectangular Weir** (Weir Controls 0.73 cfs @ 1.16 fps)
└3=**Orifice/Grate** (Orifice Controls 0.65 cfs @ 7.47 fps)



## Pond UGDS-1: FS Apron - Chamber Wizard Field A

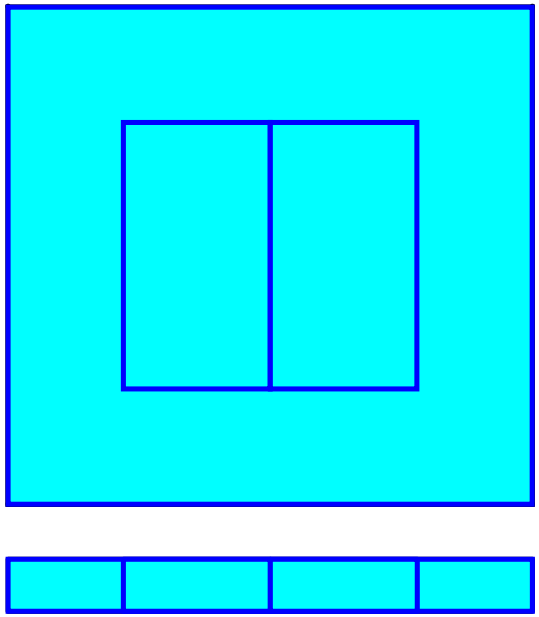
**Chamber Model = StormTrap ST2 SingleTrap 2-6 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 30.0"H => 18.82 sf x 15.40'L = 289.8 cf
Outside= 101.7"W x 36.0"H => 25.44 sf x 15.40'L = 391.6 cf

1 Chambers/Row x 15.40' Long = 15.40' Row Length +79.9" Border x 2 = 28.71' Base Length
2 Rows x 101.7" Wide + 79.9" Side Border x 2 = 30.27' Base Width
36.0" Chamber Height = 3.00' Field Height

2 Chambers x 289.8 cf + 1,300.8 cf Border = 1,880.4 cf Chamber Storage
2 Chambers x 391.6 cf + 1,823.8 cf Border = 2,607.1 cf Displacement

Chamber Storage = 1,880.4 cf = 0.043 af
Overall Storage Efficiency = 72.1%
Overall System Size = 28.71' x 30.27' x 3.00'

2 Chambers (plus border)
96.6 cy Field



## Stage-Discharge for Pond UGDS-1: FS Apron

| Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) |
|---|---|---|---|---|---|
| 192.00 | 0.00 | 193.02 | 0.39 | 194.04 | 0.58 |
| 192.02 | 0.00 | 193.04 | 0.39 | 194.06 | 0.58 |
| 192.04 | 0.00 | 193.06 | 0.40 | 194.08 | 0.58 |
| 192.06 | 0.01 | 193.08 | 0.40 | 194.10 | 0.58 |
| 192.08 | 0.02 | 193.10 | 0.41 | 194.12 | 0.59 |
| 192.10 | 0.02 | 193.12 | 0.41 | 194.14 | 0.59 |
| 192.12 | 0.03 | 193.14 | 0.41 | 194.16 | 0.59 |
| 192.14 | 0.04 | 193.16 | 0.42 | 194.18 | 0.60 |
| 192.16 | 0.06 | 193.18 | 0.42 | 194.20 | 0.60 |
| 192.18 | 0.07 | 193.20 | 0.43 | 194.22 | 0.60 |
| 192.20 | 0.08 | 193.22 | 0.43 | 194.24 | 0.61 |
| 192.22 | 0.10 | 193.24 | 0.44 | 194.26 | 0.61 |
| 192.24 | 0.11 | 193.26 | 0.44 | 194.28 | 0.61 |
| 192.26 | 0.13 | 193.28 | 0.44 | 194.30 | 0.61 |
| 192.28 | 0.14 | 193.30 | 0.45 | 194.32 | 0.62 |
| 192.30 | 0.15 | 193.32 | 0.45 | 194.34 | 0.62 |
| 192.32 | 0.17 | 193.34 | 0.46 | 194.36 | 0.62 |
| 192.34 | 0.17 | 193.36 | 0.46 | 194.38 | 0.63 |
| 192.36 | 0.18 | 193.38 | 0.46 | 194.40 | 0.63 |
| 192.38 | 0.19 | 193.40 | 0.47 | 194.42 | 0.63 |
| 192.40 | 0.20 | 193.42 | 0.47 | 194.44 | 0.63 |
| 192.42 | 0.21 | 193.44 | 0.47 | 194.46 | 0.65 |
| 192.44 | 0.22 | 193.46 | 0.48 | 194.48 | 0.72 |
| 192.46 | 0.23 | 193.48 | 0.48 | 194.50 | 0.82 |
| 192.48 | 0.24 | 193.50 | 0.49 | 194.52 | 0.95 |
| 192.50 | 0.24 | 193.52 | 0.49 | 194.54 | 1.09 |
| 192.52 | 0.25 | 193.54 | 0.49 | 194.56 | 1.24 |
| 192.54 | 0.26 | 193.56 | 0.50 | 194.58 | 1.42 |
| 192.56 | 0.26 | 193.58 | 0.50 | 194.60 | 1.60 |
| 192.58 | 0.27 | 193.60 | 0.50 | 194.62 | 1.80 |
| 192.60 | 0.28 | 193.62 | 0.51 | 194.64 | 2.00 |
| 192.62 | 0.28 | 193.64 | 0.51 | 194.66 | 2.22 |
| 192.64 | 0.29 | 193.66 | 0.51 | 194.68 | 2.45 |
| 192.66 | 0.30 | 193.68 | 0.52 | 194.70 | 2.69 |
| 192.68 | 0.30 | 193.70 | 0.52 | 194.72 | 2.94 |
| 192.70 | 0.31 | 193.72 | 0.52 | 194.74 | 3.20 |
| 192.72 | 0.31 | 193.74 | 0.53 | 194.76 | 3.46 |
| 192.74 | 0.32 | 193.76 | 0.53 | 194.78 | 3.74 |
| 192.76 | 0.32 | 193.78 | 0.53 | 194.80 | 4.02 |
| 192.78 | 0.33 | 193.80 | 0.54 | 194.82 | 4.31 |
| 192.80 | 0.33 | 193.82 | 0.54 | 194.84 | 4.61 |
| 192.82 | 0.34 | 193.84 | 0.54 | 194.86 | 4.91 |
| 192.84 | 0.34 | 193.86 | 0.55 | 194.88 | 5.22 |
| 192.86 | 0.35 | 193.88 | 0.55 | 194.90 | 5.54 |
| 192.88 | 0.35 | 193.90 | 0.55 | 194.92 | 5.87 |
| 192.90 | 0.36 | 193.92 | 0.56 | 194.94 | 5.91 |
| 192.92 | 0.36 | 193.94 | 0.56 | 194.96 | 5.93 |
| 192.94 | 0.37 | 193.96 | 0.56 | 194.98 | 5.96 |
| 192.96 | 0.37 | 193.98 | 0.57 | 195.00 | **5.98** |
| 192.98 | 0.38 | 194.00 | 0.57 | | |
| 193.00 | 0.38 | 194.02 | 0.57 | | |



## Stage-Area-Storage for Pond UGDS-1: FS Apron

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|---|---|
| 192.00 | 0.000 | 193.02 | 0.018 | 194.04 | 0.035 |
| 192.02 | 0.000 | 193.04 | 0.018 | 194.06 | 0.036 |
| 192.04 | 0.001 | 193.06 | 0.018 | 194.08 | 0.036 |
| 192.06 | 0.001 | 193.08 | 0.019 | 194.10 | 0.036 |
| 192.08 | 0.001 | 193.10 | 0.019 | 194.12 | 0.037 |
| 192.10 | 0.002 | 193.12 | 0.019 | 194.14 | 0.037 |
| 192.12 | 0.002 | 193.14 | 0.020 | 194.16 | 0.037 |
| 192.14 | 0.002 | 193.16 | 0.020 | 194.18 | 0.038 |
| 192.16 | 0.003 | 193.18 | 0.020 | 194.20 | 0.038 |
| 192.18 | 0.003 | 193.20 | 0.021 | 194.22 | 0.038 |
| 192.20 | 0.003 | 193.22 | 0.021 | 194.24 | 0.039 |
| 192.22 | 0.004 | 193.24 | 0.021 | 194.26 | 0.039 |
| 192.24 | 0.004 | 193.26 | 0.022 | 194.28 | 0.039 |
| 192.26 | 0.004 | 193.28 | 0.022 | 194.30 | 0.040 |
| 192.28 | 0.005 | 193.30 | 0.022 | 194.32 | 0.040 |
| 192.30 | 0.005 | 193.32 | 0.023 | 194.34 | 0.040 |
| 192.32 | 0.006 | 193.34 | 0.023 | 194.36 | 0.041 |
| 192.34 | 0.006 | 193.36 | 0.023 | 194.38 | 0.041 |
| 192.36 | 0.006 | 193.38 | 0.024 | 194.40 | 0.041 |
| 192.38 | 0.007 | 193.40 | 0.024 | 194.42 | 0.042 |
| 192.40 | 0.007 | 193.42 | 0.025 | 194.44 | 0.042 |
| 192.42 | 0.007 | 193.44 | 0.025 | 194.46 | 0.042 |
| 192.44 | 0.008 | 193.46 | 0.025 | 194.48 | 0.043 |
| 192.46 | 0.008 | 193.48 | 0.026 | 194.50 | 0.043 |
| 192.48 | 0.008 | 193.50 | 0.026 | 194.52 | 0.043 |
| 192.50 | 0.009 | 193.52 | 0.026 | 194.54 | 0.043 |
| 192.52 | 0.009 | 193.54 | 0.027 | 194.56 | 0.043 |
| 192.54 | 0.009 | 193.56 | 0.027 | 194.58 | 0.043 |
| 192.56 | 0.010 | 193.58 | 0.027 | 194.60 | **0.043** |
| 192.58 | 0.010 | 193.60 | 0.028 | 194.62 | 0.043 |
| 192.60 | 0.010 | 193.62 | 0.028 | 194.64 | 0.043 |
| 192.62 | 0.011 | 193.64 | 0.028 | 194.66 | 0.043 |
| 192.64 | 0.011 | 193.66 | 0.029 | 194.68 | 0.043 |
| 192.66 | 0.011 | 193.68 | 0.029 | 194.70 | 0.043 |
| 192.68 | 0.012 | 193.70 | 0.029 | 194.72 | 0.043 |
| 192.70 | 0.012 | 193.72 | 0.030 | 194.74 | 0.043 |
| 192.72 | 0.012 | 193.74 | 0.030 | 194.76 | 0.043 |
| 192.74 | 0.013 | 193.76 | 0.030 | 194.78 | 0.043 |
| 192.76 | 0.013 | 193.78 | 0.031 | 194.80 | 0.043 |
| 192.78 | 0.013 | 193.80 | 0.031 | 194.82 | 0.043 |
| 192.80 | 0.014 | 193.82 | 0.031 | 194.84 | 0.043 |
| 192.82 | 0.014 | 193.84 | 0.032 | 194.86 | 0.043 |
| 192.84 | 0.015 | 193.86 | 0.032 | 194.88 | 0.043 |
| 192.86 | 0.015 | 193.88 | 0.032 | 194.90 | 0.043 |
| 192.88 | 0.015 | 193.90 | 0.033 | 194.92 | 0.043 |
| 192.90 | 0.016 | 193.92 | 0.033 | 194.94 | 0.043 |
| 192.92 | 0.016 | 193.94 | 0.033 | 194.96 | 0.043 |
| 192.94 | 0.016 | 193.96 | 0.034 | 194.98 | 0.043 |
| 192.96 | 0.017 | 193.98 | 0.034 | 195.00 | 0.043 |
| 192.98 | 0.017 | 194.00 | 0.035 | | |
| 193.00 | 0.017 | 194.02 | 0.035 | | |

## Summary for Pond UGDS-2: Back Lot

Inflow Area = 0.586 ac, 88.56% Impervious, Inflow Depth = 5.45" for 100-Year event
Inflow = 3.65 cfs @ 12.07 hrs, Volume= 0.266 af
Outflow = 0.78 cfs @ 12.47 hrs, Volume= 0.266 af, Atten= 79%, Lag= 24.1 min
Primary = 0.78 cfs @ 12.47 hrs, Volume= 0.266 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 202.44' @ 12.47 hrs Surf.Area= 0.041 ac Storage= 0.107 af

Plug-Flow detention time= 113.2 min calculated for 0.266 af (100% of inflow)
Center-of-Mass det. time= 112.8 min ( 890.5 - 777.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 199.50' | 0.000 af | **30.27'W x 59.50'L x 3.50'H Field A**<br>0.145 af Overall - 0.145 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 199.50' | 0.109 af | **StormTrap ST2 SingleTrap 3-0** x 6 Inside #1<br>Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf<br>Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf<br>2 Rows of 3 Chambers<br>16.96' x 46.19' Core + 6.66' Border = 30.27' x 59.50' System |
| | | 0.109 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 199.50' | **12.0" Round Culvert** L= 390.0' Ke= 0.500<br>Inlet / Outlet Invert= 199.50' / 186.63' S= 0.0330 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 202.40' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 201.00' | **3.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 199.50' | **3.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.78 cfs @ 12.47 hrs HW=202.44' TW=185.73' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.78 cfs of 5.90 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.12 cfs @ 0.63 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.27 cfs @ 5.52 fps)
  └─**4=Orifice/Grate** (Orifice Controls 0.40 cfs @ 8.07 fps)



## Pond UGDS-2: Back Lot - Chamber Wizard Field A

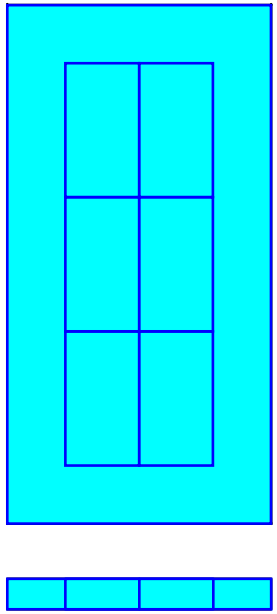
**Chamber Model = StormTrap ST2 SingleTrap 3-0 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 36.0"H => 22.99 sf x 15.40'L = 354.0 cf
Outside= 101.7"W x 42.0"H => 29.68 sf x 15.40'L = 456.9 cf

3 Chambers/Row x 15.40' Long = 46.19' Row Length +79.9" Border x 2 = 59.50' Base Length
2 Rows x 101.7" Wide + 79.9" Side Border x 2 = 30.27' Base Width
42.0" Chamber Height = 3.50' Field Height

6 Chambers x 354.0 cf + 2,645.3 cf Border = 4,769.2 cf Chamber Storage
6 Chambers x 456.9 cf + 3,562.5 cf Border = 6,303.9 cf Displacement

Chamber Storage = 4,769.2 cf = 0.109 af
Overall Storage Efficiency = 75.7%
Overall System Size = 59.50' x 30.27' x 3.50'

