Stormwater Management Report
Hidden Pines Lane
Andover, Massachusetts

Prepared for:
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Andover, Massachusetts 01810

February 1, 2022

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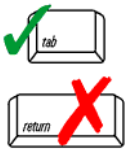
Checklist for Stormwater Report

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.

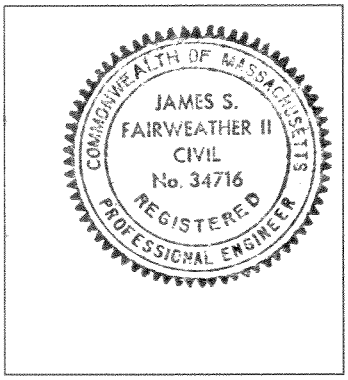
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the 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



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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:

- [X] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [X] 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

- [X] No new untreated discharges
- [X] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [X] 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.

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00). Technically, this project is exempt from the Massachusetts Standards as a four lot subdivision. However, this report is prepared to demonstrate compliance with the Town of Andover's Rules and Regulations for stormwater design and mitigation per the **Town of Andover Stormwater Management and Erosion Control By-Law.**

Project Description

The Applicant, Steven Leed, is proposing to construct 315± long subdivision road that will support a four lot single family residential development. The project includes an existing dwelling that is to remain on a reconfigured lot (Lot 1) and proposes 3 new lots.

The proposed work will also include the construction of a subsurface infiltration/detention structure, lot grading, drainage and other utilities. The proposed road ends with a cul-de- sac and is within an existing 60-foot wide drainage and sewer easement. The subsurface infiltration/detention structure, at the end of the road, is proposed to treat and mitigate stormwater quality and quantity. The design accommodates the existing utilities while providing a new drainage system to discharge into the subsurface system. A new looped water main is to be constructed and each new lot will be serviced by this as well as new sewer service connections to the existing sewer, the existing sewer discharges north to south through the property.

No alteration of existing wetland resources are proposed, but the project will disturb more than an acre of land which requires the project to comply with the By-Law noted above as well as filing with the EPA for a Construction General Permit.

Site Description

The Project Site is on a 2.33-acre parcel of land located off of William Street in Northern Andover, Massachusetts. The Site lies within the surface watersheds of Hussy Brook and the Shawsheen River and runoff ultimately discharges into the Merrimack River. The existing parcel to be developed is within the single lot residential zoning district SRA and is surrounded by existing single family lots to the west, north and east. The Hunter Ridge Condominium abuts the parcel to the south.

There are no Wetland Resource Areas on the Site, but there is a Bordering Vegetated Wetland (flagged series "B") just south of the property, on the condominium property. Portions of the work are within the buffer zone of this wetland and

jurisdictional under the State's WPA and the Town's Bylaw. Another wetland (flagged series "A") is approximately 100 feet west of the property so the work is outside of the buffer for this resource. The wetland series "A" is depicted on the national Wetland Inventory website, while series "B" is not.

According to the National Resources Conservation Service (NRCS), surface soils on the Site consist of Hinckley Loamy Sand (Map units 253B, 253C) and are classified as a Hydrologic Soil Groups (HSG) A soil, a soil with low runoff potential and high infiltration rates when thoroughly wetted.

The Site does not lie within floodplain according to FEMA Flood Insurance Rate Map 25009C0217F, dated July3, 2012.

The Site is not in or near habitat of rare or endangered species according to the NHESP online map, dated 8-1-2021.

Existing Drainage Conditions

Under existing conditions, the Site is a combination of landscaped, mowed lawn and undeveloped woodland consisting of a combination of trees and grass ground covers. There are 2 existing single family dwellings within the watershed of the proposed roadway drainage system; the project proponent resides in one of them, at 22 William Street. Both dwelling lots have associated paved driveways that connect to William Street, the driveway area for abutting property, at 24 William Street, was approximated.

Topography on site ranges from a high elevation of 78 along the northern side of the property line, at William Street, to a low elevation of 67 at the southerly end of the property, just north of an existing retaining wall. In addition to the dwellings there is a large garage in the southeast corner of the lot, a shed, a pool and pool house along the south, and an existing tennis court in the southwest corner of the lot. These features will be razed during construction.

For purposes of this study, two subcatchment areas and design checkpoints are were analyzed. Existing subcatchment 1 (EX 1) is a 0.6± acre portion of the project area and its surrounds which discharges westerly from the site and consists of lawn, and grass/woods combination ground cover and the existing tennis court.

Stormwater runoff from the majority of the site, and surrounds, comprise area 2 (EX 2), a 2.8± acre sub-watershed and discharges runoff southerly towards the flagged wetland series B. This area consists of lawn, woods/grass combination ground covers and includes the existing dwellings, graveled drives the large garage in the southeast corner of the lot, a shed, a pool and pool house along the south noted above. Runoff from this area is principally via overland sheet flow with some internal area tributary to an existing drain discharging southerly.

Proposed Drainage Conditions

Under developed conditions, the Site is a comprised of the two existing dwellings, three new single-family lots and the proposed roadway.

Under developed conditions, three subcatchment areas were analyzed. Developed subcatchment 1 (DEV 1) is a 0.36± acre portion of the project area and its surrounds consisting of offsite lawn at 24 William Street and the developed portion of the westerly side of the development not captured by the proposed swale on that side of the project. Ground covers in this area include the noted abutter lawn and an onsite area proposed to revegetate naturally after removal of the tennis court. This area discharges westerly and to be compared to EX1 for pre vs. post runoff conditions.

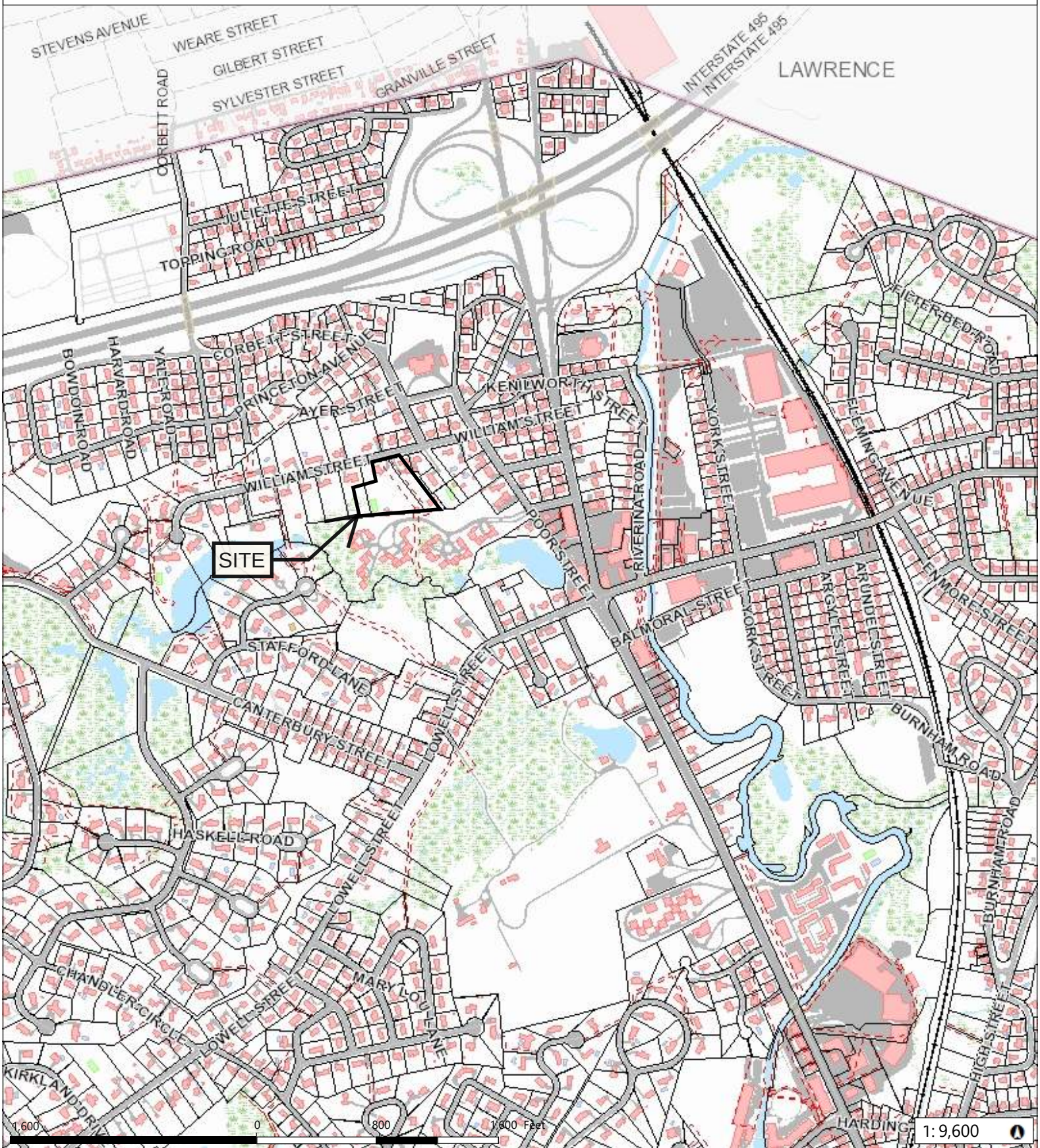
Developed area 2 (DEV2) is a 2.34± acre sub-watershed consisting of most of the proposed development and which is collected by the proposed drainage system or graded swale and is tributary to the proposed sub-surface infiltration/detention chamber system. This area also includes a small area of William Street, mostly paved, which will be picked up by the drainage system not originally tributary to the property.

Developed area 3 (DEV3), 0.74± acre, is the remaining portion of the project property and surrounds which is not tributary the subsurface system and consists of the developed portion of lot 2, the lawn are over the chambers and a portion of the property, and abutting land, along the southerly end of the property that is proposed to revegetate naturally after removal the existing garage and shed. Runoff from this area is summed with the controlled runoff from the chambers to form SUM and forms the post developed runoff to be compared to EX2 for the pre vs. post condition.

Figure 1: Site Locus Map

Site Locus

12/21/2021



Data Sources: Produced by Merrimack Valley Planning Commission (MVPC) using data provided by the Town of Andover & MassIT/MassGIS.

