ALLEN & MAJOR ASSOCIATES, INC.

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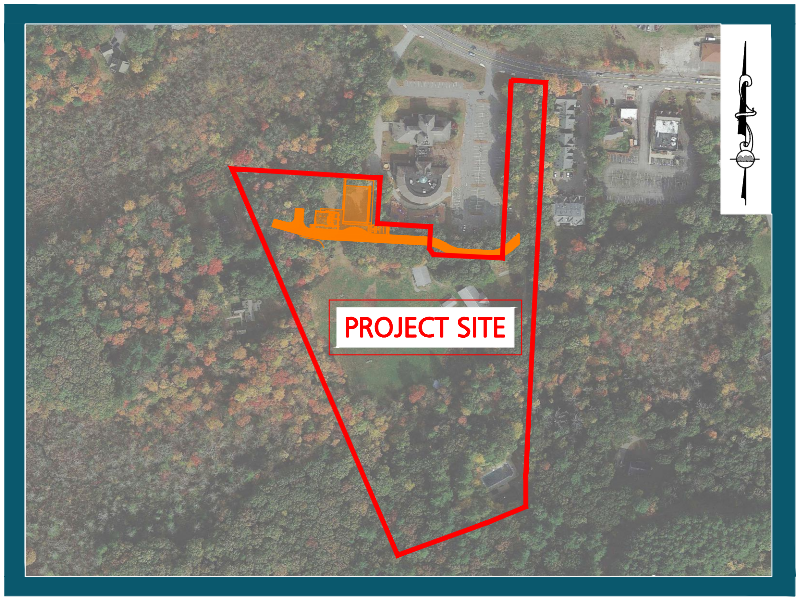



# CAMP CHICKAMI DRAINAGE REPORT

139 BOSTON POST ROAD
WAYLAND, MASSACHUSETTS

**DATE PREPARED:**
NOVEMBER 10, 2021

**DATE REVISED:**
DECEMBER 23, 2021

**APPLICANT:**
WEST SUBURBAN YMCA
276 CHURCH STREET
NEWTON, MA 02458

**PREPARED BY:**
ALLEN & MAJOR ASSOCIATES, INC.
400 HARVEY ROAD, SUITE D
MANCHESTER, NH 03103

COMMONWEALTH OF MASSACHUSETTS
BRIAN D. JONES
CIVIL
No. 49212
REGISTERED PROFESSIONAL ENGINEER

12·23·21

**A&M PROJECT NO. :** 2562-01

ALLEN & MAJOR ASSOCIATES, INC.

December 23, 2021

Sarkis Sarkisian
Town Planner
41 Cochituate Road
Wayland, MA 01778

RE: Camp Chickami
Drainage Report
139 Boston Post Road
Wayland, MA 01778

Dear Mr. Sarkisian,

On behalf of our Client, West Suburban YMCA, Allen & Major Associates (A&M) is pleased to provide this letter summarizing the drainage design for the proposed work to enhance the existing Camp Chickami. This letter will summarize how the proposed stormwater management system meets all Massachusetts stormwater performance standards and mitigates stormwater runoff from pre to post conditions.

**Existing Conditions**

The site is located on the eastern side of the Town of Wayland south of Boston Post Road (MA Route 20). It is accessed through an existing gravel driveway (Chickami Road) that leads to the majority of the lot located behind Temple Shir Tikva. The lot is identified on Town tax Map 29, as Lot 42. Elevations onsite range from elevation 160± at the southwest portion along the rear property line to elevation 125± leading into Pine Brook. Pine Brook and the surrounding wetlands are located within the centralized portion of the site. Stormwater flows to this area as the site's topography pitches from the southern boundary to the north and northern boundary to the south. The majority of the stormwater from the site discharges to various wetland locations leading to Pine Brook. A review of the NRCS soil report for Middlesex County indicates that the majority of soils onsite are considered various types loamy sand which have a Hydrologic Soil Group rating of an "A", see a copy of the NRCS soil report within the appendix of this report. A copy of the Existing Watershed Plan used for stormwater calculations is included herewith.

**Proposed Conditions**

The project proposes to add a multi-use camp building, tent, and associated septic system to the existing Camp Chickami. A permeable gravel driveway will also be constructed that will connect the existing Chickami Road to the proposed development area for emergency vehicle access. This driveway will be constructed out of EZ roll gravel pavers with the shoulders being constructed from EZ roll grass pavers. These systems are able to withstand AASHTO H-20 loading, providing adequate structural integrity for both emergency and passenger vehicles. In certain sections of the accessway, the pavers are designed to act as a permeable surface with varying depth of #57 stone with 40% voids beneath them that

enable the stormwater to be stored and infiltrated. Using the EZ roll paver systems, stormwater runoff is mitigated from pre to post conditions accounting for the additional impervious areas proposed on site. The proposed work will result in an additional 3,359± square feet of impervious area on site that will be compensated for as the proposed system can store and infiltrate all of the design storm events. The design infiltration rate used for calculations was 2.41 in/hr. derived from the "Massachusetts Stormwater Handbook, Table 2.3.3. 1982 Rawls Rates" for loamy sand.

Runoff flows were estimated for both pre and post development conditions using HydroCAD 10.1-6a software, at three specific "Study Points" (SP-1 & SP-2). Study Point 1 represents the flows that will discharge from the northwestern corner of the parcel toward Hayward Brook and surrounding wetland. Study Point 2 represents the stormwater flows that will flow to the existing wetlands that surround and discharge to Pine Brook. The table below shows that the project causes a reduction in the peak rate of runoff and volume of stormwater leaving the site at the two Study Points. Copies of the HydroCAD worksheets and Watershed Plans used for design calculations are included herewith.

| **STUDY POINT #1** (flow toward Hayward Brook) | | | | |
|---|---|---|---|---|
| | 1" Storm | 2-Year | 10-Year | 100-Year |
| Existing Flow (CFS) | 0.00 | 0.08 | 0.53 | 2.20 |
| Proposed Flow (CFS) | 0.00 | 0.00 | 0.00 | 0.23 |
| **Decrease (CFS)** | **0.00** | **0.08** | **0.53** | **1.97** |
| Existing Volume (CF) | 0 | 621 | 2,042 | 7,091 |
| Proposed Volume (CF) | 0 | 0 | 116 | 1,074 |
| **Decrease (CF)** | **0** | **621** | **1,1926** | **6,017** |

| **STUDY POINT #2** (flow to Pine Brook) | | | | |
|---|---|---|---|---|
| | 1" Storm | 2-Year | 10-Year | 100-Year |
| Existing Flow (CFS) | 0.00 | 0.00 | 0.01 | 0.62 |
| Proposed Flow (CFS) | 0.00 | 0.00 | 0.01 | 0.44 |
| **Decrease (CFS)** | **0.00** | **0.00** | **0.00** | **0.18** |
| Existing Volume (CF) | 0 | 0 | 209 | 3,939 |
| Proposed Volume (CF) | 0 | 0 | 178 | 2,656 |
| **Decrease (CF)** | **0** | **0** | **58** | **1,283** |

The surface water drainage requirements of the Town of Wayland and the Stormwater Management Policy of the Massachusetts Department of Environmental Protection have

been reviewed and met with the proposed design. The proposed project will introduce an increase of the amount of impervious area onsite, however the proposed stormwater management system has been designed to mitigate stormwater runoff from the pre to post conditions. See below the Massachusetts Department of Environmental Protection performance standards that have been met regarding a new development project.

**MA DEP Stormwater Performance Standards**

The MA DEP Stormwater Management Policy was developed to improve water quality by implementing performance standards for storm water management. The intent is to implement the stormwater management standards through the review of Notice of Intent filings by the issuing authority (Conservation Commission or DEP). The following section outlines how the proposed Stormwater Management System meets the standards set forth by the Policy.

BMP's implemented in the design include:

- Pervious Pavers (EZ grass & gravel paver systems)

Stormwater Best Management Practices have been incorporated into the design of the project to mitigate stormwater runoff and aid groundwater recharge. An Operations and Maintenance Plan has been developed for the project, which addresses the long-term maintenance requirements of the proposed system.

Temporary erosion and sedimentation controls will be incorporated into the construction phase of the project. These temporary controls may include tubular sediment barriers, inlet sediment traps, slope stabilization, and stabilized construction entrances.

The Massachusetts Department of Environmental Protection has established ten (10) Stormwater Management Standards. A project that meets or exceeds the standards is presumed to satisfy the regulatory requirements regarding stormwater management. The Standards are enumerated below as well as descriptions and supporting calculations as to how the project will comply with the Standards:

1. *No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.*

   The proposed development will not introduce any new stormwater conveyances (e.g. outfalls) that discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. There are no structural BMPs used in the design. All proposed systems have been designed to infiltrate and store the 100-year storm event.

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

*may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.*

The proposed development has been designed so that the post-development peak discharge rates do not exceed the pre-development peak discharge rates. See the peak flow rate table, above.

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

The existing annual recharge for the site will be approximated in the developed condition. Subsurface infiltration using permeable EZ roll grass and gravel pavers will be designed to meet this requirement. Additionally, the EZ roll paver systems achieve LEED design points, making it environmentally sensitive. The permeable infiltration system was designed using the Static Method per the MA DEP Stormwater Management Standards, Volume 3, Chapter 1. See the attachments enclosed for water quality/recharge calculations for the project site.

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

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

The proposed stormwater management system is designed so that the 80% TSS removal standard is met for the project site. Standard #4 is met when stormwater best management practices are sized to capture and treat the required water quality volume and pretreatment is provided in accordance with the Massachusetts Stormwater Handbook. Standard #4 also requires that suitable source control measures are identified in the Long-Term Pollution Prevention Plan.

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

The proposed development is not considered a source of higher potential pollutant loading.

6. *Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "storm water discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.*

The proposed project is not located within a critical area.

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

The proposed project is considered a new development project under the Stormwater Management Handbook guidelines as there is an increase in the amount of impervious area.

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

A plan to control construction-related impacts, including erosion, sedimentation and other pollutant sources during construction and land disturbance activities has been developed within the site development plan set, see Sheet C-101, "Site Preparation Plan".

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

A Long-Term Operation and Maintenance (O&M) Plan has been developed for the proposed stormwater management system and is included within this document. See the appendix of this report.

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

There are no expected illicit discharges to the stormwater management system.

See the appendix section for the Mass DEP Stormwater Checklist.

**Summary**

Through achieving all Massachusetts DEP stormwater performance standards and mitigating the proposed stormwater runoff from the existing condition of the site, the proposed development will have a positive impact for Camp Chickami and the surrounding area regarding stormwater management practices.

Very truly yours,

**ALLEN & MAJOR ASSOCIATES, INC.**

Brian Jones, P.E.
Senior Project Manager

Attachments:

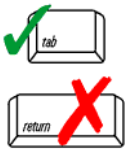
1. MA Stormwater Checklist
2. Long Term Pollution Prevention Plan
3. Operation & Maintenance Log
4. Existing Watershed Plan
5. Proposed Watershed Plan
6. Pre-Development HydroCAD Calculations
7. Post-Development HydroCAD Calculations
8. Extreme Precipitation Table
9. NRCS Soil Report
10. Camp Chickami Test Pit Logs
11. EZ Roll Permeable Paver Operation & Maintenance Brochure
12. MA Recharge Calculation
13. MA Water Quality Volume Calculation
14. MA TSS Removal Calculation

**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


12·23·21

Signature and Date

## Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

# Checklist for Stormwater Report

## Checklist (continued)

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

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

**Standard 1: No New Untreated Discharges**

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

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 2: Peak Rate Attenuation**

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

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

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

**Standard 3: Recharge**

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## Checklist (continued)

**Standard 3: Recharge** (continued)

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

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

**Standard 4: Water Quality**

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## Checklist (continued)

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

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

**Standard 6: Critical Areas**

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

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

# Checklist for Stormwater Report

## Checklist (continued)

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

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

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

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

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

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

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

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

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

# Checklist for Stormwater Report

## Checklist (continued)

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

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

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

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

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

**Standard 9: Operation and Maintenance Plan**

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

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

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

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

**Standard 10: Prohibition of Illicit Discharges**

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

☐ An Illicit Discharge Compliance Statement is attached;

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

**Long-Term Pollution Prevention Plan**

Standard #4 from the MassDEP Stormwater Management Handbook requires that a Long-Term Pollution Prevention Plan (LTPPP) be prepared and incorporated as part of the Operation and Maintenance Plan of the Stormwater Management System. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges, and to describe the implementation of practices to reduce the pollutants in stormwater discharges. The following items describe the source control and proper procedures of the LTPPP.

- Housekeeping
  The existing development has been designed to maintain a high level of water quality treatment for all stormwater discharge to the wetland areas. An Operation and Maintenance (O&M) plan has been prepared and is included in this section of the report. The owner (or its designee) is responsible for adherence to the O&M plan in a strict and complete manner.

- Storing of Materials & Water Products
  The trash and waste program for the site includes exterior dumpsters. There is a trash contractor used to pick up the waste material in the dumpsters. The stormwater drainage system has water quality inlets designed to capture trash and debris.

- Vehicle Washing
  Outdoor vehicle washing has the potential to result in high loads of nutrients, metals, and hydrocarbons during dry weather conditions, as the detergent-rich water used to wash the grime off the vehicle enters the stormwater drainage system. The existing development does not include any designated vehicle washing areas, nor is it expected that any vehicle washing will take place on-site.

- Spill Prevention & Response
  Sources of potential spill hazards include vehicle fluids, liquid fuels, pesticides, paints, solvents, and liquid cleaning products. The majority of the spill hazards would likely occur within the buildings and would not enter the stormwater drainage system. However, there are spill hazards from vehicle fluids or liquid fuels located outside of the buildings. These exterior spill hazards have the potential to enter the stormwater drainage system and are to be addressed as follows:

  1. Spill hazards of pesticides, paints, and solvents shall be remediated using the Manufacturers' recommended spill cleanup protocol.
  2. Vehicle fluids and liquid fuel spill shall be remediated according to the local and state regulations governing fuel spills.

3. The owner shall have the following equipment and materials on hand to address a spill clean-up: brooms, dust pans, mops, rags, gloves, absorptive material, sand, sawdust, plastic and metal trash containers.
4. All spills shall be cleaned up immediately after discovery.
5. Spills of toxic or hazardous material shall be reported, regardless of size, to the Massachusetts Department of Environmental Protection at (888) 304-1333.
6. Should a spill occur, the pollution prevention plan will be adjusted to include measures to prevent another spill of a similar nature. A description of the spill, along with the causes and cleanup measures will be included in the updated pollution prevention plan.

- Maintenance of Lawns, Gardens, and Other Landscaped Areas

  It should be recognized that this is a general guideline towards achieving high quality and well-groomed landscaped areas. The grounds staff/landscape contractor must recognize the shortcomings of a general maintenance plan such as this, and modify and/or augment it based on weekly, monthly, and yearly observations. In order to assure the highest quality conditions, the staff must also recognize and appreciate the need to be aware of the constantly changing conditions of the landscaping and be able to respond to them on a proactive basis. No trees shall be planted over the drain lines or recharge area, and that only shallow rooted plants and shrubs will be allowed.

  - Fertilizer

    Maintenance practices should be aimed at reducing environmental, mechanical and pest stresses to promote healthy and vigorous growth. When necessary, pest outbreaks should be treated with the most sensitive control measure available. Synthetic chemical controls should be used only as a last resort to organic and biological control methods. Fertilizer, synthetic chemical controls and pest management applications (when necessary) shall be performed only by licensed applicators in accordance with the manufacturer's label instructions when environmental conditions are conducive to controlled product application.

    Only slow-release organic fertilizers should be used in the planting and mulch areas to limit the amount of nutrients that could enter downstream resource areas. Fertilization of the planting and mulch areas will be performed within manufacturers labeling instructions and shall not exceed an NPK ration of 1:1:1 (i.e. Triple 10 fertilizer mix), considered a low nitrogen mixture. Fertilizers approved for the use under this O&M Plan are as follows:

Type: LESCO® 28-0-12 (Lawn Fertilizer)
MERIT® 0.2 Plus Turf Fertilizer
MOMENTUM™ Force Weed & Feed

- Suggested Aeration Program

  In-season aeration of lawn areas is good cultural practice, and is recommended whenever feasible. It should be accomplished with a solid thin tine aeration method to reduce disruption to the use of the area. The depth of solid tine aeration is similar to core type, but should be performed when the soil is somewhat drier for a greater overall effect.

  Depending on the intensity of use, it can be expected that all landscaped lawn areas will need aeration to reduce compaction at least once per year. The first operation should occur in late May following the spring season. Methods of reducing compaction will vary based on the nature of the compaction. Compaction on newly established landscaped areas is generally limited to the top 2-3" and can be alleviated using hollow core or thin tine aeration methods.

  The spring aeration should consist of two passes at opposite directions with 1/4" hollow core tines penetrating 3-5" into the soil profile. Aeration should occur when the soil is moist but not saturated. The soil cores should be shattered in place and dragged or swept back into the turf to control thatch. If desired the cores may also be removed and the area top-dressed with sand or sandy loam. If the area drains on average too slowly, the topdressing should contain a higher percentage of sand. If it is draining on average too quickly, the top dressing should contain a higher percentage of soil and organic matter.

- Landscape Maintenance Program Practices:
  - Lawn
    1. Mow a minimum of once a week in spring, to a height of 2" to 2 1/2" high. Mowing should be frequent enough so that no more than 1/3 of grass blade is removed at each mowing. The top growth supports the roots; the shorter the grass is cute, the less the roots will grow. Short cutting also dries out the soil and encourages weeds to germinate.
    2. Mow approximately once every two weeks from July 1st to August 15th depending on lawn growth.
    3. Mow on a ten-day cycle in fall, when growth is stimulated by cooler nights and increased moisture.

4. Do not remove grass clippings after mowing.
5. Keep mower blades sharp to prevent ragged cuts on grass leaves, which cause a brownish appearance and increase the chance for disease to enter a leaf.

- Shrubs
  1. Mulch not more than 3" depth with shredded pine or fir bark.
  2. Hand prune annually, immediately after blooming, to remove 1/3 of the above-ground biomass (older stems). Stem removals are to occur within 6" of the ground to open up shrub and maintain two-year wood (the blooming wood).
  3. Hand-prune evergreen shrubs only as needed to remove dead and damaged wood and to maintain the naturalistic form of the shrub. Never mechanically shear evergreen shrubs.
- Trees
  1. Provide aftercare of new tree plantings for the first three years.
  2. Do not fertilize trees, it artificially stimulates them (unless tree health warrants).
  3. Water once a week for the first year; twice a month for the second; once a month for the third year.
  4. Prune trees on a four-year cycle.
- Invasive Species
  1. Inform the Conservation Commission Agent prior to the removal of invasive species proposed either through hand work or through chemical removal.

- Storage and Use of Herbicides and Pesticides
  Integrated Pest Management is the combination of all methods (of pest control) which may prevent, reduce, suppress, eliminate, or repel an insect population. The main requirements necessary to support any pest population are food, shelter and water, and any upset of the balance of these will assist in controlling a pest population. Scientific pest management is the knowledgeable use of all pest control methods (sanitation, mechanical, chemical) to benefit mankind's health, welfare, comfort, property and food. A Pest Management Professional (PMP) should be retained who is licensed with the Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs, Department of Agricultural Resources.

The site manager will be provided with approved bulletin before entering into or renewing an agreement to apply pesticides for the control of indoor household or structural pests, refer to 333 CMR 13.08.

Before beginning each application, the applicator must post a Department approved notice on all of the entrances to the treated room or area. The applicator must leave such notices posted after the application. The notice will be posted at conspicuous point(s) of access to the area treated. The location and number of signs will be determined by the configuration of the area to be treated based on the applicator's best judgment. It is intended to give sufficient notice so that no one comes into an area being treated unaware that the applicator is working and pesticides are being applied. However, if the contracting entity does not want the signs posted, he/she may sign a Department approved waiver indicating this.

The applicator or employer will provide to any person upon their request the following information on previously conducted applications:

1. Name and phone number of pest control company;
2. Date and time of the application;
3. Name and license number of the applicator;
4. Target pests; and
5. Name and EPA Registration Number of pesticide products applied.

- <u>Management of Deicing Chemicals and Snow</u>
  Snow will be stockpiled on site until the accumulated snow becomes a hazard to the daily operations of the site. It will be the responsibility of the snow removal contractor to properly dispose of transported snow according to MassDEP, Bureau of Resource Protection – Snow Disposal Guideline #BRPG01-01, governing the proper disposal of snow. It will be the responsibility of the snow removal contractor to follow these guidelines and all applicable laws and regulations

  The owner's maintenance staff (or its designee) will be responsible for the clearing of the sidewalk and building entrances. The owner may be required to use a de-icing agent such as potassium chloride to maintain a safe walking surface. If used, the de-icing agent for the walkways and building entrances will be kept within the storage rooms located within the building. If used, de-icing agents will not be stored outside. The owner's maintenance staff will limit the application of sand.

## OPERATION AND MAINTENANCE PLAN SCHEDULE

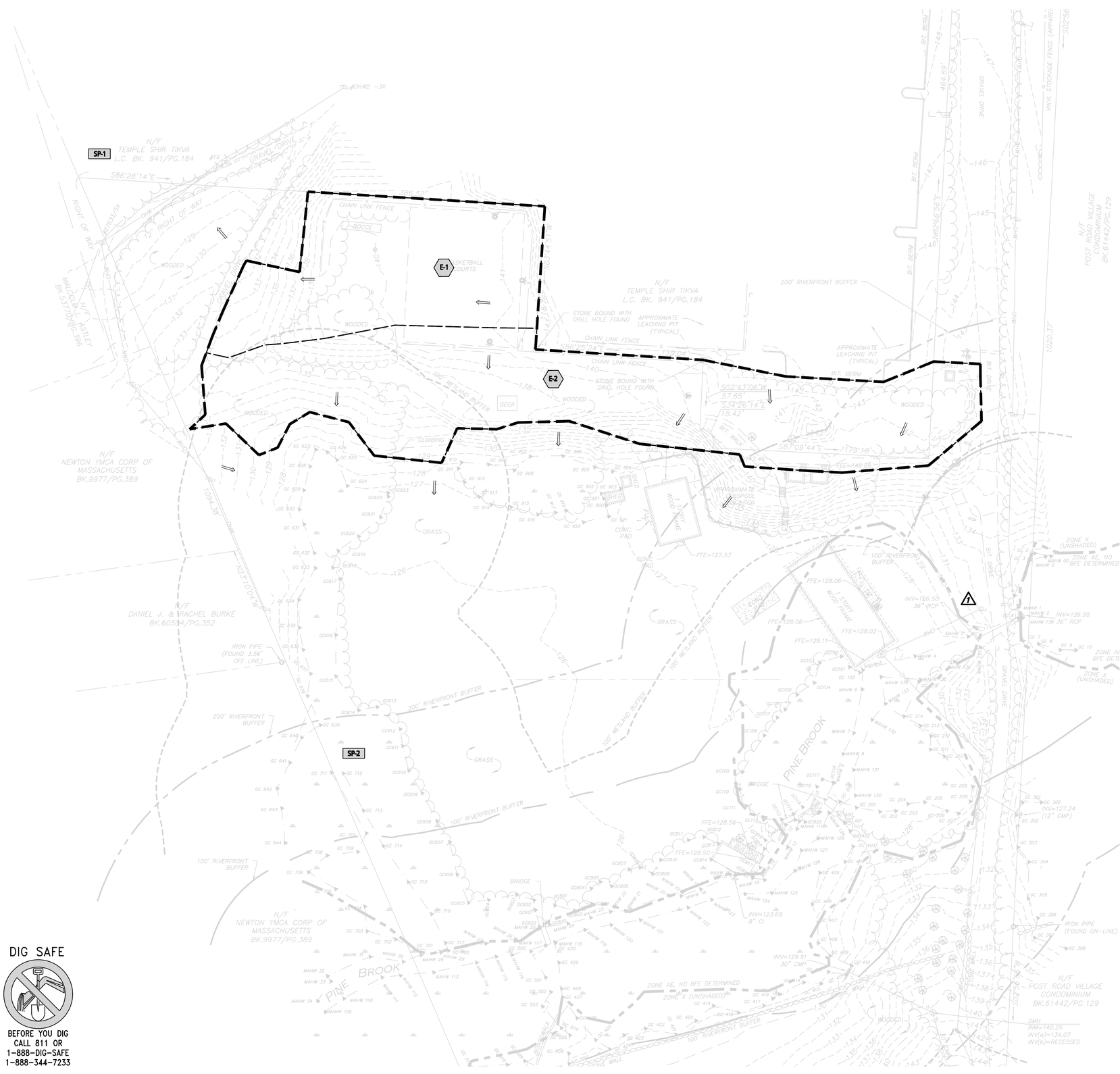
ALLEN & MAJOR ASSOCIATES, INC.

**A&M Project No.: 2562-01**
**Project: Camp Chickami**
**Project Address: 139 Boston Post Road**

**Responsible for O&M Plan: West Suburban YMCA**
**Address: 276 Church St, Newton, MA 02458**

*All information within table is derived from Massachussetts Stormwater Handbook: Volume 2, Chapter 2*

| BMP CATEGORY | BMP OR MAINTENANCE ACTIVITY | SCHEDULE/ FREQUENCY | NOTES | ESTIMATED ANNUAL MAINTENANCE COST | INSPECTION PERFORMED | |
|---|---|---|---|---|---|---|
| | | | | | DATE: | BY: |
| OTHER BMPs | NYLOPLAST CLEAN OUT | Inspect the clean out sump annually to ensure the system is fuctioning properly. | Inspect and remove any accumulated debris or sediment observed during inspection. | $250 | | |
| | PERVIOUS PAVERS | Assess exfiltration capability at least once a year. Inspect for deterioration annually. Monitor, using inspection ports, if paver surface is draining properly as needed (within 72 hours). | Monitor to ensure that the paving surface drains properly after storms. Inspect the surface annually for deterioration. If erosion is observed, add additional gravel and and or topsoil to achieve design grade. Use inspection port to monitor is the system is draining properly. | $500 | | |
| | TRENCH DRAIN | Inspect the drain annually to ensure the system is draining properly. Clear debris out of grate as needed. | Inspect and remove any accumulated debris or sediment observed during inspection. | $250 | | |
| INFILTRATION BMPs | INFILTRATION TRENCH | Inspect the infiltration trench annually to ensure the system is draining properly within 72 hours. Monitor if the system is draining using inspection port. | Inspect and remove any accumulated debris or sediment observed during inspection. Use inspection port to monitor is the system is draining properly. | $250 | | |
| OTHER MAINTENANCE ACTIVITY | SNOW STORAGE | Clear and remove snow to approved storage locations as necessary to ensure systems are working properly and are protected from meltwater pollutants. | Carefully select snow disposal sites before winter. Avoid dumping removed snow in rivers, wetlands, and flood plains. Ensure plow skid height is 2" above EZ Roll paver surfaces. | $500 | | |




## LEGEND

- EXISTING WATERSHED
- SUBCATCHMENT LABEL (E-1)
- SUBCATCHMENT BOUNDARY
- FLOW DIRECTION

## PLAN NOTES:

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GRAPHIC SCALE

40 0 20 40 80 160

( IN FEET )
1 inch = 40 ft.