6 Chambers (plus border)
233.5 cy Field



## Stage-Discharge for Pond UGDS-2: Back Lot

| Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) | Elevation (feet) | Primary (cfs) |
|---|---|---|---|---|---|---|---|
| 199.50 | 0.00 | 200.52 | 0.22 | 201.54 | 0.48 | 202.56 | 1.73 |
| 199.52 | 0.00 | 200.54 | 0.23 | 201.56 | 0.48 | 202.58 | 1.93 |
| 199.54 | 0.00 | 200.56 | 0.23 | 201.58 | 0.49 | 202.60 | 2.15 |
| 199.56 | 0.01 | 200.58 | 0.23 | 201.60 | 0.50 | 202.62 | 2.37 |
| 199.58 | 0.01 | 200.60 | 0.23 | 201.62 | 0.50 | 202.64 | 2.61 |
| 199.60 | 0.02 | 200.62 | 0.24 | 201.64 | 0.51 | 202.66 | 2.85 |
| 199.62 | 0.03 | 200.64 | 0.24 | 201.66 | 0.51 | 202.68 | 3.10 |
| 199.64 | 0.04 | 200.66 | 0.24 | 201.68 | 0.51 | 202.70 | 3.37 |
| 199.66 | 0.05 | 200.68 | 0.24 | 201.70 | 0.52 | 202.72 | 3.64 |
| 199.68 | 0.05 | 200.70 | 0.25 | 201.72 | 0.52 | 202.74 | 3.91 |
| 199.70 | 0.06 | 200.72 | 0.25 | 201.74 | 0.53 | 202.76 | 4.20 |
| 199.72 | 0.07 | 200.74 | 0.25 | 201.76 | 0.53 | 202.78 | 4.50 |
| 199.74 | 0.08 | 200.76 | 0.25 | 201.78 | 0.54 | 202.80 | 4.80 |
| 199.76 | 0.09 | 200.78 | 0.25 | 201.80 | 0.54 | 202.82 | 5.11 |
| 199.78 | 0.09 | 200.80 | 0.26 | 201.82 | 0.55 | 202.84 | 5.42 |
| 199.80 | 0.10 | 200.82 | 0.26 | 201.84 | 0.55 | 202.86 | 5.74 |
| 199.82 | 0.10 | 200.84 | 0.26 | 201.86 | 0.56 | 202.88 | 6.07 |
| 199.84 | 0.11 | 200.86 | 0.26 | 201.88 | 0.56 | 202.90 | 6.41 |
| 199.86 | 0.11 | 200.88 | 0.26 | 201.90 | 0.56 | 202.92 | 6.46 |
| 199.88 | 0.12 | 200.90 | 0.27 | 201.92 | 0.57 | 202.94 | 6.48 |
| 199.90 | 0.12 | 200.92 | 0.27 | 201.94 | 0.57 | 202.96 | 6.51 |
| 199.92 | 0.13 | 200.94 | 0.27 | 201.96 | 0.58 | 202.98 | 6.53 |
| 199.94 | 0.13 | 200.96 | 0.27 | 201.98 | 0.58 | 203.00 | **6.55** |
| 199.96 | 0.14 | 200.98 | 0.28 | 202.00 | 0.59 | | |
| 199.98 | 0.14 | 201.00 | 0.28 | 202.02 | 0.59 | | |
| 200.00 | 0.14 | 201.02 | 0.28 | 202.04 | 0.59 | | |
| 200.02 | 0.15 | 201.04 | 0.28 | 202.06 | 0.60 | | |
| 200.04 | 0.15 | 201.06 | 0.29 | 202.08 | 0.60 | | |
| 200.06 | 0.16 | 201.08 | 0.30 | 202.10 | 0.61 | | |
| 200.08 | 0.16 | 201.10 | 0.31 | 202.12 | 0.61 | | |
| 200.10 | 0.16 | 201.12 | 0.32 | 202.14 | 0.61 | | |
| 200.12 | 0.17 | 201.14 | 0.33 | 202.16 | 0.62 | | |
| 200.14 | 0.17 | 201.16 | 0.34 | 202.18 | 0.62 | | |
| 200.16 | 0.17 | 201.18 | 0.35 | 202.20 | 0.62 | | |
| 200.18 | 0.18 | 201.20 | 0.36 | 202.22 | 0.63 | | |
| 200.20 | 0.18 | 201.22 | 0.37 | 202.24 | 0.63 | | |
| 200.22 | 0.18 | 201.24 | 0.38 | 202.26 | 0.64 | | |
| 200.24 | 0.19 | 201.26 | 0.39 | 202.28 | 0.64 | | |
| 200.26 | 0.19 | 201.28 | 0.40 | 202.30 | 0.64 | | |
| 200.28 | 0.19 | 201.30 | 0.40 | 202.32 | 0.65 | | |
| 200.30 | 0.19 | 201.32 | 0.41 | 202.34 | 0.65 | | |
| 200.32 | 0.20 | 201.34 | 0.42 | 202.36 | 0.65 | | |
| 200.34 | 0.20 | 201.36 | 0.43 | 202.38 | 0.66 | | |
| 200.36 | 0.20 | 201.38 | 0.43 | 202.40 | 0.66 | | |
| 200.38 | 0.21 | 201.40 | 0.44 | 202.42 | 0.71 | | |
| 200.40 | 0.21 | 201.42 | 0.45 | 202.44 | 0.80 | | |
| 200.42 | 0.21 | 201.44 | 0.45 | 202.46 | 0.91 | | |
| 200.44 | 0.21 | 201.46 | 0.46 | 202.48 | 1.04 | | |
| 200.46 | 0.22 | 201.48 | 0.46 | 202.50 | 1.19 | | |
| 200.48 | 0.22 | 201.50 | 0.47 | 202.52 | 1.36 | | |
| 200.50 | 0.22 | 201.52 | 0.47 | 202.54 | 1.54 | | |



## Stage-Area-Storage for Pond UGDS-2: Back Lot

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|
| 199.50 | 0.000 | 202.05 | 0.093 |
| 199.55 | 0.002 | 202.10 | 0.095 |
| 199.60 | 0.004 | 202.15 | 0.097 |
| 199.65 | 0.005 | 202.20 | 0.099 |
| 199.70 | 0.007 | 202.25 | 0.100 |
| 199.75 | 0.009 | 202.30 | 0.102 |
| 199.80 | 0.011 | 202.35 | 0.104 |
| 199.85 | 0.013 | 202.40 | 0.106 |
| 199.90 | 0.015 | 202.45 | 0.108 |
| 199.95 | 0.016 | 202.50 | **0.109** |
| 200.00 | 0.018 | 202.55 | **0.109** |
| 200.05 | 0.020 | 202.60 | 0.109 |
| 200.10 | 0.022 | 202.65 | 0.109 |
| 200.15 | 0.024 | 202.70 | 0.109 |
| 200.20 | 0.026 | 202.75 | 0.109 |
| 200.25 | 0.027 | 202.80 | 0.109 |
| 200.30 | 0.029 | 202.85 | 0.109 |
| 200.35 | 0.031 | 202.90 | 0.109 |
| 200.40 | 0.033 | 202.95 | 0.109 |
| 200.45 | 0.035 | 203.00 | 0.109 |
| 200.50 | 0.036 | | |
| 200.55 | 0.038 | | |
| 200.60 | 0.040 | | |
| 200.65 | 0.042 | | |
| 200.70 | 0.044 | | |
| 200.75 | 0.046 | | |
| 200.80 | 0.047 | | |
| 200.85 | 0.049 | | |
| 200.90 | 0.051 | | |
| 200.95 | 0.053 | | |
| 201.00 | 0.055 | | |
| 201.05 | 0.057 | | |
| 201.10 | 0.058 | | |
| 201.15 | 0.060 | | |
| 201.20 | 0.062 | | |
| 201.25 | 0.064 | | |
| 201.30 | 0.066 | | |
| 201.35 | 0.068 | | |
| 201.40 | 0.069 | | |
| 201.45 | 0.071 | | |
| 201.50 | 0.073 | | |
| 201.55 | 0.075 | | |
| 201.60 | 0.077 | | |
| 201.65 | 0.078 | | |
| 201.70 | 0.080 | | |
| 201.75 | 0.082 | | |
| 201.80 | 0.084 | | |
| 201.85 | 0.086 | | |
| 201.90 | 0.088 | | |
| 201.95 | 0.089 | | |
| 202.00 | 0.091 | | |

## Summary for Pond UGIS-2: Lower Lot

Inflow Area = 2.492 ac, 70.12% Impervious, Inflow Depth = 4.32" for 100-Year event
Inflow = 7.55 cfs @ 12.08 hrs, Volume= 0.898 af
Outflow = 1.31 cfs @ 13.71 hrs, Volume= 0.898 af, Atten= 83%, Lag= 98.2 min
Discarded = 0.28 cfs @ 10.64 hrs, Volume= 0.589 af
Primary = 1.03 cfs @ 13.71 hrs, Volume= 0.308 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 186.45' @ 13.71 hrs Surf.Area= 0.115 ac Storage= 0.354 af

Plug-Flow detention time= 302.9 min calculated for 0.898 af (100% of inflow)
Center-of-Mass det. time= 302.9 min ( 1,146.2 - 843.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 183.00' | 0.000 af | **55.71'W x 90.29'L x 4.00'H Field A**<br>0.462 af Overall - 0.462 af Embedded = 0.000 af x 40.0% Voids |
| #2A | 183.00' | 0.359 af | **StormTrap ST2 SingleTrap 3-6** x 25 Inside #1<br>Inside= 101.7"W x 42.0"H => 26.77 sf x 15.40'L = 412.1 cf<br>Outside= 101.7"W x 48.0"H => 33.92 sf x 15.40'L = 522.2 cf<br>5 Rows of 5 Chambers<br>42.40' x 76.98' Core + 6.66' Border = 55.71' x 90.29' System |
| | | 0.359 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 185.00' | **12.0" Round Culvert** L= 26.0' Ke= 0.500<br>Inlet / Outlet Invert= 185.00' / 184.74' S= 0.0100 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Device 1 | 186.40' | **5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Discarded | 183.00' | **2.410 in/hr Exfiltration over Surface area** Phase-In= 0.01' |
| #4 | Primary | 185.40' | **6.0" Vert. Orifice/Grate** C= 0.600 |

**Discarded OutFlow** Max=0.28 cfs @ 10.64 hrs HW=183.04' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.28 cfs)

**Primary OutFlow** Max=1.03 cfs @ 13.71 hrs HW=186.45' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Passes 0.18 cfs of 3.49 cfs potential flow)
│ └**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.18 cfs @ 0.73 fps)
└**4=Orifice/Grate** (Orifice Controls 0.85 cfs @ 4.31 fps)



## Pond UGIS-2: Lower Lot - Chamber Wizard Field A

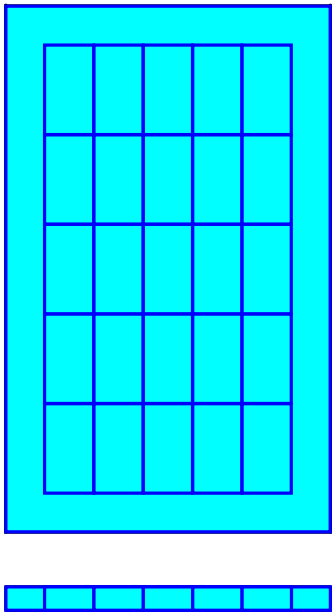
**Chamber Model = StormTrap ST2 SingleTrap 3-6 (StormTrap ST2 SingleTrap® Type II+IV)**
Inside= 101.7"W x 42.0"H => 26.77 sf x 15.40'L = 412.1 cf
Outside= 101.7"W x 48.0"H => 33.92 sf x 15.40'L = 522.2 cf

5 Chambers/Row x 15.40' Long = 76.98' Row Length +79.9" Border x 2 = 90.29' Base Length
5 Rows x 101.7" Wide + 79.9" Side Border x 2 = 55.71' Base Width
48.0" Chamber Height = 4.00' Field Height

25 Chambers x 412.1 cf + 5,349.6 cf Border = 15,652.9 cf Chamber Storage
25 Chambers x 522.2 cf + 7,065.6 cf Border = 20,120.0 cf Displacement

Chamber Storage = 15,652.9 cf = 0.359 af
Overall Storage Efficiency = 77.8%
Overall System Size = 90.29' x 55.71' x 4.00'

25 Chambers (plus border)
745.2 cy Field



## Stage-Discharge for Pond UGIS-2: Lower Lot

| Elevation (feet) | Discharge (cfs) | Discarded (cfs) | Primary (cfs) | Elevation (feet) | Discharge (cfs) | Discarded (cfs) | Primary (cfs) |
|---|---|---|---|---|---|---|---|
| 183.00 | 0.00 | **0.00** | 0.00 | 185.55 | 0.35 | 0.28 | 0.07 |
| 183.05 | 0.28 | **0.28** | 0.00 | 185.60 | 0.39 | 0.28 | 0.11 |
| 183.10 | 0.28 | 0.28 | 0.00 | 185.65 | 0.45 | 0.28 | 0.17 |
| 183.15 | 0.28 | 0.28 | 0.00 | 185.70 | 0.51 | 0.28 | 0.23 |
| 183.20 | 0.28 | 0.28 | 0.00 | 185.75 | 0.58 | 0.28 | 0.30 |
| 183.25 | 0.28 | 0.28 | 0.00 | 185.80 | 0.64 | 0.28 | 0.36 |
| 183.30 | 0.28 | 0.28 | 0.00 | 185.85 | 0.71 | 0.28 | 0.43 |
| 183.35 | 0.28 | 0.28 | 0.00 | 185.90 | 0.75 | 0.28 | 0.47 |
| 183.40 | 0.28 | 0.28 | 0.00 | 185.95 | 0.80 | 0.28 | 0.52 |
| 183.45 | 0.28 | 0.28 | 0.00 | 186.00 | 0.84 | 0.28 | 0.56 |
| 183.50 | 0.28 | 0.28 | 0.00 | 186.05 | 0.88 | 0.28 | 0.60 |
| 183.55 | 0.28 | 0.28 | 0.00 | 186.10 | 0.91 | 0.28 | 0.63 |
| 183.60 | 0.28 | 0.28 | 0.00 | 186.15 | 0.95 | 0.28 | 0.67 |
| 183.65 | 0.28 | 0.28 | 0.00 | 186.20 | 0.98 | 0.28 | 0.70 |
| 183.70 | 0.28 | 0.28 | 0.00 | 186.25 | 1.01 | 0.28 | 0.73 |
| 183.75 | 0.28 | 0.28 | 0.00 | 186.30 | 1.04 | 0.28 | 0.76 |
| 183.80 | 0.28 | 0.28 | 0.00 | 186.35 | 1.07 | 0.28 | 0.79 |
| 183.85 | 0.28 | 0.28 | 0.00 | 186.40 | 1.10 | 0.28 | 0.82 |
| 183.90 | 0.28 | 0.28 | 0.00 | 186.45 | 1.31 | 0.28 | 1.03 |
| 183.95 | 0.28 | 0.28 | 0.00 | 186.50 | 1.67 | 0.28 | 1.39 |
| 184.00 | 0.28 | 0.28 | 0.00 | 186.55 | 2.12 | 0.28 | 1.84 |
| 184.05 | 0.28 | 0.28 | 0.00 | 186.60 | 2.65 | 0.28 | 2.37 |
| 184.10 | 0.28 | 0.28 | 0.00 | 186.65 | 3.25 | 0.28 | 2.97 |
| 184.15 | 0.28 | 0.28 | 0.00 | 186.70 | 3.90 | 0.28 | 3.62 |
| 184.20 | 0.28 | 0.28 | 0.00 | 186.75 | 4.61 | 0.28 | 4.33 |
| 184.25 | 0.28 | 0.28 | 0.00 | 186.80 | 5.36 | 0.28 | 5.08 |
| 184.30 | 0.28 | 0.28 | 0.00 | 186.85 | 5.68 | 0.28 | 5.40 |
| 184.35 | 0.28 | 0.28 | 0.00 | 186.90 | 5.80 | 0.28 | 5.52 |
| 184.40 | 0.28 | 0.28 | 0.00 | 186.95 | 5.91 | 0.28 | 5.63 |
| 184.45 | 0.28 | 0.28 | 0.00 | 187.00 | **6.01** | 0.28 | **5.73** |
| 184.50 | 0.28 | 0.28 | 0.00 | | | | |
| 184.55 | 0.28 | 0.28 | 0.00 | | | | |
| 184.60 | 0.28 | 0.28 | 0.00 | | | | |
| 184.65 | 0.28 | 0.28 | 0.00 | | | | |
| 184.70 | 0.28 | 0.28 | 0.00 | | | | |
| 184.75 | 0.28 | 0.28 | 0.00 | | | | |
| 184.80 | 0.28 | 0.28 | 0.00 | | | | |
| 184.85 | 0.28 | 0.28 | 0.00 | | | | |
| 184.90 | 0.28 | 0.28 | 0.00 | | | | |
| 184.95 | 0.28 | 0.28 | 0.00 | | | | |
| 185.00 | 0.28 | 0.28 | 0.00 | | | | |
| 185.05 | 0.28 | 0.28 | 0.00 | | | | |
| 185.10 | 0.28 | 0.28 | 0.00 | | | | |
| 185.15 | 0.28 | 0.28 | 0.00 | | | | |
| 185.20 | 0.28 | 0.28 | 0.00 | | | | |
| 185.25 | 0.28 | 0.28 | 0.00 | | | | |
| 185.30 | 0.28 | 0.28 | 0.00 | | | | |
| 185.35 | 0.28 | 0.28 | 0.00 | | | | |
| 185.40 | 0.28 | 0.28 | 0.00 | | | | |
| 185.45 | 0.29 | 0.28 | 0.01 | | | | |
| 185.50 | 0.31 | 0.28 | 0.03 | | | | |