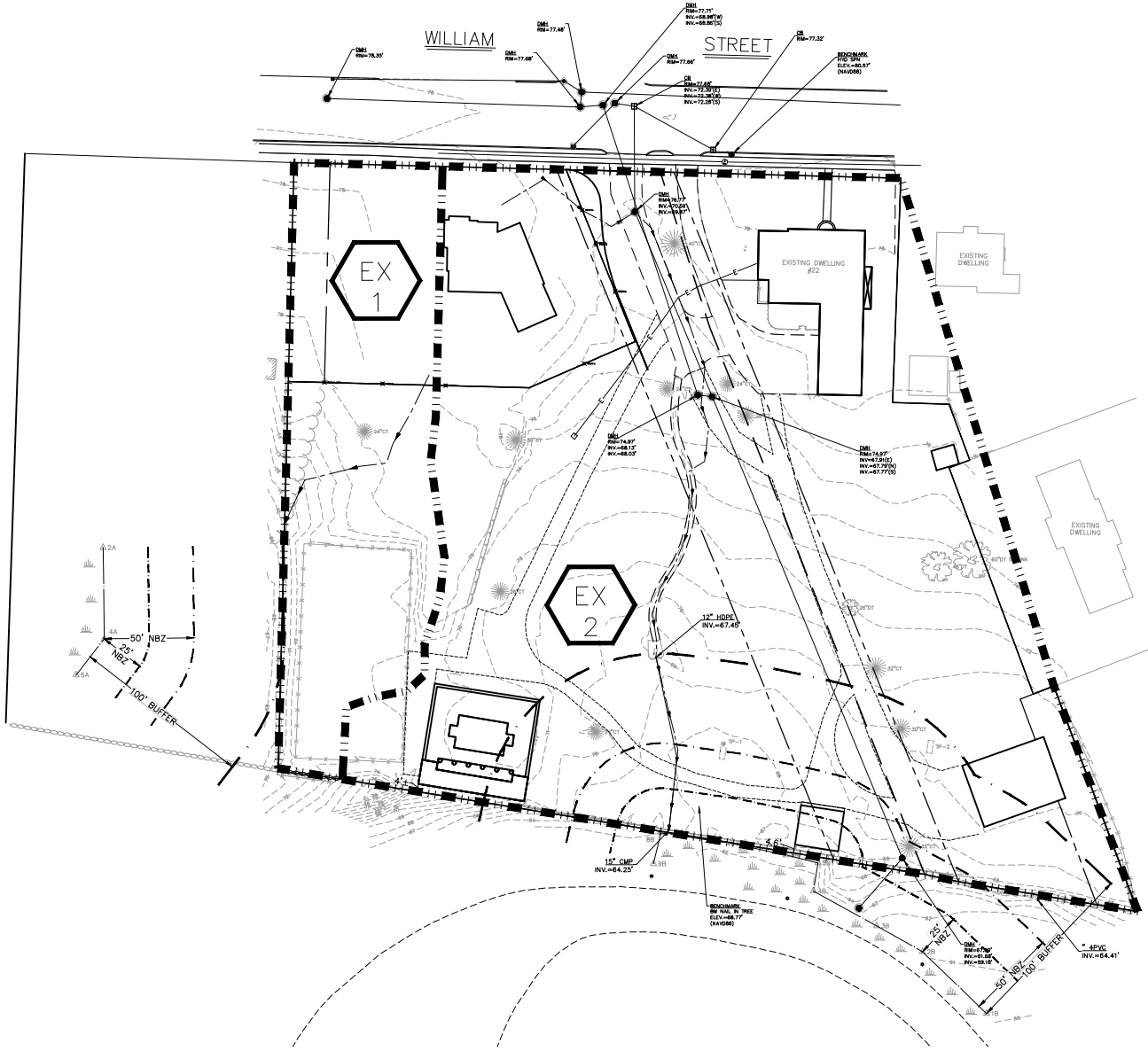
MVPC AND THE TOWN OF ANDOVER MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, CONCERNING THE ACCURACY, COMPLETENESS, RELIABILITY, OR SUITABILITY OF THESE DATA. THE TOWN OF ANDOVER AND MVPC DOES NOT ASSUME ANY LIABILITY ASSOCIATED WITH THE USE OR MISUSE OF THIS INFORMATION

Legend

- Municipal Boundary
- Parcels
- Easement
- Structures
- Building; <Null>
- Fuel Tank
- Water Tank
- Pool
- Basketball Court
- Tennis Court
- Bridge
- Roads
- Rail Line
- Road Right of Way
- Paved
- Unpaved
- Hydrographic Features
- Streams
- Wetlands

Projection: NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001

Figure 2: Existing Conditions Drainage Divide Area Map



DEFINITIVE SUBDIVISION
DRAINAGE DIVIDES–EXISTING
HIDDEN PINES LANE
ANDOVER, MASSACHUSETTS

PREPARED FOR: STEVEN LEED
DATE: FEBRUARY 1, 2022
SCALE: 1"=30'

andover consultants inc.
1 East River Place
Methuen, Mass. 01844
Telephone: 978-687-3828

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0 8 16 32 Meter

SHEET 1 OF 2

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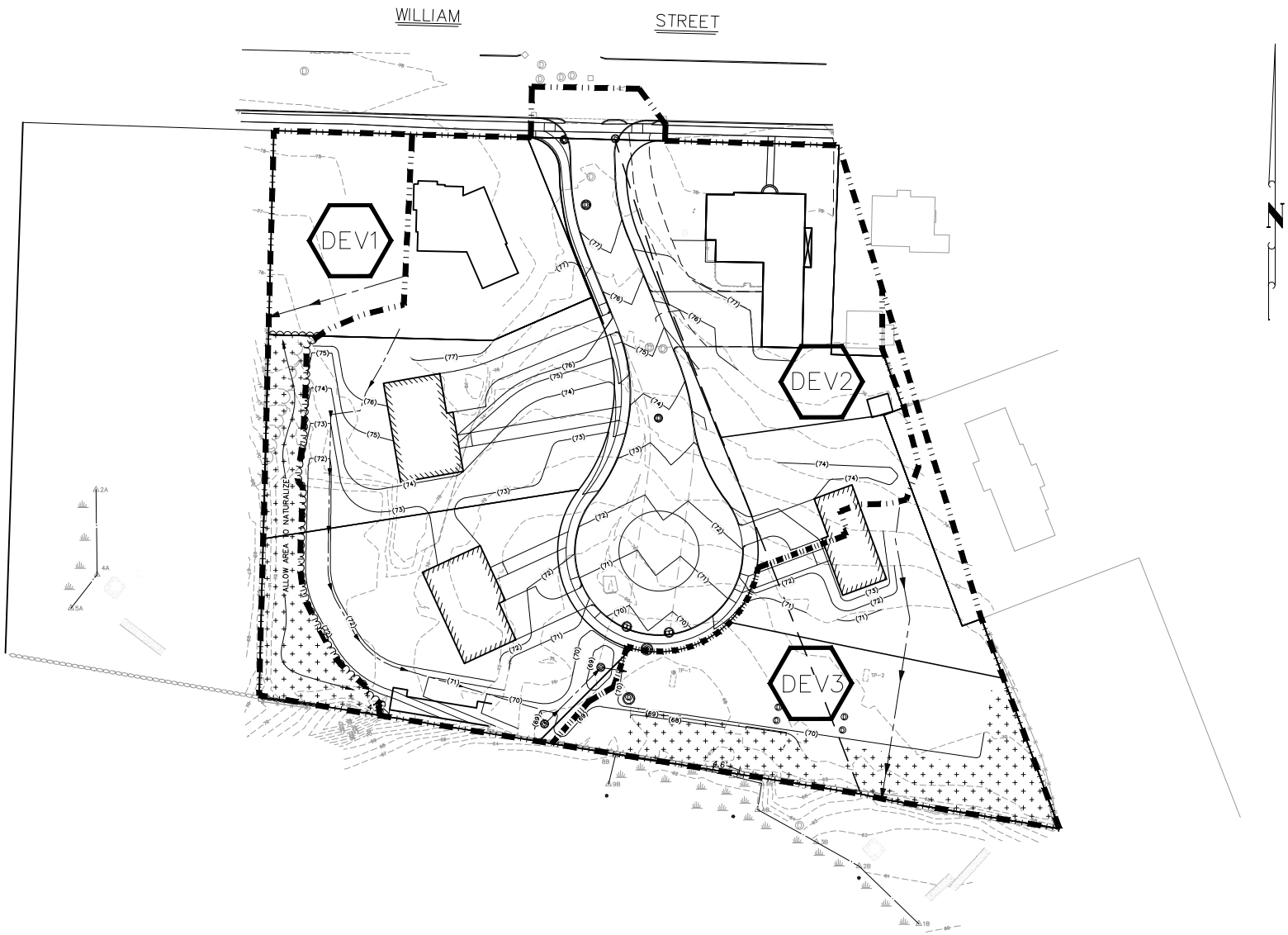
Figure 3: Developed Conditions Drainage Divide Area Map



DEFINITIVE SUBDIVISION
DRAINAGE DIVIDES–DEVELOPED
HIDDEN PINES LANE
ANDOVER, MASSACHUSETTS

PREPARED FOR: STEVEN LEED
DATE: FEBRUARY 1, 2022
SCALE: 1"=30'

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SHEET 2 OF 2

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Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards and the Town of Andover's Rules and Regulations for Stormwater Design.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to fully comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, 25, and 100-years. The results of the analysis, as summarized in the table below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions for all storm events except for the 2 year event at point 2. This storm results in a very small increase rate of 0.2 cfs, and more importantly, a very small increase in runoff volume of just 59 cubic feet, which is minimal.

HydroCAD hydrologic modeling result printouts are attached at the end of this report.

Peak Discharge Rates (cfs*)

Design Point	*2-year*	*10-year*	*25-year*	*100-year*
Design Point 1: west property line				
Existing	0.0	0.3	0.6	1.2
Proposed	0.0	0.3	0.6	1.1

Design Point 2: Wetland series "B"				
Existing	0.0	1.1	2.6	5.6
Proposed	0.2	1.0	2.0	3.8

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3.

In accordance with the Town of Andover Stormwater Management Regulations, and as calculated below, the Required Recharge Volume for the Project is 1,816.4 cubic feet.

$Re_v = [(R_v)\ (A)]/12$, where

Re_v = required recharge volume
Rv = depth per soil type = 0.6 ft. for HSG A soil
A = total impervious area = 36,327 s.f. (includes offsite #24 roof area, and offsite portion of William St.)

$Re_v = [(0.6/12)*(36,327)$
$Re_v = 1,816.4$ c.f.

Note: total impervious area not captured = 1,475 s.f. (unconnected roof and walk)
Impervious area captured 36,327 – 1,475 = 34,852 sf and tributary to subsurface infiltration chamber

34,852/36,327 = 0.959 (95.9% captured > 65%, OK)

Area scale factor = (1/0.959) =1.043
Rv = 1.043 x 1,816.4 cf = 1,894.5 c.f.

Volume below invert out @ elevation 65.4 (+0.60') = 3,167 c.f. > 1,894.5 c.f., OK

Recharge of stormwater has been provided through the use of the subsurface infiltration structure and should drain completely within 72 hours per the following calculation using the static method and the provided recharge volume.

Where:
$Time_{Drawdown} = R_v/ (K)$ (Bottom Area)
Re_v = 3,167 c.f.
K =2.41 in/hr for HSG A loamy sand
Bottom Area = 5,278 s.f.

$Time_{Drawdown}$ = 3,167 c.f. / ((2.41 in/hr) (1'/12") (5,278 sf))
$Time_{Drawdown}$ = 3 hours < 72 hours, OK

Soil test pit data, recharge mounding evaluation and supporting information are included at the end of this report.

Standard 4: Water Quality

The Project has been designed to fully comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide a minimum 80% TSS removal of stormwater runoff from all proposed impervious surfaces.

The required water quality volume required based on the total impervious area is calculated below:

$V_{WQ} = (D_{WQ}/12''/foot) \times (A_{IMP})$
Where:
V_{WQ} = Require Water Quality Volume (cf)
D_{WQ} = Water Quality Depth = 1″ per Andover regulation
A_{IMP} = Total Impervious Area = 36,327 s.f.