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1-888-344-7233

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PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | |

APPLICANT\OWNER:

WEST SUBURBAN YMCA
276 CHURCH STREET
NEWTON, MA 02458

PROJECT:

CAMP CHICKAMI
139 BOSTON POST ROAD
WAYLAND, MA

| | | | |
|---|---|---|---|
| PROJECT NO. | 2562-01 | DATE: | 11-10-21 |
| SCALE: | 1" = 40' | DWG. NAME: | C2562-01 |
| DESIGNED BY: | JG | CHECKED BY: | BDJ |


PREPARED BY:

ALLEN & MAJOR ASSOCIATES, INC.
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environmental consulting ◆ landscape architecture
www.allenmajor.com
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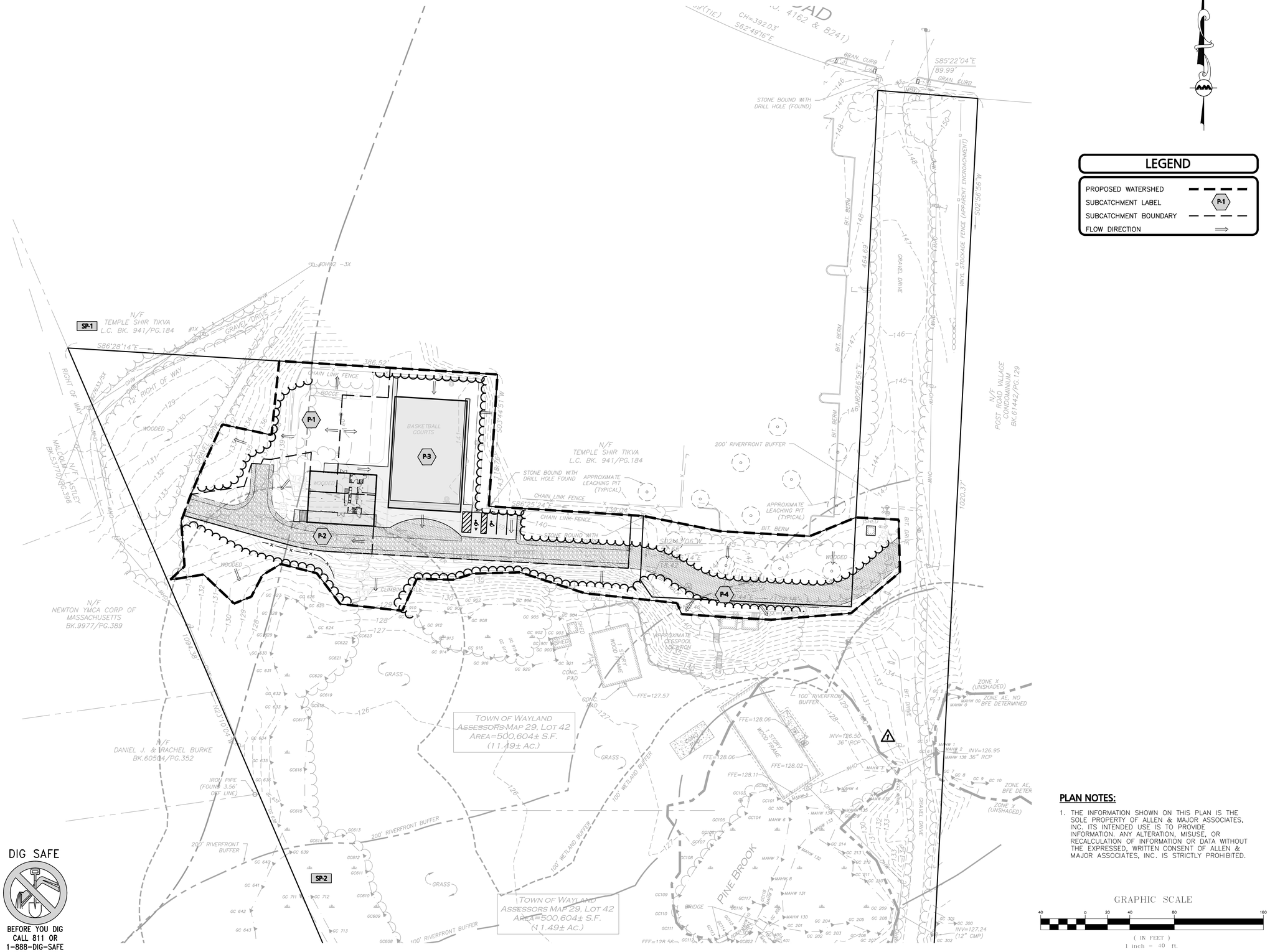
WOBURN MA 01801
TEL: (781) 935-6889
FAX: (781) 935-2896

WOBURN, MA ◆ LAKEVILLE, MA ◆ MANCHESTER, NH




| DRAWING TITLE: | SHEET No. |
|---|---|
| EXISTING WATERSHED PLAN | EWS-1 |




## LEGEND

| | |
|---|---|
| PROPOSED WATERSHED | |
| SUBCATCHMENT LABEL | P-1 |
| SUBCATCHMENT BOUNDARY | |
| FLOW DIRECTION | ⟹ |

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1 inch = 40 ft.

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R:\PROJECTS\2562-01\CIVIL\DRAWINGS\CURRENT\C-2562-01_WATERSHED-PROPOSED.DWG

PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

| REV | DATE | DESCRIPTION |
|---|---|---|
| | | |

APPLICANT\OWNER:

WEST SUBURBAN YMCA
276 CHURCH STREET
NEWTON, MA 02458

PROJECT:

CAMP CHICKAMI
139 BOSTON POST ROAD
WAYLAND, MA

| | | | |
|---|---|---|---|
| PROJECT NO. | 2562-01 | DATE: | 11-10-21 |
| SCALE: | 1" = 40' | DWG. NAME: | C2562-01 |
| DESIGNED BY: | JG | CHECKED BY: | BDJ |

PREPARED BY:

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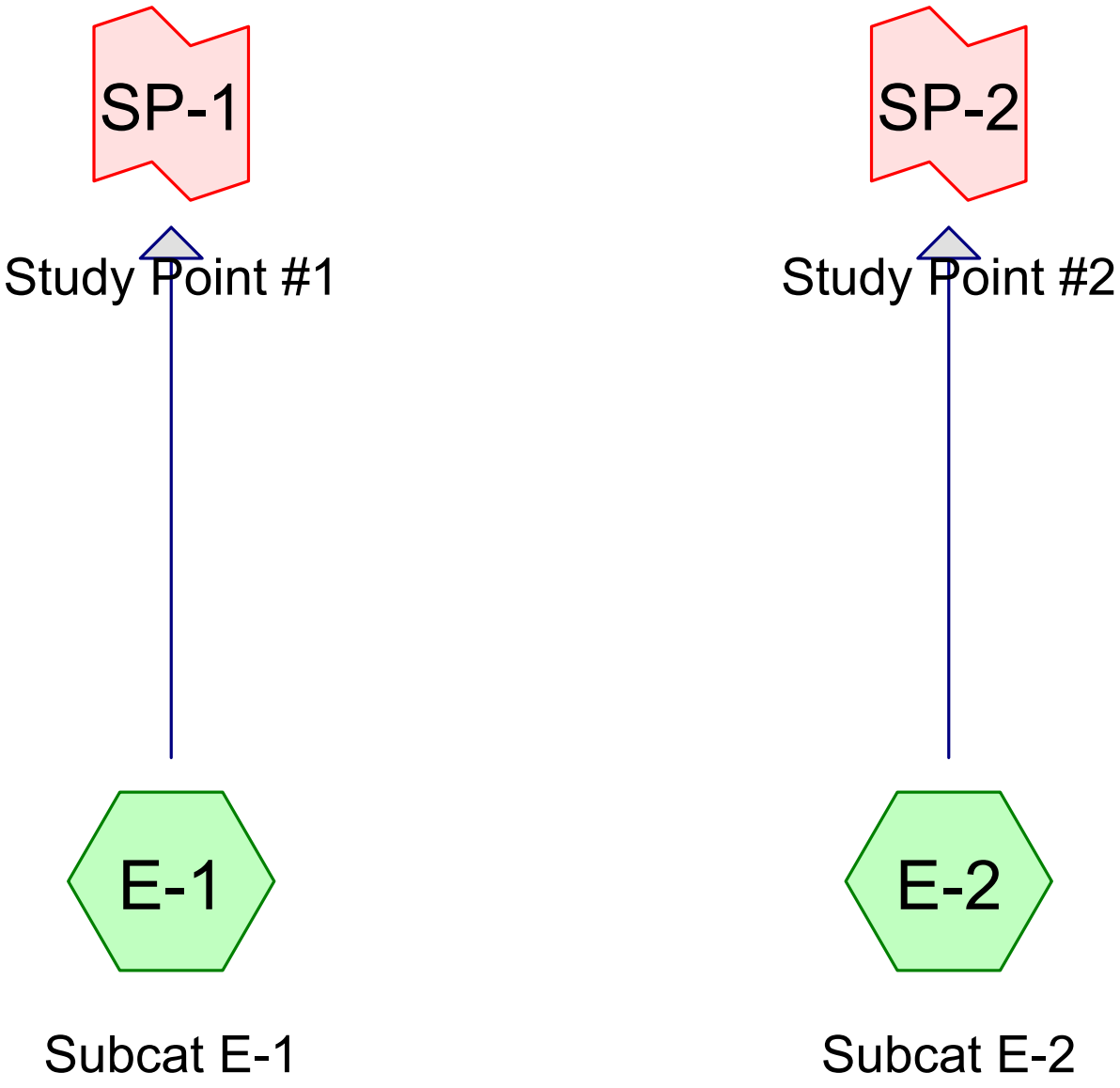
DRAWING TITLE:

PROPOSED WATERSHED PLAN

SHEET No.

PWS-1




Subcat Reach Pond Link

**Routing Diagram for 2562-01 - Existing HydroCAD**
Prepared by Allen & Major Associates Inc., Printed 12/23/2021

## Rainfall Events Listing

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 1" Storm | Type III 24-hr | | Default | 24.00 | 1 | 1.00 | 2 |
| 2 | 2-year | Type III 24-hr | | Default | 24.00 | 1 | 3.14 | 2 |
| 3 | 10-year | Type III 24-hr | | Default | 24.00 | 1 | 4.71 | 2 |
| 4 | 25-year | Type III 24-hr | | Default | 24.00 | 1 | 5.93 | 2 |
| 5 | 100-year | Type III 24-hr | | Default | 24.00 | 1 | 8.43 | 2 |

## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 22,773 | 39 | >75% Grass cover, Good, HSG A (E-1, E-2) |
| 213 | 96 | Gravel surface, HSG A (E-1) |
| 70 | 98 | Roofs, HSG A (E-2) |
| 11,216 | 98 | Unconnected pavement, HSG A (E-1, E-2) |
| 5,703 | 36 | Woods, Fair, HSG A (E-2) |
| 35,220 | 30 | Woods, Good, HSG A (E-1, E-2) |
| **75,195** | **44** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (sq-ft) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 75,195 | HSG A | E-1, E-2 |
| 0 | HSG B | |
| 0 | HSG C | |
| 0 | HSG D | |
| 0 | Other | |
| **75,195** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (sq-ft) | HSG-B (sq-ft) | HSG-C (sq-ft) | HSG-D (sq-ft) | Other (sq-ft) | Total (sq-ft) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 22,773 | 0 | 0 | 0 | 0 | 22,773 | >75% Grass cover, Good | E-1, E-2 |
| 213 | 0 | 0 | 0 | 0 | 213 | Gravel surface | E-1 |
| 70 | 0 | 0 | 0 | 0 | 70 | Roofs | E-2 |
| 11,216 | 0 | 0 | 0 | 0 | 11,216 | Unconnected pavement | E-1, E-2 |
| 5,703 | 0 | 0 | 0 | 0 | 5,703 | Woods, Fair | E-2 |
| 35,220 | 0 | 0 | 0 | 0 | 35,220 | Woods, Good | E-1, E-2 |
| **75,195** | **0** | **0** | **0** | **0** | **75,195** | **TOTAL AREA** | |

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

**Subcatchment E-1: Subcat E-1** Runoff Area=25,694 sf 35.49% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=57 Runoff=0.00 cfs 0 cf

**Subcatchment E-2: Subcat E-2** Runoff Area=49,500 sf 4.38% Impervious Runoff Depth=0.00"
Tc=6.0 min UI Adjusted CN=35 Runoff=0.00 cfs 0 cf

**Link SP-1: Study Point #1** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Link SP-2: Study Point #2** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 0 cf Average Runoff Depth = 0.00"**
**84.99% Pervious = 63,909 sf 15.01% Impervious = 11,285 sf**

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

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1" Storm Rainfall=1.00"

| Area (sf) | CN | Description |
|---|---|---|
| 7,745 | 39 | >75% Grass cover, Good, HSG A |
| 213 | 96 | Gravel surface, HSG A |
| 9,119 | 98 | Unconnected pavement, HSG A |
| 8,617 | 30 | Woods, Good, HSG A |
| 25,694 | 57 | Weighted Average |
| 16,575 | | 64.51% Pervious Area |
| 9,119 | | 35.49% Impervious Area |
| 9,119 | | 100.00% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

Woods fair used due to the absence of topsoil and vegetation.

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 1" Storm Rainfall=1.00"

| Area (sf) | CN | Adj | Description |
|---|---|---|---|
| 15,028 | 39 | | >75% Grass cover, Good, HSG A |
| 70 | 98 | | Roofs, HSG A |
| 2,097 | 98 | | Unconnected pavement, HSG A |
| 5,703 | 36 | | Woods, Fair, HSG A |
| 26,603 | 30 | | Woods, Good, HSG A |
| 49,500 | 36 | 35 | Weighted Average, UI Adjusted |
| 47,334 | | | 95.62% Pervious Area |
| 2,166 | | | 4.38% Impervious Area |
| 2,097 | | | 96.79% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Link SP-1: Study Point #1

Inflow Area = 25,694 sf, 35.49% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 49,500 sf, 4.38% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

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

**Subcatchment E-1: Subcat E-1** Runoff Area=25,694 sf 35.49% Impervious Runoff Depth=0.29"
Tc=6.0 min CN=57 Runoff=0.08 cfs 621 cf

**Subcatchment E-2: Subcat E-2** Runoff Area=49,500 sf 4.38% Impervious Runoff Depth=0.00"
Tc=6.0 min UI Adjusted CN=35 Runoff=0.00 cfs 0 cf

**Link SP-1: Study Point #1** Inflow=0.08 cfs 621 cf
Primary=0.08 cfs 621 cf

**Link SP-2: Study Point #2** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 621 cf Average Runoff Depth = 0.10"**
**84.99% Pervious = 63,909 sf 15.01% Impervious = 11,285 sf**

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

Runoff = 0.08 cfs @ 12.29 hrs, Volume= 621 cf, Depth= 0.29"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.14"

| Area (sf) | CN | Description |
|---|---|---|
| 7,745 | 39 | >75% Grass cover, Good, HSG A |
| 213 | 96 | Gravel surface, HSG A |
| 9,119 | 98 | Unconnected pavement, HSG A |
| 8,617 | 30 | Woods, Good, HSG A |
| 25,694 | 57 | Weighted Average |
| 16,575 | | 64.51% Pervious Area |
| 9,119 | | 35.49% Impervious Area |
| 9,119 | | 100.00% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

Woods fair used due to the absence of topsoil and vegetation.

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year Rainfall=3.14"

| Area (sf) | CN | Adj | Description |
|---|---|---|---|
| 15,028 | 39 | | >75% Grass cover, Good, HSG A |
| 70 | 98 | | Roofs, HSG A |
| 2,097 | 98 | | Unconnected pavement, HSG A |
| 5,703 | 36 | | Woods, Fair, HSG A |
| 26,603 | 30 | | Woods, Good, HSG A |
| 49,500 | 36 | 35 | Weighted Average, UI Adjusted |
| 47,334 | | | 95.62% Pervious Area |
| 2,166 | | | 4.38% Impervious Area |
| 2,097 | | | 96.79% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Link SP-1: Study Point #1

Inflow Area = 25,694 sf, 35.49% Impervious, Inflow Depth = 0.29" for 2-year event
Inflow = 0.08 cfs @ 12.29 hrs, Volume= 621 cf
Primary = 0.08 cfs @ 12.29 hrs, Volume= 621 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 49,500 sf, 4.38% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

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

**Subcatchment E-1: Subcat E-1** Runoff Area=25,694 sf 35.49% Impervious Runoff Depth=0.95"
Tc=6.0 min CN=57 Runoff=0.53 cfs 2,042 cf

**Subcatchment E-2: Subcat E-2** Runoff Area=49,500 sf 4.38% Impervious Runoff Depth=0.05"
Tc=6.0 min UI Adjusted CN=35 Runoff=0.01 cfs 209 cf

**Link SP-1: Study Point #1** Inflow=0.53 cfs 2,042 cf
Primary=0.53 cfs 2,042 cf

**Link SP-2: Study Point #2** Inflow=0.01 cfs 209 cf
Primary=0.01 cfs 209 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 2,251 cf Average Runoff Depth = 0.36"**
**84.99% Pervious = 63,909 sf 15.01% Impervious = 11,285 sf**

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

Runoff = 0.53 cfs @ 12.11 hrs, Volume= 2,042 cf, Depth= 0.95"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.71"

| Area (sf) | CN | Description |
|---|---|---|
| 7,745 | 39 | >75% Grass cover, Good, HSG A |
| 213 | 96 | Gravel surface, HSG A |
| 9,119 | 98 | Unconnected pavement, HSG A |
| 8,617 | 30 | Woods, Good, HSG A |
| 25,694 | 57 | Weighted Average |
| 16,575 | | 64.51% Pervious Area |
| 9,119 | | 35.49% Impervious Area |
| 9,119 | | 100.00% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

Woods fair used due to the absence of topsoil and vegetation.

Runoff = 0.01 cfs @ 15.61 hrs, Volume= 209 cf, Depth= 0.05"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year Rainfall=4.71"

| Area (sf) | CN | Adj | Description |
|---|---|---|---|
| 15,028 | 39 | | >75% Grass cover, Good, HSG A |
| 70 | 98 | | Roofs, HSG A |
| 2,097 | 98 | | Unconnected pavement, HSG A |
| 5,703 | 36 | | Woods, Fair, HSG A |
| 26,603 | 30 | | Woods, Good, HSG A |
| 49,500 | 36 | 35 | Weighted Average, UI Adjusted |
| 47,334 | | | 95.62% Pervious Area |
| 2,166 | | | 4.38% Impervious Area |
| 2,097 | | | 96.79% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Link SP-1: Study Point #1

Inflow Area = 25,694 sf, 35.49% Impervious, Inflow Depth = 0.95" for 10-year event
Inflow = 0.53 cfs @ 12.11 hrs, Volume= 2,042 cf
Primary = 0.53 cfs @ 12.11 hrs, Volume= 2,042 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 49,500 sf, 4.38% Impervious, Inflow Depth = 0.05" for 10-year event
Inflow = 0.01 cfs @ 15.61 hrs, Volume= 209 cf
Primary = 0.01 cfs @ 15.61 hrs, Volume= 209 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

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

**Subcatchment E-1: Subcat E-1** Runoff Area=25,694 sf 35.49% Impervious Runoff Depth=1.63"
Tc=6.0 min CN=57 Runoff=1.02 cfs 3,498 cf

**Subcatchment E-2: Subcat E-2** Runoff Area=49,500 sf 4.38% Impervious Runoff Depth=0.24"
Tc=6.0 min UI Adjusted CN=35 Runoff=0.05 cfs 974 cf

**Link SP-1: Study Point #1** Inflow=1.02 cfs 3,498 cf
Primary=1.02 cfs 3,498 cf

**Link SP-2: Study Point #2** Inflow=0.05 cfs 974 cf
Primary=0.05 cfs 974 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 4,472 cf Average Runoff Depth = 0.71"**
**84.99% Pervious = 63,909 sf 15.01% Impervious = 11,285 sf**

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

Runoff = 1.02 cfs @ 12.10 hrs, Volume= 3,498 cf, Depth= 1.63"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.93"

| Area (sf) | CN | Description |
|---|---|---|
| 7,745 | 39 | >75% Grass cover, Good, HSG A |
| 213 | 96 | Gravel surface, HSG A |
| 9,119 | 98 | Unconnected pavement, HSG A |
| 8,617 | 30 | Woods, Good, HSG A |
| 25,694 | 57 | Weighted Average |
| 16,575 | | 64.51% Pervious Area |
| 9,119 | | 35.49% Impervious Area |
| 9,119 | | 100.00% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

Woods fair used due to the absence of topsoil and vegetation.

Runoff = 0.05 cfs @ 12.48 hrs, Volume= 974 cf, Depth= 0.24"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year Rainfall=5.93"

| Area (sf) | CN | Adj | Description |
|---|---|---|---|
| 15,028 | 39 | | >75% Grass cover, Good, HSG A |
| 70 | 98 | | Roofs, HSG A |
| 2,097 | 98 | | Unconnected pavement, HSG A |
| 5,703 | 36 | | Woods, Fair, HSG A |
| 26,603 | 30 | | Woods, Good, HSG A |
| 49,500 | 36 | 35 | Weighted Average, UI Adjusted |
| 47,334 | | | 95.62% Pervious Area |
| 2,166 | | | 4.38% Impervious Area |
| 2,097 | | | 96.79% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Link SP-1: Study Point #1

Inflow Area = 25,694 sf, 35.49% Impervious, Inflow Depth = 1.63" for 25-year event
Inflow = 1.02 cfs @ 12.10 hrs, Volume= 3,498 cf
Primary = 1.02 cfs @ 12.10 hrs, Volume= 3,498 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 49,500 sf, 4.38% Impervious, Inflow Depth = 0.24" for 25-year event
Inflow = 0.05 cfs @ 12.48 hrs, Volume= 974 cf
Primary = 0.05 cfs @ 12.48 hrs, Volume= 974 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

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

**Subcatchment E-1: Subcat E-1** Runoff Area=25,694 sf 35.49% Impervious Runoff Depth=3.31"
Tc=6.0 min CN=57 Runoff=2.20 cfs 7,091 cf

**Subcatchment E-2: Subcat E-2** Runoff Area=49,500 sf 4.38% Impervious Runoff Depth=0.95"
Tc=6.0 min UI Adjusted CN=35 Runoff=0.62 cfs 3,939 cf

**Link SP-1: Study Point #1** Inflow=2.20 cfs 7,091 cf
Primary=2.20 cfs 7,091 cf

**Link SP-2: Study Point #2** Inflow=0.62 cfs 3,939 cf
Primary=0.62 cfs 3,939 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 11,030 cf Average Runoff Depth = 1.76"**
**84.99% Pervious = 63,909 sf 15.01% Impervious = 11,285 sf**

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

Runoff = 2.20 cfs @ 12.10 hrs, Volume= 7,091 cf, Depth= 3.31"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=8.43"

| Area (sf) | CN | Description |
|---|---|---|
| 7,745 | 39 | >75% Grass cover, Good, HSG A |
| 213 | 96 | Gravel surface, HSG A |
| 9,119 | 98 | Unconnected pavement, HSG A |
| 8,617 | 30 | Woods, Good, HSG A |
| 25,694 | 57 | Weighted Average |
| 16,575 | | 64.51% Pervious Area |
| 9,119 | | 35.49% Impervious Area |
| 9,119 | | 100.00% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

Woods fair used due to the absence of topsoil and vegetation.

Runoff = 0.62 cfs @ 12.16 hrs, Volume= 3,939 cf, Depth= 0.95"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=8.43"

| Area (sf) | CN | Adj | Description |
|---|---|---|---|
| 15,028 | 39 | | >75% Grass cover, Good, HSG A |
| 70 | 98 | | Roofs, HSG A |
| 2,097 | 98 | | Unconnected pavement, HSG A |
| 5,703 | 36 | | Woods, Fair, HSG A |
| 26,603 | 30 | | Woods, Good, HSG A |
| 49,500 | 36 | 35 | Weighted Average, UI Adjusted |
| 47,334 | | | 95.62% Pervious Area |
| 2,166 | | | 4.38% Impervious Area |
| 2,097 | | | 96.79% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Link SP-1: Study Point #1

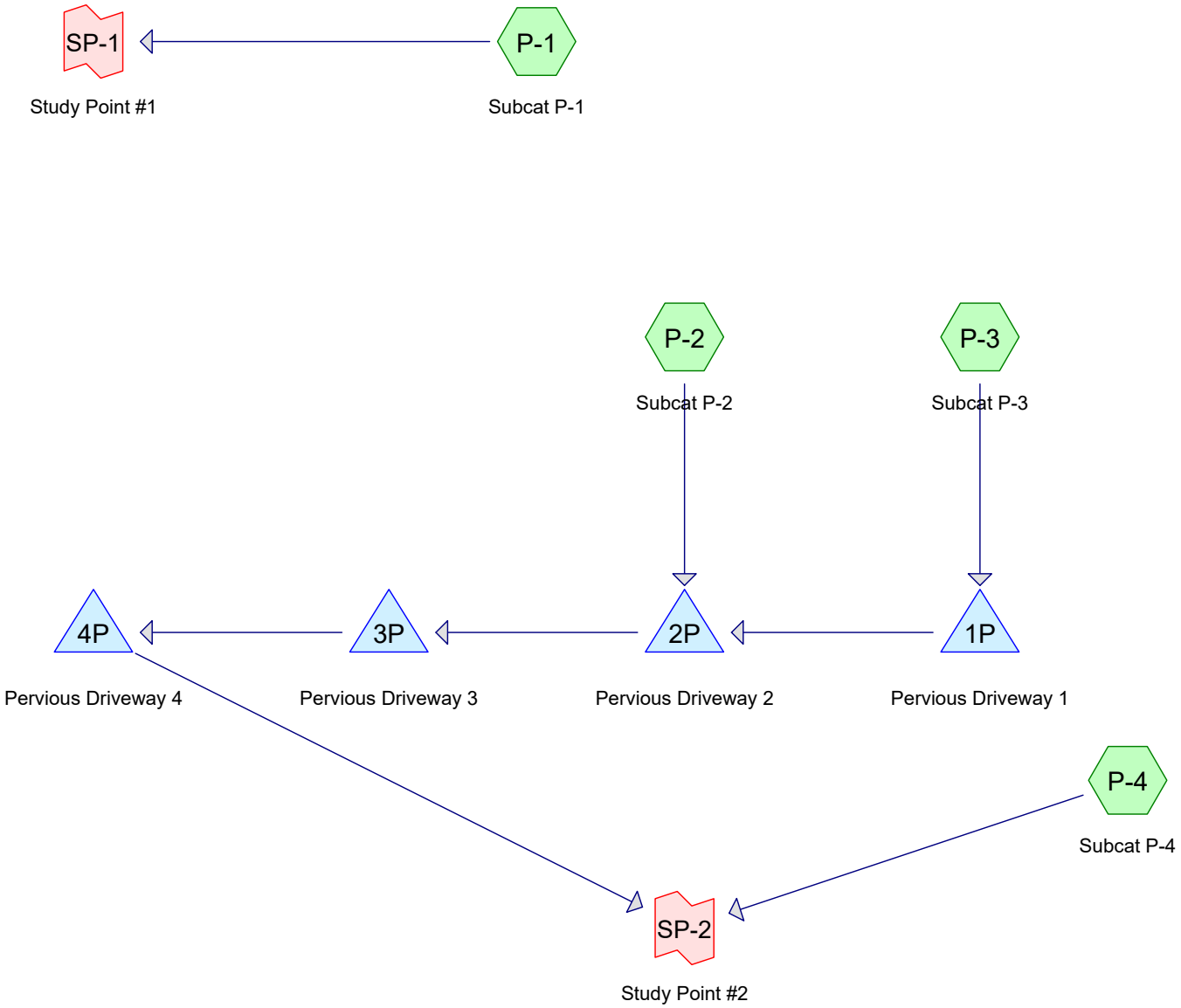
Inflow Area = 25,694 sf, 35.49% Impervious, Inflow Depth = 3.31" for 100-year event
Inflow = 2.20 cfs @ 12.10 hrs, Volume= 7,091 cf
Primary = 2.20 cfs @ 12.10 hrs, Volume= 7,091 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 49,500 sf, 4.38% Impervious, Inflow Depth = 0.95" for 100-year event
Inflow = 0.62 cfs @ 12.16 hrs, Volume= 3,939 cf
Primary = 0.62 cfs @ 12.16 hrs, Volume= 3,939 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs




Subcat Reach Pond Link

**Routing Diagram for 2562-01 - Proposed HydroCAD**
Prepared by Allen & Major Associates Inc., Printed 12/23/2021

## Rainfall Events Listing

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 1" Storm | Type III 24-hr | | Default | 24.00 | 1 | 1.00 | 2 |
| 2 | 2-year | Type III 24-hr | | Default | 24.00 | 1 | 3.14 | 2 |
| 3 | 10-year | Type III 24-hr | | Default | 24.00 | 1 | 4.71 | 2 |
| 4 | 25-year | Type III 24-hr | | Default | 24.00 | 1 | 5.93 | 2 |
| 5 | 100-year | Type III 24-hr | | Default | 24.00 | 1 | 8.43 | 2 |

## Area Listing (all nodes)

| Area (sq-ft) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 35,463 | 39 | >75% Grass cover, Good, HSG A (P-1, P-2, P-3, P-4) |
| 5,473 | 98 | Paved parking, HSG A (P-1, P-2, P-3) |
| 9,333 | 98 | Roofs, HSG A (P-1, P-2, P-3, P-4) |
| 52 | 98 | Unconnected pavement, HSG A (P-2) |
| 5,819 | 98 | Water Surface, HSG A (P-2, P-3) |
| 19,054 | 30 | Woods, Good, HSG A (P-1, P-3, P-4) |
| **75,195** | **53** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (sq-ft) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 75,195 | HSG A | P-1, P-2, P-3, P-4 |
| 0 | HSG B | |
| 0 | HSG C | |
| 0 | HSG D | |
| 0 | Other | |
| **75,195** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (sq-ft) | HSG-B (sq-ft) | HSG-C (sq-ft) | HSG-D (sq-ft) | Other (sq-ft) | Total (sq-ft) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 35,463 | 0 | 0 | 0 | 0 | 35,463 | >75% Grass cover, Good | P-1, P-2, P-3, P-4 |
| 5,473 | 0 | 0 | 0 | 0 | 5,473 | Paved parking | P-1, P-2, P-3 |
| 9,333 | 0 | 0 | 0 | 0 | 9,333 | Roofs | P-1, P-2, P-3, P-4 |
| 52 | 0 | 0 | 0 | 0 | 52 | Unconnected pavement | P-2 |
| 5,819 | 0 | 0 | 0 | 0 | 5,819 | Water Surface | P-2, P-3 |
| 19,054 | 0 | 0 | 0 | 0 | 19,054 | Woods, Good | P-1, P-3, P-4 |
| **75,195** | **0** | **0** | **0** | **0** | **75,195** | **TOTAL AREA** | |

Time span=0.00-36.00 hrs, dt=0.10 hrs, 361 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: Subcat P-1** Runoff Area=9,603 sf 5.71% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39 Runoff=0.00 cfs 0 cf

**Subcatchment P-2: Subcat P-2** Runoff Area=8,930 sf 51.26% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=69 Runoff=0.00 cfs 2 cf

**Subcatchment P-3: Subcat P-3** Runoff Area=26,276 sf 58.92% Impervious Runoff Depth=0.01"
Tc=6.0 min CN=72 Runoff=0.00 cfs 26 cf

**Subcatchment P-4: Subcat P-4** Runoff Area=30,386 sf 0.23% Impervious Runoff Depth=0.00"
Tc=0.0 min CN=36 Runoff=0.00 cfs 0 cf

**Pond 1P: Pervious Driveway 1** Peak Elev=137.00' Storage=0 cf Inflow=0.00 cfs 26 cf
Discarded=0.00 cfs 26 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 26 cf

**Pond 2P: Pervious Driveway 2** Peak Elev=136.83' Storage=0 cf Inflow=0.00 cfs 2 cf
Discarded=0.00 cfs 2 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 2 cf

**Pond 3P: Pervious Driveway 3** Peak Elev=134.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Discarded=0.00 cfs 0 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 0 cf

**Pond 4P: Pervious Driveway 4** Peak Elev=133.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

**Link SP-1: Study Point #1** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Link SP-2: Study Point #2** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 28 cf Average Runoff Depth = 0.00"**
**72.50% Pervious = 54,517 sf 27.50% Impervious = 20,678 sf**

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

[49] Hint: Tc<2dt may require smaller dt
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 1" Storm Rainfall=1.00"

| Area (sf) | CN | Description |
|---|---|---|
| 5,481 | 39 | >75% Grass cover, Good, HSG A |
| 99 | 98 | Paved parking, HSG A |
| 449 | 98 | Roofs, HSG A |
| 3,574 | 30 | Woods, Good, HSG A |
| 9,603 | 39 | Weighted Average |
| 9,055 | | 94.29% Pervious Area |
| 549 | | 5.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.00 cfs @ 22.65 hrs, Volume= 2 cf, Depth= 0.00"
Routed to Pond 2P : Pervious Driveway 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 1" Storm Rainfall=1.00"

| Area (sf) | CN | Description |
|---|---|---|
| 4,352 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 1,673 | 98 | Roofs, HSG A |
| 52 | 98 | Unconnected pavement, HSG A |
| 2,852 | 98 | Water Surface, HSG A |
| 8,930 | 69 | Weighted Average |
| 4,352 | | 48.74% Pervious Area |
| 4,578 | | 51.26% Impervious Area |
| 52 | | 1.14% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-3: Subcat P-3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.00 cfs @ 15.50 hrs, Volume= 26 cf, Depth= 0.01"
Routed to Pond 1P : Pervious Driveway 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 1" Storm Rainfall=1.00"

| Area (sf) | CN | Description |
|---|---|---|
| 6,871 | 39 | >75% Grass cover, Good, HSG A |
| 5,374 | 98 | Paved parking, HSG A |
| 7,141 | 98 | Roofs, HSG A |
| 2,966 | 98 | Water Surface, HSG A |
| 3,923 | 30 | Woods, Good, HSG A |
| 26,276 | 72 | Weighted Average |
| 10,794 | | 41.08% Pervious Area |
| 15,482 | | 58.92% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-4: Subcat P-4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 1" Storm Rainfall=1.00"

| Area (sf) | CN | Description |
|---|---|---|
| 18,759 | 39 | >75% Grass cover, Good, HSG A |
| 70 | 98 | Roofs, HSG A |
| 11,557 | 30 | Woods, Good, HSG A |
| 30,386 | 36 | Weighted Average |
| 30,316 | | 99.77% Pervious Area |
| 70 | | 0.23% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Pond 1P: Pervious Driveway 1

Inflow Area = 26,276 sf, 58.92% Impervious, Inflow Depth = 0.01" for 1" Storm event
Inflow = 0.00 cfs @ 15.50 hrs, Volume= 26 cf
Outflow = 0.00 cfs @ 15.52 hrs, Volume= 26 cf, Atten= 0%, Lag= 1.2 min
Discarded = 0.00 cfs @ 15.52 hrs, Volume= 26 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 2P : Pervious Driveway 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 137.00' @ 15.52 hrs Surf.Area= 272 sf Storage= 0 cf
Flood Elev= 140.50' Surf.Area= 5,707 sf Storage= 3,488 cf

Plug-Flow detention time= 1.2 min calculated for 26 cf (100% of inflow)
Center-of-Mass det. time= 1.2 min ( 1,120.6 - 1,119.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 137.00' | 254 cf | **Trench Drain (Irregular)** Listed below (Recalc)<br>634 cf Overall x 40.0% Voids |
| #2 | 139.00' | 3,234 cf | **Permeable Driveway (Irregular)** Listed below<br>8,086 cf Overall x 40.0% Voids |
| | | 3,488 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 137.00 | 272 | 276.0 | 0 | 0 | 272 |
| 139.33 | 272 | 276.0 | 634 | 634 | 915 |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 139.00 | 5,346 | 511.0 | 0 | 0 | 5,346 |
| 140.50 | 5,435 | 511.0 | 8,086 | 8,086 | 6,113 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 137.00' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 129.33' Phase-In= 0.01' |
| #2 | Primary | 140.33' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.00 cfs @ 15.52 hrs HW=137.00' (Free Discharge)
↑—**1=Exfiltration** ( Controls 0.00 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=137.00' TW=136.83' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 2P: Pervious Driveway 2

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 22.65 hrs, Volume= 2 cf
Outflow = 0.00 cfs @ 22.69 hrs, Volume= 2 cf, Atten= 0%, Lag= 2.0 min
Discarded = 0.00 cfs @ 22.69 hrs, Volume= 2 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 3P : Pervious Driveway 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 136.83' @ 22.69 hrs Surf.Area= 1,031 sf Storage= 0 cf
Flood Elev= 138.00' Surf.Area= 1,031 sf Storage= 483 cf

Plug-Flow detention time= 1.2 min calculated for 2 cf (100% of inflow)
Center-of-Mass det. time= 1.2 min ( 1,260.9 - 1,259.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 136.83' | 483 cf | **Custom Stage Data (Irregular)** Listed below 1,206 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 136.83 | 1,031 | 133.0 | 0 | 0 | 1,031 |
| 138.00 | 1,031 | 133.0 | 1,206 | 1,206 | 1,187 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 136.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67' Phase-In= 0.01' |
| #2 | Primary | 137.84' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.00 cfs @ 22.69 hrs HW=136.83' (Free Discharge)
↑—**1=Exfiltration** ( Controls 0.00 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=136.83' TW=134.83' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 3P: Pervious Driveway 3

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 4P : Pervious Driveway 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3

Peak Elev= 134.83' @ 0.00 hrs Surf.Area= 920 sf Storage= 0 cf
Flood Elev= 136.00' Surf.Area= 920 sf Storage= 431 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 134.83' | 431 cf | **Custom Stage Data (Irregular)** Listed below<br>1,076 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 134.83 | 920 | 128.0 | 0 | 0 | 920 |
| 136.00 | 920 | 128.0 | 1,076 | 1,076 | 1,070 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 134.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |
| #2 | Primary | 135.83' | **22.0' long x 1.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00<br>Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.00 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' TW=133.83' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 4P: Pervious Driveway 4

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 133.83' @ 0.00 hrs Surf.Area= 2,813 sf Storage= 0 cf
Flood Elev= 135.00' Surf.Area= 2,813 sf Storage= 1,316 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 133.83' | 1,316 cf | **Custom Stage Data (Irregular)** Listed below<br>3,291 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 133.83 | 2,813 | 290.0 | 0 | 0 | 2,813 |
| 135.00 | 2,813 | 290.0 | 3,291 | 3,291 | 3,152 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 133.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=133.83' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.00 cfs)

## Summary for Link SP-1: Study Point #1

Inflow Area = 9,603 sf, 5.71% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 65,592 sf, 30.69% Impervious, Inflow Depth = 0.00" for 1" Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

Time span=0.00-36.00 hrs, dt=0.10 hrs, 361 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: Subcat P-1** Runoff Area=9,603 sf 5.71% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39 Runoff=0.00 cfs 0 cf

**Subcatchment P-2: Subcat P-2** Runoff Area=8,930 sf 51.26% Impervious Runoff Depth=0.75"
Tc=6.0 min CN=69 Runoff=0.15 cfs 555 cf

**Subcatchment P-3: Subcat P-3** Runoff Area=26,276 sf 58.92% Impervious Runoff Depth=0.89"
Tc=6.0 min CN=72 Runoff=0.55 cfs 1,955 cf

**Subcatchment P-4: Subcat P-4** Runoff Area=30,386 sf 0.23% Impervious Runoff Depth=0.00"
Tc=0.0 min CN=36 Runoff=0.00 cfs 0 cf

**Pond 1P: Pervious Driveway 1** Peak Elev=139.03' Storage=289 cf Inflow=0.55 cfs 1,955 cf
Discarded=0.32 cfs 1,955 cf Primary=0.00 cfs 0 cf Outflow=0.32 cfs 1,955 cf

**Pond 2P: Pervious Driveway 2** Peak Elev=137.00' Storage=71 cf Inflow=0.15 cfs 555 cf
Discarded=0.06 cfs 555 cf Primary=0.00 cfs 0 cf Outflow=0.06 cfs 555 cf

**Pond 3P: Pervious Driveway 3** Peak Elev=134.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Discarded=0.00 cfs 0 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 0 cf

**Pond 4P: Pervious Driveway 4** Peak Elev=133.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

**Link SP-1: Study Point #1** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Link SP-2: Study Point #2** Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 2,510 cf Average Runoff Depth = 0.40"**
**72.50% Pervious = 54,517 sf 27.50% Impervious = 20,678 sf**

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.00 cfs @ 23.98 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-year Rainfall=3.14"

| Area (sf) | CN | Description |
|---|---|---|
| 5,481 | 39 | >75% Grass cover, Good, HSG A |
| 99 | 98 | Paved parking, HSG A |
| 449 | 98 | Roofs, HSG A |
| 3,574 | 30 | Woods, Good, HSG A |
| 9,603 | 39 | Weighted Average |
| 9,055 | | 94.29% Pervious Area |
| 549 | | 5.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.15 cfs @ 12.12 hrs, Volume= 555 cf, Depth= 0.75"
Routed to Pond 2P : Pervious Driveway 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-year Rainfall=3.14"

| Area (sf) | CN | Description |
|---|---|---|
| 4,352 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 1,673 | 98 | Roofs, HSG A |
| 52 | 98 | Unconnected pavement, HSG A |
| 2,852 | 98 | Water Surface, HSG A |
| 8,930 | 69 | Weighted Average |
| 4,352 | | 48.74% Pervious Area |
| 4,578 | | 51.26% Impervious Area |
| 52 | | 1.14% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-3: Subcat P-3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.55 cfs @ 12.11 hrs, Volume= 1,955 cf, Depth= 0.89"
Routed to Pond 1P : Pervious Driveway 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-year Rainfall=3.14"

| Area (sf) | CN | Description |
|---|---|---|
| 6,871 | 39 | >75% Grass cover, Good, HSG A |
| 5,374 | 98 | Paved parking, HSG A |
| 7,141 | 98 | Roofs, HSG A |
| 2,966 | 98 | Water Surface, HSG A |
| 3,923 | 30 | Woods, Good, HSG A |
| 26,276 | 72 | Weighted Average |
| 10,794 | | 41.08% Pervious Area |
| 15,482 | | 58.92% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-4: Subcat P-4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 2-year Rainfall=3.14"

| Area (sf) | CN | Description |
|---|---|---|
| 18,759 | 39 | >75% Grass cover, Good, HSG A |
| 70 | 98 | Roofs, HSG A |
| 11,557 | 30 | Woods, Good, HSG A |
| 30,386 | 36 | Weighted Average |
| 30,316 | | 99.77% Pervious Area |
| 70 | | 0.23% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Pond 1P: Pervious Driveway 1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=18)

Inflow Area = 26,276 sf, 58.92% Impervious, Inflow Depth = 0.89" for 2-year event
Inflow = 0.55 cfs @ 12.11 hrs, Volume= 1,955 cf
Outflow = 0.32 cfs @ 12.30 hrs, Volume= 1,955 cf, Atten= 42%, Lag= 11.0 min
Discarded = 0.32 cfs @ 12.30 hrs, Volume= 1,955 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 2P : Pervious Driveway 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 139.03' @ 12.29 hrs Surf.Area= 5,620 sf Storage= 289 cf
Flood Elev= 140.50' Surf.Area= 5,707 sf Storage= 3,488 cf

Plug-Flow detention time= 77.5 min calculated for 1,950 cf (100% of inflow)
Center-of-Mass det. time= 77.8 min ( 947.9 - 870.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 137.00' | 254 cf | **Trench Drain (Irregular)** Listed below (Recalc)<br>634 cf Overall x 40.0% Voids |
| #2 | 139.00' | 3,234 cf | **Permeable Driveway (Irregular)** Listed below<br>8,086 cf Overall x 40.0% Voids |
| | | 3,488 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 137.00 | 272 | 276.0 | 0 | 0 | 272 |
| 139.33 | 272 | 276.0 | 634 | 634 | 915 |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 139.00 | 5,346 | 511.0 | 0 | 0 | 5,346 |
| 140.50 | 5,435 | 511.0 | 8,086 | 8,086 | 6,113 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 137.00' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 129.33' Phase-In= 0.01' |
| #2 | Primary | 140.33' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.32 cfs @ 12.30 hrs HW=139.03' (Free Discharge)
└**1=Exfiltration** ( Controls 0.32 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=137.00' TW=136.83' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 2P: Pervious Driveway 2

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.19" for 2-year event
Inflow = 0.15 cfs @ 12.12 hrs, Volume= 555 cf
Outflow = 0.06 cfs @ 12.45 hrs, Volume= 555 cf, Atten= 60%, Lag= 20.3 min
Discarded = 0.06 cfs @ 12.45 hrs, Volume= 555 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 3P : Pervious Driveway 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 137.00' @ 12.45 hrs Surf.Area= 1,031 sf Storage= 71 cf
Flood Elev= 138.00' Surf.Area= 1,031 sf Storage= 483 cf

Plug-Flow detention time= 6.1 min calculated for 554 cf (100% of inflow)
Center-of-Mass det. time= 6.1 min ( 887.0 - 880.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 136.83' | 483 cf | **Custom Stage Data (Irregular)** Listed below 1,206 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 136.83 | 1,031 | 133.0 | 0 | 0 | 1,031 |
| 138.00 | 1,031 | 133.0 | 1,206 | 1,206 | 1,187 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 136.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67' Phase-In= 0.01' |
| #2 | Primary | 137.84' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.06 cfs @ 12.45 hrs HW=137.00' (Free Discharge)
└**1=Exfiltration** ( Controls 0.06 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=136.83' TW=134.83' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 3P: Pervious Driveway 3

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 4P : Pervious Driveway 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 134.83' @ 0.00 hrs Surf.Area= 920 sf Storage= 0 cf
Flood Elev= 136.00' Surf.Area= 920 sf Storage= 431 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 134.83' | 431 cf | **Custom Stage Data (Irregular)** Listed below<br>1,076 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 134.83 | 920 | 128.0 | 0 | 0 | 920 |
| 136.00 | 920 | 128.0 | 1,076 | 1,076 | 1,070 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 134.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |
| #2 | Primary | 135.83' | **22.0' long x 1.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00<br>Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' (Free Discharge)
↑—**1=Exfiltration** ( Controls 0.00 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' TW=133.83' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 4P: Pervious Driveway 4

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 133.83' @ 0.00 hrs Surf.Area= 2,813 sf Storage= 0 cf
Flood Elev= 135.00' Surf.Area= 2,813 sf Storage= 1,316 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 133.83' | 1,316 cf | **Custom Stage Data (Irregular)** Listed below<br>3,291 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 133.83 | 2,813 | 290.0 | 0 | 0 | 2,813 |
| 135.00 | 2,813 | 290.0 | 3,291 | 3,291 | 3,152 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 133.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=133.83' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.00 cfs)

## Summary for Link SP-1: Study Point #1

Inflow Area = 9,603 sf, 5.71% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 23.98 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 23.98 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 65,592 sf, 30.69% Impervious, Inflow Depth = 0.00" for 2-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

Time span=0.00-36.00 hrs, dt=0.10 hrs, 361 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: Subcat P-1** Runoff Area=9,603 sf 5.71% Impervious Runoff Depth=0.15"
Tc=6.0 min CN=39 Runoff=0.00 cfs 116 cf

**Subcatchment P-2: Subcat P-2** Runoff Area=8,930 sf 51.26% Impervious Runoff Depth=1.75"
Tc=6.0 min CN=69 Runoff=0.39 cfs 1,302 cf

**Subcatchment P-3: Subcat P-3** Runoff Area=26,276 sf 58.92% Impervious Runoff Depth=1.98"
Tc=6.0 min CN=72 Runoff=1.30 cfs 4,329 cf

**Subcatchment P-4: Subcat P-4** Runoff Area=30,386 sf 0.23% Impervious Runoff Depth=0.07"
Tc=0.0 min CN=36 Runoff=0.01 cfs 178 cf

**Pond 1P: Pervious Driveway 1** Peak Elev=139.43' Storage=1,186 cf Inflow=1.30 cfs 4,329 cf
Discarded=0.33 cfs 4,331 cf Primary=0.00 cfs 0 cf Outflow=0.33 cfs 4,331 cf

**Pond 2P: Pervious Driveway 2** Peak Elev=137.75' Storage=379 cf Inflow=0.39 cfs 1,302 cf
Discarded=0.07 cfs 1,302 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 1,302 cf

**Pond 3P: Pervious Driveway 3** Peak Elev=134.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Discarded=0.00 cfs 0 cf Primary=0.00 cfs 0 cf Outflow=0.00 cfs 0 cf

**Pond 4P: Pervious Driveway 4** Peak Elev=133.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

**Link SP-1: Study Point #1** Inflow=0.00 cfs 116 cf
Primary=0.00 cfs 116 cf

**Link SP-2: Study Point #2** Inflow=0.01 cfs 178 cf
Primary=0.01 cfs 178 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 5,925 cf Average Runoff Depth = 0.95"**
**72.50% Pervious = 54,517 sf 27.50% Impervious = 20,678 sf**

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.00 cfs @ 13.75 hrs, Volume= 116 cf, Depth= 0.15"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-year Rainfall=4.71"

| Area (sf) | CN | Description |
|---|---|---|
| 5,481 | 39 | >75% Grass cover, Good, HSG A |
| 99 | 98 | Paved parking, HSG A |
| 449 | 98 | Roofs, HSG A |
| 3,574 | 30 | Woods, Good, HSG A |
| 9,603 | 39 | Weighted Average |
| 9,055 | | 94.29% Pervious Area |
| 549 | | 5.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.39 cfs @ 12.11 hrs, Volume= 1,302 cf, Depth= 1.75"
Routed to Pond 2P : Pervious Driveway 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-year Rainfall=4.71"

| Area (sf) | CN | Description |
|---|---|---|
| 4,352 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 1,673 | 98 | Roofs, HSG A |
| 52 | 98 | Unconnected pavement, HSG A |
| 2,852 | 98 | Water Surface, HSG A |
| 8,930 | 69 | Weighted Average |
| 4,352 | | 48.74% Pervious Area |
| 4,578 | | 51.26% Impervious Area |
| 52 | | 1.14% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-3: Subcat P-3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.30 cfs @ 12.11 hrs, Volume= 4,329 cf, Depth= 1.98"
Routed to Pond 1P : Pervious Driveway 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-year Rainfall=4.71"

| Area (sf) | CN | Description |
|---|---|---|
| 6,871 | 39 | >75% Grass cover, Good, HSG A |
| 5,374 | 98 | Paved parking, HSG A |
| 7,141 | 98 | Roofs, HSG A |
| 2,966 | 98 | Water Surface, HSG A |
| 3,923 | 30 | Woods, Good, HSG A |
| 26,276 | 72 | Weighted Average |
| 10,794 | | 41.08% Pervious Area |
| 15,482 | | 58.92% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-4: Subcat P-4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.01 cfs @ 15.17 hrs, Volume= 178 cf, Depth= 0.07"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 10-year Rainfall=4.71"

| Area (sf) | CN | Description |
|---|---|---|
| 18,759 | 39 | >75% Grass cover, Good, HSG A |
| 70 | 98 | Roofs, HSG A |
| 11,557 | 30 | Woods, Good, HSG A |
| 30,386 | 36 | Weighted Average |
| 30,316 | | 99.77% Pervious Area |
| 70 | | 0.23% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Pond 1P: Pervious Driveway 1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=24)

Inflow Area = 26,276 sf, 58.92% Impervious, Inflow Depth = 1.98" for 10-year event
Inflow = 1.30 cfs @ 12.11 hrs, Volume= 4,329 cf
Outflow = 0.33 cfs @ 12.52 hrs, Volume= 4,331 cf, Atten= 74%, Lag= 25.2 min
Discarded = 0.33 cfs @ 12.52 hrs, Volume= 4,331 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 2P : Pervious Driveway 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 139.43' @ 12.52 hrs Surf.Area= 5,644 sf Storage= 1,186 cf
Flood Elev= 140.50' Surf.Area= 5,707 sf Storage= 3,488 cf

Plug-Flow detention time= 59.3 min calculated for 4,319 cf (100% of inflow)
Center-of-Mass det. time= 59.9 min ( 905.6 - 845.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 137.00' | 254 cf | **Trench Drain (Irregular)** Listed below (Recalc)<br>634 cf Overall x 40.0% Voids |
| #2 | 139.00' | 3,234 cf | **Permeable Driveway (Irregular)** Listed below<br>8,086 cf Overall x 40.0% Voids |
| | | 3,488 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 137.00 | 272 | 276.0 | 0 | 0 | 272 |
| 139.33 | 272 | 276.0 | 634 | 634 | 915 |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 139.00 | 5,346 | 511.0 | 0 | 0 | 5,346 |
| 140.50 | 5,435 | 511.0 | 8,086 | 8,086 | 6,113 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 137.00' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 129.33' Phase-In= 0.01' |
| #2 | Primary | 140.33' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.33 cfs @ 12.52 hrs HW=139.43' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.33 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=137.00' TW=136.83' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 2P: Pervious Driveway 2

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.44" for 10-year event
Inflow = 0.39 cfs @ 12.11 hrs, Volume= 1,302 cf
Outflow = 0.07 cfs @ 12.68 hrs, Volume= 1,302 cf, Atten= 83%, Lag= 34.1 min
Discarded = 0.07 cfs @ 12.68 hrs, Volume= 1,302 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 3P : Pervious Driveway 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 137.75' @ 12.68 hrs Surf.Area= 1,031 sf Storage= 379 cf
Flood Elev= 138.00' Surf.Area= 1,031 sf Storage= 483 cf

Plug-Flow detention time= 43.3 min calculated for 1,298 cf (100% of inflow)
Center-of-Mass det. time= 43.2 min ( 896.8 - 853.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 136.83' | 483 cf | **Custom Stage Data (Irregular)** Listed below 1,206 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 136.83 | 1,031 | 133.0 | 0 | 0 | 1,031 |
| 138.00 | 1,031 | 133.0 | 1,206 | 1,206 | 1,187 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 136.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67' Phase-In= 0.01' |
| #2 | Primary | 137.84' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.07 cfs @ 12.68 hrs HW=137.75' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.07 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=136.83' TW=134.83' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 3P: Pervious Driveway 3

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 10-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 4P : Pervious Driveway 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 134.83' @ 0.00 hrs Surf.Area= 920 sf Storage= 0 cf
Flood Elev= 136.00' Surf.Area= 920 sf Storage= 431 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 134.83' | 431 cf | **Custom Stage Data (Irregular)** Listed below<br>1,076 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 134.83 | 920 | 128.0 | 0 | 0 | 920 |
| 136.00 | 920 | 128.0 | 1,076 | 1,076 | 1,070 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 134.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |
| #2 | Primary | 135.83' | **22.0' long x 1.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00<br>Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.00 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' TW=133.83' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 4P: Pervious Driveway 4

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 10-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 133.83' @ 0.00 hrs Surf.Area= 2,813 sf Storage= 0 cf
Flood Elev= 135.00' Surf.Area= 2,813 sf Storage= 1,316 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 133.83' | 1,316 cf | **Custom Stage Data (Irregular)** Listed below<br>3,291 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 133.83 | 2,813 | 290.0 | 0 | 0 | 2,813 |
| 135.00 | 2,813 | 290.0 | 3,291 | 3,291 | 3,152 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 133.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=133.83' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.00 cfs)

## Summary for Link SP-1: Study Point #1

Inflow Area = 9,603 sf, 5.71% Impervious, Inflow Depth = 0.15" for 10-year event
Inflow = 0.00 cfs @ 13.75 hrs, Volume= 116 cf
Primary = 0.00 cfs @ 13.75 hrs, Volume= 116 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 65,592 sf, 30.69% Impervious, Inflow Depth = 0.03" for 10-year event
Inflow = 0.01 cfs @ 15.17 hrs, Volume= 178 cf
Primary = 0.01 cfs @ 15.17 hrs, Volume= 178 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