## Stage-Area-Storage for Pond UGIS-2: Lower Lot

| Elevation (feet) | Surface (acres) | Storage (acre-feet) | Elevation (feet) | Surface (acres) | Storage (acre-feet) |
|---|---|---|---|---|---|
| 183.00 | **0.115** | 0.000 | 185.55 | 0.115 | 0.262 |
| 183.05 | 0.115 | 0.005 | 185.60 | 0.115 | 0.267 |
| 183.10 | 0.115 | 0.010 | 185.65 | 0.115 | 0.272 |
| 183.15 | 0.115 | 0.015 | 185.70 | 0.115 | 0.277 |
| 183.20 | 0.115 | 0.021 | 185.75 | 0.115 | 0.282 |
| 183.25 | 0.115 | 0.026 | 185.80 | 0.115 | 0.287 |
| 183.30 | 0.115 | 0.031 | 185.85 | 0.115 | 0.293 |
| 183.35 | 0.115 | 0.036 | 185.90 | 0.115 | 0.298 |
| 183.40 | 0.115 | 0.041 | 185.95 | 0.115 | 0.303 |
| 183.45 | 0.115 | 0.046 | 186.00 | 0.115 | 0.308 |
| 183.50 | 0.115 | 0.051 | 186.05 | 0.115 | 0.313 |
| 183.55 | 0.115 | 0.056 | 186.10 | 0.115 | 0.318 |
| 183.60 | 0.115 | 0.062 | 186.15 | 0.115 | 0.323 |
| 183.65 | 0.115 | 0.067 | 186.20 | 0.115 | 0.329 |
| 183.70 | 0.115 | 0.072 | 186.25 | 0.115 | 0.334 |
| 183.75 | 0.115 | 0.077 | 186.30 | 0.115 | 0.339 |
| 183.80 | 0.115 | 0.082 | 186.35 | 0.115 | 0.344 |
| 183.85 | 0.115 | 0.087 | 186.40 | 0.115 | 0.349 |
| 183.90 | 0.115 | 0.092 | 186.45 | 0.115 | 0.354 |
| 183.95 | 0.115 | 0.098 | 186.50 | 0.115 | 0.359 |
| 184.00 | 0.115 | 0.103 | 186.55 | 0.115 | 0.359 |
| 184.05 | 0.115 | 0.108 | 186.60 | 0.115 | 0.359 |
| 184.10 | 0.115 | 0.113 | 186.65 | 0.115 | 0.359 |
| 184.15 | 0.115 | 0.118 | 186.70 | 0.115 | 0.359 |
| 184.20 | 0.115 | 0.123 | 186.75 | 0.115 | 0.359 |
| 184.25 | 0.115 | 0.128 | 186.80 | 0.115 | 0.359 |
| 184.30 | 0.115 | 0.133 | 186.85 | 0.115 | **0.359** |
| 184.35 | 0.115 | 0.139 | 186.90 | 0.115 | **0.359** |
| 184.40 | 0.115 | 0.144 | 186.95 | 0.115 | 0.359 |
| 184.45 | 0.115 | 0.149 | 187.00 | 0.115 | 0.359 |
| 184.50 | 0.115 | 0.154 | | | |
| 184.55 | 0.115 | 0.159 | | | |
| 184.60 | 0.115 | 0.164 | | | |
| 184.65 | 0.115 | 0.169 | | | |
| 184.70 | 0.115 | 0.175 | | | |
| 184.75 | 0.115 | 0.180 | | | |
| 184.80 | 0.115 | 0.185 | | | |
| 184.85 | 0.115 | 0.190 | | | |
| 184.90 | 0.115 | 0.195 | | | |
| 184.95 | 0.115 | 0.200 | | | |
| 185.00 | 0.115 | 0.205 | | | |
| 185.05 | 0.115 | 0.210 | | | |
| 185.10 | 0.115 | 0.216 | | | |
| 185.15 | 0.115 | 0.221 | | | |
| 185.20 | 0.115 | 0.226 | | | |
| 185.25 | 0.115 | 0.231 | | | |
| 185.30 | 0.115 | 0.236 | | | |
| 185.35 | 0.115 | 0.241 | | | |
| 185.40 | 0.115 | 0.246 | | | |
| 185.45 | 0.115 | 0.252 | | | |
| 185.50 | 0.115 | 0.257 | | | |

## Summary for Link 1L: Total to Roadway

Inflow Area = 2.875 ac, 65.45% Impervious, Inflow Depth = 1.60" for 100-Year event
Inflow = 1.12 cfs @ 13.70 hrs, Volume= 0.383 af
Primary = 1.12 cfs @ 13.70 hrs, Volume= 0.383 af, Atten= 0%, Lag= 0.0 min

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



## Summary for Link 2L: Total to Wetlands

Inflow Area = 1.116 ac, 0.62% Impervious, Inflow Depth = 1.40" for 100-Year event
Inflow = 1.38 cfs @ 12.14 hrs, Volume= 0.130 af
Primary = 1.38 cfs @ 12.14 hrs, Volume= 0.130 af, Atten= 0%, Lag= 0.0 min

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

## Summary for Link DP-1: Culvert

Inflow Area = 3.991 ac, 47.31% Impervious, Inflow Depth = 1.54" for 100-Year event
Inflow = 2.31 cfs @ 12.13 hrs, Volume= 0.513 af
Primary = 2.31 cfs @ 12.13 hrs, Volume= 0.513 af, Atten= 0%, Lag= 0.0 min

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

# Hydraulic Design Table (25-year Design Storm)

| From (Inlet) Node | To (Outlet) Node | Length (ft) | Inlet Invert Elevation (ft) | Outlet Invert Elevation (ft) | Total Drop (ft) | Average Slope (%) | Pipe Diameter or Height (inches) | Manning's Roughness | Peak Flow (cfs) | Max Flow Velocity (ft/sec) | Design Flow Capacity (cfs) | Max Flow / Design Flow Ratio | Max Flow Depth (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RD-1 | DMH-12 | 36.00 | 192.95 | 192.50 | 0.45 | 1.2500 | 12 | 0.0120 | 0.99 | 4.47 | 4.32 | 0.23 | 0.33 |
| wye | DMH-1 | 12.00 | 186.77 | 186.40 | 0.37 | 3.0800 | 12 | 0.0120 | 0.49 | 5.02 | 6.78 | 0.07 | 0.18 |
| AD-8 | wye | 12.88 | 188.30 | 186.77 | 1.53 | 11.8800 | 12 | 0.0120 | 0.03 | 3.39 | 13.30 | 0.00 | 0.03 |
| RD-3 | UGDS-2(B) | 20.00 | 200.45 | 200.18 | 0.27 | 1.3500 | 12 | 0.0120 | 1.13 | 4.75 | 4.48 | 0.25 | 0.34 |
| OCS-2 | DMH-4 | 25.00 | 182.40 | 181.00 | 1.40 | 5.6000 | 12 | 0.0120 | 0.50 | 6.23 | 9.13 | 0.05 | 0.16 |
| DMH-12 | UGDS-1(A) | 16.00 | 192.40 | 192.20 | 0.20 | 1.2500 | 12 | 0.0120 | 1.73 | 5.19 | 4.32 | 0.40 | 0.44 |
| RD-2 | DMH-3 | 5.00 | 184.25 | 184.15 | 0.10 | 2.0000 | 18 | 0.0150 | 1.59 | 4.95 | 12.87 | 0.12 | 0.36 |
| AD-9 | UGIS-1(E) | 23.00 | 187.00 | 186.50 | 0.50 | 2.1700 | 12 | 0.0120 | 0.28 | 3.76 | 5.69 | 0.05 | 0.15 |
| OCS-4 | FlaredEnd | 27.00 | 186.80 | 186.50 | 0.30 | 1.1100 | 12 | 0.0120 | 0.00 | 0.00 | 4.07 | 0.00 | 0.00 |
| DMH-2 | UGIS-1(A) | 12.00 | 184.75 | 184.60 | 0.15 | 1.2500 | 12 | 0.0120 | 1.45 | 4.95 | 4.32 | 0.34 | 0.40 |
| DMH-1 | DMH-2 | 69.00 | 186.30 | 185.30 | 1.00 | 1.4500 | 12 | 0.0120 | 0.78 | 4.41 | 4.65 | 0.17 | 0.28 |
| OCS-1 | wye | 62.00 | 189.65 | 186.77 | 2.88 | 4.6500 | 12 | 0.0120 | 0.46 | 5.69 | 8.32 | 0.06 | 0.16 |
| CB-4 | DMH-2 | 20.00 | 185.10 | 184.85 | 0.25 | 1.2500 | 12 | 0.0120 | 0.66 | 3.99 | 4.32 | 0.15 | 0.27 |
| CB-6 | DMH-7 | 4.00 | 187.50 | 187.30 | 0.20 | 5.0000 | 12 | 0.0120 | 0.43 | 5.73 | 8.63 | 0.05 | 0.15 |
| CB-8 | DMH-8 | 27.00 | 190.50 | 190.20 | 0.30 | 1.1100 | 12 | 0.0120 | 1.18 | 4.49 | 4.07 | 0.29 | 0.37 |
| CB-2 | DMH-6 | 35.00 | 202.25 | 201.95 | 0.30 | 0.8600 | 12 | 0.0120 | 0.82 | 3.70 | 3.57 | 0.23 | 0.33 |
| CB-10 | DMH-6 | 5.00 | 202.05 | 201.95 | 0.10 | 2.0000 | 12 | 0.0120 | 0.29 | 3.67 | 5.46 | 0.05 | 0.15 |
| CB-9 | DMH-5 | 11.00 | 202.00 | 201.70 | 0.30 | 2.7300 | 12 | 0.0120 | 1.10 | 6.07 | 6.37 | 0.17 | 0.28 |
| WQS-1 | UGDS-1(B) | 12.00 | 192.20 | 192.10 | 0.10 | 0.8300 | 12 | 0.0120 | 1.29 | 4.13 | 3.52 | 0.37 | 0.42 |
| CB-1 | WQS-1 | 25.00 | 192.40 | 192.20 | 0.20 | 0.8000 | 12 | 0.0120 | 1.29 | 4.08 | 3.45 | 0.37 | 0.42 |
| DMH-8 | DMH-7 | 87.00 | 190.10 | 187.00 | 3.10 | 3.5600 | 12 | 0.0120 | 3.03 | 8.87 | 7.29 | 0.42 | 0.45 |
| DMH-9 | DMH-8 | 79.30 | 191.30 | 190.40 | 0.90 | 1.1300 | 12 | 0.0120 | 0.89 | 4.20 | 4.11 | 0.22 | 0.32 |
| DMH-10 | DMH-9 | 57.81 | 196.30 | 193.40 | 2.90 | 5.0200 | 12 | 0.0120 | 0.58 | 6.24 | 8.64 | 0.07 | 0.18 |
| DMH-11 | DMH-10 | 91.87 | 198.50 | 196.40 | 2.10 | 2.2900 | 12 | 0.0120 | 0.58 | 4.76 | 5.84 | 0.10 | 0.21 |
| CB-7 | DMH-8 | 4.95 | 190.50 | 190.40 | 0.10 | 2.0200 | 12 | 0.0120 | 0.96 | 5.25 | 5.49 | 0.18 | 0.28 |
| AD-3 | DMH-9 | 37.00 | 191.60 | 191.40 | 0.20 | 0.5400 | 12 | 0.0120 | 0.21 | 2.79 | 2.84 | 0.07 | 0.18 |
| OCS-3 | DMH-11 | 73.00 | 199.32 | 198.60 | 0.72 | 0.9900 | 12 | 0.0120 | 0.58 | 3.53 | 3.83 | 0.15 | 0.26 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DMH-5 | UGDS-2(A) | 11.00 | 201.60 | 201.50 | 0.10 | 0.9100 | 12 | 0.0120 | 2.20 | 4.89 | 3.68 | 0.60 | 0.56 |
| DMH-3 | UGIS-1(AC) | 43.00 | 184.15 | 183.50 | 0.65 | 1.5100 | 12 | 0.0120 | 1.58 | 5.45 | 4.75 | 0.33 | 0.40 |
| AD-6 | UGDS-2(C) | 25.00 | 204.30 | 202.00 | 2.30 | 9.2000 | 12 | 0.0120 | 0.34 | 6.63 | 11.71 | 0.03 | 0.12 |
| AD-1 | DMH-12 | 67.00 | 195.30 | 193.30 | 2.00 | 2.9900 | 12 | 0.0120 | 0.74 | 5.86 | 6.67 | 0.11 | 0.22 |
| AD-2 | DMH-1 | 39.00 | 188.60 | 186.40 | 2.20 | 5.6400 | 12 | 0.0120 | 0.30 | 5.40 | 9.17 | 0.03 | 0.12 |
| CB-5 | UGIS-1(B) | 26.00 | 183.90 | 183.60 | 0.30 | 1.1500 | 12 | 0.0120 | 1.25 | 4.62 | 4.15 | 0.30 | 0.38 |
| AD-4 | DMH-9 | 28.00 | 194.90 | 193.40 | 1.50 | 5.3600 | 12 | 0.0120 | 0.10 | 3.82 | 8.93 | 0.01 | 0.08 |
| AD-5 | OCS-3 | 28.00 | 202.95 | 202.30 | 0.65 | 2.3200 | 12 | 0.0120 | 0.03 | 2.05 | 5.88 | 0.01 | 0.06 |
| AD-7 | AD-6 | 66.00 | 205.00 | 204.40 | 0.60 | 0.9100 | 12 | 0.0120 | 0.29 | 3.90 | 3.68 | 0.08 | 0.19 |
| DMH-6 | DMH-5 | 13.00 | 201.85 | 201.70 | 0.15 | 1.1500 | 12 | 0.0120 | 1.10 | 4.46 | 4.15 | 0.27 | 0.35 |
| DMH-7 | UGIS-1(D) | 8.00 | 185.80 | 185.28 | 0.52 | 6.5000 | 12 | 0.0120 | 3.44 | 11.41 | 9.84 | 0.35 | 0.41 |

## APPENDIX C

TSS Removal Calculation
Recharge Calculation
Tree Box Filter Calculation
Riprap Apron Calculation
Hydrodynamic Separator Calculation
Green Roof Calculation

# TOTAL SUSPENDED SOLIDS REMOVAL

**17044.03 - Ashland Public Safety Facility**

| BMP | TSS Removal Rate | Starting TSS Load | TSS Removed | Remaining Load |
|---|---|---|---|---|
| **PDA-1A** | | | | |
| Tree Box Filter 1 | 80% | 1.00 | 0.80 | 0.20 |
| Subsurface Infitration System | 80% | 0.20 | 0.16 | 0.04 |
| | total TSS removal: | | **96%** | |
| **PDA-1B** | | | | |
| Deep Sump Catch Basins | 25% | 1.00 | 0.25 | 0.75 |
| Hydrodynamic Separator* | 60% | 0.75 | 0.45 | 0.30 |
| Subsurface Infitration System | 80% | 0.30 | 0.24 | 0.06 |
| | total TSS removal: | | **94%** | |
| **PDA-1C** | | | | |
| Tree Box Filter | 80% | 1.00 | 0.80 | 0.20 |
| Subsurface Infitration System | 80% | 0.20 | 0.16 | 0.04 |
| | total TSS removal: | | **96%** | |
| **PDA-1D** | | | | |
| | total TSS removal: | | **0%** | |
| **PDA-1E** | | | | |
| | total TSS removal: | | **0%** | |

| Drainage Area | Vehicular Area (SF) | % of Total Vehicular Area | TSS Removed | Weighted % TSS Removal |
|---|---|---|---|---|
| PDA-1A | 38,983 | 0.47 | 96.0% | 45.5% |
| PDA-1B | 14,521 | 0.18 | 94.0% | 16.6% |
| PDA-1C | 22,618 | 0.27 | 96.0% | 26.4% |
| PDA-1D | 5,833 | 0.07 | 0.0% | 0.0% |
| PDA-1E | 301 | 0.00 | 0.0% | 0.0% |
| **Total** | 82,256 | 1.00 | | **88.5%** |

Total Annual TSS Removal Rate = **88.5%**

Notes:

* Based on TARP Reports of Hydrodynamic Separators

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# MASTEP Technology Review

**Technology Name:** Stormceptor OSR

**Studies Reviewed:** NJCAT Technology Verification Stormceptor OSR, Imbrium Systems Corporation, August 2007.

**Date:** March 10, 2008

**Reviewer:** Sarah Titus

**Rating:** 2

**Brief rationale for rating:** The test procedures were modeled after NJDEP laboratory testing protocol which MASTEP considers equivalent to TARP protocol for field testing. They tested the unit at an adequate number of test runs, samples, flow rates and influent concentrations. They intentionally deviated from the NJDEP protocol test sediment mix in order to test the OSR's removal of fine sand size particles; the targeted particle size for the OSR series. They also deviated from NJDEP protocol by not performing scour tests. Samples were collected and analyzed for both TSS and SSC but TSS data was not reported or used in the NJCAT verification.