V_{WQ} = (1″) x (1′/12″) x (36,327 s.f.)
V_{WQ} = 3,027.2 c.f.
Invert out of chamber = 65.4
Storage provided below elevation 65.4 = 3,167 c.f > 3,027.2, OK

TSS removal treatment:
Catch basin sumps = 25% TSS
Subsurface Chamber (infiltration) = 80% TSS
Treatment Device (Stormceptor® 900 water quality unit) is rated for 50% TSS removal by NJCAT)

Calculate WQF:
Water Quality Flow Rate for 50% removal:
WQF = Qu x A x WQV
Where: Qu = 774 csm /in., for Tc = 0.1 hr
Paved area to unit = 25,064 s.f. = 0.000899 sm
WQV = 1″ (per by-law)

WQF = 774csm/in. x 0.000899 sm x 1 in. = 0.69 cfs

WQF for STC 900 is rated for 0.64 cfs close enough, but prorate 50% removal rate
50 x 0.64/0.69 = 46%

TSS removal:
Total impervious area tributary to drains and subsurface chamber = 25,064 s.f.
Uncaptured area = 11,263 s.f., note all uncaptured is unconnected (mostly roof area) and runs over lawn prior to entering subsurface system consistent with low impact development for roof runoff.

TSS removal for new paved roadway, drives and sidewalks tributary to the site drains and subsurface chambers:
TSS removal rate:
25% deep sump
46% Stormceptor

80% subsurface chamber
Removal rate = 0.25 + 0.46(0.75) + 0.80(0.405) = 0.919, say 92%
A TSS calculation sheet is included at the end of this report.

Per the Town of Andover's Stormwater Management Regulations, the annual sediment volume load is calculated as:

Paved area to be sanded x 750 lbs./acre storm ÷ 90 lbs./ft^3 x 10 storms/year = c.f. of sediment
Paved area = 25,064 s.f. = 0.575 acres

Volume = 0.575 acres x 750 lbs. /acre storm ÷ 90 lbs. /ft^3 x 10 storms/year = 47.9 c.f. of sediment
Stormwater will pass through an oil & grit structure (Stormceptor 900) and will intercept this volume.

Phosphorus removal:

Based upon the "Stormwater Best Management Practices (BMP) Performance Analysis" document, dated March 2010, and prepared for EPA-Region 1 the subsurface structure removes 98% of TP exceeding the required removal per the Andover Stormwater Regulation.

Excerpts from the report noted above for infiltration basins and infiltration trenches are attached at the end of this report.

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

The Project is not considered a LUHPPL.

Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

Although some of the property has been previously developed, this project is not considered a redevelopment.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb approximately 2.3± acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins.

A recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included at the end of this report.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included at the end of this report as part of the Long Term Pollution Prevention Plan.

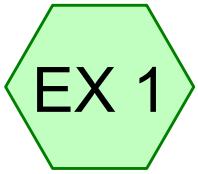
Standard 10: Prohibition of Illicit Discharges

The site has a number of existing sewer and drainage infrastructure running through the site in existing easements, but there are no known illicit discharges generated by the property owner. No illicit discharges are proposed. Prior to land disturbance, an illicit discharge statement will be provided, if requested.

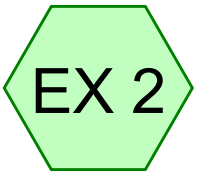
Appendix - Standard 2 Supporting Information

Rainfall volumes used for this analysis were based on the Natural Resources Conservation Service (NRCS) Type III, 24-hour storm event for Andover, Massachusetts. Runoff coefficients for the existing and proposed conditions were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

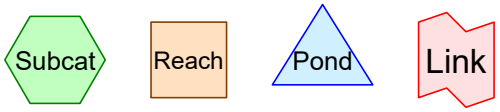
HydroCAD Analysis: Existing Conditions



Existing Area 1



Existing Area 2



Routing Diagram for 21-31 William Court existing
Prepared by Andover Consultants, Inc.

Summary for Subcatchment EX 1: Existing Area 1

Runoff = 0.0 cfs @ 12.53 hrs, Volume= 342 cf, Depth= 0.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Year Rainfall=3.13"

	Area (sf)	CN	Description
*	5,969	98	Tennis court, HSG A
	20,198	39	>75% Grass cover, Good, HSG A
	26,167	52	Weighted Average
	20,198		77.19% Pervious Area
	5,969		22.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.3	78	0.0770	4.47		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.8	128	Total			

Summary for Subcatchment EX 2: Existing Area 2

Runoff = 0.0 cfs @ 13.79 hrs, Volume= 974 cf, Depth= 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Year Rainfall=3.13"

	Area (sf)	CN	Adj	Description
*	1,161	98		Tennis court, HSG A
	9,000	76		Gravel roads, HSG A
	7,145	98		Paved parking, HSG A
	12,494	98		Unconnected roofs, HSG A
	92,022	39		>75% Grass cover, Good, HSG A
	121,822	52	49	Weighted Average, UI Adjusted
	101,022			82.93% Pervious Area
	20,800			17.07% Impervious Area
	12,494			60.07% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0160	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	25	0.0160	2.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	110	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	61	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	112	0.0540	4.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	98	0.0550	11.53	9.05	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
8.1	456	Total			

Summary for Subcatchment EX 1: Existing Area 1

Runoff = 0.3 cfs @ 12.23 hrs, Volume= 1,722 cf, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Year Rainfall=4.97"

	Area (sf)	CN	Description
*	5,969	98	Tennis court, HSG A
	20,198	39	>75% Grass cover, Good, HSG A
	26,167	52	Weighted Average
	20,198		77.19% Pervious Area
	5,969		22.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.3	78	0.0770	4.47		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.8	128	Total			

Summary for Subcatchment EX 2: Existing Area 2

Runoff = 1.1 cfs @ 12.17 hrs, Volume= 6,370 cf, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Year Rainfall=4.97"

	Area (sf)	CN	Adj	Description
*	1,161	98		Tennis court, HSG A
	9,000	76		Gravel roads, HSG A
	7,145	98		Paved parking, HSG A
	12,494	98		Unconnected roofs, HSG A
	92,022	39		>75% Grass cover, Good, HSG A
	121,822	52	49	Weighted Average, UI Adjusted
	101,022			82.93% Pervious Area
	20,800			17.07% Impervious Area
	12,494			60.07% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0160	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	25	0.0160	2.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	110	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	61	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	112	0.0540	4.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	98	0.0550	11.53	9.05	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
8.1	456	Total			

Summary for Subcatchment EX 1: Existing Area 1

Runoff = 0.6 cfs @ 12.20 hrs, Volume= 2,938 cf, Depth= 1.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 25-Year Rainfall=6.11"

	Area (sf)	CN	Description
*	5,969	98	Tennis court, HSG A
	20,198	39	>75% Grass cover, Good, HSG A
	26,167	52	Weighted Average
	20,198		77.19% Pervious Area
	5,969		22.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.3	78	0.0770	4.47		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.8	128	Total			

Summary for Subcatchment EX 2: Existing Area 2

Runoff = 2.6 cfs @ 12.14 hrs, Volume= 11,411 cf, Depth= 1.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 25-Year Rainfall=6.11"

	Area (sf)	CN	Adj	Description
*	1,161	98		Tennis court, HSG A
	9,000	76		Gravel roads, HSG A
	7,145	98		Paved parking, HSG A
	12,494	98		Unconnected roofs, HSG A
	92,022	39		>75% Grass cover, Good, HSG A
	121,822	52	49	Weighted Average, UI Adjusted
	101,022			82.93% Pervious Area
	20,800			17.07% Impervious Area
	12,494			60.07% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0160	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	25	0.0160	2.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	110	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	61	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	112	0.0540	4.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	98	0.0550	11.53	9.05	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
8.1	456	Total			

Summary for Subcatchment EX 1: Existing Area 1

Runoff = 1.2 cfs @ 12.19 hrs, Volume= 5,187 cf, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Year Rainfall=7.87"

	Area (sf)	CN	Description
*	5,969	98	Tennis court, HSG A
	20,198	39	>75% Grass cover, Good, HSG A
	26,167	52	Weighted Average
	20,198		77.19% Pervious Area
	5,969		22.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.3	78	0.0770	4.47		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.8	128	Total			

Summary for Subcatchment EX 2: Existing Area 2

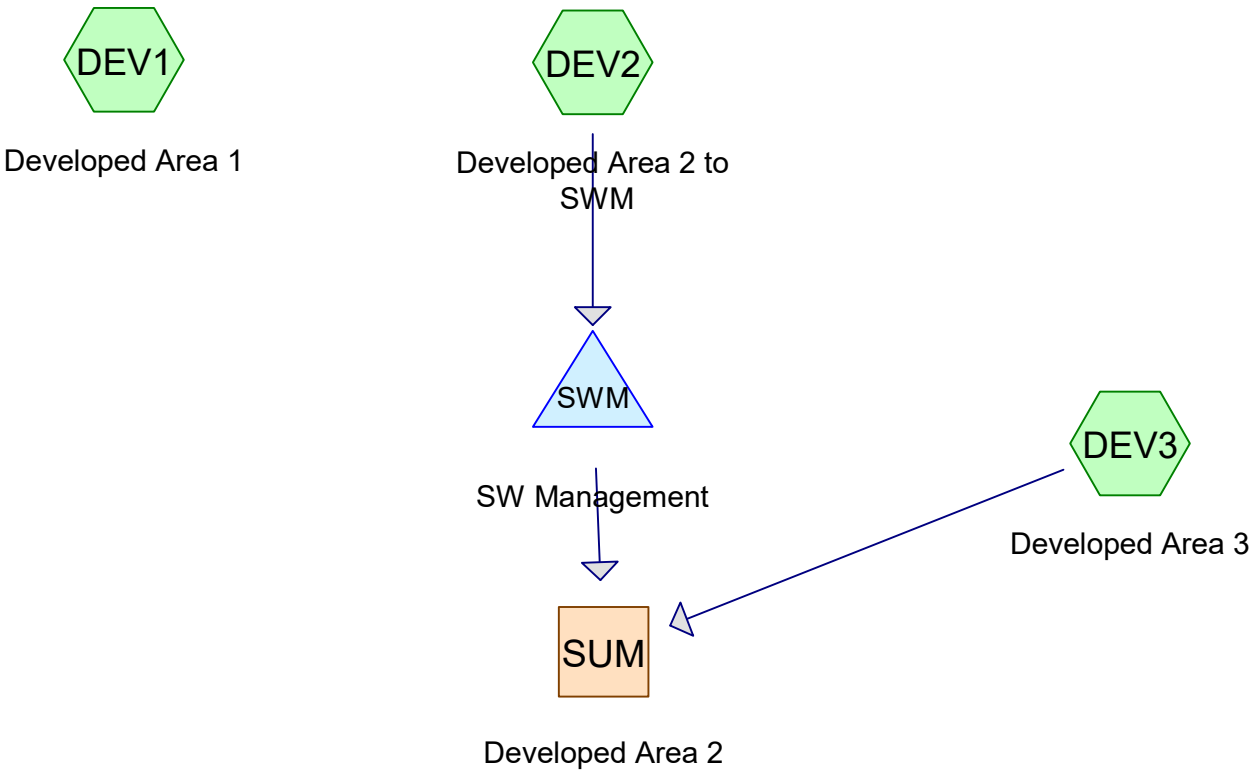
Runoff = 5.6 cfs @ 12.13 hrs, Volume= 21,001 cf, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Year Rainfall=7.87"

	Area (sf)	CN	Adj	Description
*	1,161	98		Tennis court, HSG A
	9,000	76		Gravel roads, HSG A
	7,145	98		Paved parking, HSG A
	12,494	98		Unconnected roofs, HSG A
	92,022	39		>75% Grass cover, Good, HSG A
	121,822	52	49	Weighted Average, UI Adjusted
	101,022			82.93% Pervious Area
	20,800			17.07% Impervious Area
	12,494			60.07% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.0160	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	25	0.0160	2.04		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	110	0.0140	2.40		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	61	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	112	0.0540	4.72		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	98	0.0550	11.53	9.05	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012
8.1	456	Total			

HydroCAD Analysis: Proposed Conditions



Subcat Reach Pond Link

Routing Diagram for 21-31 William Court developed-Chambers
Prepared by Andover Consultants, Inc.