Time span=0.00-36.00 hrs, dt=0.10 hrs, 361 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: Subcat P-1** Runoff Area=9,603 sf 5.71% Impervious Runoff Depth=0.43"
Tc=6.0 min CN=39 Runoff=0.04 cfs 341 cf

**Subcatchment P-2: Subcat P-2** Runoff Area=8,930 sf 51.26% Impervious Runoff Depth=2.66"
Tc=6.0 min CN=69 Runoff=0.60 cfs 1,978 cf

**Subcatchment P-3: Subcat P-3** Runoff Area=26,276 sf 58.92% Impervious Runoff Depth=2.94"
Tc=6.0 min CN=72 Runoff=1.95 cfs 6,429 cf

**Subcatchment P-4: Subcat P-4** Runoff Area=30,386 sf 0.23% Impervious Runoff Depth=0.28"
Tc=0.0 min CN=36 Runoff=0.05 cfs 708 cf

**Pond 1P: Pervious Driveway 1** Peak Elev=139.84' Storage=2,068 cf Inflow=1.95 cfs 6,429 cf
Discarded=0.35 cfs 6,430 cf Primary=0.00 cfs 0 cf Outflow=0.35 cfs 6,430 cf

**Pond 2P: Pervious Driveway 2** Peak Elev=137.87' Storage=430 cf Inflow=0.60 cfs 1,978 cf
Discarded=0.07 cfs 1,677 cf Primary=0.37 cfs 301 cf Outflow=0.44 cfs 1,978 cf

**Pond 3P: Pervious Driveway 3** Peak Elev=135.33' Storage=185 cf Inflow=0.37 cfs 301 cf
Discarded=0.06 cfs 302 cf Primary=0.00 cfs 0 cf Outflow=0.06 cfs 302 cf

**Pond 4P: Pervious Driveway 4** Peak Elev=133.83' Storage=0 cf Inflow=0.00 cfs 0 cf
Outflow=0.00 cfs 0 cf

**Link SP-1: Study Point #1** Inflow=0.04 cfs 341 cf
Primary=0.04 cfs 341 cf

**Link SP-2: Study Point #2** Inflow=0.05 cfs 708 cf
Primary=0.05 cfs 708 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 9,456 cf Average Runoff Depth = 1.51"**
**72.50% Pervious = 54,517 sf 27.50% Impervious = 20,678 sf**

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.04 cfs @ 12.35 hrs, Volume= 341 cf, Depth= 0.43"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-year Rainfall=5.93"

| Area (sf) | CN | Description |
|---|---|---|
| 5,481 | 39 | >75% Grass cover, Good, HSG A |
| 99 | 98 | Paved parking, HSG A |
| 449 | 98 | Roofs, HSG A |
| 3,574 | 30 | Woods, Good, HSG A |
| 9,603 | 39 | Weighted Average |
| 9,055 | | 94.29% Pervious Area |
| 549 | | 5.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.60 cfs @ 12.10 hrs, Volume= 1,978 cf, Depth= 2.66"
Routed to Pond 2P : Pervious Driveway 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-year Rainfall=5.93"

| Area (sf) | CN | Description |
|---|---|---|
| 4,352 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 1,673 | 98 | Roofs, HSG A |
| 52 | 98 | Unconnected pavement, HSG A |
| 2,852 | 98 | Water Surface, HSG A |
| 8,930 | 69 | Weighted Average |
| 4,352 | | 48.74% Pervious Area |
| 4,578 | | 51.26% Impervious Area |
| 52 | | 1.14% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-3: Subcat P-3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.95 cfs @ 12.10 hrs, Volume= 6,429 cf, Depth= 2.94"
Routed to Pond 1P : Pervious Driveway 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-year Rainfall=5.93"

| Area (sf) | CN | Description |
|---|---|---|
| 6,871 | 39 | >75% Grass cover, Good, HSG A |
| 5,374 | 98 | Paved parking, HSG A |
| 7,141 | 98 | Roofs, HSG A |
| 2,966 | 98 | Water Surface, HSG A |
| 3,923 | 30 | Woods, Good, HSG A |
| 26,276 | 72 | Weighted Average |
| 10,794 | | 41.08% Pervious Area |
| 15,482 | | 58.92% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-4: Subcat P-4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.05 cfs @ 12.35 hrs, Volume= 708 cf, Depth= 0.28"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 25-year Rainfall=5.93"

| Area (sf) | CN | Description |
|---|---|---|
| 18,759 | 39 | >75% Grass cover, Good, HSG A |
| 70 | 98 | Roofs, HSG A |
| 11,557 | 30 | Woods, Good, HSG A |
| 30,386 | 36 | Weighted Average |
| 30,316 | | 99.77% Pervious Area |
| 70 | | 0.23% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Pond 1P: Pervious Driveway 1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=28)

Inflow Area = 26,276 sf, 58.92% Impervious, Inflow Depth = 2.94" for 25-year event
Inflow = 1.95 cfs @ 12.10 hrs, Volume= 6,429 cf
Outflow = 0.35 cfs @ 12.62 hrs, Volume= 6,430 cf, Atten= 82%, Lag= 31.0 min
Discarded = 0.35 cfs @ 12.62 hrs, Volume= 6,430 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 2P : Pervious Driveway 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 139.84' @ 12.62 hrs Surf.Area= 5,668 sf Storage= 2,068 cf
Flood Elev= 140.50' Surf.Area= 5,707 sf Storage= 3,488 cf

Plug-Flow detention time= 66.1 min calculated for 6,412 cf (100% of inflow)
Center-of-Mass det. time= 66.6 min ( 900.7 - 834.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 137.00' | 254 cf | **Trench Drain (Irregular)** Listed below (Recalc)<br>634 cf Overall x 40.0% Voids |
| #2 | 139.00' | 3,234 cf | **Permeable Driveway (Irregular)** Listed below<br>8,086 cf Overall x 40.0% Voids |
| | | 3,488 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 137.00 | 272 | 276.0 | 0 | 0 | 272 |
| 139.33 | 272 | 276.0 | 634 | 634 | 915 |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 139.00 | 5,346 | 511.0 | 0 | 0 | 5,346 |
| 140.50 | 5,435 | 511.0 | 8,086 | 8,086 | 6,113 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 137.00' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 129.33' Phase-In= 0.01' |
| #2 | Primary | 140.33' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.35 cfs @ 12.62 hrs HW=139.84' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.35 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=137.00' TW=136.83' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 2P: Pervious Driveway 2

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=2)

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.67" for 25-year event
Inflow = 0.60 cfs @ 12.10 hrs, Volume= 1,978 cf
Outflow = 0.44 cfs @ 12.29 hrs, Volume= 1,978 cf, Atten= 27%, Lag= 11.2 min
Discarded = 0.07 cfs @ 12.30 hrs, Volume= 1,677 cf
Primary = 0.37 cfs @ 12.29 hrs, Volume= 301 cf
Routed to Pond 3P : Pervious Driveway 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 137.87' @ 12.30 hrs Surf.Area= 1,031 sf Storage= 430 cf
Flood Elev= 138.00' Surf.Area= 1,031 sf Storage= 483 cf

Plug-Flow detention time= 44.7 min calculated for 1,972 cf (100% of inflow)
Center-of-Mass det. time= 44.6 min ( 885.8 - 841.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 136.83' | 483 cf | **Custom Stage Data (Irregular)** Listed below 1,206 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 136.83 | 1,031 | 133.0 | 0 | 0 | 1,031 |
| 138.00 | 1,031 | 133.0 | 1,206 | 1,206 | 1,187 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 136.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67' Phase-In= 0.01' |
| #2 | Primary | 137.84' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.07 cfs @ 12.30 hrs HW=137.87' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.07 cfs)

**Primary OutFlow** Max=0.35 cfs @ 12.29 hrs HW=137.87' TW=135.07' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 0.35 cfs @ 0.47 fps)

## Summary for Pond 3P: Pervious Driveway 3

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.10" for 25-year event
Inflow = 0.37 cfs @ 12.29 hrs, Volume= 301 cf
Outflow = 0.06 cfs @ 12.60 hrs, Volume= 302 cf, Atten= 84%, Lag= 18.4 min
Discarded = 0.06 cfs @ 12.60 hrs, Volume= 302 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Pond 4P : Pervious Driveway 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 135.33' @ 12.60 hrs Surf.Area= 920 sf Storage= 185 cf
Flood Elev= 136.00' Surf.Area= 920 sf Storage= 431 cf

Plug-Flow detention time= 32.0 min calculated for 300 cf (100% of inflow)
Center-of-Mass det. time= 32.3 min ( 774.5 - 742.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 134.83' | 431 cf | **Custom Stage Data (Irregular)** Listed below<br>1,076 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 134.83 | 920 | 128.0 | 0 | 0 | 920 |
| 136.00 | 920 | 128.0 | 1,076 | 1,076 | 1,070 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 134.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |
| #2 | Primary | 135.83' | **22.0' long x 1.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00<br>Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.06 cfs @ 12.60 hrs HW=135.33' (Free Discharge)
└**1=Exfiltration** ( Controls 0.06 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=134.83' TW=133.83' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Summary for Pond 4P: Pervious Driveway 4

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.00" for 25-year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 133.83' @ 0.00 hrs Surf.Area= 2,813 sf Storage= 0 cf
Flood Elev= 135.00' Surf.Area= 2,813 sf Storage= 1,316 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 133.83' | 1,316 cf | **Custom Stage Data (Irregular)** Listed below<br>3,291 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 133.83 | 2,813 | 290.0 | 0 | 0 | 2,813 |
| 135.00 | 2,813 | 290.0 | 3,291 | 3,291 | 3,152 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 133.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |

**Discarded OutFlow** Max=0.00 cfs @ 0.00 hrs HW=133.83' (Free Discharge)
└**1=Exfiltration** ( Controls 0.00 cfs)

## Summary for Link SP-1: Study Point #1

Inflow Area = 9,603 sf, 5.71% Impervious, Inflow Depth = 0.43" for 25-year event
Inflow = 0.04 cfs @ 12.35 hrs, Volume= 341 cf
Primary = 0.04 cfs @ 12.35 hrs, Volume= 341 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 65,592 sf, 30.69% Impervious, Inflow Depth = 0.13" for 25-year event
Inflow = 0.05 cfs @ 12.35 hrs, Volume= 708 cf
Primary = 0.05 cfs @ 12.35 hrs, Volume= 708 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

Time span=0.00-36.00 hrs, dt=0.10 hrs, 361 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment P-1: Subcat P-1** Runoff Area=9,603 sf 5.71% Impervious Runoff Depth=1.34"
Tc=6.0 min CN=39 Runoff=0.23 cfs 1,074 cf

**Subcatchment P-2: Subcat P-2** Runoff Area=8,930 sf 51.26% Impervious Runoff Depth=4.72"
Tc=6.0 min CN=69 Runoff=1.06 cfs 3,510 cf

**Subcatchment P-3: Subcat P-3** Runoff Area=26,276 sf 58.92% Impervious Runoff Depth=5.07"
Tc=6.0 min CN=72 Runoff=3.36 cfs 11,110 cf

**Subcatchment P-4: Subcat P-4** Runoff Area=30,386 sf 0.23% Impervious Runoff Depth=1.05"
Tc=0.0 min CN=36 Runoff=0.44 cfs 2,656 cf

**Pond 1P: Pervious Driveway 1** Peak Elev=140.42' Storage=3,305 cf Inflow=3.36 cfs 11,110 cf
Discarded=0.37 cfs 9,941 cf Primary=1.30 cfs 1,169 cf Outflow=1.67 cfs 11,110 cf

**Pond 2P: Pervious Driveway 2** Peak Elev=137.93' Storage=454 cf Inflow=1.76 cfs 4,680 cf
Discarded=0.07 cfs 2,295 cf Primary=1.78 cfs 2,384 cf Outflow=1.85 cfs 4,680 cf

**Pond 3P: Pervious Driveway 3** Peak Elev=135.92' Storage=401 cf Inflow=1.78 cfs 2,384 cf
Discarded=0.06 cfs 674 cf Primary=1.56 cfs 1,712 cf Outflow=1.63 cfs 2,386 cf

**Pond 4P: Pervious Driveway 4** Peak Elev=134.95' Storage=1,257 cf Inflow=1.56 cfs 1,712 cf
Outflow=0.21 cfs 1,726 cf

**Link SP-1: Study Point #1** Inflow=0.23 cfs 1,074 cf
Primary=0.23 cfs 1,074 cf

**Link SP-2: Study Point #2** Inflow=0.44 cfs 2,656 cf
Primary=0.44 cfs 2,656 cf

**Total Runoff Area = 75,195 sf Runoff Volume = 18,350 cf Average Runoff Depth = 2.93"**
**72.50% Pervious = 54,517 sf 27.50% Impervious = 20,678 sf**

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.23 cfs @ 12.13 hrs, Volume= 1,074 cf, Depth= 1.34"
Routed to Link SP-1 : Study Point #1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-year Rainfall=8.43"

| Area (sf) | CN | Description |
|---|---|---|
| 5,481 | 39 | >75% Grass cover, Good, HSG A |
| 99 | 98 | Paved parking, HSG A |
| 449 | 98 | Roofs, HSG A |
| 3,574 | 30 | Woods, Good, HSG A |
| 9,603 | 39 | Weighted Average |
| 9,055 | | 94.29% Pervious Area |
| 549 | | 5.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

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

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.06 cfs @ 12.10 hrs, Volume= 3,510 cf, Depth= 4.72"
Routed to Pond 2P : Pervious Driveway 2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-year Rainfall=8.43"

| Area (sf) | CN | Description |
|---|---|---|
| 4,352 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 1,673 | 98 | Roofs, HSG A |
| 52 | 98 | Unconnected pavement, HSG A |
| 2,852 | 98 | Water Surface, HSG A |
| 8,930 | 69 | Weighted Average |
| 4,352 | | 48.74% Pervious Area |
| 4,578 | | 51.26% Impervious Area |
| 52 | | 1.14% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-3: Subcat P-3

[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.36 cfs @ 12.10 hrs, Volume= 11,110 cf, Depth= 5.07"
Routed to Pond 1P : Pervious Driveway 1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-year Rainfall=8.43"

| Area (sf) | CN | Description |
|---|---|---|
| 6,871 | 39 | >75% Grass cover, Good, HSG A |
| 5,374 | 98 | Paved parking, HSG A |
| 7,141 | 98 | Roofs, HSG A |
| 2,966 | 98 | Water Surface, HSG A |
| 3,923 | 30 | Woods, Good, HSG A |
| 26,276 | 72 | Weighted Average |
| 10,794 | | 41.08% Pervious Area |
| 15,482 | | 58.92% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Subcatchment P-4: Subcat P-4

[46] Hint: Tc=0 (Instant runoff peak depends on dt)

Runoff = 0.44 cfs @ 12.07 hrs, Volume= 2,656 cf, Depth= 1.05"
Routed to Link SP-2 : Study Point #2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs
Type III 24-hr 100-year Rainfall=8.43"

| Area (sf) | CN | Description |
|---|---|---|
| 18,759 | 39 | >75% Grass cover, Good, HSG A |
| 70 | 98 | Roofs, HSG A |
| 11,557 | 30 | Woods, Good, HSG A |
| 30,386 | 36 | Weighted Average |
| 30,316 | | 99.77% Pervious Area |
| 70 | | 0.23% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.0 | | | | | **Direct Entry, TR-55 min.** |

## Summary for Pond 1P: Pervious Driveway 1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=33)

Inflow Area = 26,276 sf, 58.92% Impervious, Inflow Depth = 5.07" for 100-year event
Inflow = 3.36 cfs @ 12.10 hrs, Volume= 11,110 cf
Outflow = 1.67 cfs @ 12.33 hrs, Volume= 11,110 cf, Atten= 50%, Lag= 13.8 min
Discarded = 0.37 cfs @ 12.34 hrs, Volume= 9,941 cf
Primary = 1.30 cfs @ 12.33 hrs, Volume= 1,169 cf
Routed to Pond 2P : Pervious Driveway 2

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 140.42' @ 12.34 hrs Surf.Area= 5,702 sf Storage= 3,305 cf
Flood Elev= 140.50' Surf.Area= 5,707 sf Storage= 3,488 cf

Plug-Flow detention time= 76.2 min calculated for 11,080 cf (100% of inflow)
Center-of-Mass det. time= 76.6 min ( 895.0 - 818.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 137.00' | 254 cf | **Trench Drain (Irregular)** Listed below (Recalc)<br>634 cf Overall x 40.0% Voids |
| #2 | 139.00' | 3,234 cf | **Permeable Driveway (Irregular)** Listed below<br>8,086 cf Overall x 40.0% Voids |
| | | 3,488 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 137.00 | 272 | 276.0 | 0 | 0 | 272 |
| 139.33 | 272 | 276.0 | 634 | 634 | 915 |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 139.00 | 5,346 | 511.0 | 0 | 0 | 5,346 |
| 140.50 | 5,435 | 511.0 | 8,086 | 8,086 | 6,113 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 137.00' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 129.33' Phase-In= 0.01' |
| #2 | Primary | 140.33' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.37 cfs @ 12.34 hrs HW=140.40' (Free Discharge)
**1=Exfiltration** ( Controls 0.37 cfs)

**Primary OutFlow** Max=1.13 cfs @ 12.33 hrs HW=140.40' TW=137.92' (Dynamic Tailwater)
**2=Broad-Crested Rectangular Weir** (Weir Controls 1.13 cfs @ 0.70 fps)

## Summary for Pond 2P: Pervious Driveway 2

[90] Warning: Qout>Qin may require smaller dt or Finer Routing

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 1.60" for 100-year event
Inflow = 1.76 cfs @ 12.32 hrs, Volume= 4,680 cf
Outflow = 1.85 cfs @ 12.32 hrs, Volume= 4,680 cf, Atten= 0%, Lag= 0.0 min
Discarded = 0.07 cfs @ 12.32 hrs, Volume= 2,295 cf
Primary = 1.78 cfs @ 12.32 hrs, Volume= 2,384 cf
Routed to Pond 3P : Pervious Driveway 3

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 137.93' @ 12.32 hrs Surf.Area= 1,031 sf Storage= 454 cf
Flood Elev= 138.00' Surf.Area= 1,031 sf Storage= 483 cf

Plug-Flow detention time= 28.5 min calculated for 4,667 cf (100% of inflow)
Center-of-Mass det. time= 28.5 min ( 833.3 - 804.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 136.83' | 483 cf | **Custom Stage Data (Irregular)** Listed below 1,206 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 136.83 | 1,031 | 133.0 | 0 | 0 | 1,031 |
| 138.00 | 1,031 | 133.0 | 1,206 | 1,206 | 1,187 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 136.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67' Phase-In= 0.01' |
| #2 | Primary | 137.84' | **24.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.07 cfs @ 12.32 hrs HW=137.93' (Free Discharge)
**1=Exfiltration** ( Controls 0.07 cfs)

**Primary OutFlow** Max=1.62 cfs @ 12.32 hrs HW=137.93' TW=135.91' (Dynamic Tailwater)
**2=Broad-Crested Rectangular Weir** (Weir Controls 1.62 cfs @ 0.79 fps)

## Summary for Pond 3P: Pervious Driveway 3

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.81" for 100-year event
Inflow = 1.78 cfs @ 12.32 hrs, Volume= 2,384 cf
Outflow = 1.63 cfs @ 12.37 hrs, Volume= 2,386 cf, Atten= 9%, Lag= 2.8 min
Discarded = 0.06 cfs @ 12.37 hrs, Volume= 674 cf
Primary = 1.56 cfs @ 12.37 hrs, Volume= 1,712 cf
Routed to Pond 4P : Pervious Driveway 4

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 135.92' @ 12.37 hrs Surf.Area= 920 sf Storage= 401 cf
Flood Elev= 136.00' Surf.Area= 920 sf Storage= 431 cf

Plug-Flow detention time= 19.8 min calculated for 2,380 cf (100% of inflow)
Center-of-Mass det. time= 20.0 min ( 763.5 - 743.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 134.83' | 431 cf | **Custom Stage Data (Irregular)** Listed below<br>1,076 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 134.83 | 920 | 128.0 | 0 | 0 | 920 |
| 136.00 | 920 | 128.0 | 1,076 | 1,076 | 1,070 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 134.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |
| #2 | Primary | 135.83' | **22.0' long x 1.0' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00<br>Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32 |

**Discarded OutFlow** Max=0.06 cfs @ 12.37 hrs HW=135.91' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.06 cfs)

**Primary OutFlow** Max=1.43 cfs @ 12.37 hrs HW=135.91' TW=134.43' (Dynamic Tailwater)
↑**2=Broad-Crested Rectangular Weir** (Weir Controls 1.43 cfs @ 0.78 fps)

## Summary for Pond 4P: Pervious Driveway 4

Inflow Area = 35,206 sf, 56.98% Impervious, Inflow Depth = 0.58" for 100-year event
Inflow = 1.56 cfs @ 12.37 hrs, Volume= 1,712 cf
Outflow = 0.21 cfs @ 12.69 hrs, Volume= 1,726 cf, Atten= 86%, Lag= 19.5 min
Discarded = 0.21 cfs @ 12.69 hrs, Volume= 1,726 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs / 3
Peak Elev= 134.95' @ 12.69 hrs Surf.Area= 2,813 sf Storage= 1,257 cf
Flood Elev= 135.00' Surf.Area= 2,813 sf Storage= 1,316 cf

Plug-Flow detention time= 59.1 min calculated for 1,711 cf (100% of inflow)
Center-of-Mass det. time= 59.8 min ( 803.6 - 743.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 133.83' | 1,316 cf | **Custom Stage Data (Irregular)** Listed below<br>3,291 cf Overall x 40.0% Voids |

| Elevation (feet) | Surf.Area (sq-ft) | Perim. (feet) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) | Wet.Area (sq-ft) |
|---|---|---|---|---|---|
| 133.83 | 2,813 | 290.0 | 0 | 0 | 2,813 |
| 135.00 | 2,813 | 290.0 | 3,291 | 3,291 | 3,152 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 133.83' | **2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 130.67'<br>Phase-In= 0.01' |

**Discarded OutFlow** Max=0.21 cfs @ 12.69 hrs HW=134.94' (Free Discharge)
↑**1=Exfiltration** ( Controls 0.21 cfs)

## Summary for Link SP-1: Study Point #1

Inflow Area = 9,603 sf, 5.71% Impervious, Inflow Depth = 1.34" for 100-year event
Inflow = 0.23 cfs @ 12.13 hrs, Volume= 1,074 cf
Primary = 0.23 cfs @ 12.13 hrs, Volume= 1,074 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

## Summary for Link SP-2: Study Point #2

Inflow Area = 65,592 sf, 30.69% Impervious, Inflow Depth = 0.49" for 100-year event
Inflow = 0.44 cfs @ 12.07 hrs, Volume= 2,656 cf
Primary = 0.44 cfs @ 12.07 hrs, Volume= 2,656 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.10 hrs

# Extreme Precipitation Tables

## Northeast Regional Climate Center

***Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.***

| | |
|---|---|
| **Smoothing** | Yes |
| **State** | Massachusetts |
| **Location** | |
| **Longitude** | 71.347 degrees West |
| **Latitude** | 42.359 degrees North |
| **Elevation** | 0 feet |
| **Date/Time** | Mon, 19 Jul 2021 13:12:42 -0400 |

## Extreme Precipitation Estimates

| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1yr** | 0.28 | 0.43 | 0.54 | 0.70 | 0.88 | 1.11 | **1yr** | 0.76 | 1.05 | 1.29 | 1.62 | 2.06 | 2.62 | 2.83 | **1yr** | 2.32 | 2.72 | 3.21 | 3.87 | 4.53 | **1yr** |
| **2yr** | 0.35 | 0.54 | 0.67 | 0.88 | 1.11 | 1.39 | **2yr** | 0.95 | 1.28 | 1.61 | 2.01 | 2.51 | 3.14 | 3.46 | **2yr** | 2.78 | 3.33 | 3.83 | 4.57 | 5.20 | **2yr** |
| **5yr** | 0.41 | 0.64 | 0.81 | 1.08 | 1.38 | 1.76 | **5yr** | 1.19 | 1.60 | 2.04 | 2.55 | 3.18 | 3.96 | 4.41 | **5yr** | 3.50 | 4.24 | 4.87 | 5.79 | 6.48 | **5yr** |
| **10yr** | 0.47 | 0.74 | 0.93 | 1.26 | 1.64 | 2.10 | **10yr** | 1.42 | 1.89 | 2.44 | 3.06 | 3.81 | 4.71 | 5.30 | **10yr** | 4.17 | 5.09 | 5.84 | 6.93 | 7.66 | **10yr** |
| **25yr** | 0.56 | 0.89 | 1.13 | 1.55 | 2.06 | 2.65 | **25yr** | 1.78 | 2.37 | 3.10 | 3.88 | 4.82 | 5.93 | 6.75 | **25yr** | 5.25 | 6.49 | 7.43 | 8.78 | 9.56 | **25yr** |
| **50yr** | 0.63 | 1.01 | 1.30 | 1.82 | 2.45 | 3.19 | **50yr** | 2.11 | 2.81 | 3.73 | 4.67 | 5.78 | 7.07 | 8.12 | **50yr** | 6.26 | 7.81 | 8.92 | 10.52 | 11.32 | **50yr** |
| **100yr** | 0.73 | 1.18 | 1.51 | 2.14 | 2.91 | 3.81 | **100yr** | 2.51 | 3.33 | 4.46 | 5.59 | 6.91 | 8.43 | 9.76 | **100yr** | 7.46 | 9.39 | 10.71 | 12.60 | 13.39 | **100yr** |
| **200yr** | 0.83 | 1.36 | 1.76 | 2.51 | 3.47 | 4.56 | **200yr** | 2.99 | 3.95 | 5.35 | 6.71 | 8.27 | 10.06 | 11.75 | **200yr** | 8.90 | 11.30 | 12.86 | 15.09 | 15.85 | **200yr** |
| **500yr** | 1.01 | 1.65 | 2.16 | 3.13 | 4.38 | 5.79 | **500yr** | 3.78 | 4.96 | 6.81 | 8.53 | 10.49 | 12.71 | 15.02 | **500yr** | 11.25 | 14.44 | 16.40 | 19.18 | 19.83 | **500yr** |