**TARP Requirements Not Met*:**

- TSS sampled but not reported or used in this verification
- No scour tests
- No documentation of a Quality Assurance Project Plan
- PSD was larger than recommended, although this was intentional to test the design of the unit.

* Criteria also based on NJDEP laboratory testing guidelines.

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# MASTEP Technology Review

**Technology Name:** VortSentry

**Studies Reviewed:**

- NJCAT Technology Verification, VortSentry Stormwater Treatment System December 2005

**Date:** January 23, 2008

**Reviewer:** Jerry Schoen

**Rating:** 2

**Brief rationale for rating:** This is a well conducted laboratory study, but it was run by Vortechnics staff, and is therefore not a third-party study. The particle size distribution was slightly higher than recommended (d50 120 microns vs. recommended < 100 microns). Sediment removal was measured according to SSC method; this method is considered by many to be superior than TSS for stormwater monitoring; however, Massachusetts policy and guidance documents reference TSS rather than SSC. The MASTEP rating is for SSC only - MASTEP has not evaluated any studies that focus on TSS removal.

**Recommended Study Protocols Not Met:**

- Studies should be conducted by independent third parties.
- Sediment removal performance measured using Suspended Sediment Concentration (SSC) method; it is preferable to measure both SSC and Total Suspended Sediment (TSS) methods. If only one, TSS is preferred for technologies used in Massachusetts.

**Other Comments:**

- The report contains little discussion of quality assurance/quality control measures. However, Contech (formerly Vortechnics) has subsequently provided supporting information that documents QC procedures generally followed at the company's testing facilities.
- Aside from the issues mentioned above, the study did closely follow recommended laboratory testing procedures, including a sufficient number of test runs at preferred operating rates and influent sediment concentration levels.
- Scour test was performed according to NJ-recommended procedures. Results satisfactory – this unit did not appear to contribute re-suspended sediment into the waste stream when the system runs at operating rates up to and including the design flow.

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# MASTEP Technology Review

**Technology Name:** Hydro International Downstream Defender

**Studies Reviewed:** NJCAT Technology Review Hydro International February 2005
Hydrodynamic Separator Sediment Retention Testing. St. Anthony Falls Laboratory, University of Minnesota. Mohseni, 2010.

**MASTEP Review Date:** September 18, 2013
**Reviewer:** Jerry Schoen

**Rating:** 2

**Brief rationale for rating:** This is a reasonably well-conducted laboratory study. However, only 8 test runs were performed. Ideally, at least 10-15 runs would be performed, covering a wide range of flow rate and influent TSS concentration combinations. In addition, tests were performed with no initial sediment loading in the unit (a 50% initial loading is considered an appropriate representation of "real world" conditions); the F-95 Sand mix used in test contains fewer fine particles than is desirable; and no information is provided on quality control procedures used in the test.

**Other Comments:**

- This test was performed by HI personnel at the HI laboratory facilities. Third-party studies performed at certified state or national laboratories are preferred.
- Because the F-95 sand mix used for this test consists of a relatively high proportion of sand-sized particles vs. silt, this study is more likely to predict performance at sites with large particle loadings than at sites where small particle sizes are expected.
- Removal rates were calculated using a mass balance method, which captures all sediments used in the test and compares dry weight of influent sediments vs. those captured by the system. This is the most accurate method of performing laboratory tests.
- The report describes a "confirmation test" performed on a separate date, witnessed by the Maine Department of Environmental Protection. This test used a different method to measure solids removal (ASTM's Suspended Sediment Concentration method). Six runs were conducted, at flow rates from 611 – 644 gpm (or 1.36-1.44 cfs), with influent concentrations ranging from 190 mg/l to 289.3 mg/l. These test runs produced a mean removal efficiency of 86% SSC. Caution should be taken in comparing removal rates for these different tests, as the methods, flow ranges and influent sediment concentrations all differed between the two tests. Nonetheless, the second test does provide additional useful data that is generally consistent with the results of the initial HI study.
- The 2010 Mohseni study evaluates the susceptibility of the Downstream Defender to scouring, or washout of collected sediments. As a result of this study, authors recommend the maximum storage capacity of the Downstream Defender be set at 75% of the current maximum capacity, i.e. 6 inches below the rim of the bench skirt to minimize the washout rate. Excessive scouring was found at sediment depths of approximately 85% of capacity.




## Performance Evaluation

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**VortSentry :: A product from** CONTECH STORMWATER SOLUTIONS, INC. **::**

**Performance information:** (This product was evaluated in at least one third-party study. See MASTEP Evaluation Summary.)

Performance was evaluated in an NJCAT laboratory study that achieved 69% sediment removal as measured by the Suspended Sediment Concentration method, not the Total Suspended Sediment method. It is generally easier to achieve a high level of removal with the SSC method than with TSS. Comparison of TSS vs. SSC results is not an exact science. It is not advisable to apply results obtained with SSC method towards a sediment removal goal expressed in TSS. VortSentry was evaluated by the New Jersey Department of Environmental Protection and has received the Conditional Interim Certification (March 20, 2006).

| Pollutants addressed | Manufacturer's Removal Efficiency claim | Minimum particle size | Tested removal efficiency (*) | Test Data Status (**) | Notes |
|---|---|---|---|---|---|
| Oil and grease | 35-85% | - | - | 0 | - |
| Zinc | 0-80% | - | - | 0 | - |
| Iron | 0-80% | - | - | 0 | - |
| Cadmium | 0-80% | - | - | 0 | - |
| Organic contaminants | 0-80% | - | - | 0 | - |
| E. coli | 0-80% | - | - | 0 | - |
| Total Phosphorus | 0-80% | - | - | 0 | - |
| Temperature | 0-80% | - | - | 0 | - |
| Copper | 0-80% | - | - | 0 | - |
| Lead | 0-80% | - | - | 0 | - |
| Chromium | 0-80% | - | - | 0 | - |
| Mercury | 0-80% | - | - | 0 | - |
| Ammonium | 0-80% | - | - | 0 | - |
| Hydrocarbons | 35-85% | - | - | 0 | - |
| Salt | 0-80% | - | - | 0 | - |
| Fecal coliform | 0-80% | - | - | 0 | - |
| Enterococcus | 0-80% | - | - | 0 | - |
| Total nitrogen | 0-80% | - | - | 0 | - |
| Debris - floatables | 35-85% | - | - | 0 | - |
| Debris- sinking | 35-85% | - | - | 0 | - |
| Total suspended solids | 35-85% | - | - | 0 | - |
| Total solids | 35-85% | - | - | 0 | - |
| Suspended sediment concentration | 35-85% | - | 69 % | 2 | No particle size given,. but one can assume |

| | |
|---|---|
| | that average particle size is approximately 110 microns |

***** - Pollution removal efficiency evaluated by MASTEP staff based on review of available performance evaluation reports.

****** - **1** = sufficient credible data to be able to evaluate pollution removal efficiency claims. **2** = promising studies are underway. **3** = insufficient credible data be able to evaluate claims. **0** = data review not yet conducted.

**Test reports: (click on link to view a summary of a test, click on disk icon to download the full report)**

| Title | Author/ Agency | Date | TARP compliancy | Test protocol compliancy | Documents |
|---|---|---|---|---|---|
| Vortsentry Technical Bulletin 1 | - | - | - | - | Vortsentry tech bulletin 1.pdf |
| VortSentry TECHNICAL DESIGN MANUAL | Allen, Vaikko | - | - | - | VortSentry TDM.pdf |
| NJCAT Technology Verification, VortSentry Stormwater Treatment System, 12/05 | - | 12/01/2005 | - | - | VortSentry_VerificationNJCAT2005.pdf |

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## Performance Evaluation

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**Downstream Defender :: A product from HYDRO INTERNATIONAL ::**

**Performance information:** (This product was evaluated in at least one third-party study. See MASTEP Evaluation Summary.)

Performance evaluation is based primarily on information provided in 2005 NJCAT Technology Verification report (prepared for NJDEP). This report reviewed a vendor-conducted laboratory study, which was run prior to development of NJDEP laboratory protocol development, and hence not in compliance with the guidelines. NJCAT still deemed the data "to be sufficient to determine and verify a laboratory removal claim" of 70% sediment removal, under conditions described in the report. Downstream Defender has received a General Use Level Determination for Pretreatment of TSS by the Washington State Department of Ecology (February 2005). Downstream Defender also received the New Jersey Department of Environmental Protection Conditional Interim Certification (5-11-2005).

| Pollutants addressed | Manufacturer's Removal Efficiency claim | Minimum particle size | Tested removal efficiency (*) | Test Data Status (**) | Notes |
|---|---|---|---|---|---|
| **Total suspended solids** | 90% | 150 | 70 % | 2 | Rating based NJCAT lab tests. Coventry University lab study found 68-99% efficiency for tests done with 270 micron average particle size, conducted at different flow rates |
| **Total solids** | 90% | - | - | 0 | - |
| **Oil and grease** | 90% | - | - | 0 | Coventry University lab study yielded 82-97% removal efficiency |
| **Debris - floatables** | - | - | - | 0 | - |

***** - Pollution removal efficiency evaluated by MASTEP staff based on review of available performance evaluation reports.

****** - **1** = sufficient credible data to be able to evaluate pollution removal efficiency claims. **2** = promising studies are underway. **3** = insufficient credible data be able to evaluate claims. **0** = data review not yet conducted.

**Test reports: (click on link to view a summary of a test, click on disk icon to download the full report)**

| Title | Author / Agency | Date | TARP compliancy | Test protocol compliancy | Documents |
|---|---|---|---|---|---|
| Laboratory Tests on Downstream Defender | Professor C. J. Pratt | 07/21/2000 | No | - | Laboratory Tests on Downstream Defender Coventry U.pdf |
| Hydrodynamic Separator Sediment Retention Testing | Omid Mohseni | 03/01/2010 | No | - | Mn_DOT2010-10-HS Sediment_Retention_Testing.pdf |
| NJCAT Technology Verification Hydro International Downstream Defender | - | 02/01/2005 | No | - | NJCAT technology verification hydro international downstream defender.pdf |

 

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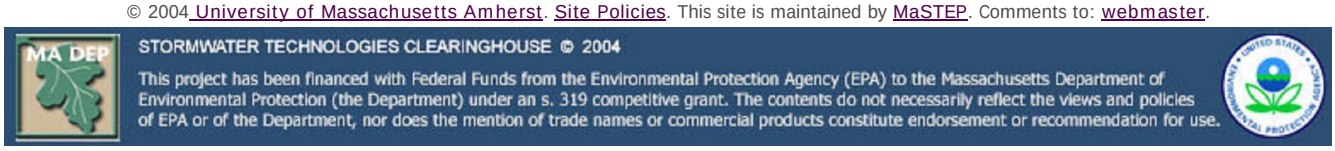




## Performance Evaluation

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**Stormceptor :: A product from IMBRIUM SYSTEMS CORPORATION ::**

**Performance information:** (This product was evaluated in at least one third-party study. See MASTEP Evaluation Summary.)

MASTEP rating is primarily based on the 2005 NJCAT Technology Verification study. In general, this was a well-conducted test, which in large part followed NJDEP test guidelines for laboratory studies. Issues of concern: the study measured suspended sediment concentration (SSC) rather than total suspended solids (TSS). The test was conducted with higher influent sediment concentrations than is preferred, but results were fairly consistent across all ranges studied. The particle size distribution also appears to be higher than the target test range. There are additional field studies that in general support the results obtained in this laboratory studies. These studies do not satisfy TARP protocols, but they do not contradict results obtained in the NJCAT study. The Stormceptor system has received a General Use Level Determination for Pretreatment of TSS by the Washington State Department of Ecology (September 2007).

| Pollutants addressed | Manufacturer's Removal Efficiency claim | Minimum particle size | Tested removal efficiency (*) | Test Data Status (**) | Notes |
|---|---|---|---|---|---|
| **Suspended sediment concentration** | 50-80% | 20 | 75 % | 2 | 75% found in NJCAT lab study |
| **Total suspended solids** | 50-80% | 20 | - | 2 | - |
| **Oil and grease** | 0-90% | - | - | 3 | Evaluated in Coventry U. study |
| **Zinc** | 0-80% | - | - | 0 | - |
| **Copper** | 0-80% | - | - | 0 | - |
| **Lead** | 0-80% | - | - | 0 | - |
| **Iron** | 0-80% | - | - | 0 | - |
| **Chromium** | 0-80% | - | - | 0 | - |
| **Mercury** | 0-80% | - | - | 0 | - |
| **Cadmium** | 0-80% | - | - | 0 | - |
| **Hydrocarbons** | 0-98% | - | - | 0 | - |
| **Ammonium** | 0-80% | - | - | 0 | - |
| **Total Keldhal Nitrogen** | 0-70% | - | - | 0 | - |
| **Total Phosphorus** | 0-60% | - | - | 0 | - |

***** - Pollution removal efficiency evaluated by MASTEP staff based on review of available performance evaluation reports.

****** - **1** = sufficient credible data to be able to evaluate pollution removal efficiency claims. **2** = promising studies are underway. **3** = insufficient credible data be able to evaluate claims. **0** = data review not yet conducted.