Summary for Subcatchment DEV1: Developed Area 1

Runoff = 0.0 cfs @ 12.37 hrs, Volume= 237 cf, Depth= 0.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.13"

	Area (sf)	CN	Description
*	9,315	68	>75% Grass cover, Good, HSG A
	6,474	32	Woods/grass comb., Good, HSG A
	15,789	53	Weighted Average
	15,789		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	35	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.5	85	Total			

Summary for Subcatchment DEV2: Developed Area 2 to SWM

Runoff = 3.0 cfs @ 12.12 hrs, Volume= 10,389 cf, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.13"

	Area (sf)	CN	Description
*	25,064	98	Paved, HSG A
	9,788	98	Unconnected roofs, HSG A
*	67,147	68	>75% Grass cover, Good, HSG A
	101,999	78	Weighted Average
	67,147		65.83% Pervious Area
	34,852		34.17% Impervious Area
	9,788		28.08% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	48	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	162	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.6	95	0.0300	2.60		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.3	355	Total			

Summary for Subcatchment DEV3: Developed Area 3

Runoff = 0.2 cfs @ 12.12 hrs, Volume= 1,033 cf, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.13"

	Area (sf)	CN	Adj	Description
	1,105	98		Unconnected roofs, HSG A
*	370	98		Unconnected walk, HSG A
	7,904	32		Woods/grass comb., Good, HSG A
*	23,107	68		>75% Grass cover, Good, HSG A
	32,486	61	60	Weighted Average, UI Adjusted
	31,011			95.46% Pervious Area
	1,475			4.54% Impervious Area
	1,475			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.0	126	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.0	176	Total			

Summary for Reach SUM: Developed Area 2

Inflow Area = 134,485 sf, 27.01% Impervious, Inflow Depth = 0.09" for 2-Year event
Inflow = 0.2 cfs @ 12.12 hrs, Volume= 1,033 cf
Outflow = 0.2 cfs @ 12.12 hrs, Volume= 1,033 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond SWM: SW Management

Inflow Area = 101,999 sf, 34.17% Impervious, Inflow Depth = 1.22" for 2-Year event
Inflow = 3.0 cfs @ 12.12 hrs, Volume= 10,389 cf
Outflow = 0.4 cfs @ 12.97 hrs, Volume= 13,563 cf, Atten= 87%, Lag= 50.9 min
Discarded = 0.4 cfs @ 12.97 hrs, Volume= 13,563 cf
Primary = 0.0 cfs @ 12.97 hrs, Volume= 1 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 65.40' Surf.Area= 5,278 sf Storage= 3,167 cf
Peak Elev= 65.51' @ 12.97 hrs Surf.Area= 5,278 sf Storage= 3,734 cf (567 cf above start)
Flood Elev= 68.80' Surf.Area= 5,278 sf Storage= 21,112 cf (17,945 cf above start)

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

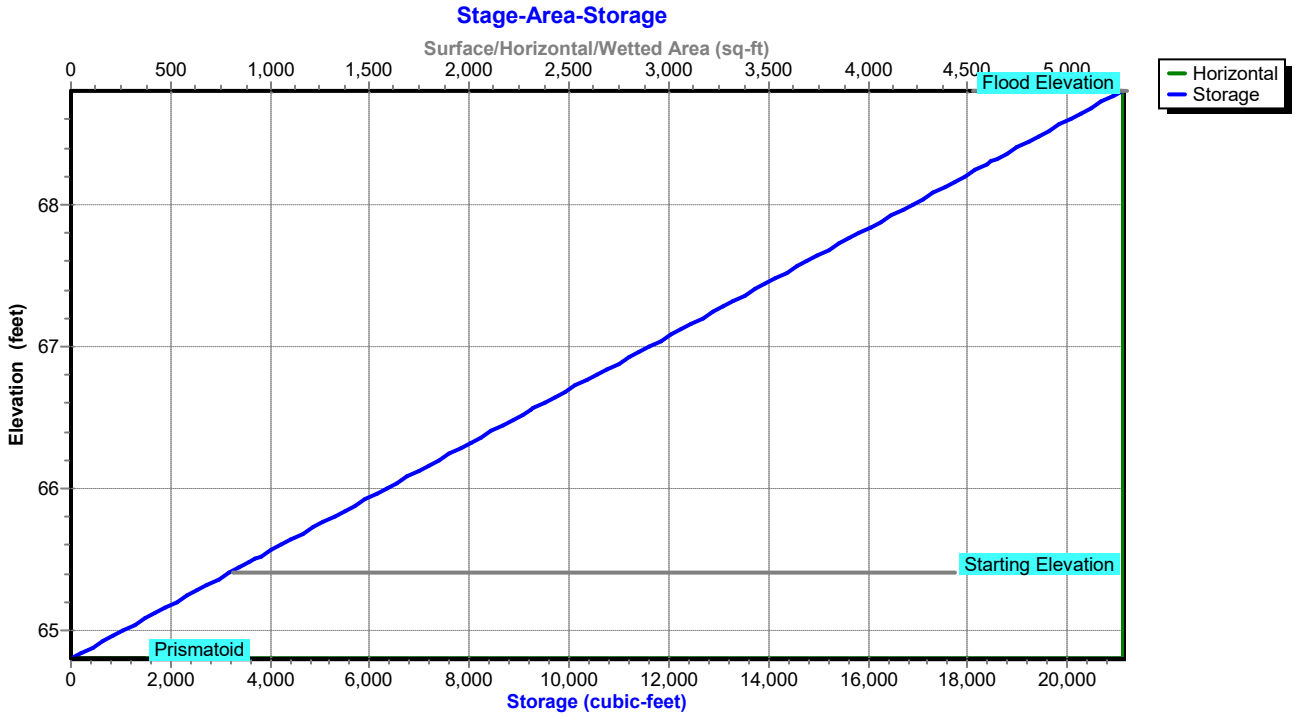
Volume	Invert	Avail.Storage	Storage Description
#1	64.80'	21,112 cf	**7.00'W x 13.00'L x 4.00'H Prismatoid** x 58

Device	Routing	Invert	Outlet Devices
#1	Primary	64.50'	**15.0" Round Culvert Outlet** L= 30.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 64.50' / 64.25' S= 0.0083 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf
#2	Discarded	64.80'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 62.80' Phase-In= 0.01'
#3	Device 1	65.50'	**2.0" W x 1.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	66.55'	**18.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	68.30'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 0.5' Crest Height

Discarded OutFlow Max=0.4 cfs @ 12.97 hrs HW=65.51' (Free Discharge)
└**2=Exfiltration** (Controls 0.4 cfs)

Primary OutFlow Max=0.0 cfs @ 12.97 hrs HW=65.51' (Free Discharge)
└**1=Culvert Outlet** (Passes 0.0 cfs of 2.6 cfs potential flow)
  ├**3=Orifice/Grate** (Orifice Controls 0.0 cfs @ 0.28 fps)
  ├**4=Orifice/Grate** (Controls 0.0 cfs)
  └**5=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond SWM: SW Management



Summary for Subcatchment DEV1: Developed Area 1

Runoff = 0.3 cfs @ 12.09 hrs, Volume= 1,114 cf, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.97"

	Area (sf)	CN	Description
*	9,315	68	>75% Grass cover, Good, HSG A
	6,474	32	Woods/grass comb., Good, HSG A
	15,789	53	Weighted Average
	15,789		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	35	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.5	85	Total			

Summary for Subcatchment DEV2: Developed Area 2 to SWM

Runoff = 6.8 cfs @ 12.12 hrs, Volume= 22,833 cf, Depth= 2.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.97"

	Area (sf)	CN	Description
*	25,064	98	Paved, HSG A
	9,788	98	Unconnected roofs, HSG A
*	67,147	68	>75% Grass cover, Good, HSG A
	101,999	78	Weighted Average
	67,147		65.83% Pervious Area
	34,852		34.17% Impervious Area
	9,788		28.08% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	48	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	162	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.6	95	0.0300	2.60		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.3	355	Total			

Summary for Subcatchment DEV3: Developed Area 3

Runoff = 1.0 cfs @ 12.09 hrs, Volume= 3,475 cf, Depth= 1.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.97"

	Area (sf)	CN	Adj	Description
	1,105	98		Unconnected roofs, HSG A
*	370	98		Unconnected walk, HSG A
	7,904	32		Woods/grass comb., Good, HSG A
*	23,107	68		>75% Grass cover, Good, HSG A
	32,486	61	60	Weighted Average, UI Adjusted
	31,011			95.46% Pervious Area
	1,475			4.54% Impervious Area
	1,475			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.0	126	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.0	176	Total			

Summary for Reach SUM: Developed Area 2

Inflow Area = 134,485 sf, 27.01% Impervious, Inflow Depth = 0.47" for 10-Year event
Inflow = 1.0 cfs @ 12.09 hrs, Volume= 5,296 cf
Outflow = 1.0 cfs @ 12.09 hrs, Volume= 5,296 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond SWM: SW Management

Inflow Area = 101,999 sf, 34.17% Impervious, Inflow Depth = 2.69" for 10-Year event
Inflow = 6.8 cfs @ 12.12 hrs, Volume= 22,833 cf
Outflow = 0.8 cfs @ 12.98 hrs, Volume= 26,007 cf, Atten= 89%, Lag= 51.9 min
Discarded = 0.6 cfs @ 12.98 hrs, Volume= 24,186 cf
Primary = 0.2 cfs @ 12.98 hrs, Volume= 1,821 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 65.40' Surf.Area= 5,278 sf Storage= 3,167 cf
Peak Elev= 66.65' @ 12.98 hrs Surf.Area= 5,278 sf Storage= 9,747 cf (6,580 cf above start)
Flood Elev= 68.80' Surf.Area= 5,278 sf Storage= 21,112 cf (17,945 cf above start)

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 55.2 min (884.8 - 829.5)