## Lower Confidence Limits

| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1yr** | 0.23 | 0.35 | 0.43 | 0.58 | 0.71 | 0.82 | **1yr** | 0.61 | 0.81 | 1.05 | 1.44 | 1.77 | 2.28 | 2.44 | **1yr** | 2.02 | 2.35 | 2.83 | 3.48 | 3.95 | **1yr** |
| **2yr** | 0.33 | 0.51 | 0.63 | 0.85 | 1.05 | 1.25 | **2yr** | 0.91 | 1.23 | 1.43 | 1.88 | 2.42 | 3.07 | 3.38 | **2yr** | 2.72 | 3.25 | 3.68 | 4.47 | 5.08 | **2yr** |
| **5yr** | 0.38 | 0.59 | 0.73 | 1.00 | 1.27 | 1.48 | **5yr** | 1.10 | 1.45 | 1.72 | 2.23 | 2.86 | 3.68 | 4.07 | **5yr** | 3.26 | 3.91 | 4.49 | 5.41 | 6.08 | **5yr** |
| **10yr** | 0.42 | 0.65 | 0.81 | 1.13 | 1.46 | 1.68 | **10yr** | 1.26 | 1.64 | 1.87 | 2.52 | 3.21 | 4.20 | 4.66 | **10yr** | 3.72 | 4.48 | 5.08 | 6.27 | 6.94 | **10yr** |
| **25yr** | 0.49 | 0.74 | 0.92 | 1.31 | 1.73 | 1.97 | **25yr** | 1.49 | 1.93 | 2.18 | 2.96 | 3.77 | 4.99 | 5.57 | **25yr** | 4.42 | 5.35 | 5.92 | 7.60 | 8.26 | **25yr** |
| **50yr** | 0.53 | 0.81 | 1.01 | 1.45 | 1.95 | 2.23 | **50yr** | 1.68 | 2.18 | 2.44 | 3.35 | 4.25 | 5.67 | 6.34 | **50yr** | 5.02 | 6.10 | 6.58 | 8.80 | 9.45 | **50yr** |
| **100yr** | 0.58 | 0.88 | 1.10 | 1.59 | 2.18 | 2.52 | **100yr** | 1.88 | 2.47 | 2.73 | 3.36 | 4.81 | 6.44 | 7.19 | **100yr** | 5.70 | 6.92 | 7.28 | 10.20 | 10.81 | **100yr** |
| **200yr** | 0.64 | 0.96 | 1.22 | 1.76 | 2.46 | 2.85 | **200yr** | 2.12 | 2.79 | 3.06 | 3.71 | 5.44 | 7.30 | 8.14 | **200yr** | 6.46 | 7.83 | 7.97 | 11.83 | 12.35 | **200yr** |
| **500yr** | 0.72 | 1.08 | 1.39 | 2.02 | 2.87 | 3.35 | **500yr** | 2.47 | 3.28 | 3.56 | 4.23 | 6.43 | 8.60 | 9.54 | **500yr** | 7.61 | 9.17 | 8.80 | 14.41 | 14.76 | **500yr** |

## Upper Confidence Limits

| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1yr** | 0.32 | 0.49 | 0.60 | 0.81 | 0.99 | 1.18 | **1yr** | 0.85 | 1.15 | 1.36 | 1.80 | 2.27 | 2.81 | 3.14 | **1yr** | 2.49 | 3.02 | 3.45 | 4.17 | 4.84 | **1yr** |
| **2yr** | 0.37 | 0.57 | 0.70 | 0.95 | 1.17 | 1.37 | **2yr** | 1.01 | 1.34 | 1.57 | 2.07 | 2.65 | 3.24 | 3.58 | **2yr** | 2.87 | 3.45 | 4.02 | 4.69 | 5.35 | **2yr** |
| **5yr** | 0.45 | 0.70 | 0.86 | 1.19 | 1.51 | 1.80 | **5yr** | 1.30 | 1.76 | 2.03 | 2.62 | 3.32 | 4.27 | 4.78 | **5yr** | 3.78 | 4.59 | 5.26 | 6.20 | 6.91 | **5yr** |
| **10yr** | 0.54 | 0.83 | 1.03 | 1.44 | 1.86 | 2.23 | **10yr** | 1.61 | 2.18 | 2.58 | 3.17 | 3.98 | 5.29 | 5.98 | **10yr** | 4.68 | 5.75 | 6.54 | 7.68 | 8.44 | **10yr** |
| **25yr** | 0.70 | 1.06 | 1.32 | 1.89 | 2.48 | 2.96 | **25yr** | 2.14 | 2.89 | 3.44 | 4.08 | 5.06 | 7.04 | 8.08 | **25yr** | 6.23 | 7.77 | 8.80 | 10.18 | 11.01 | **25yr** |
| **50yr** | 0.84 | 1.28 | 1.59 | 2.29 | 3.08 | 3.67 | **50yr** | 2.66 | 3.59 | 4.27 | 4.94 | 6.08 | 8.76 | 10.16 | **50yr** | 7.76 | 9.77 | 11.05 | 12.61 | 13.46 | **50yr** |
| **100yr** | 1.02 | 1.54 | 1.94 | 2.80 | 3.83 | 4.55 | **100yr** | 3.31 | 4.44 | 5.31 | 6.67 | 7.30 | 10.93 | 12.80 | **100yr** | 9.67 | 12.31 | 13.93 | 15.63 | 16.45 | **100yr** |
| **200yr** | 1.24 | 1.87 | 2.36 | 3.42 | 4.77 | 5.64 | **200yr** | 4.12 | 5.51 | 6.62 | 8.23 | 8.75 | 13.64 | 16.15 | **200yr** | 12.07 | 15.53 | 17.63 | 19.37 | 20.09 | **200yr** |
| **500yr** | 1.61 | 2.40 | 3.09 | 4.48 | 6.38 | 7.46 | **500yr** | 5.50 | 7.29 | 8.85 | 10.88 | 11.14 | 18.35 | 21.99 | **500yr** | 16.24 | 21.15 | 24.17 | 25.74 | 26.21 | **500yr** |

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United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

# Custom Soil Resource Report for Middlesex County, Massachusetts


July 19, 2021

# Preface

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

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

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

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

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

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

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# Contents

# How Soil Surveys Are Made

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

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

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

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

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

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

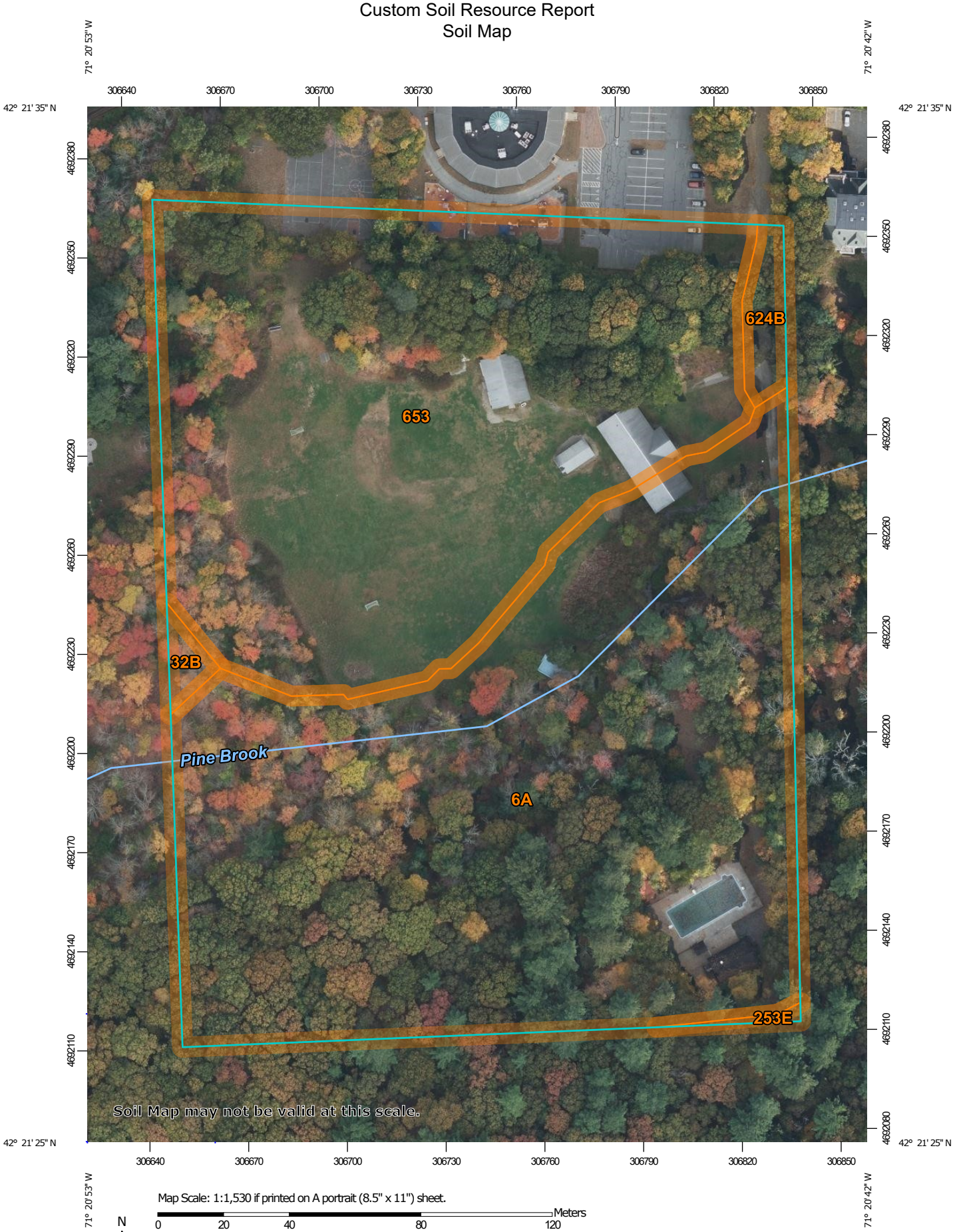
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

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

# Custom Soil Resource Report
## Soil Map




Map Scale: 1:1,530 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

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

**Background**
- Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 20, Jun 9, 2020

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

Date(s) aerial images were photographed: Oct 4, 2020—Oct 19, 2020

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

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 6A | Scarboro mucky fine sandy loam, 0 to 3 percent slopes | 6.3 | 53.5% |
| 32B | Wareham loamy fine sand, 0 to 5 percent slopes | 0.1 | 0.6% |
| 253E | Hinckley loamy sand, 25 to 35 percent slopes | 0.0 | 0.2% |
| 624B | Haven-Urban land complex, 0 to 8 percent slopes | 0.2 | 1.3% |
| 653 | Udorthents, sandy | 5.2 | 44.5% |
| **Totals for Area of Interest** | | **11.7** | **100.0%** |

# Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

# Middlesex County, Massachusetts

## 6A—Scarboro mucky fine sandy loam, 0 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 2svky
*Elevation:* 0 to 1,320 feet
*Mean annual precipitation:* 36 to 71 inches
*Mean annual air temperature:* 39 to 55 degrees F
*Frost-free period:* 140 to 250 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

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

### Description of Scarboro

#### Setting

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

#### Typical profile

*Oe - 0 to 3 inches:* mucky peat
*A - 3 to 11 inches:* mucky fine sandy loam
*Cg1 - 11 to 21 inches:* sand
*Cg2 - 21 to 65 inches:* gravelly coarse sand

#### Properties and qualities

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Very poorly drained
*Runoff class:* Negligible
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (1.42 to 14.17 in/hr)
*Depth to water table:* About 0 to 2 inches
*Frequency of flooding:* None
*Frequency of ponding:* Frequent
*Maximum salinity:* Nonsaline (0.0 to 1.9 mmhos/cm)
*Available water capacity:* Low (about 4.7 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 5w
*Hydrologic Soil Group:* A/D
*Ecological site:* F144AY031MA - Very Wet Outwash
*Hydric soil rating:* Yes

**Minor Components**

**Swansea**

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

**Walpole**

*Percent of map unit:* 5 percent
*Landform:* Depressions, deltas, outwash plains, depressions, outwash terraces
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Tread, dip, talf
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* Yes

**Wareham**

*Percent of map unit:* 5 percent
*Landform:* Depressions
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* Yes

## 32B—Wareham loamy fine sand, 0 to 5 percent slopes

**Map Unit Setting**

*National map unit symbol:* vqnd
*Elevation:* 0 to 2,100 feet
*Mean annual precipitation:* 45 to 54 inches
*Mean annual air temperature:* 43 to 54 degrees F
*Frost-free period:* 145 to 240 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

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

**Description of Wareham**

**Setting**

*Landform:* Depressions, deltas, terraces
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Tread, dip
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Loose sandy glaciofluvial deposits

**Typical profile**

*H1 - 0 to 10 inches:* loamy fine sand
*H2 - 10 to 24 inches:* loamy sand
*H3 - 24 to 34 inches:* stratified sand to fine sand
*H4 - 34 to 65 inches:* stratified coarse sand to sand

**Properties and qualities**

*Slope:* 0 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Poorly drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* About 6 to 18 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Low (about 4.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4w
*Hydrologic Soil Group:* A/D
*Ecological site:* F144AY028MA - Wet Outwash
*Hydric soil rating:* Yes

**Minor Components**

**Sudbury**

*Percent of map unit:* 10 percent
*Landform:* Plains, terraces
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Tread, dip
*Down-slope shape:* Linear
*Across-slope shape:* Concave
*Hydric soil rating:* No

**Scarboro**

*Percent of map unit:* 5 percent
*Landform:* Terraces
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Hydric soil rating:* Yes

**Deerfield**

*Percent of map unit:* 5 percent
*Landform:* Deltas, stream terraces, depressions
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Tread, dip
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* No

## 253E—Hinckley loamy sand, 25 to 35 percent slopes

### Map Unit Setting

*National map unit symbol:* 2svmf
*Elevation:* 0 to 1,200 feet
*Mean annual precipitation:* 36 to 71 inches
*Mean annual air temperature:* 39 to 55 degrees F
*Frost-free period:* 140 to 240 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

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

### Description of Hinckley

#### Setting

*Landform:* Outwash plains, kames, eskers, moraines, outwash terraces, outwash deltas, kame terraces
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Nose slope, side slope, crest, head slope, riser
*Down-slope shape:* Convex, linear, concave
*Across-slope shape:* Linear, convex, concave
*Parent material:* Sandy and gravelly glaciofluvial deposits derived from gneiss and/or granite and/or schist

#### Typical profile

*Oe - 0 to 1 inches:* moderately decomposed plant material
*A - 1 to 8 inches:* loamy sand
*Bw1 - 8 to 11 inches:* gravelly loamy sand
*Bw2 - 11 to 16 inches:* gravelly loamy sand
*BC - 16 to 19 inches:* very gravelly loamy sand
*C - 19 to 65 inches:* very gravelly sand

#### Properties and qualities

*Slope:* 25 to 35 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Excessively drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to very high (1.42 to 99.90 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Maximum salinity:* Nonsaline (0.0 to 1.9 mmhos/cm)
*Available water capacity:* Low (about 3.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6e
*Hydrologic Soil Group:* A
*Ecological site:* F144AY022MA - Dry Outwash
*Hydric soil rating:* No

**Minor Components**

**Windsor**

*Percent of map unit:* 10 percent
*Landform:* Outwash plains, outwash terraces, outwash deltas, kames, eskers, moraines, kame terraces
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Nose slope, side slope, crest, head slope, riser
*Down-slope shape:* Convex, linear, concave
*Across-slope shape:* Linear, convex, concave
*Hydric soil rating:* No

**Merrimac**

*Percent of map unit:* 3 percent
*Landform:* Eskers, moraines, outwash plains, kames, outwash terraces, kame terraces
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope, head slope, nose slope, crest, riser
*Down-slope shape:* Linear, convex, concave
*Across-slope shape:* Convex, linear, concave
*Hydric soil rating:* No

**Sudbury**

*Percent of map unit:* 2 percent
*Landform:* Outwash terraces, kame terraces, outwash plains, moraines, outwash deltas
*Landform position (two-dimensional):* Backslope, footslope, toeslope
*Landform position (three-dimensional):* Base slope, tread
*Down-slope shape:* Concave, linear
*Across-slope shape:* Linear, concave
*Hydric soil rating:* No

## 624B—Haven-Urban land complex, 0 to 8 percent slopes

**Map Unit Setting**

*National map unit symbol:* 9956
*Elevation:* 0 to 1,000 feet
*Mean annual precipitation:* 45 to 54 inches
*Mean annual air temperature:* 43 to 54 degrees F
*Frost-free period:* 145 to 240 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Haven and similar soils:* 45 percent
*Urban land:* 35 percent
*Minor components:* 20 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Haven**

**Setting**

*Landform:* Terraces, plains
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Tread, rise
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Friable loamy eolian deposits over loose sandy glaciofluvial deposits

**Typical profile**

*H1 - 0 to 2 inches:* silt loam
*H2 - 2 to 20 inches:* silt loam
*H3 - 20 to 32 inches:* very fine sandy loam
*H4 - 32 to 65 inches:* stratified coarse sand to sand to fine sand

**Properties and qualities**

*Slope:* 0 to 8 percent
*Depth to restrictive feature:* 18 to 36 inches to strongly contrasting textural stratification
*Drainage class:* Well drained
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water capacity:* Low (about 4.3 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 2e
*Hydrologic Soil Group:* A
*Ecological site:* F144AY023CT - Well Drained Outwash
*Hydric soil rating:* No

**Description of Urban Land**

**Setting**

*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Excavated and filled land

**Minor Components**

**Tisbury**

*Percent of map unit:* 10 percent
*Landform:* Plains, terraces

*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Tread, dip
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* No

**Merrimac**

*Percent of map unit:* 5 percent
*Landform:* Plains, terraces
*Landform position (two-dimensional):* Shoulder
*Landform position (three-dimensional):* Tread, rise
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Hydric soil rating:* No

**Hinckley**

*Percent of map unit:* 5 percent
*Landform:* Eskers, ridges, terraces
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear
*Across-slope shape:* Convex
*Hydric soil rating:* No

## 653—Udorthents, sandy

### Map Unit Setting

*National map unit symbol:* vr1k
*Elevation:* 0 to 3,000 feet
*Mean annual precipitation:* 32 to 50 inches
*Mean annual air temperature:* 45 to 50 degrees F
*Frost-free period:* 110 to 200 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Udorthents, sandy, and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Udorthents, Sandy

#### Setting

*Parent material:* Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

#### Properties and qualities

*Slope:* 0 to 25 percent
*Depth to restrictive feature:* More than 80 inches
*Depth to water table:* More than 80 inches

*Frequency of flooding:* None
*Frequency of ponding:* None

**Minor Components**

**Udorthents, loamy**
*Percent of map unit:* 5 percent
*Hydric soil rating:* No

**Urban land**
*Percent of map unit:* 5 percent
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear

**Unnamed**
*Percent of map unit:* 5 percent

# Soil Information for All Uses

## Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

## Soil Physical Properties

Soil Physical Properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

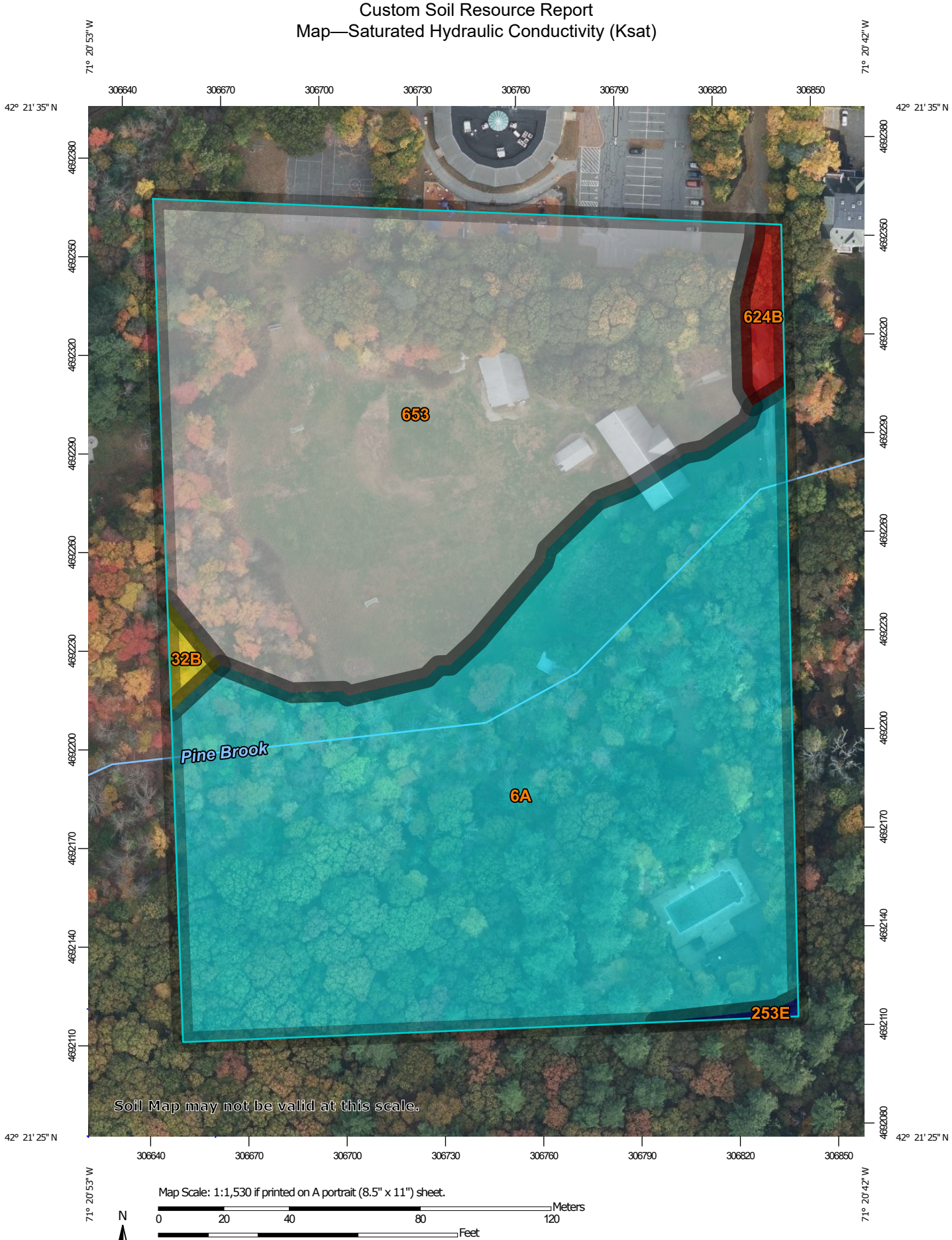
### Saturated Hydraulic Conductivity (Ksat)

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

# Custom Soil Resource Report
## Map—Saturated Hydraulic Conductivity (Ksat)




Map Scale: 1:1,530 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

- <= 69.0031
- > 69.0031 and <= 91.7400
- > 91.7400 and <= 93.3333
- > 93.3333 and <= 100.0000
- Not rated or not available

**Soil Rating Lines**

- <= 69.0031
- > 69.0031 and <= 91.7400
- > 91.7400 and <= 93.3333
- > 93.3333 and <= 100.0000
- Not rated or not available

**Soil Rating Points**

- <= 69.0031
- > 69.0031 and <= 91.7400
- > 91.7400 and <= 93.3333
- > 93.3333 and <= 100.0000
- Not rated or not available

**Water Features**

- Streams and Canals

**Transportation**

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

**Background**

- Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 20, Jun 9, 2020

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

Date(s) aerial images were photographed: Oct 4, 2020—Oct 19, 2020

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

### Table—Saturated Hydraulic Conductivity (Ksat)

| Map unit symbol | Map unit name | Rating (micrometers per second) | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 6A | Scarboro mucky fine sandy loam, 0 to 3 percent slopes | 93.3333 | 6.3 | 53.5% |
| 32B | Wareham loamy fine sand, 0 to 5 percent slopes | 91.7400 | 0.1 | 0.6% |
| 253E | Hinckley loamy sand, 25 to 35 percent slopes | 100.0000 | 0.0 | 0.2% |
| 624B | Haven-Urban land complex, 0 to 8 percent slopes | 69.0031 | 0.2 | 1.3% |
| 653 | Udorthents, sandy | | 5.2 | 44.5% |
| **Totals for Area of Interest** | | | **11.7** | **100.0%** |

### Rating Options—Saturated Hydraulic Conductivity (Ksat)

*Units of Measure:* micrometers per second

*Aggregation Method:* Dominant Component

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Fastest

*Interpret Nulls as Zero:* No

*Layer Options (Horizon Aggregation Method):* Depth Range (Weighted Average)

*Top Depth:* 12

*Bottom Depth:* 120

*Units of Measure:* Centimeters

# Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

## Hydrologic Soil Group

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

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

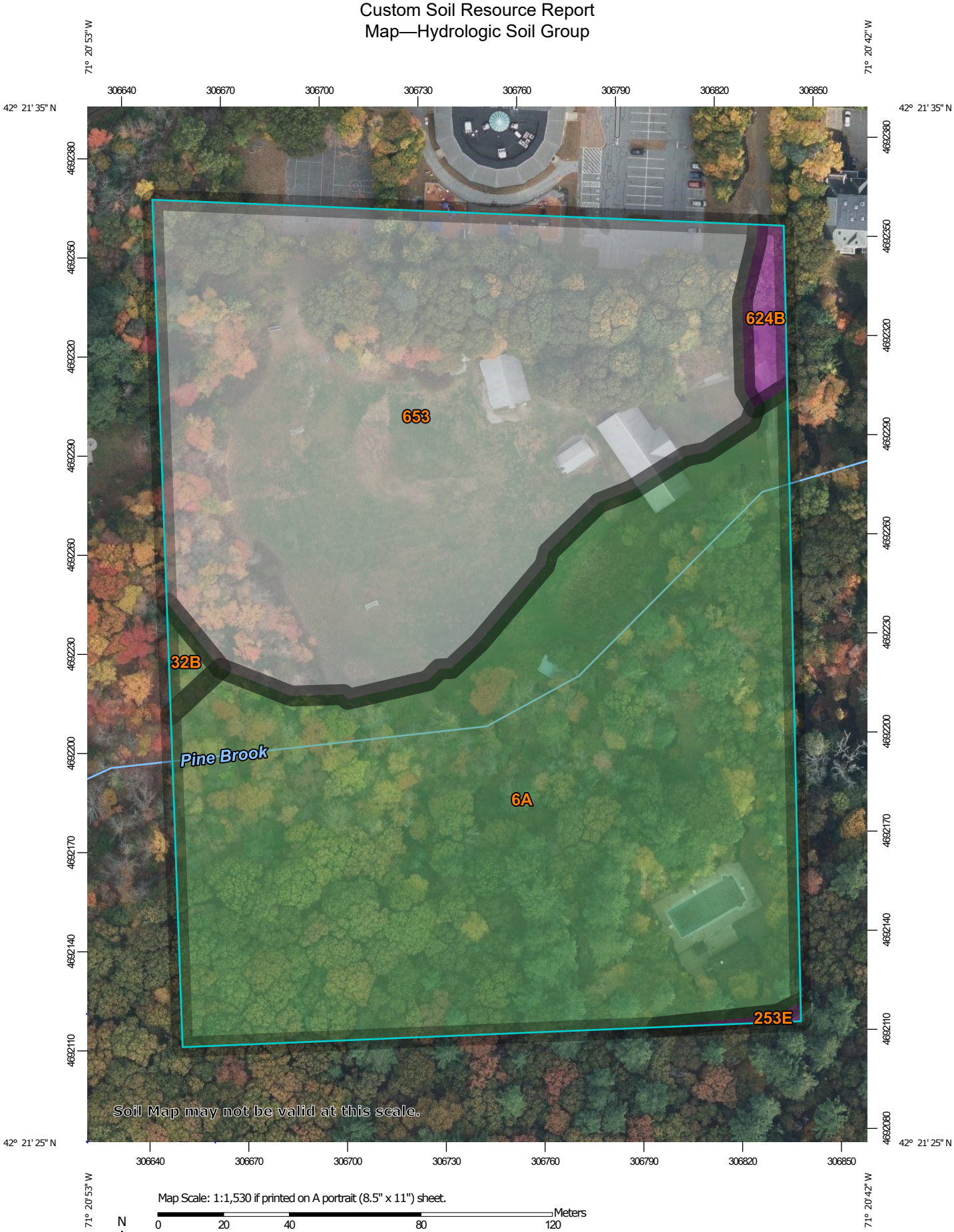
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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

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

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

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




Map Scale: 1:1,530 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 20 40 80 120

Feet
0 50 100 200 300

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

## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Lines**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Points**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Water Features**

Streams and Canals

**Transportation**

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

**Background**

Aerial Photography

## MAP INFORMATION

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

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Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 20, Jun 9, 2020

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

Date(s) aerial images were photographed: Oct 4, 2020—Oct 19, 2020

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

## Table—Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 6A | Scarboro mucky fine sandy loam, 0 to 3 percent slopes | A/D | 6.3 | 53.5% |
| 32B | Wareham loamy fine sand, 0 to 5 percent slopes | A/D | 0.1 | 0.6% |
| 253E | Hinckley loamy sand, 25 to 35 percent slopes | A | 0.0 | 0.2% |
| 624B | Haven-Urban land complex, 0 to 8 percent slopes | A | 0.2 | 1.3% |
| 653 | Udorthents, sandy | | 5.2 | 44.5% |
| **Totals for Area of Interest** | | | **11.7** | **100.0%** |

## Rating Options—Hydrologic Soil Group

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

**Commonwealth of Massachusetts**
**City/Town of** Wayland

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

## A. Facility Information

West Suburban YMCA - Camp Chickami
Owner Name

139 Boston Post Road
Street Address

Map 29 / Lot 42
Map/Lot #

Wayland
City

MA
State

01778
Zip Code

## B. Site Information

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

2. Soil Survey Available? ☒ Yes ☐ No If yes: USDA NRCS (Source) 310C (Soil Map Unit)

Udorthents, sandy (653)
Soil Name

None listed
Soil Limitations

Glacial Outwash
Soil Parent material

Proglacial Outwash
Landform

3. Surficial Geological Report Available? ☐ Yes ☒ No If yes: (Year Published/Source) (Map Unit)

Description of Geologic Map Unit:

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

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: N/A (Wetland Type)

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

8. Other references reviewed: Topographic survey and wetland delineation performed by Allen & Major Associates, September 2020

**Commonwealth of Massachusetts**
**City/Town of** Wayland

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

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

**Deep Observation Hole Number:** TP1 (Hole #) | 04-26-21 (Date) | 10:30 a.m. (Time) | Clear, 45 degrees (Weather) | 42.359609 (Latitude) | -71.347257 (Longitude:)

1. Land Use: YMCA Camp facility (e.g., woodland, agricultural field, vacant lot, etc.) | grass (Vegetation) | none (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

Description of Location:

2. Soil Parent Material: Glacial Outwash | Proglacial outwash (Landform) | (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >200 feet | Drainage Way >100 feet | Wetlands >100 feet | Property Line 55 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: None Depth Weeping from Pit | None Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-29" | HTM | - | - | - | - | - | - | - | - | Dry | |
| 29-36" | Ab | Sandy Loam | 10YR 3/3 | - | - | - | - | - | Massive Friable | Dry | |
| 36-42" | Bw | Fine Loamy Sand | 2.5YR 5/6 | - | - | - | - | - | Massive Friable | Dry | - |
| 42-120" | C | Fine Loamy Sand | 2.5Y 5/4 | 80" | 2.5YR 5/6 2.5Y 7/4 | 5% | - | - | Massive Friable | Dry to Moist | One lense of coarse sand around 100" depth |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes:
HTM (Fill layer) is consistent with C-horizon. On-site material may have been used to level the grade.