**Test reports: (click on link to view a summary of a test, click on disk icon to download the full report)**

| Title | Author/ Agency | Date | TARP compliancy | Test protocol compliancy | Documents |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| SeaTac Stormceptor Performance Monitoring Report | Associated Earth Sciences Inc. | 04/23/2001 | No | Stormceptor 1998 protocol | Seatac Stormceptor pm report.pdf |
| NJCAT Technology Verification - Stormceptor | New Jersey Corporation for Advanced Technologies | 09/09/2004 | No | NJCAT Technology Verification Program | STC NJCAT Verif.pdf |
| Performance Assessment of Two Types of Oil & Grit Separator for Stormwater Mgt | SWAMP | 07/01/2004 | No | - | Perf Assessment 2 Types Oil & Grit Separator.pdf |
| Hydrodynamic Separator Sediment Retention Testing | Omid Mohseni | 03/01/2010 | No | - | Mn_DOT2010-10-HS Sediment_Retention_Testing.pdf |
| Technology Assessment Report, Stormceptor CSR New England Pipe | Dr. Eric Winkler | 12/01/1997 | No | STEP technology assessment process | SC STEP Report.pdf |
| X-CEPTOR CONCRETE BYPASS INTERCEPTOR | Professor C J Pratt BSc (Eng) PhD CEng FICE FCIWEM | 09/06/1996 | No | - | Coventry.pdf |
| STEP Stormceptor Fact Sheet | STEP | 02/01/2003 | No | - | Stormceptor_fact_sheet_2003.pdf |
| Urban Runoff Pollution Mitigation Study: 1996 Pollution Abatement Device Monitoring Prog | Phoenix Group | - | No | - | City of Edmonton - Pollution Mitigation Study - May 1996.pdf |
| Field Evaluation of a Stormceptor Model STC 1200 | Stormceptor Group of Companies | 06/01/2004 | No | - | Field Evaluation Stormceptor STC1200.pdf |
| The Effects of Backwater on Stormceptor Treatment Systems Denver, CO area | Applied Hydrology Associates | 09/01/2003 | No | SOP created by management committee served as QAPP | Effects of Backwater on Stormceptor Denver.pdf |
| Stormceptor Monitoring Study, Como Park, St. Paul MN | Rinker Materials | 02/01/2002 | No | - | Como Park study report.pdf |
| TESTING OF ULTRA-URBAN STORMWATER BEST MANAGEMENT PRACTICES | Shaw L. Yu and Monika D. Stopinski | 01/01/2001 | No | - | YuStopinski2001.pdf |

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| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17144.03 |
| SUBJECT | Required Recharge Volume | | |
| COMPUTATIONS BY | N Capistran | DATE | 8/4/2020 |
| CHECK BY | L Machamer | DATE | 8/13/2020 |

# Groundwater Recharge Calculation

A. Resources:

MassDEP Stormwater Handbook, 2008 Volume 3

B. Data:

| | | | |
|---|---|---|---|
| Existing Impervious Area = | 8,664 | SF | *Gravel & ROW included |
| Proposed Impervious Area = | 82,256 | SF | *ROW included |
| Net Increase = | 73,592 | SF | |

C. Equation

$$R_v = F \times Impervious\ Area$$

Rv = (0.60'/12") x 75,316 SF

$R_v$ = Require Recharge Volume, $Ft^3$ (soil group A = .60 in)

F = Target Depth Factor

Impervious Area = net impervious area

C. Calculations:

Required Recharge Volume:

| Soil Group | Impervious Area (SF) | Required Volume (CF) | Volume Provided* (CF) |
|---|---|---|---|
| A | 73592 | 3680 | 10716 |

*Volume provided by the *Underground Infiltration System* below the invert out at el. 185.4

Bottom of system @ 183

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 1 & 2 (Combined System)**

Total Area to Tree Box Filter No. 1 & 2 = 8,787 SF
Impervious Area = 8,348 SF

**Water Quality Volume (WQV)**

WQV = Impervious Area x 1.0 inches = 696 CF

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 19.9 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.3' x 6.5' | 41 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

PARE CORPORATION

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 3 & 4 (Combined System)**

Total Area to Tree Box Filter No. 3 & 4 = 4,668 SF
Impervious Area = 3,705 SF

**Water Quality Volume (WQV)**

WQV = Impervious Area x 1.0 inches = 309 CF

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 8.8 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 5**

Total Area to Tree Box Filter No. 5 = 7,588 SF
Impervious Area = 7,259 SF

**Water Quality Volume (WQV)**

WQV = Impervious Area x 1.0 inches = 605 CF

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 17.3 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 6**

Total Area to Tree Box Filter No. 6 = 5,914 SF
Impervious Area = 5,914 SF

**Water Quality Volume (WQV)**

WQV = Impervious Area x 1.0 inches = 493 CF

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 14.1 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 7**

| | | |
|---|---|---|
| Total Area to Tree Box Filter No. 7 = | 2,576 | SF |
| Impervious Area = | 2,576 | SF |

**Water Quality Volume (WQV)**

| | | |
|---|---|---|
| WQV = Impervious Area x 1.0 inches = | 215 | CF |

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 6.1 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 8**

Total Area to Tree Box Filter No. 8 = 4,517 SF
Impervious Area = 4,517 SF

**Water Quality Volume (WQV)**

WQV = Impervious Area x 1.0 inches = 376 CF

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 10.8 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 9**

| | | |
|---|---|---|
| Total Area to Tree Box Filter No. 9 = | 3,419 | SF |
| Impervious Area = | 2,796 | SF |

**Water Quality Volume (WQV)**

| | | |
|---|---|---|
| WQV = Impervious Area x 1.0 inches = | 233 | CF |

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 6.7 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

PARE CORPORATION

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Tree Box Filter | | |
| COMPUTATIONS BY | NPC | DATE | 8/18/2020 |
| CHECK BY | | DATE | |

# Tree Box Filters

**Tree Box Filter No. 10**

Total Area to Tree Box Filter No. 10 = 4,901 SF
Impervious Area = 3,623 SF

**Water Quality Volume (WQV)**

WQV = Impervious Area x 1.0 inches = 302 CF

**Required Filter Bed Area ($A_f$)**

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

$A_f$ = Surface area of filter bed ($ft^2$)
$d_f$ = Filter Bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
(Value from UNH Stormwater Center)
$h_f$ = Average Height of water above surface of practice (I.e., height above the uppermost mulch/organic layer)
$t_f$ = Design filter bed drain time (days)
$W_{qv}$ = Water Quality Volume

| Required | |
|---|---|
| hmax (ft) | 0.50 |
| $d_f$ (ft) | 3.00 |
| $h_f$ (ft) | 0.50 |
| K (ft/day) | 30.00 |
| $t_f$ (days) | 1.00 |
| Required Filter Area (sf) | 8.6 |

| | |
|---|---|
| Provided Filter Area (sf) = | 25 |

| Provided (Rectangular) | |
|---|---|
| Dia (ft) | Area (sf) |
| 4' x 4' | 16 |
| 5' x 5' | 25 |
| 5' x 6' | 30 |
| 6' x 6' | 36 |
| 6.5' x 6.5' | 42 |
| 6' x 7' | 42 |
| 7' x 7' | 49 |

Note: Tree Box filter has been designed in accordance with the UNH Stormwater Center. The UNH Stormwater Center 2016 Bi-Annual Report documents the hydraulic performance and the pollutant removal from 2004 to 2016. Please see the attached UNH Stormwater Center Bi Annual Report.

# Breaking Through UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER 2016 REPORT

Stormwater

# Tree filter

Though small, tree filters can manage runoff from the numerous lighter rain events that make up the majority of the annual rainfall in most regions. This makes them valuable assets in treating areas with large amounts of impervious cover.

## Overview

An excellent example of the inherent adaptability of low impact development (LID) systems, the tree filter leverages landscaping to improve drainage in an urban setting. On the surface, these systems present much like conventional street trees. Underground, however, they are designed to facilitate filtration, infiltration, and even storage of stormwater runoff. These designs can vary widely—from single-tree, off the shelf, proprietary structures to large-scale urban retrofits, known as "tree trenches," with multiple trees connected by underground infiltration and a reservoir that maximizes runoff storage and retention. The tree filters we've tested have outperformed our expectations for volume reduction. Though small, they are able to manage runoff from the numerous smaller rain events that make up the majority of the annual rainfall in most regions. This capability makes them valuable assets for managing areas with large amounts of impervious cover.

## Implementation and Practice

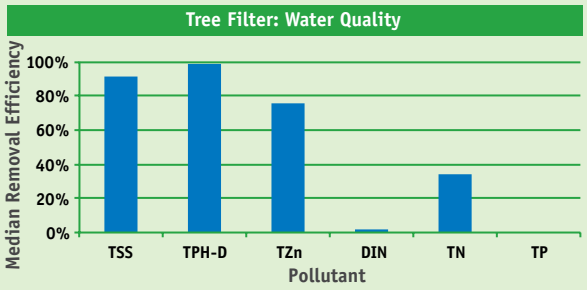
Tree filters can be used in many development and LID retrofit scenarios; they are especially useful in settings where minimal space is available. In urban areas like Philadelphia and New York City, they are used in the design of integrated street landscapes—a choice that transforms isolated street trees into stormwater filtration devices. They can be installed in open-bottomed chambers in locations where infiltration is desirable, or in close-bottomed chambers if infiltration is impossible (clay soils) or undesirable (high groundwater or contaminated soils). These chambers can include lateral openings or be combined with structural cells to provide soil and space for root growth under sidewalks and other pavements.

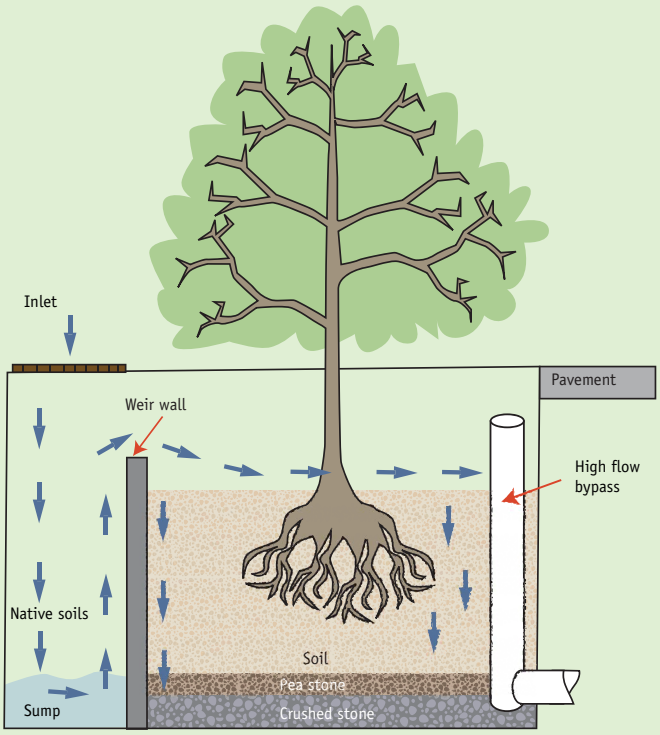
## Sizing and Design

In general, tree filters are sized and spaced much like catch basin inlets. When the primary objective is stormwater runoff storage or long-term detention, their designs can be adjusted for more reservoir storage space and detailed underdrain and orifice control configurations.

Common catch basin drainage areas may range from 3,000 to 30,000 square feet of impervious cover. Alternatively, they can be sized to support a desired water quality flow rate or storage capture volume. We have evaluated multiple tree filter systems that drain areas ranging from 5,000 to more than 250,000 square feet.

## TREE FILTER DESIGN SCHEMATIC



Our research indicates that while tree filters can provide shade, habitat, street beautification, and stormwater control, they can't be designed to maximize all of these benefits simultaneously. Therefore, the primary management objectives should inform their final configuration. If that goal is stormwater management, then soil media composition and tree selection are critical. Tree species should be selected for the growing zone and street conditions. Because these trees typically receive large volumes of water during storms, they need to tolerate wet and dry conditions well. In cold climates, where street de-icing regularly occurs, they should have high salt tolerance. Soil media is the dominant factor in determining pollutant removal. Prescribed soils are typically coarse with high infiltration rate capacities. In such cases, trees may need to be replaced every seven to 12 years. If the primary objectives are street beautification, habitat creation, and shading, then one could consider different tree species and combine them with design elements that prevent soil compaction from foot and vehicle traffic, such as grates and Silva Cells.

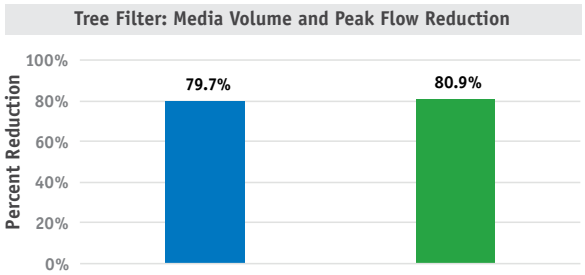
## Maintenance

Both conventional street trees and stormwater tree filters require maintenance, which can vary from routine litter collection to raking and removal of the fine sediments that collect on the surface of the soil media. Other activities may include replanting or removal of certain tree species every seven to 12 years. While there are few commercially available tools for maintaining the surface of these systems, Vactor truck attachments and handheld power rakes could be modified to accomplish relatively simple maintenance tasks.

## Installation Cost

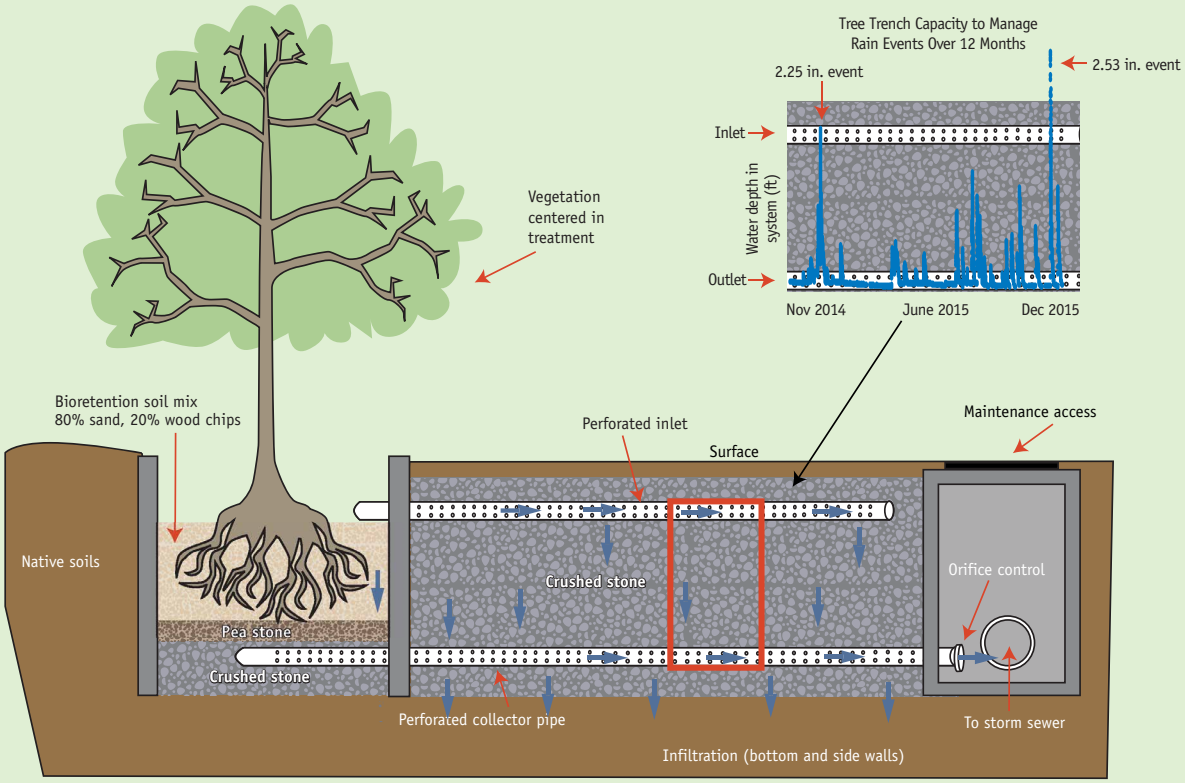
The cost of tree filters ranges from roughly $3,000 to more than $20,000 for proprietary systems. Since they are often sized for water quality flow rates, cost estimates per cubic yard of storage capacity are difficult to calculate. Recent innovations in these technologies approximate typical bioretention or infiltration trench design. The Philadelphia tree trench is more of a linear infiltration trench with trees planted in it for aesthetic reasons.