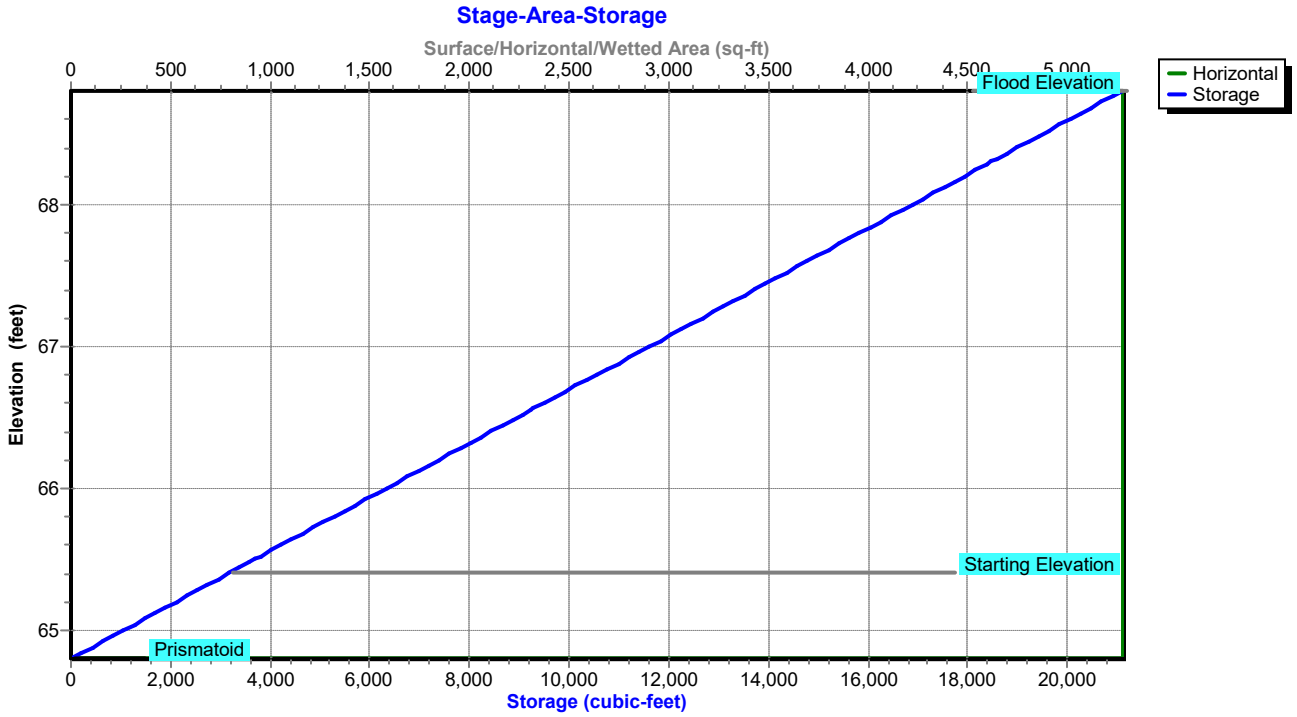
Volume	Invert	Avail.Storage	Storage Description
#1	64.80'	21,112 cf	**7.00'W x 13.00'L x 4.00'H Prismatoid** x 58

Device	Routing	Invert	Outlet Devices
#1	Primary	64.50'	**15.0" Round Culvert Outlet** L= 30.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 64.50' / 64.25' S= 0.0083 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf
#2	Discarded	64.80'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 62.80' Phase-In= 0.01'
#3	Device 1	65.50'	**2.0" W x 1.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	66.55'	**18.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	68.30'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 0.5' Crest Height

Discarded OutFlow Max=0.6 cfs @ 12.98 hrs HW=66.65' (Free Discharge)
└**2=Exfiltration** (Controls 0.6 cfs)

Primary OutFlow Max=0.2 cfs @ 12.98 hrs HW=66.65' (Free Discharge)
└**1=Culvert Outlet** (Passes 0.2 cfs of 5.9 cfs potential flow)
  ├**3=Orifice/Grate** (Orifice Controls 0.1 cfs @ 5.06 fps)
  ├**4=Orifice/Grate** (Orifice Controls 0.1 cfs @ 1.00 fps)
  └**5=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond SWM: SW Management



Summary for Subcatchment DEV1: Developed Area 1

Runoff = 0.6 cfs @ 12.08 hrs, Volume= 1,874 cf, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.11"

	Area (sf)	CN	Description
*	9,315	68	>75% Grass cover, Good, HSG A
	6,474	32	Woods/grass comb., Good, HSG A
	15,789	53	Weighted Average
	15,789		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	35	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.5	85	Total			

Summary for Subcatchment DEV2: Developed Area 2 to SWM

Runoff = 9.3 cfs @ 12.12 hrs, Volume= 31,248 cf, Depth= 3.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.11"

	Area (sf)	CN	Description
*	25,064	98	Paved, HSG A
	9,788	98	Unconnected roofs, HSG A
*	67,147	68	>75% Grass cover, Good, HSG A
	101,999	78	Weighted Average
	67,147		65.83% Pervious Area
	34,852		34.17% Impervious Area
	9,788		28.08% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	48	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	162	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.6	95	0.0300	2.60		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.3	355	Total			

Summary for Subcatchment DEV3: Developed Area 3

Runoff = 1.7 cfs @ 12.08 hrs, Volume= 5,398 cf, Depth= 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.11"

	Area (sf)	CN	Adj	Description
	1,105	98		Unconnected roofs, HSG A
*	370	98		Unconnected walk, HSG A
	7,904	32		Woods/grass comb., Good, HSG A
*	23,107	68		>75% Grass cover, Good, HSG A
	32,486	61	60	Weighted Average, UI Adjusted
	31,011			95.46% Pervious Area
	1,475			4.54% Impervious Area
	1,475			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.0	126	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.0	176	Total			

Summary for Reach SUM: Developed Area 2

Inflow Area = 134,485 sf, 27.01% Impervious, Inflow Depth = 1.11" for 25-Year event
Inflow = 2.0 cfs @ 12.43 hrs, Volume= 12,474 cf
Outflow = 2.0 cfs @ 12.43 hrs, Volume= 12,474 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond SWM: SW Management

Inflow Area = 101,999 sf, 34.17% Impervious, Inflow Depth = 3.68" for 25-Year event
Inflow = 9.3 cfs @ 12.12 hrs, Volume= 31,248 cf
Outflow = 2.2 cfs @ 12.55 hrs, Volume= 34,422 cf, Atten= 76%, Lag= 25.9 min
Discarded = 0.6 cfs @ 12.55 hrs, Volume= 27,345 cf
Primary = 1.6 cfs @ 12.55 hrs, Volume= 7,077 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 65.40' Surf.Area= 5,278 sf Storage= 3,167 cf
Peak Elev= 67.10' @ 12.55 hrs Surf.Area= 5,278 sf Storage= 12,164 cf (8,997 cf above start)
Flood Elev= 68.80' Surf.Area= 5,278 sf Storage= 21,112 cf (17,945 cf above start)

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 67.0 min (887.5 - 820.5)

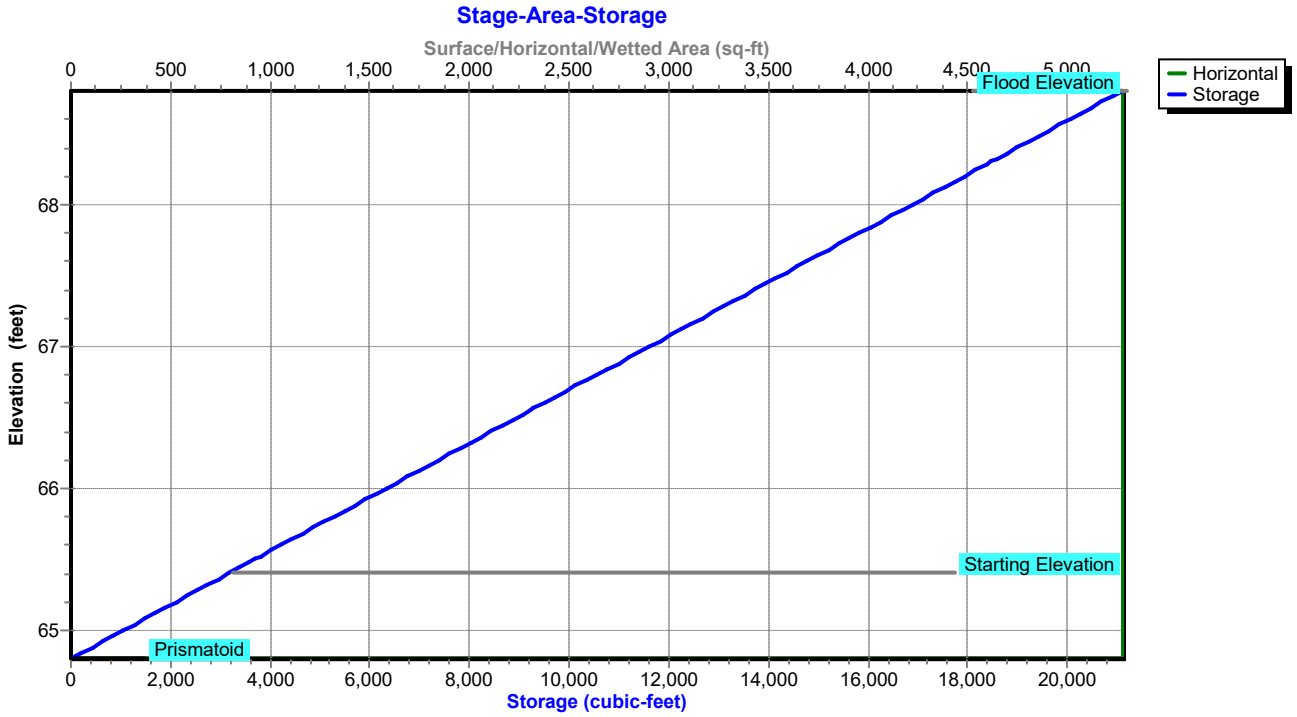
Volume	Invert	Avail.Storage	Storage Description
#1	64.80'	21,112 cf	**7.00'W x 13.00'L x 4.00'H Prismatoid** x 58

Device	Routing	Invert	Outlet Devices
#1	Primary	64.50'	**15.0" Round Culvert Outlet** L= 30.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 64.50' / 64.25' S= 0.0083 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf
#2	Discarded	64.80'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 62.80' Phase-In= 0.01'
#3	Device 1	65.50'	**2.0" W x 1.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	66.55'	**18.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	68.30'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 0.5' Crest Height

Discarded OutFlow Max=0.6 cfs @ 12.55 hrs HW=67.10' (Free Discharge)
└**2=Exfiltration** (Controls 0.6 cfs)

Primary OutFlow Max=1.6 cfs @ 12.55 hrs HW=67.10' (Free Discharge)
└**1=Culvert Outlet** (Passes 1.6 cfs of 7.0 cfs potential flow)
  ├**3=Orifice/Grate** (Orifice Controls 0.1 cfs @ 6.02 fps)
  ├**4=Orifice/Grate** (Orifice Controls 1.5 cfs @ 2.98 fps)
  └**5=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond SWM: SW Management



Summary for Subcatchment DEV1: Developed Area 1

Runoff = 1.1 cfs @ 12.07 hrs, Volume= 3,268 cf, Depth= 2.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.87"

	Area (sf)	CN	Description
*	9,315	68	>75% Grass cover, Good, HSG A
	6,474	32	Woods/grass comb., Good, HSG A
	15,789	53	Weighted Average
	15,789		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	35	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.5	85	Total			

Summary for Subcatchment DEV2: Developed Area 2 to SWM

Runoff = 13.2 cfs @ 12.12 hrs, Volume= 44,803 cf, Depth= 5.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.87"

	Area (sf)	CN	Description
*	25,064	98	Paved, HSG A
	9,788	98	Unconnected roofs, HSG A
*	67,147	68	>75% Grass cover, Good, HSG A
	101,999	78	Weighted Average
	67,147		65.83% Pervious Area
	34,852		34.17% Impervious Area
	9,788		28.08% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.2	48	0.0800	4.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	162	0.0100	1.50		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
0.6	95	0.0300	2.60		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
8.3	355	Total			

Summary for Subcatchment DEV3: Developed Area 3

Runoff = 2.9 cfs @ 12.08 hrs, Volume= 8,761 cf, Depth= 3.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.87"

	Area (sf)	CN	Adj	Description
	1,105	98		Unconnected roofs, HSG A
*	370	98		Unconnected walk, HSG A
	7,904	32		Woods/grass comb., Good, HSG A
*	23,107	68		>75% Grass cover, Good, HSG A
	32,486	61	60	Weighted Average, UI Adjusted
	31,011			95.46% Pervious Area
	1,475			4.54% Impervious Area
	1,475			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	50	0.0500	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
1.0	126	0.0180	2.16		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.0	176	Total			