**Commonwealth of Massachusetts**
**City/Town of** Wayland

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

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

**Deep Observation Hole Number:** TP2 (Hole #) | 04-26-21 (Date) | 10:45 a.m. (Time) | Clear, 45 degrees (Weather) | 42.359609 (Latitude) | -71.347257 (Longitude:)

1. Land Use: YMCA Camp facility (e.g., woodland, agricultural field, vacant lot, etc.) | paved (Vegetation) | none (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

Description of Location: See attached sketch

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

3. Distances from: Open Water Body >200 feet | Drainage Way >100 feet | Wetlands >100 feet | Property Line 50 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: None Depth Weeping from Pit | None Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA) | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-20" | HTM | - | - | - | - | - | - | - | - | Dry | |
| 20-124" | C | Fine Loamy Sand | 2.5Y 5/4 | 84" | 2.5YR 5/6 2.5Y 7/4 | 5% | - | - | Massive Friable | Dry to Moist | |
| | | | | | | | | | | | |
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Additional Notes:
HTM (Fill layer) consisted of pavement gravel base placed directly on the C-horizon

**Commonwealth of Massachusetts**
**City/Town of** Wayland

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

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

**Deep Observation Hole Number:** TP3 (Hole #) | 10-19-21 (Date) | 9:45 a.m. (Time) | Clear, 50 degrees (Weather) | 42.359704 (Latitude) | -71.347538 (Longitude:)

1. Land Use: YMCA Camp facility (e.g., woodland, agricultural field, vacant lot, etc.) | grass (Vegetation) | none (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

Description of Location:

2. Soil Parent Material: Glacial Outwash | Landform: Proglacial outwash | Position on Landscape (SU, SH, BS, FS, TS):

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

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: None Depth Weeping from Pit | None Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-4" | HTM | - | - | - | - | - | - | - | - | Dry | - |
| 4-9" | Bw | Fine Loamy Sand | 10YR 4/3 | - | - | - | - | - | Massive Friable | Dry | - |
| 9-132" | C | Fine Loamy Sand | 2.5YR 5/4 | 84" | 5YR 5/8 2.5Y 7/3 | 5% | - | - | Massive Friable | Dry to Moist | - |
| | | | | | | | | | | | |
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Additional Notes:
HTM (Fill layer) is from the bocci ball court.

**Commonwealth of Massachusetts**
**City/Town of** Wayland

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

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

**Deep Observation Hole Number:** TP4 (Hole #) | 10-19-21 (Date) | 10:15 a.m. (Time) | Clear, 45 degrees (Weather) | 42.359387 (Latitude) | -71.346947 (Longitude:)

1. Land Use: YMCA Camp facility (e.g., woodland, agricultural field, vacant lot, etc.) | wooded (Vegetation) | none (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

Description of Location:

2. Soil Parent Material: Glacial Outwash | Proglacial outwash (Landform) | (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >200 feet | Drainage Way >100 feet | Wetlands >70 feet | Property Line 15 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: None Depth Weeping from Pit | None Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-4" | HTM | - | - | - | - | - | - | - | - | Dry | |
| 4-8" | Bw | Fine Loamy Sand | 10YR 3/3 | - | - | - | - | - | Massive Friable | Dry | |
| 8-116" | C | Fine Loamy Sand | 2.5YR 5/4 | - | - | - | - | 5% | Massive Friable | Dry | - |
| | | | | | | | | | | | |
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Additional Notes:
Test pit performed for stormwater management, no perc test was performed.

**Commonwealth of Massachusetts**
**City/Town of** Wayland

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

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

**Deep Observation Hole Number:** TP5 (Hole #) | 10-19-21 (Date) | 10:45 a.m. (Time) | Clear, 45 degrees (Weather) | 42.359322 (Latitude) | -71.347923 (Longitude:)

1. Land Use: YMCA Camp facility (e.g., woodland, agricultural field, vacant lot, etc.) | wooded (Vegetation) | few (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

Description of Location: See attached sketch

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

3. Distances from: Open Water Body >200 feet | Drainage Way >100 feet | Wetlands >75 feet
Property Line 75 feet | Drinking Water Well >100 feet | Other _____ feet

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

5. Groundwater Observed: ☐ Yes ☒ No If yes: None Depth Weeping from Pit | None Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA) | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-2" | A | Fine Loamy Sand | 7.5YR 3/3 | - | - | - | - | - | Massive Friable | Dry | |
| 2-12" | Bw | Fine Loamy Sand | 7.5YR 3/4 | - | - | - | - | - | Massive Friable | Dry | |
| 12-96" | C | Fine Loamy Sand | 2.5Y 5/4 | 52" | 5YR 5/8 2.5Y7/3 | 5% | - | - | Massive Friable | Dry to Moist | |
| | | | | | | | | | | | |
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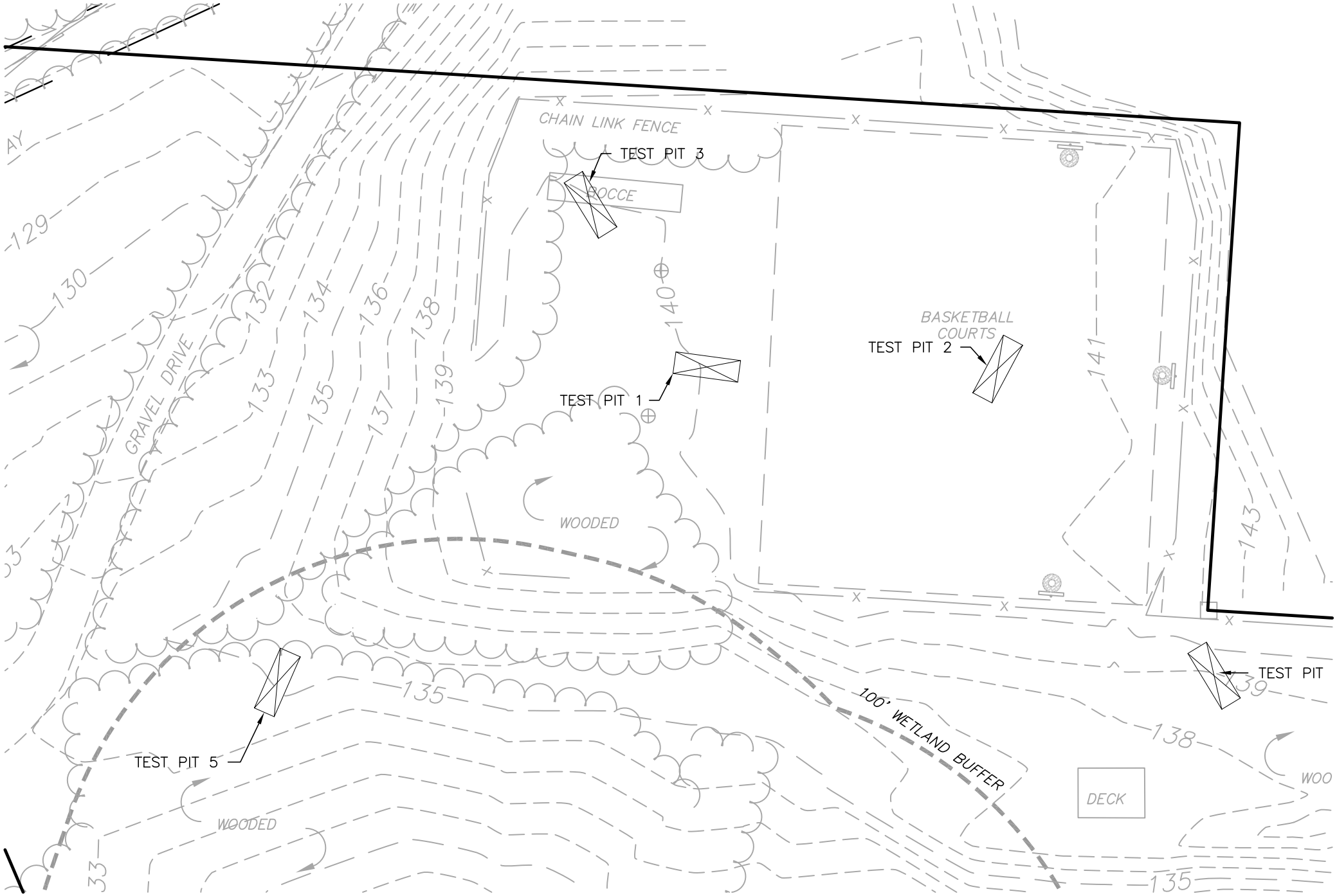
Additional Notes:
Test pit performed for stormwater management, no perc test was performed.


CHAIN LINK FENCE
TEST PIT 3
BOCCE
BASKETBALL COURTS
TEST PIT 2
TEST PIT 1
GRAVEL DRIVE
WOODED
TEST PIT 5
TEST PIT
100' WETLAND BUFFER
DECK
WOODED
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NDS®
We put water in its place

# EZ Roll™ Grass Pavers

## Technical Specifications Guide

### Model Numbers

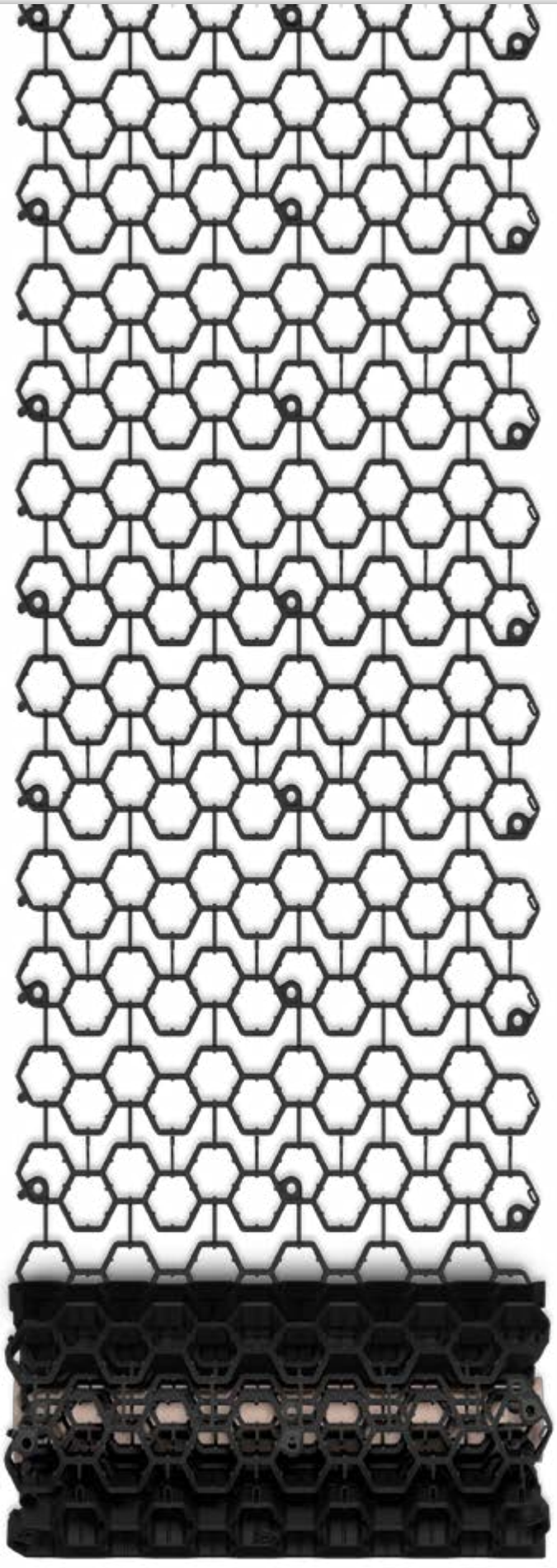
EZ4X24
EZ4X150
EZ13X150
EZ1.5X150

ndspro.com

MADE IN USA

# Table of Contents



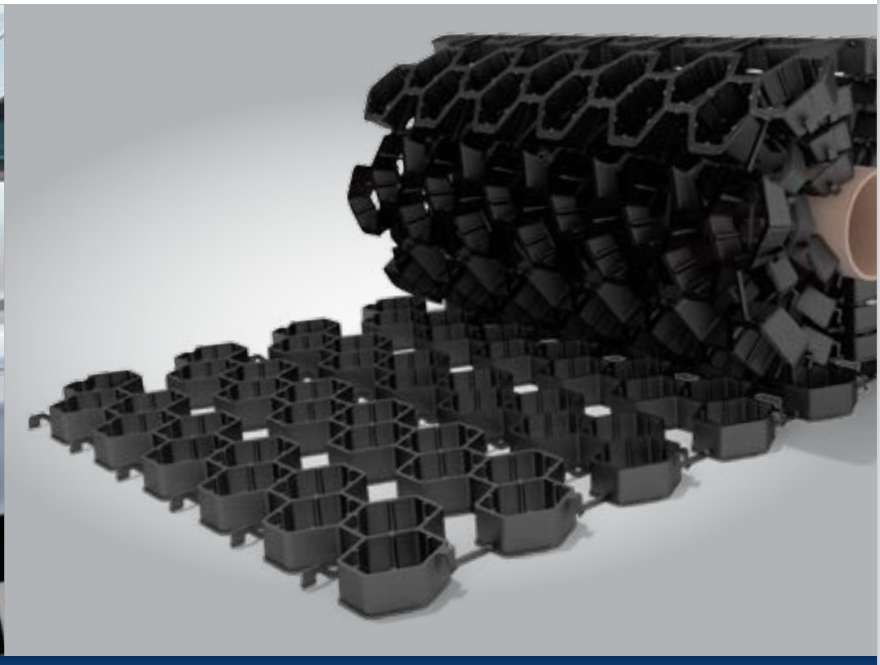


# EZ Roll™ Grass Pavers

## A turf reinforcement, load transferring paving system designed to be placed directly on an engineer specified compacted road base.

This system is designed to transfer vehicle weight directly to the supportive base course and prevent soil compaction. The web of interconnected honeycomb cells provides resistance from vehicular load as well as lateral containment that prevents the soil compaction that would inhibit healthy root growth. This system also provides a porous condition that allows rapid absorption of storm water. When properly installed according to the instructions in this guide, EZ Roll™ Grass Pavers provide a structural, green surface capable of supporting H-20 loads in a saturated condition. The 1" deep hexagonal cells of the EZ Roll™ Grass Paver are arranged in a double-row configuration that spans the width of the roll. This configuration reduces the risk of grid displacement from the torsional effects of the turning tires of a stationary vehicle. EZ Roll™ Grass Pavers have a compressive strength of 57,888 psf in an empty condition and greater than 500,000 psf when filled. The EZ Roll™ Grass Paver system has been used and accepted across the country for a wide variety of projects including emergency vehicle access purposes.

Additional information, details, and specifications can be found at
http://www.ndspro.com/permeable-pavers/grass-pavers/ez-roll-grass-pavers
For further technical support or assistance, contact: techservice@ndspro.com



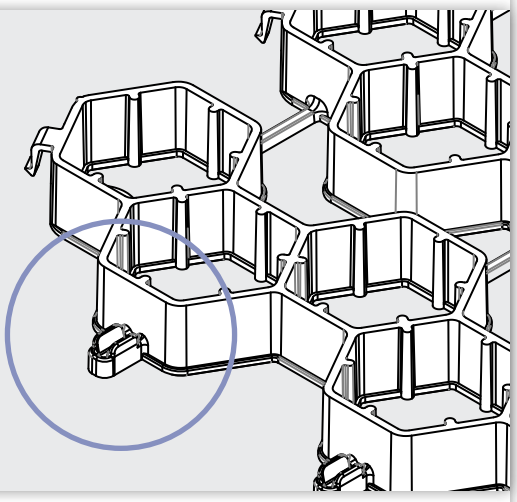
# Product Description

## Design Theory

The EZ Roll™ Grass Paver comes in pre-assembled rolls, which means it is easy to roll out, decreasing installation time and increasing efficiency.

EZ Roll™ Grass Paver has been tested for compressive strength at 57,888 psf bare product, meaning that EZ Roll™ does not rely on the fill material for load carrying.

Connections between rows of EZ Roll™ are secure due to unique side-to-side and end-to-end clips that minimize the paver mat movement and separation due to lateral and horizontal pressure. These sturdy locking clips prevent paver displacement or mat failure that could result from traffic load movement or changing ground conditions.



## Recommended Use

**Light Loads:**
Golf Cart Paths
Jogging Tracks
Bike Paths
ATV Paths
Equestrian Parks
Trail Reinforcements
Runoff Areas

**Medium Loads:**
Roadway Shoulders
Residential Driveways
Parking Lots
Overflow Parking Area
Truck & Cart Wash-Down Areas
RV and Boat Access

**Heavy Loads/Fire Lane:**
Emergency Vehicle Access Roads
Service Vehicle Utility Roads
Equipment Yards

**Non-load Applications:**
Erosion Control on Slopes (staking recommended)
Erosion Control in Swales (staking recommended)

**Not Recommended for the Following:**
Traffic on slopes exceeding a 10% grade
To support tread driven vehicles

# Product Description

The EZ Roll™ Grass Pavers from NDS is the latest and most advanced product of its type on the market. NDS has used its years of experience in the landscaping industry to create a product with all of the most desirable features.

The EZ Roll™ Grass Paver has a combined series of 72 nested hexagonal cells per paver cell with 24 connecting clips. This unique combination provides superior stability and durability.

## Product Specifications

**Material.** 100% recycled HDPE plastic (50% pre-consumer 50% post-consumer). HDPE is rugged, flexible and ideally suited for outside exposure and longevity. NDS uses UV inhibitors in the polymer structure to prevent breakdown in the strength of the paver.

**Manufacturing.** Manufactured in Lindsay, CA.

**Recyclability.** 100% recyclable. Please recycle whenever possible.

**Paver Size.** Each 24" x 24" panel contains 72, 2¼" nested hexagonal cells. Panels are integrated with crosslinks and clips to form rolls. Part No. EZ4X24 has dimensions of 4' x 24' per roll and EZ4X150 has dimensions of 4' x 150'. Custom size rolls available upon request.

**Weight Per Unit.** 2.31 pounds per 24" x 24" section.

**Paver Details.** The top surface of the hexagonal cell walls is smooth and devoid of notches or grooves. The bottom surface of the paver mat has over 80% open area for increased permeability.

**Assembly Mechanism.** 12 lateral snap locks per panel.

**Chemical Resistance.** EZ Roll™ Pavers have superior chemical resistance and are totally inert.

**Compressive Strength.** 57,888 lbs. (psf.) which is equal to 414 lbs. (psi.) For detailed specs see the Technical Specification part of this guide.

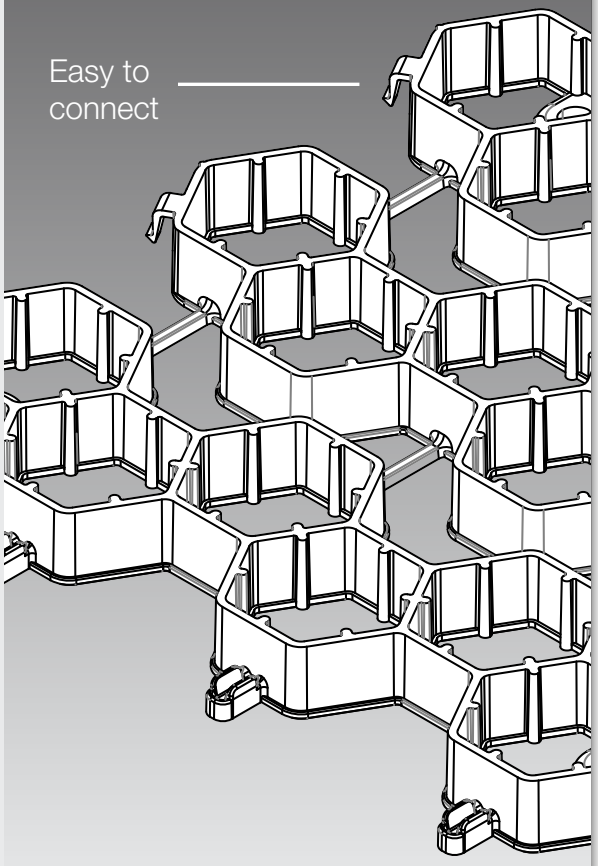
**Unique Product Features.** EZ Roll™ Pavers feature an easy to install top down locking feature. This locking mechanism allows pavers to be installed quickly and easily.

Empty cells have a compressive strength of

**57,888 psf**

Product ships in large rolls for easy rollout

Easy to connect



# Testing Methods

EZ Roll™ Grass Pavers undergo a battery of tests with each production run, as is the process with all products manufactured by NDS.

All the manufacturing tests are conducted within the manufacturing cycle to assure a quality-finished product.

## Fire Resistance

When tested in accordance with ASTM D 1929-96 and DIN 54836-1984, HDPE has an ignition temperature of 350-360°C or 662-680°F. HDPE does not support flame.

## Compression Tests

Compression tests were performed by Smith Emery Laboratories in Los Angeles, CA. Each sample paver was individually placed flat on the fixed 18' x 18' plate of a load testing machine. A load was then applied to the top surface of the paver, through a 12' x 12' steel plate until failure. The ultimate compressive strength of the paver is 57,888 pounds per square foot (bare product without fill material). This is over double that of an H-20 loading specification.

| Test Type | Test No. | Loading Plate | Max. Load (lbs.) | Remarks |
|---|---|---|---|---|
| **Unfilled Cell** | 1 | 12 x 12 | 57,888 | The wall of the paver cell buckled under pressure |
| | 2 | | 59,000 | |
| **Filled with Sand (clean concrete sand)** | 1 | 6 x 6 | 500,000+* | Paver cell was compressed down along with the sand |
| | 2 | | 500,000+* | |
| **Filled with Gravel (concrete pea gravel)** | 1 | 6 x 6 | 500,000+* | Paver cell was compressed down along with the gravel |
| | 2 | | 500,000+* | |
| **Filled with Soil (clay soil)** | 1 | 6 x 6 | 500,000+* | Paver cell crushed |
| | 2 | | 500,000+* | |

*Test maximum limit 500,000 lbs.



## Permeability

EZ Roll™ Grass Pavers provide a lower runoff coefficient, a prolonged time of concentration, a much higher rate of percolation and a cleaner runoff of storm water than concrete or asphalt.

When used over a rock and sand base with sandy loam soil (CN30), EZ Roll will promote a situation unlikely to generate surface runoff in an average rainstorm (less than 6" in 24 hours).

When EZ Roll is installed over clay soils (CN78), water absorptions will vary depending on the depth of the base course due to the storage capacity of the soil.

As per Technical release #55, US Department of Agriculture, Soil and Conservation Service, the evaluation of storm water management objective is done by the following method: calculate the pre-construction runoff volumes and time of concentration factors, calculate area runoff volumes, calculate runoff reduction and compare to Table 1 which lists runoff percentages from various soils based on 'meadow' type cover and a 24 hour rainfall.

| Runoff % – 24 Hour Rainfall Sand to Clay Soils | | | | |
|---|---|---|---|---|
| **Inches** | **CN30** | **CN58** | **CN71** | **CN78** |
| 1.0 | 0.0 | 0.0 | 0.01 | 0.06 |
| 1.2 | 0.0 | 0.0 | 0.03 | 0.10 |
| 1.4 | 0.0 | 0.0 | 0.05 | 0.14 |
| 1.6 | 0.0 | 0.0 | 0.08 | 0.18 |
| 1.8 | 0.0 | 0.01 | 0.11 | 0.21 |
| 2.0 | 0.0 | 0.02 | 0.13 | 0.24 |
| 2.5 | 0.0 | 0.05 | 0.20 | 0.32 |
| 3.0 | 0.0 | 0.09 | 0.25 | 0.38 |
| 4.0 | 0.0 | 0.17 | 0.35 | 0.47 |
| 5.0 | 0.0 | 0.23 | 0.42 | 0.54 |
| 6.0 | 0.01 | 0.29 | 0.48 | 0.60 |
| 7.0 | 0.03 | 0.34 | 0.53 | 0.64 |
| 8.0 | 0.05 | 0.39 | 0.57 | 0.67 |
| 9.0 | 0.08 | 0.43 | 0.61 | 0.70 |
| 10.0 | 0.10 | 0.46 | 0.64 | 0.73 |
| 11.0 | 0.12 | 0.49 | 0.66 | 0.75 |
| 12.0 | 0.15 | 0.52 | 0.68 | 0.76 |

# Technical Specifications

## ADA Compliancey

EZ Roll™ Grass Pavers meet the maneuverability performance requirements of ASTM F 1951-09b.
EZ Roll was installed and maintained according to the guidelines in this guide prior to testing.