To support the use of green infrastructure in New England, the UNH Stormwater Center worked with the United States Environmental Protection Agency Region I, Tetra Tech, and other partners to estimate the cost of stormwater treatment systems like the tree filter in 2016 dollars. The cost memorandum used to arrive at the figures in the table below can be found at https://www.unh.edu/unhsc/sites/default/files/media/epa-cost-memo.pdf.




| Tree Filter | Materials & Installation Cost ($/cf) | Design cost ($/cf) |
|---|---|---|
| Low difficulty | 8.12 | 4.37 |
| Moderate difficulty | 16.24 | 8.74 |
| High difficulty | 24.36 | 13.11 |

ALTERNATIVE SCHEMATIC



PROJECT Ashland Public Safetly Facility | PROJECT NUMBER 17044.03

SUBJECT Riprap Apron

COMPUTATIONS BY NPC | DATE 7/22/2020

CHECK BY LM | DATE

# RIPRAP APRON CALCULATIONS

## A. Resources:

Based on Section 10.2 Riprap Apron of the FHWA HEC-14 (Publication No. FHWA-NIH-06-086).

## B. Equations:

$$D_{50} = 0.2\,D\left(\frac{Q}{\sqrt{g}D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

Where,

$D_{50}$ = riprap size, ft
Q = design discharge, cfs
D = culvert diameter, ft
TW = tailwater depth, ft
g = acceleration due to gravity, 32.2 ft/s$^2$

Note:
Tailwater depth should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.
Based on rock specific gravity of 2.65.

**Table 10.1 Riprap Classes and Apron Dimensions**

| FHWA | | MADOT M2.02.0 | | Apron | |
|---|---|---|---|---|---|
| Class | $D_{50}$ (in) | NSA No. | $D_{50}$ (in) | Length[1] | Depth |
| 1 | 5 | R-3 | 4 | 4*D | 3.5*$D_{50}$ |
| 2 | 6 | R-4 | 7 | 4*D | 3.3*$D_{50}$ |
| 3 | 10 | R-5 | 10 | 5*D | 2.4*$D_{50}$ |
| 4 | 14 | R-6 | 13 | 6*D | 2.2*$D_{50}$ |
| 5 | 20 | R-7 | 18 | 7*D | 2.0*$D_{50}$ |
| 6 | 22 | R-8 | 24 | 8*D | 2.0*$D_{50}$ |

[1]D is the culvert rise.

Width (at apron end) = 3*D + (2/3)*Length
Width based on 1:3 flare

## C. Calculations:

| Pipe | D (in) | D (ft) | $Q_{25}$ (cfs) | TW (ft) | Calculated | | Select | | Length (ft) | Width (ft) | Depth (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $D_{50}$ (ft) | $D_{50}$ (in) | M.10.03.2 | $D_{50}$ (in) | | | |
| OCS-4 → OUT | 12 | 1.00 | 3.57 | 0.40 | 0.27 | 3.23 | R-3 | 4 | 4.0 | 5.7 | 14 |

| | | | |
|---|---|---|---|
| PROJECT | Ashland Public Safety | PROJECT NUMBER | 17044.03 |
| SUBJECT | Hydrodynamic Seperator Sizing Calculations | | |
| COMPUTATIONS BY GL | | DATE | 6/23/2020 |
| CHECK BY | NC | DATE | 8/18/2020 |

Discharge Rate Equation: $$Q_{1.0} = (qu)(A)(WQU)$$

$Q_{1.0}$ = Flow rate associated with first inch of runoff
qu = The unit peak discharge, in csm/in
A = Impervius surface drainage area (in square miles)
WQV = Water quality volume in watershed inches (1-inch in this case)

## Water Quality Volume to Discharge Rate and Hydrodynamic Separator Sizing Calculations

**HS-1**

| Total Impervius Area | |
|---|---|
| (ac) | ($mi^2$) |
| 0.182 | 2.844E-04 |

| | | | | |
|---|---|---|---|---|
| tc = | 0.10 | hrs | | |
| qu = | 835 | csm/in | | |
| A = | 0.00028 | $mi^2$ | | |
| WQV = | 1 | inch | 661 | cf |
| WQQ = | **0.24** | cfs | | |

Reference: MassDEP Wetlands Program Method to Convert Stormwater Water Quality Volume to Peak Flow Rate

Note: Unit peak discharge rates (qu) determined from Figure 4: First 1 inch of Runoff, Table of qu values for Ia/P curve = 0.0.034, listed by tc, for Type III Storm Distribution, located in the MassDEP Wetlands Program, Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices.

| Structure WQS | Rim Elevation | Invert In | Invert Out | Pipe Diameter (in) | Pipe Diameter (out) | 25 yr Flow (cfs) | WQQ (cfs) | WQV (cf) |
|---|---|---|---|---|---|---|---|---|
| 1 | 196.4 | 192.20 | 192.20 | 12 | 12 | 1.05 | 0.24 | 661 |

PARE CORPORATION

PROJECT Ashland Public Safety PROJECT NUMBER 17044.03
SUBJECT Green Roof

COMPUTATIONS BY NPC DATE 8/11/2020

CHECK BY DATE

# Green Roof Calculations

**Green Roof (GR-1) - Police Sally Port**

| | | |
|---|---|---|
| Total Area to GR-1 = | 1,700 | SF |
| Total Impervious Area = | 1,700 | SF |

**Water Quality Volume (WQV)**

| | | |
|---|---|---|
| WQV = Impervious Area x 1.0 inches = | 142 | CF |
| **Required WQV Volume =** | **142** | **CF** |
| Volume provided in Green Roof Soil = | 340 | CF in 6" of Soil with a 0.40 Void Ratio |
| **Total Volume Provided =** | **340** | **CF** |

PARE CORPORATION

PROJECT Ashland Public Safety PROJECT NUMBER 17044.03
SUBJECT Green Roof

COMPUTATIONS BY NPC DATE 8/11/2020

CHECK BY DATE

# Green Roof Calculations

**Green Roof (GR-2) - Southwest Roof**

| | | |
|---|---|---|
| Total Area to GR-2 = | 3,500 | SF |
| Total Impervious Area = | 3,500 | SF |

**Water Quality Volume (WQV)**

| | | |
|---|---|---|
| WQV = Impervious Area x 1.0 inches = | 292 | CF |
| **Required WQV Volume =** | **292** | **CF** |
| Volume provided in Green Roof Soil = | 140 | CF in 6" of Soil with a 0.40 Void Ratio |
| **Total Volume Provided =** | **140** | **CF** |

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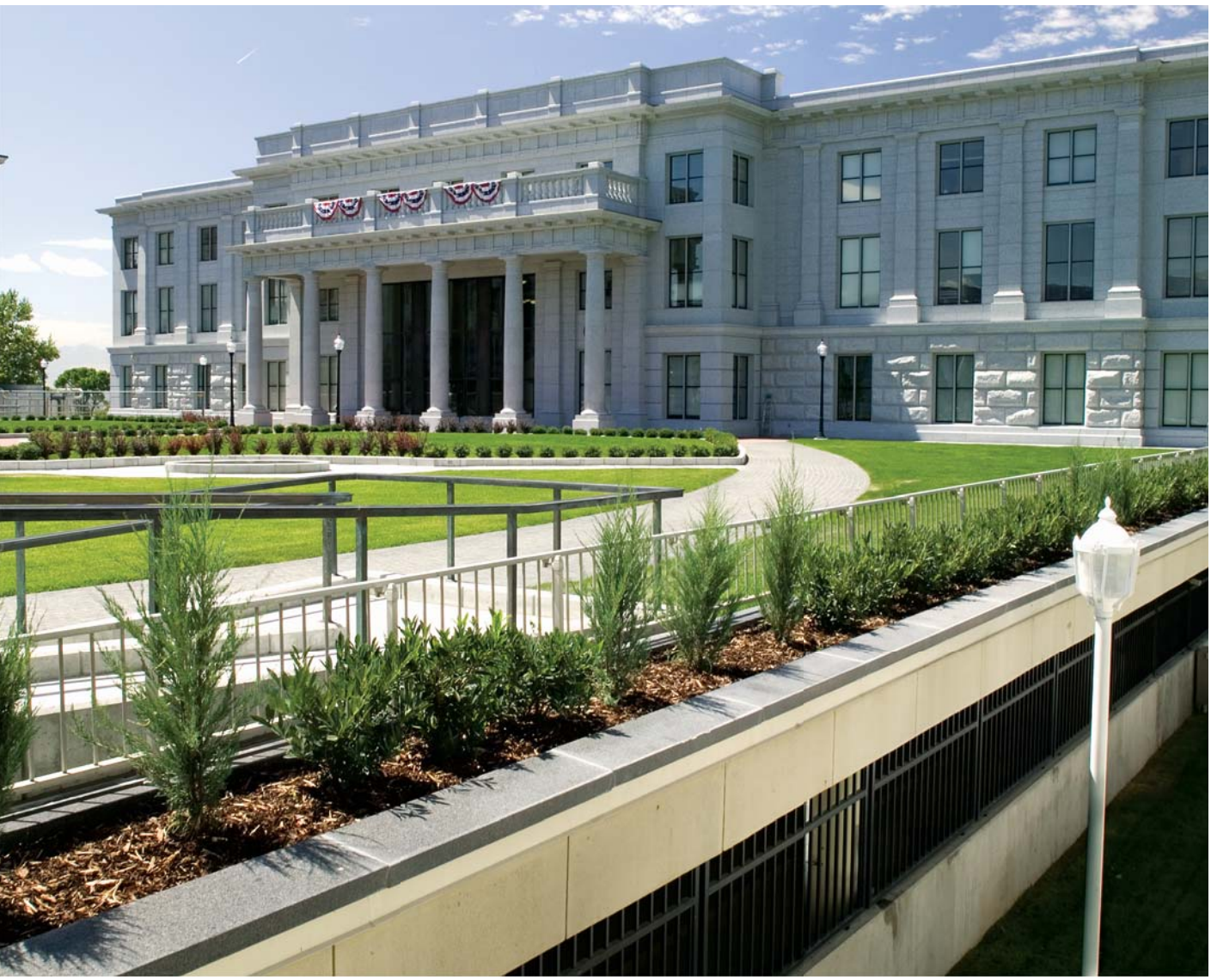
# ROOF GARDEN

## Green Roof Products, Designs and Solutions



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# ROOF GARDEN

## Green Roof Products, Designs and Solutions

Now you have the freedom to design an aesthetically pleasing landscaped roof with the security of the best waterproofing in the business. Carlisle Coatings & Waterproofing, Incorporated (CCW) the known leader in above- and below-grade waterproofing, offers multiple solutions for waterproofing and designing green roof systems. Specifying a system that provides the environmental benefits of clean air, reduced water run-off and energy conservation, with the dependability of CCW's waterproofing technology, is what architects, specifiers and building owners are demanding from green roof systems.

Established in Europe, green roofs are known to be both functional and aesthetically appealing, when the correct system design and products are applied. These roofs offer sustainability and energy efficiency while adding plant life in populated areas. Green roofs meet the objectives of many of the mandates to improve the air quality of cities by mitigating the effects of urban heat island caused by ever-increasing development. The benefits of the modern green roof have been seen with the U.S. Green Building Council's endorsement of these systems through the LEED® (Leadership in Energy Efficient Design) Green Building Rating System®.

## A Complete System

The waterproofing protection is a single-component membrane, either rolled or laid, that forms a tough flexible membrane, which adheres tenaciously to concrete substrates. This low-maintenance system also provides ecological benefits, contributing to municipal goals of decreasing heat islands and reducing run-off while increasing green spaces.

CCW provides a broad range of solutions to meet specific waterproofing needs. CCW offers technical services, research and development and manufacturing capabilities from its headquarters in Wylie, Texas and two additional manufacturing facilities in Terrell, TX and Carlisle, PA. The CCW network is further supported by over 50 manufacturer's sales representatives directed by regional sales offices throughout the country. CCW offers a complete line of waterproofing and moisture protection products for the architectural, general construction, industrial and maintenance industries. Carlisle Coatings & Waterproofing, Incorporated, is part of the Carlisle Construction Materials division of Carlisle Companies, Inc., which is a publicly traded company on the NYSE.

## Planting Solutions For Every Application

Carlisle Coatings & Waterproofing realizes each green roof is unique. CCW is teamed with RoofScapes and Hydropack to create a completely warranted CCW Green Roof that meets each building's needs. CCW also works with landscape designers to create custom green roof systems.

CCW provides the following information to assist customers in evaluation of expected weight loads of our waterproofing systems in CCW Green Roof applications.

The weights are lab test reported in square foot increments with:

- Dry (defined as absence of water)
- Saturated (exposed to water until excess water flows away)
- Flood Weight (drain failure condition to assess weight of system in a capacity mode)

Important Note: Soil weights are not available as soils are not standardized. Carlisle advises potential soils be weighed dry and saturated prior to weight designs.

## Features & Benefits

- Increase building value
- Add recreational square footage to building
- Reduce rooftop temperatures
- Reduce urban heat island
- Manage stormwater by retaining rainfall
- Improve city & building energy efficiency
- Maintain natural processes by reducing airborne pollution and generating oxygen

Above: CCW-500R Waterproofing System is one of the essential components available for CCW Green Roofs.

# ROOF GARDEN

## Green Roof Products, Designs and Solutions

## Product Weights

| Product | Dry Weight SF | Saturated Weight SF | Flood Weight SF | Water Retention SF |
|---|---|---|---|---|
| Solids Content | 563 g / 1.24 lb * | * | * | minimal |
| CCW-Protection Course-V | 26 g / 0.06 lb | (51 g ) | | 25 g or 1 oz |
| CCW-Protection Course-H | 287 g / 0.63 lb * | (333 g) * | * | 46 g / 0.1 lb or 1.6 oz * |
| CCW-Protection Course-HS | 259 g / 0.57 lb | (280 g) | | 21 g or 1 oz |
| Root Barrier | 45 g / 0.1 lb * | * | * | minimal |
| MiraDRAIN® GR9400 | 123 g / .27 lb | (739 g) / 1.63 lbs | | |
| CCW 300 HV | 46 g / 0.1 * | (360 g) / 0.80 lb* | * | 314 g/0.69 lb or 11 liquid oz |
| CCW 200V | 28 g / 0.06 lb | (190 g) / 0.42 lb | | 162 g/0.36 lb or 5.5 liquid oz |
| **System Weights** | **1,336 g / 2.95 lb** | **2,178 g / 4.80 lb** | **3,238 g / 7.13 lb** | **842g/1.85 lb or 29 liquid oz** |

* Components used in each column that make up the total “System Weights” listed
** The discrepancy in the saturated assembly weight and the components is due to water entrapped between the layers within the assembly.