Summary for Reach SUM: Developed Area 2

Inflow Area = 134,485 sf, 27.01% Impervious, Inflow Depth = 2.25" for 100-Year event
Inflow = 3.8 cfs @ 12.31 hrs, Volume= 25,214 cf
Outflow = 3.8 cfs @ 12.31 hrs, Volume= 25,214 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond SWM: SW Management

Inflow Area = 101,999 sf, 34.17% Impervious, Inflow Depth = 5.27" for 100-Year event
Inflow = 13.2 cfs @ 12.12 hrs, Volume= 44,803 cf
Outflow = 3.6 cfs @ 12.51 hrs, Volume= 47,977 cf, Atten= 73%, Lag= 23.6 min
Discarded = 0.8 cfs @ 12.51 hrs, Volume= 31,523 cf
Primary = 2.8 cfs @ 12.51 hrs, Volume= 16,453 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 65.40' Surf.Area= 5,278 sf Storage= 3,167 cf
Peak Elev= 68.00' @ 12.51 hrs Surf.Area= 5,278 sf Storage= 16,885 cf (13,718 cf above start)
Flood Elev= 68.80' Surf.Area= 5,278 sf Storage= 21,112 cf (17,945 cf above start)

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 74.2 min (884.5 - 810.3)

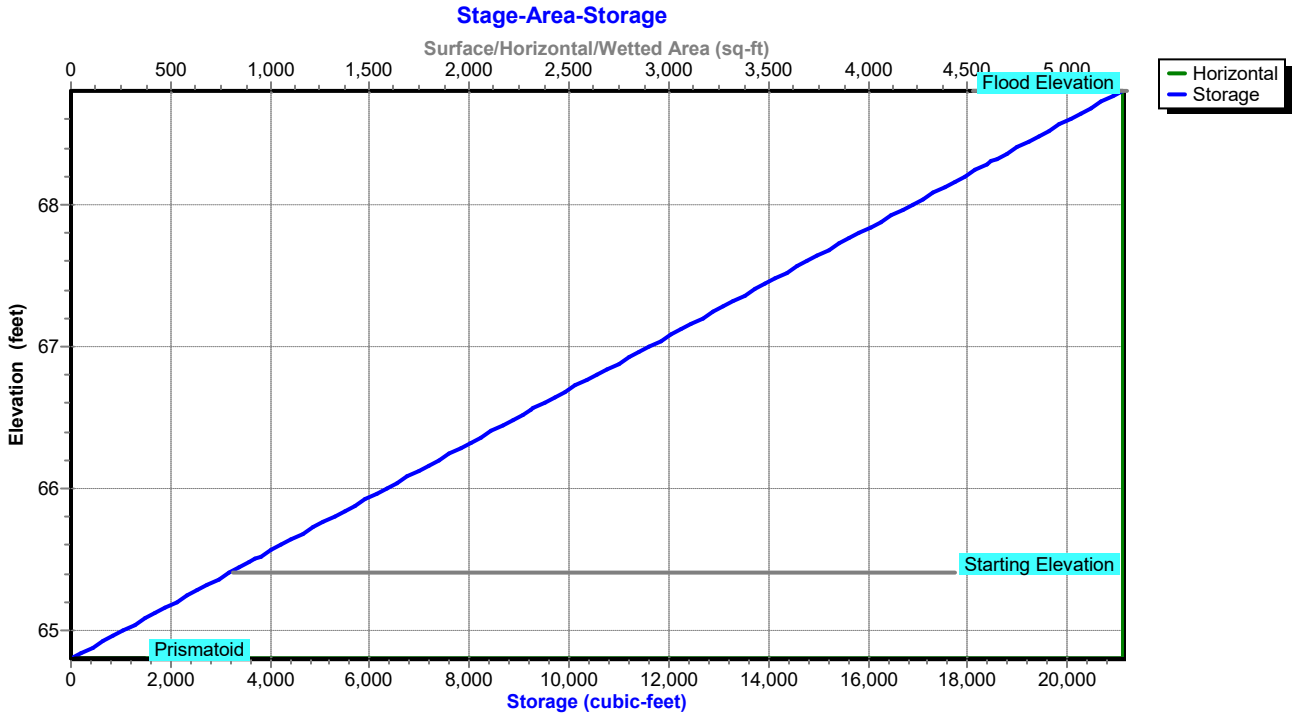
Volume	Invert	Avail.Storage	Storage Description
#1	64.80'	21,112 cf	**7.00'W x 13.00'L x 4.00'H Prismatoid** x 58

Device	Routing	Invert	Outlet Devices
#1	Primary	64.50'	**15.0" Round Culvert Outlet** L= 30.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 64.50' / 64.25' S= 0.0083 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf
#2	Discarded	64.80'	**2.410 in/hr Exfiltration over Horizontal area** Conductivity to Groundwater Elevation = 62.80' Phase-In= 0.01'
#3	Device 1	65.50'	**2.0" W x 1.0" H Vert. Orifice/Grate** C= 0.600
#4	Device 1	66.55'	**18.0" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#5	Device 1	68.30'	**2.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 0.5' Crest Height

Discarded OutFlow Max=0.8 cfs @ 12.51 hrs HW=68.00' (Free Discharge)
└**2=Exfiltration** (Controls 0.8 cfs)

Primary OutFlow Max=2.8 cfs @ 12.51 hrs HW=68.00' (Free Discharge)
└**1=Culvert Outlet** (Passes 2.8 cfs of 8.8 cfs potential flow)
  ├**3=Orifice/Grate** (Orifice Controls 0.1 cfs @ 7.55 fps)
  ├**4=Orifice/Grate** (Orifice Controls 2.7 cfs @ 5.45 fps)
  └**5=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

Pond SWM: SW Management



Appendix - Standard 3
Supporting Information

Soil Evaluation and Analysis

SOIL TEST PIT LOG

Deep Observation Hole Number: TP-1 Ground elevation: 67.8

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-8	A	10YR 2/2				fine loamy sand			massive	fri	
8-60	BC	10YR 7/3				fls			massive	fri	
60-84	C	10YR 6/4	60”	10YR 5/8		fs & g			massive	fri	

Soil Evaluator Jim Fairweather SE#702 Date of test 10-14-21

Additional Notes:

Seeping at 70”, roots to 60”, standing @80”, ESHWT 60” (EL. 62.8)

SOIL TEST PIT LOG

Deep Observation Hole Number: TP-2 Ground elevation: 70.1

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color- Moist (Munsell)	Redoximorphic			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-6	A	10YR 2/2				fine loamy sand			massive	fri	
6-72	fill										

Soil Evaluator Jim Fairweather SE#702 Date of test 10-14-21

Additional Notes:

roots to 60”, hit sprinkler line at 72”+/-

Mounding Analysis

Values of specific yield, from Johnson (1967)

Material	Specific Yield (%)		
	min	avg	max
Unconsolidated deposits			
Clay	0	2	5
Sandy clay (mud)	3	7	12
Silt	3	18	19
Fine sand	10	21	28
Medium sand	15	26	32
Coarse sand	20	27	35
Gravelly sand	20	25	35
Fine gravel	21	25	35
Medium gravel	13	23	26
Coarse gravel	12	22	26
Consolidated deposits			
Fine-grained sandstone		21	
Medium-grained sandstone		27	
Limestone		14	
Schist		26	
Siltstone		12	
Tuff		21	
Other deposits			
Dune sand		38	
Loess		18	
Peat		44	
Till, predominantly silt		6	
Till, predominantly sand		16	
Till, predominantly gravel		16	

See also

- Aquifer test
- Soil mechanics
- Groundwater flow equation describes how these terms are used in the context of solving groundwater flow

within a subsurface geological formation. Such a geological formation is said to be

TABLE 5.2 Representative Values of Saturated Hydraulic Conductivity of Different Soil Textures

Texture	Saturated Hydraulic Conductivity, K (m/yr)
Sand	5.55×10^3
Loamy sand	4.93×10^3
Sandy loam	1.09×10^3
Silty loam	2.27×10^2
Loam	2.19×10^2
Sandy clay loam	1.99×10^2
Silty clay loam	5.36×10^1
Clay loam	7.73×10^1
Sandy clay	6.84×10^1
Silty clay	3.21×10^1
Clay	4.05×10^1

Source: Clapp and Hornberger (1978).

4,930 m/yr x 3.28 ft/m x 1yr/365 days=44.3'/day

heterogeneous. If the properties of the geologic formation are invariable in space, the formation is homogeneous. A geological formation is said to be isotropic if at any point in the medium, the values of the saturated hydraulic conductivity (K) are independent of the direction of measurement. Again, because of the usually stratified nature of uncon-solidated sedimentary soil materials, soils are usually anisotropic. Within an anisotropic geological formation, the vertical component of the saturated hydraulic conductivity is usually smaller (one to two orders of magnitude) than the horizontal component.

5.2 MEASUREMENT METHODOLOGY

The saturated hydraulic conductivity of water in soil (or the intrinsic permeability of the soil) can be measured by both field and laboratory experiments. Either way, the experimental measurement of K (or k) consists in determining the numerical value for the coefficient in Darcy's equation.

The methodology used for the experimental determination of K (or k) in either laboratory or field experiments is based on the following procedures (Bear 1972):

1. Assume a flow pattern (such as one-dimensional flow in a porous medium) that can be described analytically by Darcy's law,