The Americans with Disabilities Act (ADA) requires that all public areas be accessible to those with disabilities. This affects about 50 million people in this country. The Americans with Disabilities Act Accessibility Guidelines (ADAAG) specify that accessible routes must have ground and floor surfaces that are firm and stable. Surfaces that are not firm and stable limit accessibility for wheelchair, cane, crutch, walker users, parents with strollers, and other individuals with mobility limitations. Additionally, testing was conducted using a rotational penetrometer. The rotational penetrometer tests the surface for firmness and stability providing a baseline measurement that future measurements will be compared to.

| Straight Propulsion on EZ Roll™ Grass Paver | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 54.3 | 6.5 |
| Trial 2 | 54.5 | 6.9 |
| Trial 3 | 58.0 | 7.4 |
| Trial 4 | 48.6 | 7.4 |
| Trial 5 | 53.7 | 7.4 |
| Average work per meter (n=3) 54.2 N*m | | |

| Turning on EZ Roll™ Grass Paver | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 53.3 | 6.5 |
| Trial 2 | 50.6 | 6.5 |
| Trial 3 | 52.9 | 7.1 |
| Trial 4 | 50.9 | 7.1 |
| Trial 5 | 57.6 | 7.2 |
| Average work per meter (n=3) 52.4 N*m | | |

| Straight Propulsion on 7.1% Ramp | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 75.1 | 6.5 |
| Trial 2 | 74.3 | 6.4 |
| Trial 3 | 74.9 | 6.6 |
| Trial 4 | 71.1 | 6.6 |
| Trial 5 | 74.4 | 6.9 |
| Average work per meter (n=3) 74.5 N*m | | |

| Turning on 7.1% Ramp | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 57.1 | 7.7 |
| Trial 2 | 59.7 | 6.5 |
| Trial 3 | 59.6 | 7.2 |
| Trial 4 | 59.8 | 7.4 |
| Trial 5 | 59.7 | 7.3 |
| Average work per meter (n=3) 59.7 N*m | | |

Straight Propulsion Work Ratio 0.727

Turning Work Ratio 0.878

# Contribution to LEED

EZ Roll™ Grass Pavers can be used in a number of categories that contribute points to LEED certification according to LEED v3.

## Category: Sustainable Sites

**Credit 5.1 Site Development – Protect or Restore Habitat (1 credit):**
**Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.**

- To attain this credit, all site disturbances during construction must be limited to within a certain distance from the building perimeter. Use of EZ Roll™ Grass Paver extends the allowed area of site disturbance from 10 ft to 25 ft, thus providing more area to work during construction.
- EZ Roll™ Grass Paver seeded with native plants in place of asphalt or other non-pervious surfaces will contribute to the overall percentage of habitat restored.
- For projects that qualify for 5.2 (below), use of EZ Roll™ Grass Paver on a vegetated roof with native or adapted plants can contribute to overall percentage of habitat restored or protected.

**Credit 5.2 Site Development – Maximize Open Space (1 credit):**
**Provide a high ratio of open space to development footprint to promote biodiversity.**

- Application of EZ Roll™ Grass Paver provides vegetated open space that will contribute to the open space requirements.
- Use of EZ Roll™ Grass Paver on a vegetated roof can contribute to credit compliance.

**Credit 6.1 Stormwater Design – Quantity Control (1 credit):**
**Limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants.**

- EZ Roll™ Grass Paver can be utilized as part of a stormwater management plan as it reduces impervious cover, increases on-site infiltration, and reduces pollution from stormwater runoff.
- EZ Roll™ Grass Paver can be used to maintain a vegetated roof, which will minimize impervious surface area onsite.

**Credit 6.2 Stormwater Design – Quality Control (1 credit):**
**To limit disruption and pollution of natural water flows by managing stormwater runoff.**

- EZ Roll™ Grass Paver can be utilized as part of a stormwater management plan as it reduces impervious cover, increases on-site infiltration, and reduces pollution from stormwater runoff.

**Credit 7.1 Heat Island Effect – Nonroof (1 credit):**
**To reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.**

- As open grid pavement systems, the use of EZ Roll™ Grass Paver reduces heat absorption and contributes to the overall hardscaped area calculation for this credit.

**Credit 7.2 Heat Island Effect – Roof (1 credit):**
**To reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.**

- EZ Roll™ Grass Paver utilized on a vegetated roof can reduce heat absorption.

## Category: Materials and Resources

**Credit 4.1 Recycled Content: 10% (post-consumer + ½ pre-consumer) (1 credit):**
**Increase demand for the building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.**

- EZ Roll™ Grass Paver is made from 100% recycled HPPE (approximate blend is 50% post-consumer, 50% pre-consumer material). Utilization of this product will increase the proportion of materials used on site that are recycled, and can contribute towards attainment of this credit.

**Credit 4.2 Recycled Content: 20% (post-consumer + ½ pre-consumer) (1 credit):**
**Increase demand for the building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.**

- As cited in credit 4.1 (above), utilizing EZ Roll™ Grass Paver can contribute to the attainment of this credit, if used in a larger proportion on site relative to the proportion of materials that are not recycled.

## Pre-Installation

1. The installation of EZ Roll™ Grass pavers should occur after the completion of any nearby sprinkler systems or hardscape elements.
2. It is recommended to order approximately 5% additional product to the total required to offset for curves and other unforeseen variances.
3. Check with local fire authority for any inspection requirements for areas that may provide emergency vehicle access.
4. Reclaimed and back-filled areas may require compaction and testing before the base course is installed.
5. Percolation rates of underlying soil should be at least .25 inches of water per hour.
6. Water table should be at minimum 3 feet below base course.
7. Surrounding hardscape should be 1-2 inches higher than paver surface to allow for grass growth at the top of the paver structure.
8. Define the boundary of the proposed grid using string line.

## Base Course

The first decision in project planning must address the correct base construction that will support the maximum traffic load weight anticipated on the site. **The successful installation of EZ Roll™ Grass Pavers is directly correlated to the quality of the base foundation upon which it is installed.** To calculate the depth and composition of material for the base course consider: Load bearing capacity of subsoil, plasticity or impact of moisture, frost-heave potential, and volume of traffic.

**There are three basic options:**

1. Light Load – base shall be min. 4" of engineered road base or to engineer's specification and local code.
2. Medium Load – base shall be min. 6" of engineered road base or to engineer's specification and local code.
3. Heavy Load – base shall be min. 8" of engineered road base or to engineer's specification and local code, and fire authority's requirements.

## Base course options

NDS®
We put water in its place

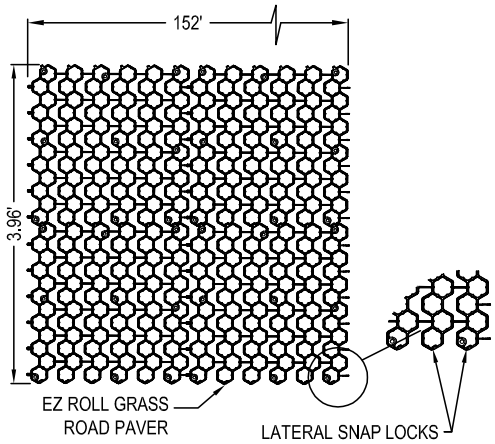
NDS, INC.
851 NORTH HARVARD AVE.
LINDSAY, CA 93247
TOLL FREE: 1-800-726-1994
PHONE: (559) 562-9888
FAX: (559) 562-4488
www.ndspro.com

**EZ ROLL GRASS PAVER PRODUCT DESCRIPTION**

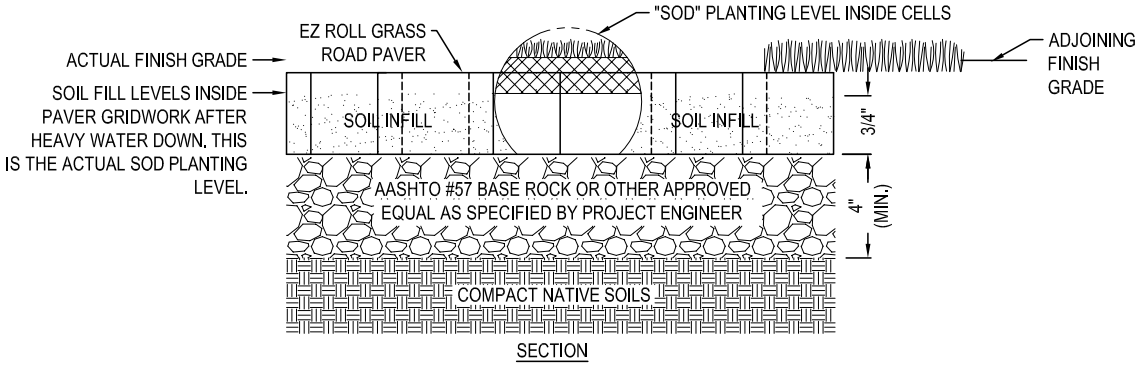
| | |
|---|---|
| **STOCK ROLL SIZE'S:** | 3.96'W X 24'L (95.1 SF)<br>3.96'W X 152'L(601.6 SQ. FT.) |
| **CUSTOM SIZES AVAILABLE UPON REQUEST:** | 1'-6" X 152' (228 SQ. FT.)<br>2' X 152' (304 SQ. FT.) |
| **NESTED HONEYCOMB CELL:** | 57, 888 PSF |
| **LAYOUT COMPRESSIVE STRENGTH (OPEN CELL NO FILL)** | 402 PSI<br>EXCEEDS H2O LOADING |

**GRASS SEED OR SOD:** TYPE TO BE AS SPECIFIED IN THE CONTRACT DOCUMENTS OR BY DESIGN LANDSCAPE ARCHITECT.

**SOIL INFILL:** THE COMPOSITION OF THE MATERIAL WILL BE BASED ON LOCAL CONDITIONS AND DETERMINED BY THE LANDSCAPE ARCHITECT OR AS SPECIFIED IN THE CONTRACT DOCUMENTS




PLAN VIEW




SECTION

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4. ALL INFORMATION CONTAINED HEREIN WAS CURRENT AT THE TIME OF DEVELOPMENT BUT MUST BE REVIEWED AND APPROVED BY THE PRODUCT MANUFACTURER TO BE CONSIDERED ACCURATE.

EZ ROLL GRASS PAVERS

LIGHT LOAD

NDS S5
KEY COMPONENT
www.ndspro.com/s5

REVISION DATE 8-24-2015

**Base course options (cont.):**

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851 NORTH HARVARD AVE.
LINDSAY, CA 93247
TOLL FREE: 1-800-726-1994
PHONE: (559) 562-9888
FAX: (559) 562-4488
www.ndspro.com

**EZ ROLL GRASS PAVER PRODUCT DESCRIPTION**

| | |
|---|---|
| **STOCK ROLL SIZE'S:** | 3.96'W X 24'L (95.1 SF)<br>3.96'W X 152'L(601.6 SQ. FT.) |
| **CUSTOM SIZES AVAILABLE UPON REQUEST:** | 1'-6" X 152' (228 SQ. FT.)<br>2' X 152' (304 SQ. FT.) |
| **NESTED HONEYCOMB CELL:** | 57, 888 PSF |
| **LAYOUT COMPRESSIVE STRENGTH (OPEN CELL NO FILL)** | 402 PSI<br>EXCEEDS H2O LOADING |

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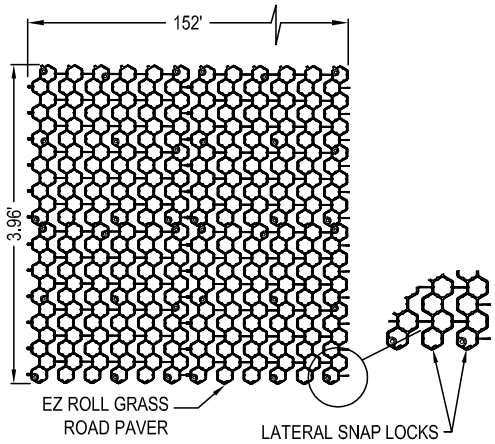
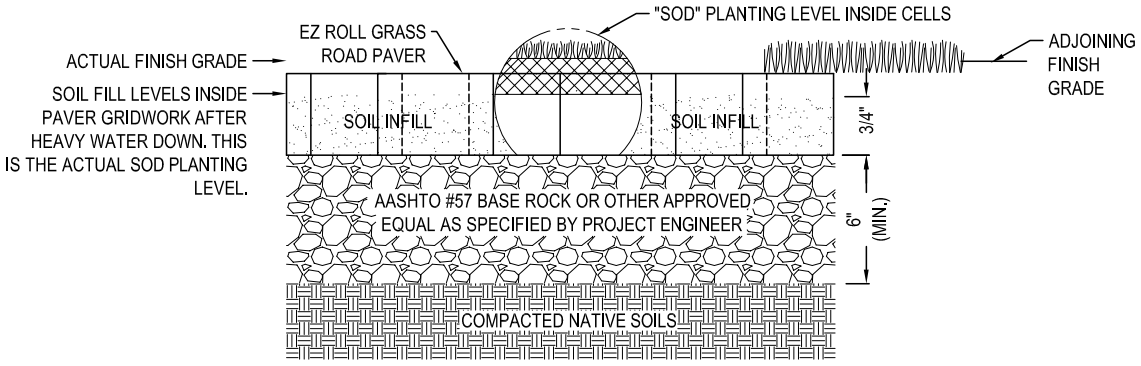



PLAN VIEW

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## EZ ROLL GRASS PAVERS

MEDIUM LOAD

NDS S5
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REVISION DATE 8-24-2015

**Base course options (cont.):**

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**EZ ROLL GRASS PAVER PRODUCT DESCRIPTION**

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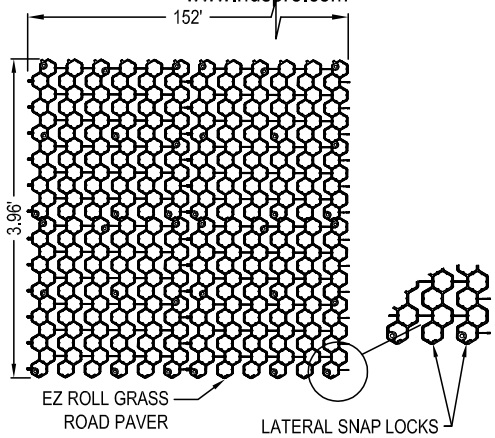


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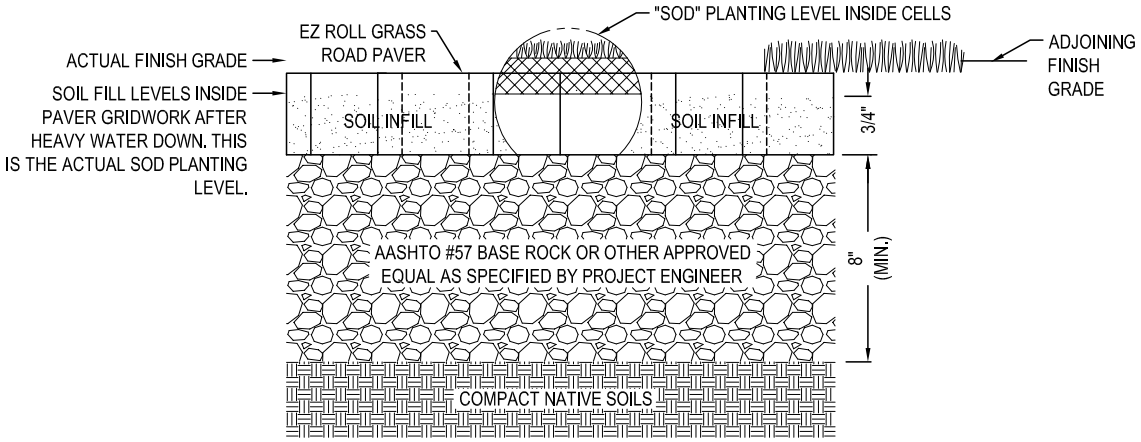


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EZ ROLL GRASS PAVERS

FIRE/HEAVY LOAD

NDS S5
KEY COMPONENT
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REVISION DATE 8-24-2015

## Traffic and Parking Considerations

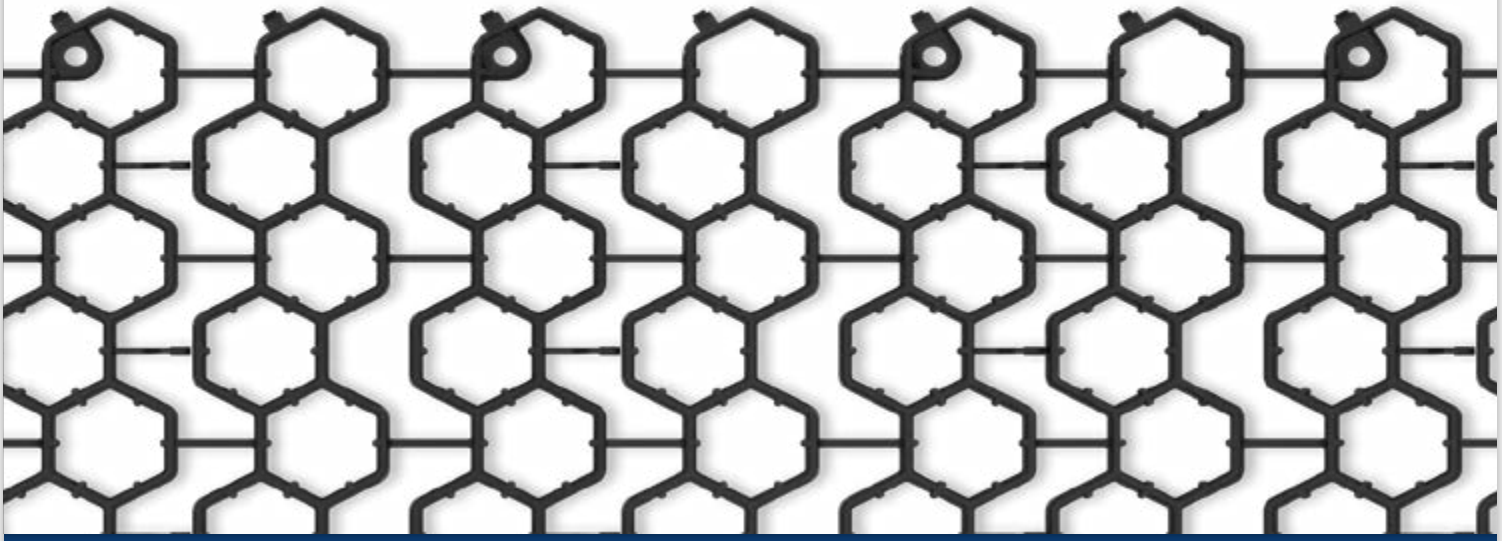
The height of the cell wall of EZ Roll™ Grass Pavers protects the root systems of turf. Frequent vehicular traffic does not harm the root structure because of the cell wall protection; however, the blades will be damaged in the event of heavy traffic from daily driving. If the area is to be used for daily parking, it is recommended that spots be rotated to allow grass to receive sunlight. Parking areas should be used less than daily or rotated.

## Root Penetration

The entire base and paver structure is designed to allow water to percolate into the soil quickly, while retaining strength. While the soil in the paver structure is important and is a source for nutrients and moisture, it is not the primary source. The main purpose of the base is to obtain 95% compaction while still allowing permeability.

## Staking Recommendations

Due to difficulty maintaining traction for motor vehicles on vegetated slopes, installing pavers on slopes between 5-10% requires staking. Installation on slopes greater than 10% should only be used for erosion control applications.



## Staking Recommendations

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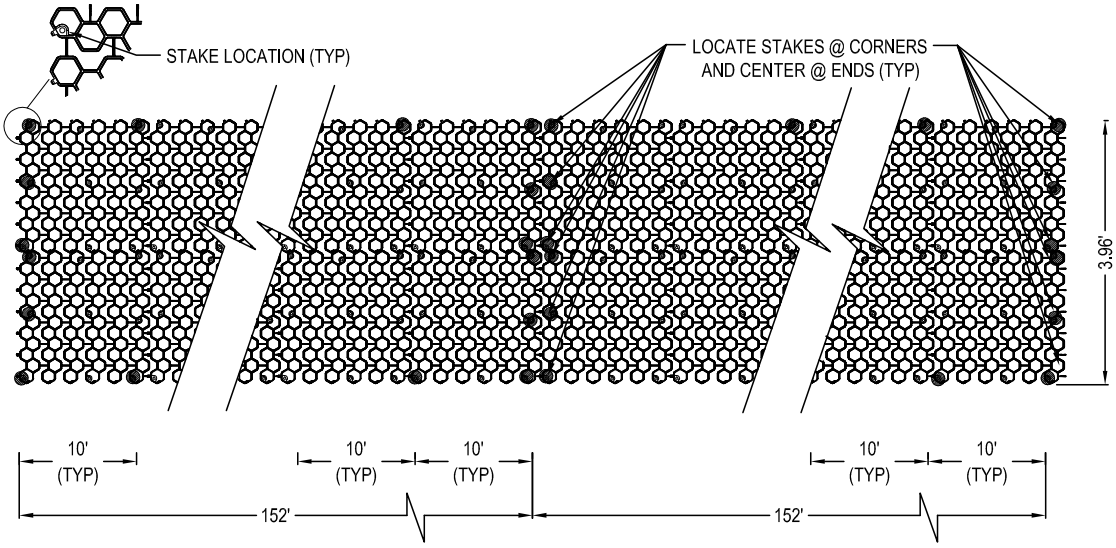


PLAN VIEW

NOTES:
1. STAKES TO BE INSERTED IN MOLDED STAKE LOCATION AS SHOWN ABV.
2. THE DIAGRAM ABV. IS DESIGNED FOR STRAIGHT LINE RUNS. MITERS, CUTS AND DIRECTIONAL CHANGES MAY REQUIRE ADDITIONAL STAKES. CONSULT YOUR LOCAL NDS DISTRIBUTOR, NDS REPRESENTATIVE OR CONTACT NDS TECHNICAL SERVICES @ NUMBER LISTED BLW.
3. STAKES ARE NOT INCLUDED, STAKES ARE REQUIRED TO BE ORDERED SEPARATELY THROUGH YOUR AUTHORIZED NDS REPRESENTATIVE USING PART # GP STAKE
4. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
5. DO NOT SCALE DRAWING.
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EZ ROLL GRASS PAVERS
STAKING

NDS S5
KEY COMPONENT
www.ndspro.com/s5

REVISION DATE 8-24-2015

## Markers

EZ Marker™ by NDS® is a modular solution to outline drive lanes, parking stalls, and fire lane edges for the EZ Roll™ family of permeable paver systems. After the pavers have been unrolled, pinned, and secured, EZ Marker™ snaps into the appropriate empty cells to outline whatever pattern necessary to properly direct vehicular traffic.

## Site Selection and Preparation

1. Remove all foreign top grade structures or objects, and excavate existing site soil to accommodate the base specified.
2. Install the base per architectural and/or engineering drawings and written specifications describing depth, load rating, construction materials, and required compaction.
3. Install with no more than a 6% grade for emergency access lanes or heavy vehicle access.
4. Install with no more than 10% grade when used for light vehicular traffic. Retention stakes must be installed in this application in a manner specified by a qualified architect or soils engineer.
5. Installations over 10% grades are for erosion resistance only. The installation of EZ Roll™ Grass Pavers on any type of slope should be pinned or staked to the soil in a manner specified by a qualified architect or soils engineer.

## Paver Assembly and Installation

1. The installation of EZ Roll™ Grass Pavers is generally done at the same time as other grass installation on the site and after the completion major area construction.
2. Ensure that the paver is installed right-side-up with the open cells facing up. Warranties are voided for pavers installed face down.
3. Roll out the first section of pavers where there is an available straight border or where there is the longest available single run.
4. Roll out additional rolls of pavers as needed to cover large areas and securely connect the lateral snap locks to create an integral paver mat.
5. Smaller areas can be filled in by attaching single sections of pavers (detached from another roll) to the already laid out paver mat.
6. Be sure to leave the recommended 1" clearance between the paver mat and any preinstalled fixed objects or surface structures.
7. The paver can be trimmed to fit any fixed object using garden shears, a hand saw, PVC pipe cutter, utility cutter, or appropriate power saw. Be sure to follow all manufacture's operation and safety recommendations.
8. For side-to-side clips, thread the clips from one panel to the slots in the adjacent panel, apply pressure until they snap in place.
9. For end-to-end clips, push down on butterfly tabs of clip with your thumb until clip snaps into receiving slot of the next panel.
10. After assembling the paver network, re-examine all paver fittings around surface utilities and bordering structures to assure 1" clearance. Do this prior to soil fill or planting.

## Paver Assembley and Installation

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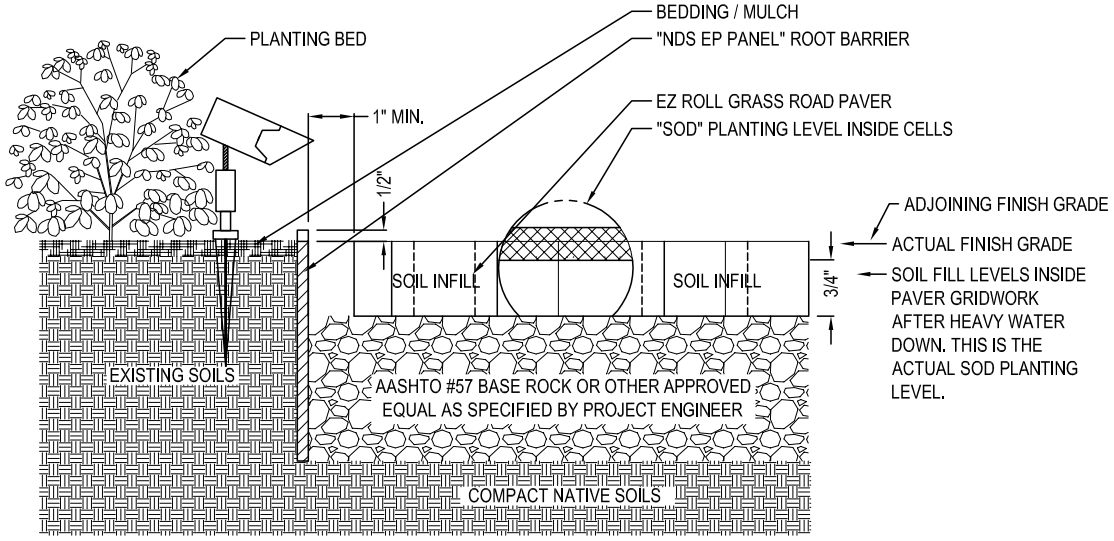


SECTION

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5. CONTRACTOR'S NOTE: FOR PRODUCT AND COMPANY INFORMATION VISIT www.caddetails.com/info AND ENTER REFERENCE NUMBER 558-136A.

EZ ROLL GRASS PAVERS

EDGING, TYPE 2

NDS S5
KEY COMPONENT
www.ndspro.com/s5

REVISION DATE 8-24-2015

## Planting

1. All EZ Roll™ Grass Pavers should be filled with soil and planted within 30 days.
2. Sandy loam, loam soil or soil specified by a soils engineer should be used to fill the empty grass paver cells. The selection of fill material should be made based upon the soil requirements of the turf selected for the project and local conditions.
3. Select a turf variety well suited to the anticipated traffic frequency and local growing conditions. Resistance to thatch build-up, drought and disease resistance should also be considered.
4. Seeded or sodded areas should be protected from non-emergency traffic for 4-6 weeks or until the grass is sufficiently established to handle traffic.
5. Grass paved areas must have irrigation systems sufficient to maintain healthy turf year round.
6. When planting trees nearby, it is advisable to install a root barrier around the root ball to prevent shallow roots from interfering with surface integrity or the road base.
7. When pavers are installed bisecting a large lawn or field to provide a service road, it is recommended to plant shrubs, trees, or EZ Marker™ to mark the ends and edges of the paved strip to guide the vehicle along the paved strip.

**Sod, Seed, Hydroseeding**

1. Sod
   a. The paver grid is filled with soil or sandy loam, leveled with rake to top of cell walls and watered moderately. If the fill settles below the top of the paver after watering, additional fill should be added until the cells are completely full. The soil is ready to have sod laid in a staggering pattern.
2. Seeding and HydroSeeding
   a. The paver grid is filled with soil or sandy loam, leveled with rake to top of cell walls and watered moderately. If the fill settles below the top of the paver after watering, additional fill should be added until the cells are completely full. The surface is now ready for seed and fertilizer to be broadcast or hydroseeded over the paver grid work.