## CCW Green Roof Without Insulation

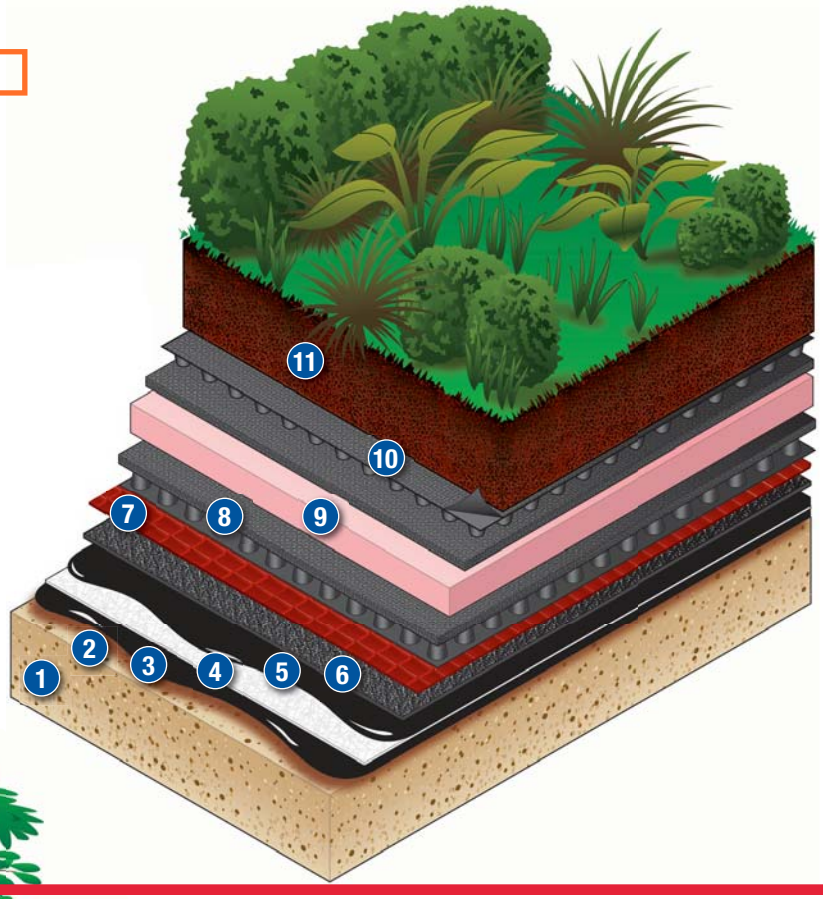
1. Concrete Substrate
2. CCW Contact Adhesive
3. 90 mils of CCW-500
4. CCW Reinforcing Fabric
5. 125 mils of CCW-500
6. CCW-Protection Board HS
7. Root Barrier
8. CCW MiraDRAIN GR9400
9. Six Inches or Less of Soil

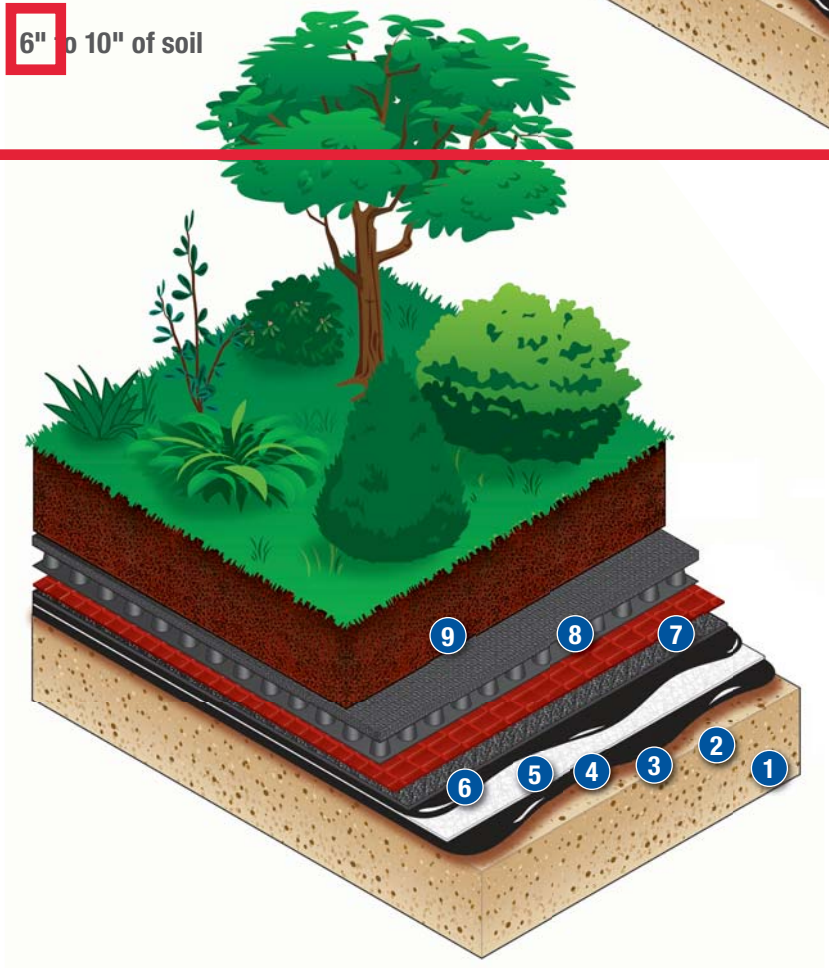
# ROOF GARDEN

## Green Roof Products, Designs and Solutions

### CCW Green Roof With Insulation

1. Concrete Substrate — 5" o/3" DECK = 8"
2. CCW Contact Adhesive
3. 90 mils of CCW-500 — +/- 1/16"
4. CCW Reinforcing Fabric
5. 125 mils of CCW-500 — +/- 1/8"
6. CCW-Protection Board HS — +/- 3/32"
7. Root Barrier
8. CCW MiraDRAIN 9900 — +/- 3/8"
9. Insulation as required — 8"
10. CCW MiraDRAIN GR9400 — 1"
11. 6" to 10" of soil




### CCW Planters

1. Concrete Substrate
2. CCW Contact Adhesive
3. 90 mils of CCW-500
4. CCW Reinforcing Fabric
5. 125 mils of CCW-500
6. CCW-Protection Board HS
7. Root Barrier
8. CCW MiraDRAIN 9800
9. 10" or more of soil

| Species | Mature Height (in) | Flower Color | Months in Bloom |
|---|---|---|---|
| Allium schoenoprasum ´Forescate` | 18–24 | Pink | May |
| Sedum acre | 12–18 | Yellow | June |
| Sedum album | 12–18 | White | JJ |
| Sedum album ´Coral Carpet` | 12–18 | White | JJ |
| Sedum ´Bailey's Gold` | 12–18 | Yellow | JJA |
| Sedum cauticola ´Lidakense` | 6–8 | Pink | AS |
| Sedum hybridum ´Immergrunchen` | 18–24 | Yellow | JJ |
| Sedum kamtschaticum | 12–18 | Yellow | MJJA |
| Sedum reflexum | 12–18 | Yellow | July |
| Sedum rupestre ´Forsteranum` | 12–18 | Yellow | JJ |
| Sedum sexangular | 6–8 | Yellow | JJ |
| Sedum spurium ´Dragon's Blood` | 12–18 | Rose Red | JJ |
| Sedum spurium ´Fuldaglut` | 12–18 | Ruby Red | JJ |
| Sedum ternatum | 12–18 | White | May |
| Sedum X ´Vera Jameson` | 12–18 | Magenta | August |
| Sempervivum tectorum | 3–6 | Red | July |
| Sempervivum tomentosum | 3–6 | Pink | July |

Note: All standard orders contain a variety of five pre-selected sedum species. Custom plant selection is available upon request and subject to additional charges.

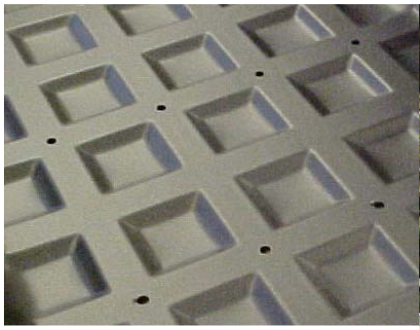
* Consult a structural engineer to determine load capabilities of the building prior to installation.

# ROOF GARDEN

## Green Roof Products, Designs and Solutions

### CCW GreenGrid System

The Carlisle Coatings & Waterproofing GreenGrid® System offers distinct advantages over more complex systems with its simplicity in design, pre-planted modules and movable modular features.



### Features & Benefits

- Single-source responsibility. Roofing/Waterproofing contractors can install both the waterproofing and the Green Roof System in one installation
- No planting on the roof. Trays are pre-planted before arriving at the jobsite, including the root barrier, soil media and plants
- The trays can be easily removed for a roof repair
- Building owners obtain single-source warranty coverage
- Easy to handle and fast to install
- Tray is a cost-competitive alternative
- Standard GreenGrid System Includes:
- Tray depth: 4"
- 4" tray - weighs 15 psf (fully saturated with water)
- Tray sizes: 2' x 4', 2' x 2' (fill product), 40" x 40" (larger designs)
- Plantings: Sedum 10" O.C.
- Custom GreenGrid System Options:
- Tray depth: 8"
- 8" tray - weighs 28 psf (fully saturated with water)
- Tray sizes: 2' x 4'
- Two more plants per tray for quicker fill
- Plantings: Sedum, other plants and special patterns

### CCW GreenGrid Assembly

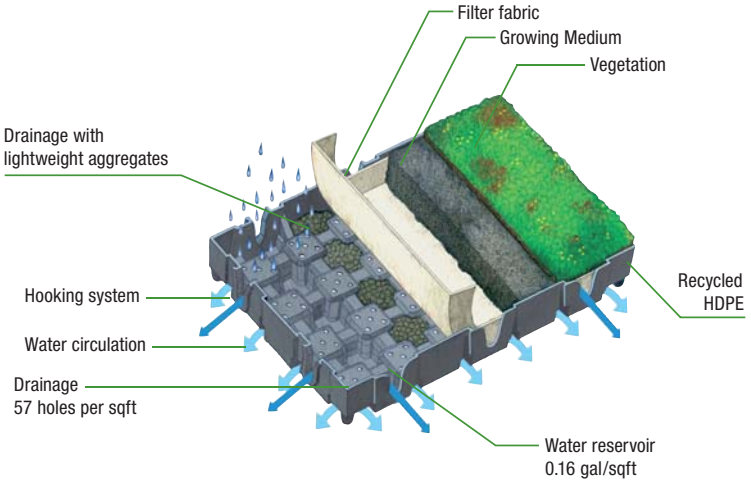
1. Concrete Substrate
2. CCW Contact Adhesive
3. 90 mils of CCW-500
4. CCW Reinforcing Fabric
5. 125 mils of CCW-500
6. CCW-Protection Board HS
7. CCW MiraDRAIN
8. GreenGrid with four inches

# Hydropack System

CCW Hydropack Green Roof system offers distinct advantages over more complex systems with its simplicity in design, pre-vegetated modules and removable modular features. Hydropack uses a dedicated aggregate drainage layer, filter fabric and FLL-compliant growth media. Hydropack modules lock together and allow sharing of moisture and nutrients, but do not permit the roots to grow from tray to tray, allowing for ease of removal.

## Features & Benefits

- No planting on the roof – modules are pre-vegetated prior to arriving on jobsite
- Lightweight, easy to handle and fast to install
- Single-source responsibility - contractors can install both the waterproofing and Green Roof in one installation
- Modules are easily moved for modifications or repair
- Single-source warranty coverage
- Only 17.5 pounds per square foot fully saturated, making it one of the lightest Green Roof modules on the market
- Protects roofing membranes from UV radiation and extreme weather conditions
- Reduces noise infiltration through the roof by up to 40 dB
- Helps to manage stormwater runoff

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# ROOF GARDEN

## Green Roof Products, Designs and Solutions

### Waterproofing – Hot-Applied


#### CCW–500 Hot-Applied

CCW–500 reinforced, hot-applied, liquid membrane system prevents water migration on both vertical and horizontal surfaces. This seamless, monolithic system offers full adhesion to most substrates. CCW–500 is an excellent waterproofing solution for green roof planting systems, plaza decks, roof terraces and planters.

### Waterproofing – Hot-Applied

#### MiraSEAL

MiraSEAL is available in a single viscosity for both horizontal and vertical surfaces. Its moisture-tolerant, polyether properties cure to form a strong, flexible membrane for both above- and below-grade applications. MiraSEAL's patented, odor-free formula cures three times faster on green concrete than other cold-applied systems and requires no primer. With MiraSEAL, your next waterproofing job is complete five days before the concrete is cured when using traditional cold-applied systems.

## Protection Board


### CCW Protection Boards

CCW Protection Boards are tough membranes that provide positive protection to the waterproofing membrane during installation of other work. CCW Protection Board H and HS are designed for installation horizontally in the CCW-500R System. CCW Protection Board V is designed as a vertical protection course on waterproofing membranes.

## Water Retention – Drainage

### CCW MiraDRAIN GR9400 & HC

CCW MiraDRAIN GR9400 is designed specifically for green roofs and large planter applications. CCW MiraDRAIN HC provides a deeper reservoir for added water retention. Used with CCW waterproofing, these drainage composites provide adequate water retention for sedums, grasses and plant life, while providing a channel for excess water to drain.

## Root Barrier

**Root Barrier Membrane**

CCW's Root Barrier membrane is a high-strength, specially formulated membrane designed for the CCW Green Roof and CCW-500R Waterproofing Systems. It does not contain plasticizers that can migrate to the surface and attack some asphalt-based materials. Root-Barrier is a 16-mil (0.41 mm) membrane made from a layer of tightly woven HDPE scrim with a continuous two-mil (.05 mm) polymeric coating on both sides.

## Water Retention – Moisture Mat

### CCW 300HV

CCW 300HV is a16-ounce per square yard, needle-punched polypropylene fabric which aids in the water-retaining volume of green roof systems. Nonbiodegradable, resistant to mildew, insects and common soil chemicals, CCW 300HV is installed between the Root Barrier and CCW MiraDRAIN drainage composite where it benefits plant growth without disturbing the waterproofing layers below.

## Engineered Soils

### Carlisle Engineered Growth Media

A lightweight FLL-approved growth media used for roof garden applications. Applied at the specified depth on Carlisle Roof Garden assemblies.

## Limited Warranty

Carlisle Coatings & Waterproofing, Incorporated (Carlisle) warrants this product to be free of defects in workmanship and materials only at the time of shipment from our factory. If any Carlisle materials prove to contain manufacturing defects that substantially affect their performance, Carlisle will, at its option, replace the materials or refund its purchase price.

This limited warranty is the only warranty extended by Carlisle with respect to its materials. There are no other warranties including the implied warranties of merchantability and fitness for a particular purpose.

Carlisle specifically disclaims liability for any incidental, consequential or other damages including, but not limited to, loss of profits or damages to a structure or its contents arising under any theory of law whatsoever.

The dollar value of Carlisle's liability and buyer's remedy under this limited warranty shall not exceed the purchase price of the Carlisle material in question.

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CARLISLE COATINGS & WATERPROOFING

# ROOF GARDEN

## Hydropack® Roof Garden System

# ROOF GARDEN

## Hydropack Roof Garden System

CCW's Hydropack Roof Garden System offers distinct advantages over more complex systems with its simplicity in design, pre-vegetated modules and removable modular features. With the introduction of its Hydropack Roof Garden System, CCW has given contractors and owners a premium, easy-to-install roof garden solution, giving all of the benefits of a traditional Roof Garden with the ease of a modular system.

### CCW's Hydropack Advantages

CCW's Hydropack incorporates all of the advantages of a traditional, planted-in-place system while providing the ease of a modular system. Hydropack uses a dedicated aggregate drainage layer, filter fabric and FLL compliant growth media. Hydropack Modules lock together and allow sharing of moisture and nutrients, but do not permit the roots to grow from tray to tray, allowing for ease of removal if needed.

### Stormwater Management

Roof Garden systems help to alleviate stormwater runoff through absorption and retention of precipitation. Hydropack is designed to maximize stormwater retention using an intelligent reservoir system. The reservoirs contain expanded aggregates that allow wicking of stored stormwater to the plants' root systems, making Hydropack the most advanced modular Roof Garden stormwater solution on the market.

### Prevents Sound Infiltration

Roof Gardens are incredibly effective at making your building a more serene location in which to reside. Hydropack can help to reduce noise infiltration through the roof by up to 40 dB. This feature can be very valuable to building occupants by helping to create an environment devoid of excess noise.

### Air Quality

Hydropack Roof Garden systems help to purify the air by converting CO2 into O2, which can help to reduce greenhouse gases.