Table 15.—Physical Properties of the Soils—continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability (Ksat)	Saturated hydraulic conductivity	Available water capacity	Linear extensibility	Organic matter	Erosion factors			Wind erodibility group	Wind erodibility index
									Kw	Kf	T		
	In	Pct	g/cc	In/hr	um/sec	In/in	Pct	Pct					
622C:													
Paxton	0-7	3-12	1.00-1.25	0.6-2	4.23-14.11	0.10-0.20	0.0-2.9	2.0-5.0	.24	.32	3	3	86
	7-13	3-12	1.35-1.60	0.6-2	4.23-14.11	0.08-0.18	0.0-2.9	1.0-3.0	.32	.49			
	13-22	3-12	1.35-1.60	0.6-2	4.23-14.11	0.08-0.18	0.0-2.9	1.0-3.0	.32	.49			
	22-26	3-12	1.70-2.00	0.01-0.2	0.09-1.41	0.05-0.10	0.0-2.9	0.0-2.0	.24	.37			
	26-65	3-12	1.70-2.00	0.01-0.2	0.09-1.41	0.05-0.10	0.0-2.9	0.0-2.0	.24	.37			
Urban land	---	---	---	---	---	---	---	---	---	---	--	8	0
623C:													
Woodbridge	0-2	---	0.10-0.30	0.6-6	4.23-42.34	0.35-0.45	0.0-2.9	50-99	---	---	3	8	0
	2-4	3-12	1.00-1.25	0.6-2	4.23-14.11	0.10-0.20	0.0-2.9	2.0-6.0	.24	.32			
	4-30	3-12	1.35-1.60	0.6-2	4.23-14.11	0.08-0.18	0.0-2.9	1.0-3.0	.32	.49			
	30-65	3-12	1.70-2.00	0.01-0.2	0.09-1.41	0.05-0.10	0.0-2.9	0.0-2.0	.24	.37			
Urban land	---	---	---	---	---	---	---	---	---	---	--	8	0
624B:													
Haven	0-2	5-18	1.10-1.40	2-6	14.11-42.34	0.15-0.25	0.0-2.9	2.0-6.0	.32	.37	3	3	86
	2-20	5-18	1.10-1.40	2-6	14.11-42.34	0.09-0.20	0.0-2.9	1.0-3.0	.24	.28			
	20-32	2-18	1.25-1.50	2-6	14.11-42.34	0.08-0.12	0.0-2.9	1.0-3.0	.24	.28			
	32-65	0-3	1.40-1.50	20-100	141.14-705.00	0.01-0.03	0.0-2.9	0.0-2.0	.17	.20			
Urban land	---	---	---	---	---	---	---	---	---	---	--	8	0
626B:													
Merrimac	0-9	3-7	1.10-1.20	2-6	14.11-42.34	0.14-0.19	0.0-2.9	1.0-5.0	.24	.32	3	3	86
	9-18	1-4	1.20-1.40	2-6	14.11-42.34	0.14-0.17	0.0-2.9	1.0-3.0	.24	.32			
	18-26	1-3	1.20-1.40	2-20	14.11-141.14	0.03-0.12	0.0-2.9	0.0-2.0	.17	.28			
	26-33	0-3	1.30-1.50	6-20	42.34-141.14	0.01-0.06	0.0-2.9	0.0-1.0	.10	.37			
	33-65	0-3	1.30-1.50	6-20	42.34-141.14	0.01-0.06	0.0-2.9	0.0-1.0	.10	.37			
Urban land	---	---	---	---	---	---	---	---	---	---	--	8	0
627C:													
Newport	0-8	4-10	1.10-1.30	0.6-6	4.23-42.34	0.11-0.21	0.0-2.9	2.0-6.0	.24	.37	3	5	56
	8-18	3-10	1.30-1.60	0.6-6	4.23-42.34	0.11-0.21	0.0-2.9	1.0-3.0	.37	.55			
	18-24	3-10	1.70-2.00	0.01-0.2	0.09-1.41	0.05-0.12	0.0-2.9	0.0-2.0	.24	.43			
	24-65	3-10	1.70-2.00	0.01-0.2	0.09-1.41	0.05-0.12	0.0-2.9	0.0-2.0	.24	.43			
Urban land	---	---	---	---	---	---	---	---	---	---	--	8	0
629C:													
Canton	0-8	1-8	0.90-1.20	2-6	14.11-42.34	0.11-0.19	0.0-2.9	1.0-6.0	.24	.32	3	3	86
	8-21	1-8	1.20-1.50	2-6	14.11-42.34	0.09-0.17	0.0-2.9	0.0-2.0	.28	.37			
	21-65	0-5	1.30-1.50	6-20	42.34-141.14	0.04-0.08	0.0-2.9	0.0-2.0	.17	.20			

6-20 in/hr = 12-40 ft/day

Rawls rate = 2.41 in/hr = 4.82 ft/day, typical assumption for ksat horizontal = 10 x Rawls rate = 48.2 ft/day. Conservative to use average of above = 26 ft/day

28 - chamber system (approximate 70' long x 32' wide)

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Sur Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the in thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can c distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click t "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be don values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
0.4000	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
26.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
35.000	**x**	**1/2 length of basin (x direction, in feet)**
16.000	**y**	**1/2 width of basin (y direction, in feet)**
1.500	**t**	**duration of infiltration period (days)**
10.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

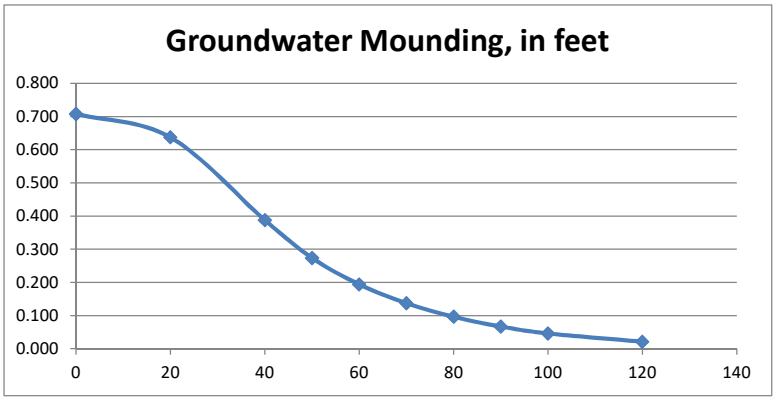
hours	days
36	1.50

In the report accompanyi (USGS SIR 2010-5102), ve (ft/d) is assumed to be or hydraulic conductivity (ft/

10.708	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.708	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.708	**0**
0.637	**20**
0.388	**40**
0.274	**50**
0.194	**60**
0.137	**70**
0.096	**80**
0.067	**90**
0.046	**100**
0.021	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

R:

Recharge depth provided = 65.4-64.8 = 0.6 feet, R = 0.60 feet / 1.5 days = 0.40 ft/day

For Sy = 0.21, & K = 26 ft/day see attached data for typical values

30 - chamber system 84' long x 40' wide

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Sur Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the in thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can c distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click t "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be don values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

hours	days
36	1.50

In the report accompanyi (USGS SIR 2010-5102), ve (ft/d) is assumed to be or hydraulic conductivity (ft/

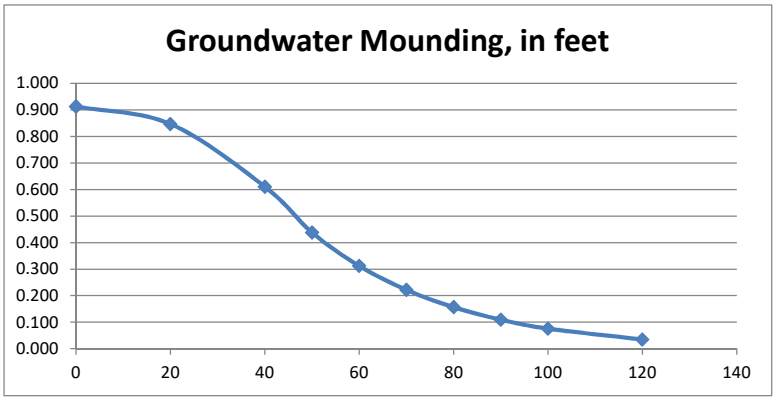
Input Values

0.4000	***R***	**Recharge (infiltration) rate (feet/day)**
0.210	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
26.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
42.000	**x**	**1/2 length of basin (x direction, in feet)**
20.000	**y**	**1/2 width of basin (y direction, in feet)**
1.500	**t**	**duration of infiltration period (days)**
10.000	**hi(0)**	**initial thickness of saturated zone (feet)**

10.913	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.913	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.913	0
0.847	20
0.610	40
0.438	50
0.312	60
0.222	70
0.157	80
0.110	90
0.076	100
0.035	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

R:

Recharge depth provided = 65.4-64.8 = 0.6 feet, R = 0.60 feet / 1.5 days = 0.40 ft/day

For Sy = 0.21, & K = 26 ft/day see attached data for typical values

Appendix - Standard 4/8 Supporting Information

TSS Removal Worksheet

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

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

Location: William Court-Andover, Massachusetts

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump & Hooded Catch Basins	0.25	1.00	0.25	0.75
Proprietary Treatment Device: Stormceptor 900	0.46	0.75	0.345	0.405
Subsurface Infiltration Structure	0.80	0.405	0.324	0.081

Total TSS Removal = 0.919

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

Project: 21-31

Prepared By: jsf

Date: 12-21-21

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

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

1. From MassDEP Stormwater Handbook Vol. 1

EPA Phosphorus Removal

BMP Performance Table

BMP Name: Infiltration Trench

Soil Infiltration Rate: 2.41 in/hr

Land Use	Pollutant	Depth of Runoff Treated (inches)							
		0.1	0.2	0.4	0.6	0.8	1	1.5	2
Commercial	TSS	50%	77%	97%	100%	100%	100%	100%	100%
	TP	32%	55%	81%	91%	96%	98%	100%	100%
	Zn	81%	98%	100%	100%	100%	100%	100%	100%
Industrial	TSS	51%	78%	97%	100%	100%	100%	100%	100%
	TP	33%	56%	81%	92%	96%	98%	100%	100%
	Zn	55%	84%	99%	100%	100%	100%	100%	100%
High-Density Residential	TSS	52%	79%	97%	100%	100%	100%	100%	100%
	TP	33%	55%	81%	91%	96%	98%	100%	100%
	Zn	63%	92%	100%	100%	100%	100%	100%	100%
Medium-Density Residential	TSS	62%	86%	98%	100%	100%	100%	100%	100%
	TP	33%	55%	80%	90%	95%	97%	99%	100%
	Zn	25%	48%	79%	94%	99%	100%	100%	100%
Low-Density Residential	TSS	57%	80%	96%	99%	100%	100%	100%	100%
	TP	35%	56%	80%	90%	95%	97%	99%	100%
	Zn	19%	39%	71%	89%	97%	100%	100%	100%
Runoff Volume Reduction		34%	55%	78%	88%	93%	96%	99%	100%

Annual Pollutant Loading Rates

Land use	Pollutant load (lbs/acre-year)		
	TSS	TP	Zn
Commercial	1117.77	1.66	2.33
Industrial	745.22	1.43	0.45
High-Density Residential	465.08	1.10	0.79
Medium-Density Residential	274.63	0.55	0.11
Low-Density Residential	72.11	0.042	0.043

BMP Performance Table

BMP Name: Infiltration Basin

Soil Infiltration Rate: 2.41 in/hr

Land Use	Pollutant	Depth of Runoff Treated (inches)							
		0.1	0.2	0.4	0.6	0.8	1	1.5	2
Commercial	TSS	70%	88%	98%	100%	100%	100%	100%	100%
	TP	45%	67%	87%	94%	97%	98%	100%	100%
	Zn	82%	95%	100%	100%	100%	100%	100%	100%
Industrial	TSS	70%	88%	98%	100%	100%	100%	100%	100%
	TP	46%	67%	87%	94%	97%	99%	100%	100%
	Zn	69%	88%	99%	100%	100%	100%	100%	100%
High Density Residential	TSS	71%	88%	98%	100%	100%	100%	100%	100%
	TP	46%	67%	87%	94%	97%	98%	100%	100%
	Zn	74%	91%	99%	100%	100%	100%	100%	100%
Medium Density Residential	TSS	76%	91%	99%	100%	100%	100%	100%	100%
	TP	46%	67%	87%	94%	97%	98%	100%	100%
	Zn	45%	68%	89%	96%	99%	100%	100%	100%
Low Density Residential	TSS	74%	89%	98%	99%	100%	100%	100%	100%
	TP	48%	68%	87%	94%	97%	98%	100%	100%
	Zn	38%	61%	84%	94%	98%	99%	100%	100%
Runoff Volume Reduction		33%	54%	78%	88%	93%	96%	99%	100%

Annual Pollutant Loading Rates

Land use	Pollutant load (lbs/acre-year)		
	TSS	TP	Zn
Commercial	1117.77	1.66	2.33
Industrial	745.22	1.43	0.45
High Density Residential	465.08	1.10	0.79
Medium Density Residential	274.63	0.55	0.11
Low Density Residential	72.11	0.042	0.043

Recommended Construction Period Pollution Prevention and Erosion Control

Recommended Construction Period Pollution Prevention and Erosion Control

General

Sediment control measures will be implemented prior to the start of construction. A staked hay bale barrier will be installed as shown on the Site Plan. When Construction is complete all disturbed areas shall be completely stabilized.

Responsible Party

The **Property Owner** shall be responsible for ensuring that the site development contractor hired for the work is continually in compliance with this Plan.

Site Development Plan

See the Site Plans prepared by Andover Consultants, Inc. for the proposed development details. Contractor shall comply with the NPDES CGP and maintain records of site work per the CGP permit.

Construction Sequencing Plan

Major activities will *generally proceed* as follows:

1. Obtain all required permits to raze existing structures and tennis court.
2. Install perimeter sediment control barrier of staked hay bales and/or silt fence as shown on the plans and demarcate the limit of work in other areas prior to commencing any work.
3. Grub areas where construction will occur and remove vegetation/roots off site. No stumps or trees/vegetation shall be buried on site.
4. Remove topsoil and stockpile on site. Protect stockpile with a perimeter of silt fencing or hay bales.
5. Obtain all required permits to construct roadway, utilities and buildings.
6. Install roadway utilities including subsurface chambers.
7. Rough grade roadway
8. Perform rough earthwork activities consisting of cut and fill on lots
9. Construct structures and connect dwelling utility services.
10. Place and compact pavement gravel base for paved road, sidewalks and driveway areas.
11. Place and compact bituminous concrete for paved roadway, sidewalk and driveway areas.
12. Fine grade remaining areas of non-paved areas, loam, seed and mulch.
13. Clean project area.

Construction Period Pollution Prevention Measures

1. Appropriate erosion and sediment control measures shall be installed prior to soil disturbance. Measures shall be taken to control erosion within the project area. Sediment in runoff water shall be trapped and retained within the project area. Wetland areas and surface waters shall be protected from sediment.

2. Runoff shall be controlled and conveyed into storm drains and other outlets so it will not erode the land or cause off-site damage; sediment in runoff shall be trapped by using staked hay bales, silt fencing, or sedimentation traps, or other approved erosion control devices.

3. Temporary sediment basins shall be constructed where necessary to detain runoff and to trap sediment during construction;

4. Sediment shall be removed once the volume reaches ¼ to ½ the height of the silt fence or hay bale barrier.

5. Any offsite runoff shall be diverted from highly erodible soils and steep slopes to stable areas downstream.

6. Soil and other materials shall not be stockpiled or redistributed, either temporarily or permanently, in locations or in such a manner as would cause suffocation of tree root systems. Stockpiles shall not be within wetland buffers.

7. Topsoil shall be stripped from disturbed areas, stockpiled in approved areas and stabilized with temporary vegetative cover if it is to be left for more than thirty (30) calendar days; perimeter sediment controls shall be installed around each area of stockpiled topsoil.

8. Soil stockpiles shall be stabilized or covered at the end of each workday.

9. The area of disturbance shall be kept to a minimum. Disturbed areas remaining idle for more than 14 days shall be stabilized with mulch or matting nets.

10. A crushed stone tracking pad shall be maintained at the start of the proposed road entrance onto William Street. Once binder is placed, the paved way may act as the tracking pad. Soil tracking onto William Street shall be closely monitored and any soil tracked onto the pavement shall be removed prior to leaving the site for the day.

11. All graded areas shall be covered with four (4") inches of topsoil and planted with a native species of vegetative cover, sufficient to prevent erosion;

12. Temporary seeding, mulching or other suitable stabilization methods shall be used to protect exposed soil areas during construction; as feasible, natural vegetation shall be retained and protected; during the months of October through March.

13. Permanent seeding should be undertaken in the spring from March through May, and in late summer and early fall from August to October 15. During the peak summer months and in the fall after October 15, when seeding is found to be impractical, appropriate temporary mulch shall be applied. Permanent seeding may be undertaken during the summer if plans provide for adequate mulching and watering. All plantings shall comply with the erosion and sedimentation vegetative practices recommended by the U.S. Soil Conservation Service;

14. All slopes steeper than 3:1 (H – V, 33.3%), shall, upon completion, be immediately stabilized with sod, or seed with straw mulch, or other approved stabilization measures (e.g. manufactured straw mats). Areas outside of the perimeter sediment control system shall not be disturbed.

15. Monitoring, daily, and maintenance of erosion and sediment control measures, when required, shall be performed throughout the course of construction.

16. Temporary sediment trapping devices shall not be removed until permanent stabilization is established in all contributory drainage areas.

17. All temporary erosion and sediment control measures shall be removed after final site stabilization. Disturbed soil areas resulting from the removal of temporary measures shall be permanently stabilized within 30 days.

18. Dust shall be controlled at the site.

Inspection Schedule

During construction the inspection schedule shall consist of the following:

1. The sediment barrier shall be visually inspected daily. The barrier shall be repaired or replaced immediately, as necessary.
2. All seeded areas shall be inspected periodically to insure proper germination and adequate coverage and shall be reseeded as necessary. Any wash outs shall be promptly repaired, reseeded and mulched
3. Maintain a construction exit at the edge of the existing pavement/sidewalk on William Street and clean vehicles tires as needed and sweep as required to prevent the spread of sediment.
4. Inspect William Street sidewalk/pavement for soil tracking daily and prior to leaving the site for the day. Any tracked soil onto the street shall be swept up as needed prior to leaving the site. No sediments tracked onto the existing ways shall remain on the ways overnight.
5. Records of inspections shall be maintained in compliance with the NPDES Construction General Permit issued by the EPA for the site.

Long Term Operation and Maintenance Plan

Long Term Operation and Maintenance Plan

1. The piped drainage system, including the catch basin sediment sumps, drain manholes, oil & grit chamber, subsurface system and outlet control structure shall be and maintained by the Owner until such time as an Home Owners Association (HOA) is created at which time the HOA shall assume the responsibility that maintenance performed.

2. All components of the drainage system, including the catch basin sediment sumps, manholes, proprietary oil & grit structure, subsurface stormwater chamber and outlet control structure shall be maintained according to the following schedule:

3. Inspect all components of the stormwater management system a minimum of four times per year unless more frequent inspections are required as noted below. The HOA shall ensure that no portion of the stormwater management system is damaged, blocked or otherwise in a state that prevents its proper operation.

4. Ensure that accumulated silt and debris within the catch basins are removed in a timely manner. The catch basins shall be cleaned when the sediment level is within the two feet of the outlet pipe (2 feet of sediment in sump). The use of vacuum trucks to clean the structures is recommended.

5. Inspect the oil and grit structure as noted below and after every major storm (rainfall exceeding 3 inches in 24 hours). Provide routine maintenance of the oil & grit chamber according to the recommendations and specifications of the chamber manufacturer, such as:

   Inspect post construction, prior to being put into service, then every 6 months for the first year to determine the oil and sediment accumulation rate. In subsequent years, inspections are based on first-year observations or local requirements. Also, inspect immediately after an oil, fuel or chemical spill. A licensed waste management company shall remove oil and sediment with a standard vacuum truck and dispose responsibly.

6. Monitor water levels in the stormwater chamber system quarterly and after every major storm of 3 inches or more in 24 hours. When chamber system is not draining within 72 hours, pumping of water from chamber into tank trucks and restoration of the infiltration surface will be required. Remove geotextile and rake stone surface, if required by evidence of soil on the surface, then install new geotextile filter. This maintenance to be performed by personnel with OSHA training for entering/accessing confined spaces.

7. Illicit discharges (oil grease or hazardous waste (e.g. pesticides) are prohibited. The Organization shall report any illicit discharges once discovered to the Police and Health Departments.

8. The paved areas shall be cleaned of sand and debris as needed, preferably in the spring, after the winter season.

9. Inspect the site for litter weekly, litter shall be cleared and stored in covered trash receptacles.

10. Estimated Operations and Maintenance budget:

    It is estimated to cost an average of $250.00 per month to inspect and maintain the parking lot and stormwater management features and approximately $2,500-3,500 dollars to periodically remove sediment from the oil & grit chamber and catch basin sumps.

As the Owner of the project, I hereby certify I have read and understand the responsibilities outlined in this Operation and Maintenance Plan. I shall conduct this work until a Home Owners Association is created at which time the HOA shall assume this responsibility

Owner:

_____

Print Name

_____ _____

Signature Date

Designated HOA representative:

_____

Print Name

_____ _____

Signature Date

Inspection and Maintenance Report

Date	Condition	Action Taken

Catch basin:

Outlet Control Structure

Grassed Swale

Drain Manhole ------

Oil & Grit Chamber (STC 900)

Roadway Sediment

Subsurface infiltration structure

Signed **Date**

Long Term Pollution Prevention Plan

Good housekeeping practices

The Home Owner Association (HOA) shall ensure regular maintenance activities at the site remain on schedule. Professional Landscape services may be utilized to maintain the grounds.

Provisions for storing materials and waste products inside or under cover

No Hazardous materials shall be stored at this site.

Requirements for routine inspections and maintenance of stormwater BMPs

The HOA will be responsible for ensuring that the inspection and maintenance activities including regular inspection and maintenance of the storm water management structures continue indefinitely.

Requirements for storage and use of fertilizers, herbicides, and pesticides

No fertilizers, herbicides or pesticides shall be stored outside at this site and must be stored in compliance with manufacturer's recommendations if stored inside.

Provisions for solid waste management

Solid waste produced at the site will be temporarily stored in trash receptacles and removed from the site via a licensed trash hauler and hauled off site.

Snow disposal and plowing

Plow damage, due to snow removal activity, to grassed areas adjacent to the pavement shall be repaired in the spring once growing season starts.

Winter Road Salt and/or Sand Use and Storage restrictions

No salt shall be stored outside at the site. Minimal use of salt and sand is encouraged, if safe to do so, to mitigate slippery conditions.

Parking Lot sweeping schedule

The roadway and driveways shall be cleaned of sand and debris, preferably after the winter season.

Provisions for prevention of illicit discharges to the stormwater management system

The storage and use of hazardous materials is prohibited. No illicit discharges of oil or other hazardous materials shall occur at the site. Any detected illicit discharges shall be reported immediately to the Andover Police and Board of Health.

List of Emergency Contacts for implementing Long-Term Pollution Prevention Plan

Andover Police Department	(978) 475-0411
Andover Conservation Department	(978) 623-8630
Andover Health Department	(978) 623-8640
Massachusetts Department of Environmental Protection	(978) 694-3200

Closed Drainage Calculations

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	11	0.00	1.77	0.00	0.00	0.94	0.0	10.1	6.0	5.66	6.15	5.69	15	0.91	65.20	65.30	66.14	66.24	69.47	70.43	PDP-7
2	1	135	0.00	0.11	0.00	0.00	0.07	0.0	5.8	7.0	0.48	4.23	2.24	12	1.41	65.60	67.50	66.24	67.73	70.43	73.65	PDP-4
3	2	131	0.00	0.11	0.00	0.00	0.07	0.0	5.3	7.2	0.49	5.25	4.19	12	2.17	69.50	72.35	69.71	72.56	73.65	77.45	PDP-3
4	3	38	0.07	0.07	0.55	0.04	0.04	5.0	5.0	7.2	0.28	3.81	2.83	12	1.15	72.45	72.88	72.63	73.06	77.45	77.10	PDP-2
5	3	39	0.04	0.04	0.75	0.03	0.03	5.0	5.0	7.2	0.22	3.72	2.58	12	1.09	72.45	72.88	72.61	73.04	77.45	77.10	PDP-1
6	1	14	0.80	0.80	0.55	0.44	0.44	10.0	10.0	6.0	2.66	6.45	4.01	15	1.00	65.40	65.54	66.24	66.10	70.43	69.58	PDP-6
7	1	12	0.86	0.86	0.50	0.43	0.43	10.0	10.0	6.0	2.60	6.43	3.95	15	0.99	65.40	65.52	66.24	66.07	70.43	69.58	PDP-5

Project File: street.stm | Number of lines: 7 | Run Date: 2/7/2022

NOTES:Intensity = 88.24 / (Inlet time + 15.50) ^ 0.83; Return period =Yrs. 10 ; c = cir e = ellip b = box