### Extends Roof Life

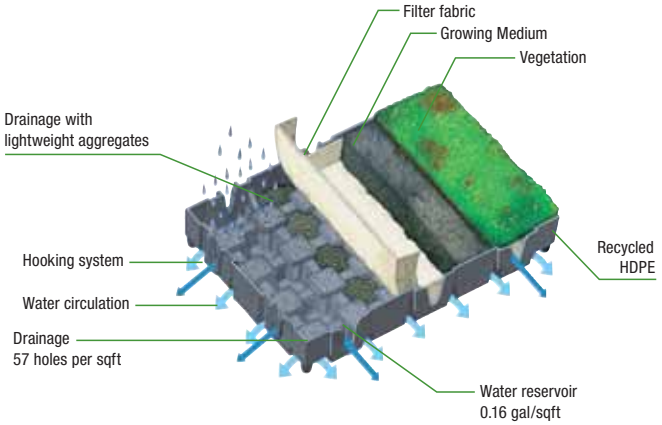
Hydropack Roof Garden modules can protect roof membranes from ultraviolet radiation, extreme temperature fluctuations and puncture or other physical damage. Minimization of such exposure can improve the long-term performance of the roofing system.

## Lowered Heating & Cooling Costs

Roof Gardens are proven to lower the costs of heating and cooling your building. During the summer, plants in the Hydropack modules transpire water and become a “sponge” for heat energy. For this reason, the temperature at the membrane and insulation level can be as much as 10ºF below the ambient air temperature.

## Maintenance

CCW’s Hydropack provides a very low-maintenance Roof Garden. Arriving fully vegetated with established plantings all but eliminates weeding and watering. Maintaining your Hydropack Roof Garden system will help you maximize the benefits associated with a vegetated roof. Maintenance levels will be dependent upon the design of your Hydropack Roof Garden. Since your Hydropack Roof Garden is a living system, a specific maintenance program needs to be adopted and performed on a regular basis. Consult CCW for a specific maintenance plan for your design.

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## Added Aesthetic Value

Hydropack Roof Garden Systems provide urban environments with visually pleasing vistas and rooftop gardens. In urban environments, roof gardens also add value by converting space into areas usable for recreation by building occupants. In such locations, the scarcity of real estate makes the addition of a roof garden for such recreation a competitive alternative.

## Benefits

- Single-source responsibility – roofing contractors can install both the waterproofing and Roof Garden in one installation
- No planting on the roof – modules are pre-vegetated prior to arriving on the jobsite
- Lightweight, easy to handle and fast to install
- Modules are easily moved for modifications or roof repair
- Building owners receive single-source warranty coverage
- Only 17.5 pounds per square foot fully saturated making Hydropak one of the lightest Roof Garden modules on the market

## Features

| | |
|---|---|
| Dimension per unit | 2 ft x 1.3 ft x 3.6 in (60 cm x 40 cm x 9 cm) |
| Tray Material | Black 100% recycled HDPE |
| Depth of water reserve | 1.2 in (3 cm) |
| Filter fabric type | Non woven 3 oz/sqy (100 g/m$^2$) |
| Water reserve sub drainage | 0.16 gal/sq ft (8 L/m$^2$) |
| Maximum water retention capacity | 0.56 gal/sq ft (27.6 L/m$^2$) |
| Number of drainage holes | 47 holes/sq ft (500 holes/m$^2$) |
| Total drainage surface | 4.5 sq in per sq ft (318 cm$^2$/m$^2$) |
| Dry weight | 11.5 lbs/sq ft (56 kg/m$^2$) |
| Saturated weight | 17.5 lbs/sq ft (85 kg/m$^2$) |
| Maximum weight per tray | 45 lbs (20.4 kg) |
| Installation time | 860 sq ft/day/person |

## Standard Plantings

- Sedum Album Coral Carpet
- Sedum Reflexum Blue Spruce
- Sedum Sexangulare
- Sedum Rupestre Angelina
- Sedum Ellacombianum
- Sedum John Creech
- Sedum Aizoon
- Sedum Spurium
- Allium Shoenoprasum

## Limited Warranty

Carlisle Coatings & Waterproofing, Incorporated (Carlisle) warrants this product to be free of defects in workmanship and materials only at the time of shipment from our factory. If any Carlisle materials prove to contain manufacturing defects that substantially affect their performance, Carlisle will, at its option, replace the materials or refund its purchase price.

This limited warranty is the only warranty extended by Carlisle with respect to its materials. There are no other warranties including the implied warranties of merchantability and fitness for a particular purpose.

Carlisle specifically disclaims liability for any incidental, consequential or other damages including, but not limited to, loss of profits or damages to a structure or its contents arising under any theory of law whatsoever.

The dollar value of Carlisle's liability and buyer's remedy under this limited warranty shall not exceed the purchase price of the Carlisle material in question.

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CARLISLE COATINGS & WATERPROOFING


REPRINT CODE: 606105 - "CCW Modular Roof Garden Brochure"

## APPENDIX D

XBT-1 Existing Hydrology
XBT-2 Proposed Hydrology
XBT-3 Existing Impervious Area
XBT-4 Proposed Impervious Area

LEGEND

TIME OF CONCENTRATION (Tc)

WATERSHED BOUNDARY

DP-1
(CULVERT)

EDA-1B
AREA = 16,684 SF
(0.383 AC)
CN = 63
Tc = 7.7 MIN.

EDA-1A
AREA = 126,629 SF
(2.907 AC)
CN = 45
Tc = 22.1 MIN.

EDA-1C
AREA = 30,536 SF
(0.701 AC)
CN = 54
Tc = 8.8 MIN.

Scale: 1"=20'
0 10' 20' 40'

NOT FOR CONSTRUCTION

HKT architects inc.
24 Roland Street,
Suite 301
Charlestown, MA 02129
T: 617.776.6545
F: 617.776.6678
www.hktarchitects.com

Revision Schedule

| Number | Revision | Date |
|---|---|---|

Registrations

Consultants

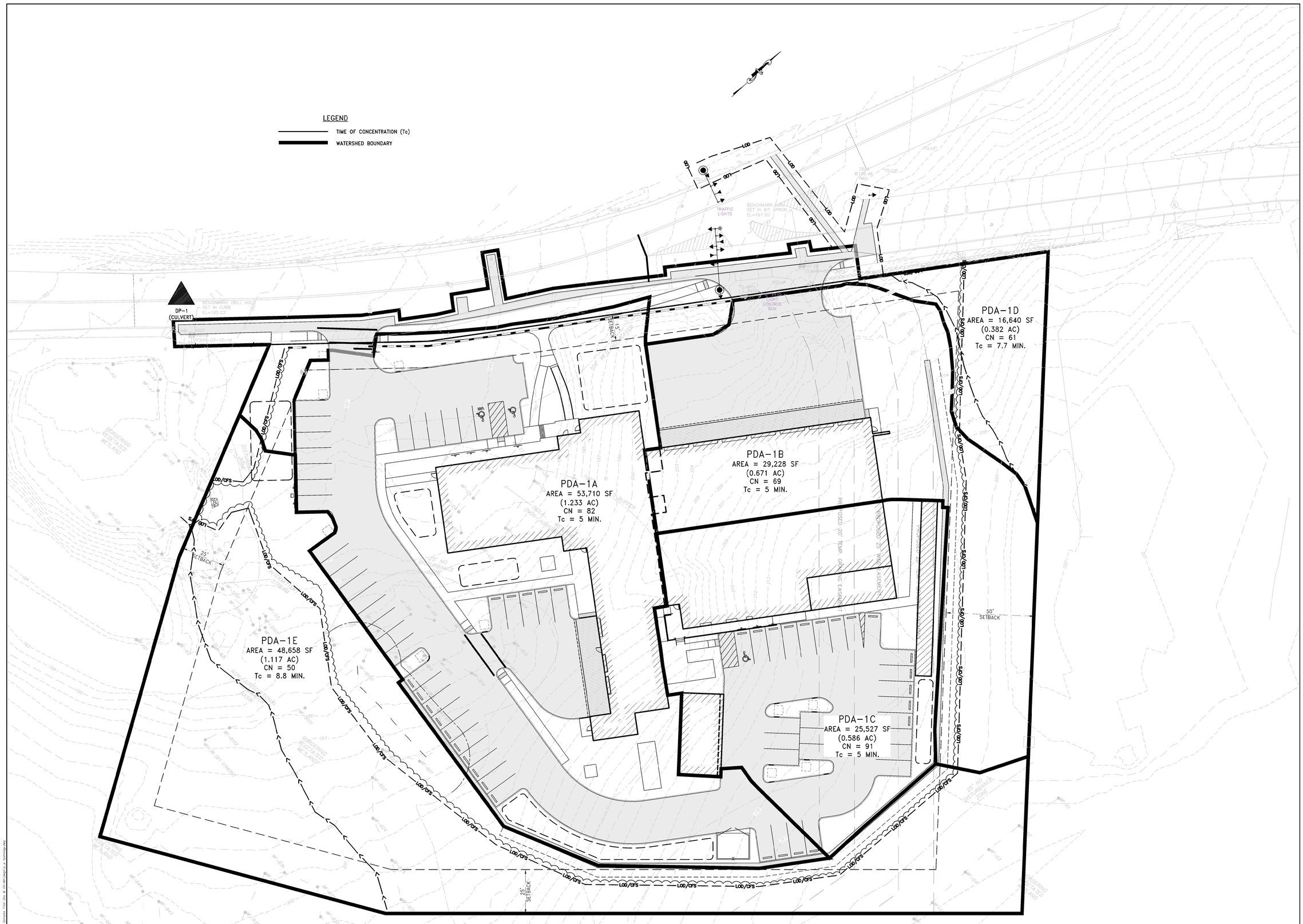
PARE
PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
508-543-1755

Project
ASHLAND PUBLIC SAFETY COMPLEX
12-16 UNION STREET, ASHLAND, MA

EXISTING HYDROLOGY PLAN

AWB Drawn by
LM Checked by
AUGUST 2020 1" = 20' Date
17044.03 Job number
PERMITTING Drawing set

Drawing number
XBT-1

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Project
ASHLAND PUBLIC SAFETY COMPLEX
12-16 UNION STREET, ASHLAND, MA

# PROPOSED HYDROLOGY PLAN

| | |
|---|---|
| AWB | LM |
| Drawn by | Checked by |
| AUGUST 2020 1" = 20' | |
| Date | |
| 17044.03 | |
| Job number | |
| PERMITTING | |
| Drawing set | |

Drawing number
XBT-2

# LEGEND

WATERSHED BOUNDARY

IMPERVIOUS AREA

EDA: 1B

WATERSHED BOUNDARY (TYP.)

EDA: 1A

EDA: 1C

EDA: 1B

WATERSHED BOUNDARY (TYP.)

## EXISTING IMPERVIOUS AREA

| | |
|---|---|
| EDA 1A: | 2,509 S.F. |
| EDA 1B: | 6,155 S.F. |
| EDA 1C: | 0 S.F. |
| TOTAL | 8,651 S.F. |

Scale: 1"=20'

0 10' 20' 40'

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Project
ASHLAND PUBLIC SAFETY COMPLEX
12-16 UNION STREET, ASHLAND, MA

EXISTING IMPERVIOUS PLAN

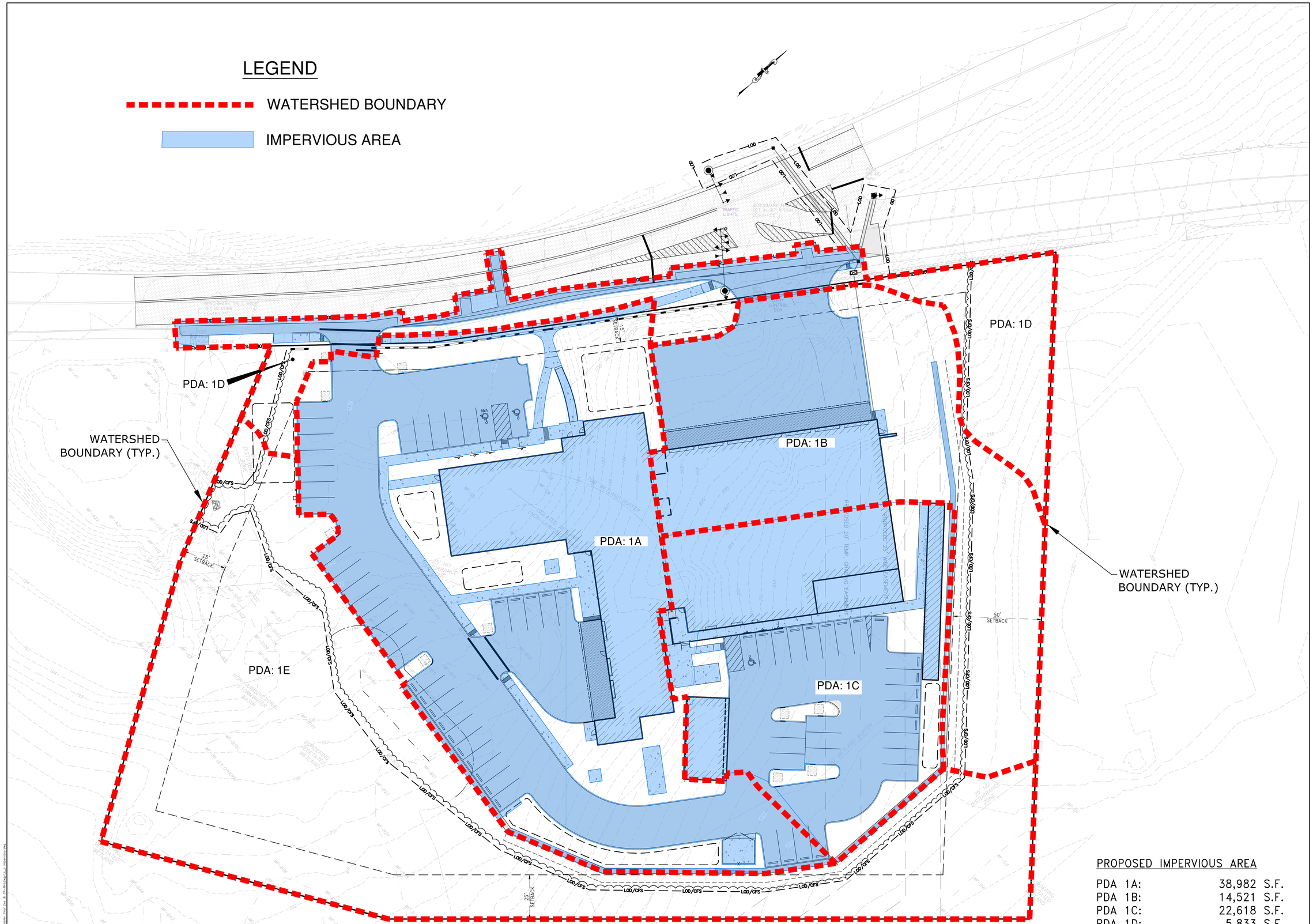
AWB Drawn by | LM Checked by
AUGUST 2020 1" = 20' Date
17044.03 Job number
PERMITTING Drawing set

Drawing number
XBT-3

## LEGEND

WATERSHED BOUNDARY

IMPERVIOUS AREA




### PROPOSED IMPERVIOUS AREA

| | |
|---|---|
| PDA 1A: | 38,982 S.F. |
| PDA 1B: | 14,521 S.F. |
| PDA 1C: | 22,618 S.F. |
| PDA 1D: | 5,833 S.F. |
| PDA 1E: | 300 S.F. |
| TOTAL | 82,254 S.F. |

Scale: 1"=20'

0 10' 20' 40'

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Revision Schedule

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|---|---|---|

Registrations

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Project
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12-16 UNION STREET, ASHLAND, MA

PROPOSED IMPERVIOUS PLAN

| | |
|---|---|
| AWB | LM |
| Drawn by | Checked by |
| AUGUST 2020 | 1" = 20' |
| Date | |
| 17044.03 | |
| Job number | |
| PERMITTING | |
| Drawing set | |

Drawing number
XBT-4