## Maintenance Tips

- Utilize turf care and mowing practices that minimize the need for de-thatching:

  Planting turf that is resistant to thatch
  Collecting grass clippings when mowing
  Using slow release fertilizers
  Adopting deep watering irrigation techniques
- Do not aerate
- Utilizing skid shoes or raising the snow plow a minimum 2" above paver surface
- Do not use equipment intended for operation for thatching or scalping over the paver

# Product Guide Specification

**NDS, Inc. / April 2015**

851 North Harvard Avenue Lindsay, California 93247

Toll Free: 800-726-1994

Phone: 559-562-9888

Toll Free Fax: 800-726-1998

Fax: 559-562-4488

Website: www.ndspro.com

Email: nds@ndspro.com

Specifier Notes: This product guide specification is written in Construction Specifications Institute (CSI) 3-Part Format in accordance with *The CSI Construction Specifications Practice Guide*, including *MasterFormat, SectionFormat,* and *PageFormat.*

This section must be carefully reviewed and edited by the Architect to meet the requirements of the project and local building code. Coordinate this section with Division 1, other specification sections, and the Drawings. Delete all Specifier Notes after editing this section.

*Section numbers and titles are based on MasterFormat 2014 Update.*

# Section 32 12 43

**POROUS FLEXIBLE PAVING**

Specifier Notes: This section covers NDS, Inc. "EZ Roll" grass pavers to construct porous flexible paving. Consult NDS, Inc. for assistance in editing this section for the specific application.

Use of "EZ Roll" grass pavers may contribute to LEED credits. Consult NDS, Inc. for more information.

# Part 1 General

### 1.1 SECTION INCLUDES

A. Porous flexible paving using grass pavers.

### 1.2 RELATED REQUIREMENTS

Specifier Notes: Edit the following list of related sections as necessary. Limit the list to sections with specific information that the reader might expect to find in this section, but is specified elsewhere.

A. Section 31 20 00 – Earth Moving: Subgrade preparation.

B. Section 32 80 00 – Irrigation: Irrigation system.

C. Section 32 91 00 – Planting Preparation: Soil preparation.

Specifier Notes: Provide section number and title for method of planting grass specified in Part 3 of this section.

D. Section 32 92 _____ – _____: Grass.

E. Section 33 46 00 – Subdrainage: Subsurface drainage.

### 1.3 PRE-INSTALLATION MEETINGS

Specifier Notes: Edit pre-installation meetings as necessary. Delete if not required.

A. Convene pre-installation meeting [1 week] [2 weeks] before start of Work of this Section.

B. Require attendance of parties directly affecting Work of this Section, including Contractor, Architect, Installer, and Manufacturer's Representative.

C. Review the Following:

1. Materials
2. Protection of in-place conditions
3. Preparation
4. Installation
5. Adjusting
6. Protection
7. Coordination with other work

### 1.4 SUBMITTALS

Specifier Notes: Edit submittal requirements as necessary. Delete submittals not required.

A. Comply with Division 1.

B. Product Data: Submit manufacturer's product data, including preparation and installation instructions.

C. Samples: Submit manufacturer's sample of one 24-inch by 24-inch grass paver.

D. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

E. Sustainable Design Submittals: Submit manufacturer's sustainable design submittals for grass pavers.

1. Recycled Content: Certify percentages of post-consumer and pre-consumer recycled content.
2. Regional Materials: Certify distance between manufacturer and project, in miles.

F. Manufacturer's Project References: Submit manufacturer's list of successfully completed grass paver projects, including project name and location, name of architect, and type and quantity of grass pavers furnished.

G. Installer's Project References: Submit installer's list of successfully completed grass paver projects, including project name and location, name of architect, and type and quantity of grass pavers installed.

H. Warranty Documentation: Submit manufacturer's standard warranty.

### 1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer regularly engaged, for a minimum of 10 years, in the manufacturing of grass pavers of similar type to that specified.

B. Installer's Qualifications:

1. Installer regularly engaged, for a minimum of 5 years, in installation of grass pavers of similar type to that specified.
2. Employ persons trained for installation of grass pavers.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery Requirements: Deliver grass pavers to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage and Handling Requirements:

1. Store and handle grass pavers in accordance with manufacturer's instructions.
2. Keep grass pavers in manufacturer's original, unopened containers and packaging until installation.
3. Store grass pavers in clean areas, protected from exposure to harmful weather conditions.
4. Store grass pavers out of direct sunlight.
5. Protect grass pavers during storage, handling, and installation to prevent damage.

### 1.7 AMBIENT CONDITIONS

A. During Cold Weather:

1. Do not use frozen materials.
2. Do not use materials mixed or coated with ice or frost.
3. Do not build on frozen work.

B. During Wet Weather: Do not build on wet, saturated, or muddy subgrade.

## Part 2 Products

### 2.1 MANUFACTURERS

A. Manufacturer: NDS, Inc., 851 North Harvard Avenue, Lindsay, California 93247. Toll Free 800-726-1994. Phone 559-562-9888. Toll Free Fax 800-726-1998. Fax 559-562-4488. Website www.ndspro.com. Email nds@ndspro.com.

| Specifier Notes: Specify if substitutions will be permitted. |
|---|

B. Substitutions: [Not permitted] [Comply with Division 1].

### 2.2 MATERIALS

A. NDS “EZ Roll” grass pavers, model “EZ4X150”.

1. Injection-molded, nested-honeycomb, rolled-plastic-panel grass pavers for permeable, natural-grass paved environments.
2. Load-transfer paving system.
3. Use full rigid base course to prevent pavers from being pressed into subbase.
4. Material: 100 percent recycled polyolefin plastic with carbon black for UV stabilization.
5. Recyclable Content: 100 percent.
6. Paver Size: Preassembled rolls comprised of 24-inch by 24-inch panels by 1 inch high with integrated connecting cross links.
7. Wall Thickness: 0.12 inch.
8. Cells:
   a. Number per Paver: 72.
   b. Shape: Hexagon.
   c. Size: 2-1/4-inches.
   d. Form: Nested honeycomb.
9. Bottom Surface of Pavers: Flat, without vertical posts or obstructions.
10. Top Surface of Pavers: Smooth, without notches or grooves.
11. Connections:
    a. Connecting Clips per Paver: 24.
    b. Between Panels to Form Rolls: End-to-end clips snap-lock together.
    c. Between Rolls: Side-to-side clips snap-lock together.
    d. Does not require additional parts or tools.
12. Bottom Open Area: Greater than 80 percent.
    a. Total Bottom Open Area per Paver: 478 square inches.
13. Paver Color: Black.
14. Paver Compressive Strength, Empty Cells: 57,888 psf.
15. Nominal Coverage Area per Paver: 4 square feet.
16. Weight per Paver: 2.31 pounds.
17. Chemical Resistance: Superior chemical resistance; totally inert.

**2.2 MATERIALS (CONT.)**

Specifier Notes: Edit the following for the local available base course material and anticipated traffic loads. Consult NDS, Inc. for more information.

B. Base Course: Sandy gravel material from local sources, commonly used for road base construction, passing the following sieve analysis:

| Percent Passing | Sieve Size |
|---|---|
| 100 | 3/4 inch |
| 85 | 3/8 inch |
| 60 | #4 |
| 30 | #40 |
| < 3 | #200 |

1. Sources of the material may include pit run or crusher run.
2. Crusher run material will typically require sand be added (33 percent by volume) to ensure long-term porosity.
3. Should local sources not be available, alternative mixture can be created by mixing 2/3 crushed stone (0.75-inch diameter) with 1/3 sand, as available.
4. Alternative materials, such as washed or clean stone (0.75-inch diameter typical) may be used with soil separator above stone base and below growing medium.
5. Confirm base course sieve analysis by testing material.

Specifier Notes: The selection of sandy loam or loam soil should be made based on the soil requirements of the grass variety selected for the project.

C. Soil:

1. Sandy loam or loam soil.
2. Sand: Not acceptable.

Specifier Notes: Select a grass variety well suited to the anticipated traffic frequency and local heat and growing conditions.

D. Grass: Specified in Section 32 92 _____.

## Part 3 Execution

**3.1 EXAMINATION**

A. Examine areas to receive porous flexible paving.

B. Examine subgrade and base course installed conditions.

C. Check for improperly compacted trenches, debris, and improper gradients.

D. Notify Architect of conditions that would adversely affect installation or subsequent use.

E. Do not begin preparation or installation until unacceptable conditions are corrected.

### 3.2 PREPARATION

A. Protection of In-Place Conditions: Protect adjacent areas and landscaping from installation of porous flexible paving.

B. Place base course material over prepared subbase to grades indicated on the drawings, in lifts not to exceed 6 inches.

C. Compact each lift separately to minimum 95 percent Modified Proctor.

D. Leave minimum 1-1/2 inches for grass pavers and soil.

E. Fill to final grade.

### 3.3 INSTALLATION

A. Install grass pavers in accordance with manufacturer's instructions at locations indicated on the drawings.

B. Install grass pavers by placing units with cells facing up and connecting lateral snap locks together to maintain proper spacing and to interlock units.

C. Clearance: Leave 1-inch-minimum clearance between grass pavers and fixed objects or surface structures.

D. Anchor grass pavers placed on curves and slopes to base course as required to secure pavers in place.

E. Top of Cells: Leave top of cells 1/4 inch to 1/2 inch below surface of adjacent hard-surface pavements.

F. Install soil in cells as grass pavers are laid in sections.

G. Add soil to grass pavers from an area already filled with soil.

H. Spread soil to fill grass pavers to top surface.

> Specifier Notes: Specify one of following methods of planting grass: top dressing with sod, recessed sod planting, seeding, or hydroseeding. Include the section number for the section specifying the appropriate method of planting.

I. Planting: Plant grass by [top dressing with sod] [recessed sod planting] [seeding] [hydroseeding] as specified in Section 32 92 _____.

J. Fill grass pavers with soil and plant within 30 days of being installed.

### 3.4 ADJUSTING

A. Remove and replace with new materials, segments of grass pavers where 3 or more adjacent cells are broken or damaged.

### 3.5 PROTECTION

A. Protect Work of this Section:

1. From traffic until grass is sufficiently established to handle traffic.
2. From damage or deterioration during construction.

# SUSTAINABLE STORMWATER SOLUTIONS

NDS has an over 40-year history manufacturing quality stormwater management products. In that time our understanding and appreciation for the effects of stormwater runoff on our environment has evolved, culminating in the development of S5 Sustainable Stormwater Solutions. This evolution towards a system-based approach to comprehensive stormwater management represents a paradigm shift reflective of ongoing research, changing attitudes and advancing regulations that aim to reduce runoff and maximize groundwater recharge. NDS is committed to providing effective solutions for the next 40 years and beyond.

**NDS Customer Service**
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**www.ndspro.com**

Visit **ndspro.com** for specs, detail drawings and case studies

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# EZ Roll™ Gravel Pavers

## Technical Specifications Guide

## Model Numbers

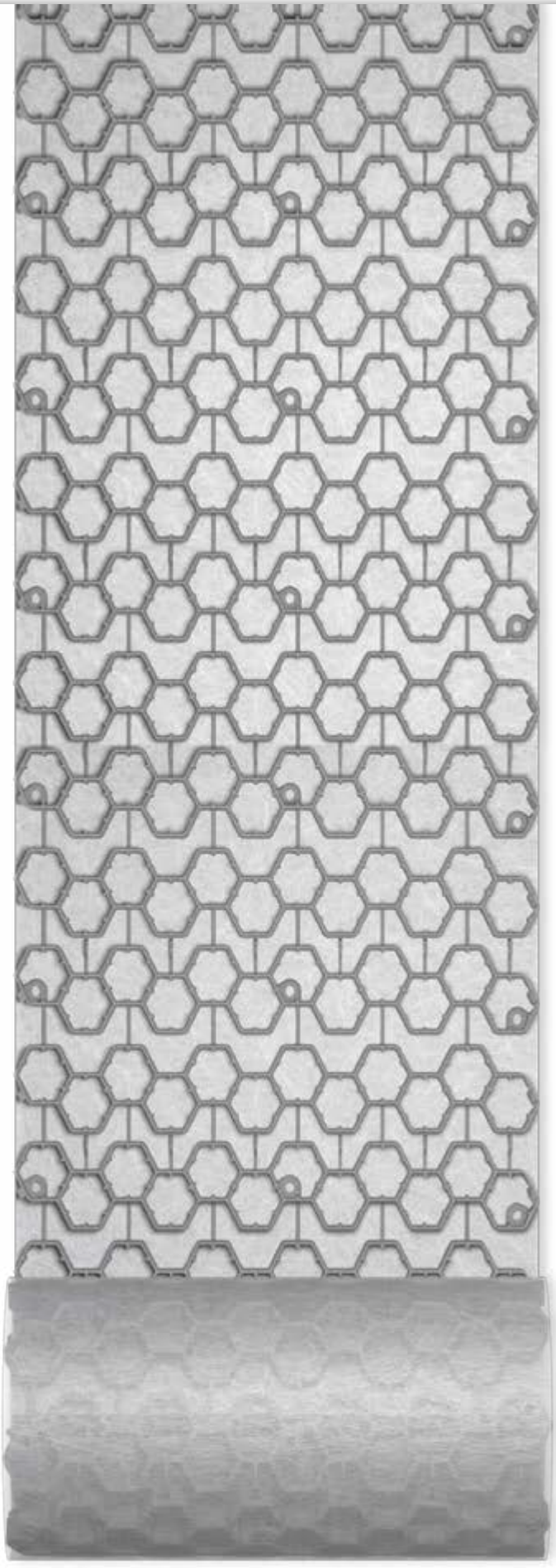
GP4X150
GP4X150G
GP4X150R
GP4X150T

ndspro.com

MADE IN USA

# Table of Contents



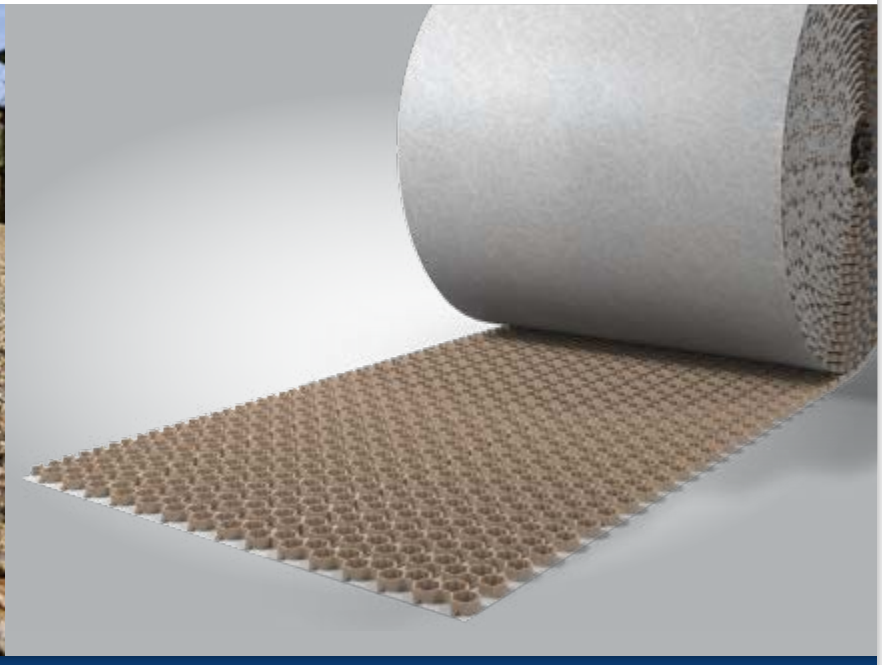


# EZ Roll™ Gravel Pavers

## A turf reinforcement, load transferring paving system designed to be placed directly on an engineer specified compacted road base.

This system is designed to transfer vehicle weight directly to the supportive base course and prevent soil compaction. The web of interconnected honeycomb cells provides resistance from vehicular load as well as lateral containment that prevents soil compaction. This system also provides a porous condition that allows rapid absorption of storm water. When properly installed according to the instructions in this guide, EZ Roll™ Gravel Pavers provide a structural surface capable of supporting H-20 loads in a saturated condition. The 1" deep hexagonal cells of the EZ Roll™ Gravel Paver are arranged in a double-row configuration that spans the width of the roll. This configuration reduces the risk of grid displacement from the torsional effects of the turning tires of a stationary vehicle. EZ Roll™ Gravel Pavers have a compressive strength of 57,888 psf in an empty condition and greater than 500,000 psf when filled. The EZ Roll™ Gravel Paver system has been used and accepted across the country for a wide variety of projects including emergency vehicle access purposes.

Additional information, details, and specifications can be found at
http://www.ndspro.com/permeable-pavers/Gravel-pavers/ez-roll-gravel-pavers
For further technical support or assistance, contact: techservice@ndspro.com



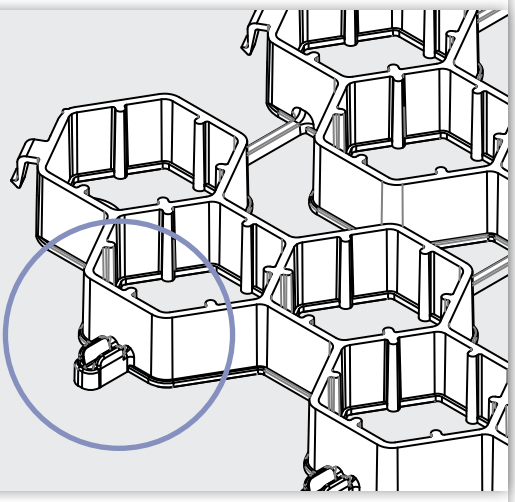
# Product Description

## Design Theory

The EZ Roll™ Gravel Paver comes in pre-assembled rolls, which means it is easy to roll out, decreasing installation time and increasing efficiency.

EZ Roll™ Gravel has been tested for compressive strength at 57,888 psf bare product, meaning that EZ Roll™ does not rely on the fill material for load carrying.

Connections between rows of EZ Roll™ are secure due to unique side-to-side and end-to-end clips that minimize the paver mat movement and separation due to lateral and horizontal pressure. These sturdy locking clips prevent paver displacement or mat failure that could result from traffic load movement or changing ground conditions.



## Recommended Use

**Light Loads:**
Golf Cart Paths
Jogging Tracks
Bike Paths
ATV Paths
Equestrian Parks
Trail Reinforcements

**Medium Loads:**
Roadway Shoulders
Residential Driveways
Parking Lots
Overflow Parking Area
Truck & Cart Wash-Down Areas
RV and Boat Access

**Heavy Loads/Fire Lane:**
Emergency Vehicle Access Roads
Service Vehicle Utility Roads
Equipment Yards

**Non-load Applications:**
Erosion Control on Slopes (staking recommended)
Erosion Control in Swales (staking recommended)

**Not Recommended for the Following:**
Traffic on slopes exceeding a 10% grade
To support tread driven vehicles

# Product Description

The EZ Roll™ Gravel Pavers from NDS is the latest and most advanced product of its type on the market. NDS has used its years of experience in the landscaping industry to create a product with all of the most desirable features.

The EZ Roll™ Gravel Paver has a combined series of 72 nested hexagonal cells per paver cell with 24 connecting clips. This unique combination provides superior stability and durability.

## Product Specifications

**Material.** 100% recycled HDPE plastic (50% pre-consumer 50% post-consumer). HDPE is rugged, flexible and ideally suited for outside exposure and longevity. NDS uses UV inhibitors in the polymer structure to prevent breakdown in the strength of the paver.

**Color.** EZ Roll™ Gravel is available in tan, black, brick red, and gray to provide design flexibility.

**Manufacturing.** Manufactured in Lindsay, CA.

**Recyclability.** 100% recyclable. Please recycle whenever possible.

**Paver Size.** Each 24" x 24" panel contains 72, 2¼" nested hexagonal cells. Panels are integrated with crosslinks and clips to form rolls. Part No. EZ4X150 has dimensions of 4' x 150' per roll. Custom size rolls available upon request.

**Weight Per Unit.** 2.31 pounds per 24" x 24" section.

**Paver Details.** The top surface of the hexagonal cell walls is smooth and devoid of notches or grooves. The bottom surface of the paver mat has over 80% open area for increased permeability.

**Assembly Mechanism.** 12 lateral snap locks per panel.

**Chemical Resistance.** EZ Roll™ Pavers have superior chemical resistance and are totally inert.

**Compressive Strength.** 57,888 lbs. (psf.) which is equal to 414 lbs. (psi.) For detailed specs see the Technical Specification part of this Guide.

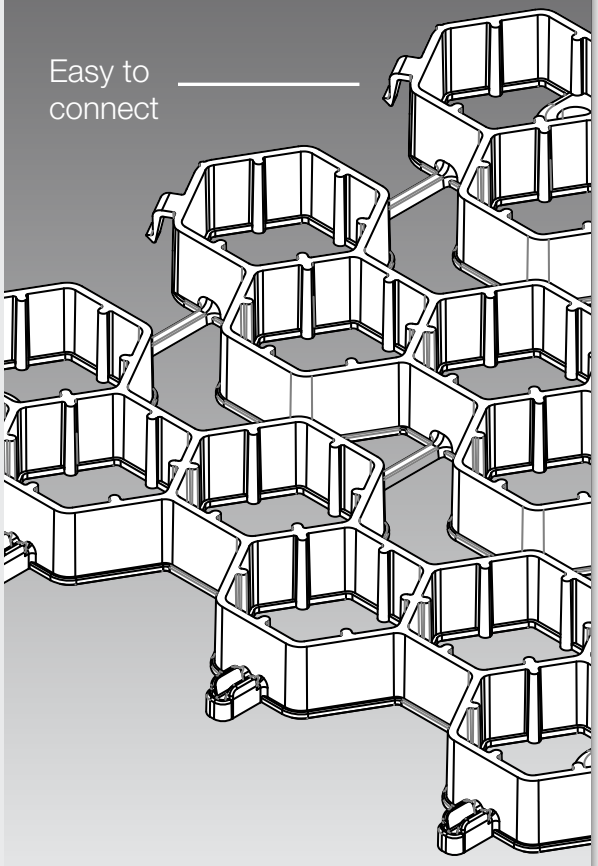
**Unique Product Features.** EZ Roll™ Pavers feature an easy to install top down locking feature. This locking mechanism allows pavers to be installed quickly and easily.

Empty cells have a compressive strength of

**57,888 psf**

Product ships in large rolls for easy rollout

Easy to connect



# Testing Methods

EZ Roll™ Gravel Pavers undergo a battery of tests with each production run, as is the process with all products manufactured by NDS.

All the manufacturing tests are conducted within the manufacturing cycle to assure a quality-finished product.

## Fire Resistance

When tested in accordance with ASTM D 1929-96 and DIN 54836-1984, HDPE has an ignition temperature of 350-360°C or 662-680°F. HDPE does not support flame.

## Compression Tests

Compression tests were performed by Smith Emery Laboratories in Los Angeles, CA. Each sample paver was individually placed flat on the fixed 18' x 18' plate of a load testing machine. A load was then applied to the top surface of the paver, through a 12' x 12' steel plate until failure. The ultimate compressive strength of the paver is 57,888 pounds per square foot (bare product without fill material). This is over double that of an H-20 loading specification.

| Test Type | Test No. | Loading Plate | Max. Load (lbs.) | Remarks |
|---|---|---|---|---|
| **Unfilled Cell** | 1 | 12 x 12 | 57,888 | The wall of the paver cell buckled under pressure |
| | 2 | | 59,000 | |
| **Filled with Sand (clean concrete sand)** | 1 | 6 x 6 | 500,000+* | Paver cell was compressed down along with the sand |
| | 2 | | 500,000+* | |
| **Filled with Gravel (concrete pea gravel)** | 1 | 6 x 6 | 500,000+* | Paver cell was compressed down along with the gravel |
| | 2 | | 500,000+* | |
| **Filled with Soil (clay soil)** | 1 | 6 x 6 | 500,000+* | Paver cell crushed |
| | 2 | | 500,000+* | |

*Test maximum limit 500,000 lbs.

## Permeability

EZ Roll™ Gravel Pavers provide a lower runoff coefficient, a prolonged time of concentration, a much higher rate of percolation and a cleaner runoff of storm water than concrete or asphalt.

When used over a rock and sand base with sandy loam soil (CN30), EZ Roll™ will promote a situation unlikely to generate surface runoff in an average rainstorm (less than 6" in 24 hours).

When EZ Roll™ is installed over clay soils (CN78), water absorptions will vary depending on the depth of the base course due to the storage capacity of the soil.

As per Technical release #55, US Department of Agriculture, Soil and Conservation Service, the evaluation of storm water management objective is done by the following method: calculate the pre-construction runoff volumes and time of concentration factors, calculate area runoff volumes, calculate runoff reduction and compare to Table 1 which lists runoff percentages from various soils based on 'meadow' type cover and a 24 hour rainfall.

| Runoff % – 24 Hour Rainfall Sand to Clay Soils | | | | |
|---|---|---|---|---|
| **Inches** | **CN30** | **CN58** | **CN71** | **CN78** |
| 1.0 | 0.0 | 0.0 | 0.01 | 0.06 |
| 1.2 | 0.0 | 0.0 | 0.03 | 0.10 |
| 1.4 | 0.0 | 0.0 | 0.05 | 0.14 |
| 1.6 | 0.0 | 0.0 | 0.08 | 0.18 |
| 1.8 | 0.0 | 0.01 | 0.11 | 0.21 |
| 2.0 | 0.0 | 0.02 | 0.13 | 0.24 |
| 2.5 | 0.0 | 0.05 | 0.20 | 0.32 |
| 3.0 | 0.0 | 0.09 | 0.25 | 0.38 |
| 4.0 | 0.0 | 0.17 | 0.35 | 0.47 |
| 5.0 | 0.0 | 0.23 | 0.42 | 0.54 |
| 6.0 | 0.01 | 0.29 | 0.48 | 0.60 |
| 7.0 | 0.03 | 0.34 | 0.53 | 0.64 |
| 8.0 | 0.05 | 0.39 | 0.57 | 0.67 |
| 9.0 | 0.08 | 0.43 | 0.61 | 0.70 |
| 10.0 | 0.10 | 0.46 | 0.64 | 0.73 |
| 11.0 | 0.12 | 0.49 | 0.66 | 0.75 |
| 12.0 | 0.15 | 0.52 | 0.68 | 0.76 |

## ADA Compliancey

EZ Roll™ Gravel Pavers meet the maneuverability performance requirements of ASTM F 1951-09b.
EZ Roll™ was installed and maintained according to the guidelines in this guide prior to testing.

The Americans with Disabilities Act (ADA) requires that all public areas be accessible to those with disabilities. This affects about 50 million people in this country. The Americans with Disabilities Act Accessibility Guidelines (ADAAG) specify that accessible routes must have ground and floor surfaces that are firm and stable. Surfaces that are not firm and stable limit accessibility for wheelchair, cane, crutch, walker users, parents with strollers, and other individuals with mobility limitations. Additionally, testing was conducted using a rotational penetrometer. The rotational penetrometer tests the surface for firmness and stability providing a baseline measurement that future measurements will be compared to.

| Straight Propulsion on EZ Roll™ Gravel Paver | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 54.3 | 6.5 |
| Trial 2 | 54.5 | 6.9 |
| Trial 3 | 58.0 | 7.4 |
| Trial 4 | 48.6 | 7.4 |
| Trial 5 | 53.7 | 7.4 |
| Average work per meter (n=3) 54.2 N*m | | |

| Turning on EZ Roll™ Gravel Paver | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 53.3 | 6.5 |
| Trial 2 | 50.6 | 6.5 |
| Trial 3 | 52.9 | 7.1 |
| Trial 4 | 50.9 | 7.1 |
| Trial 5 | 57.6 | 7.2 |
| Average work per meter (n=3) 52.4 N*m | | |

| Straight Propulsion on 7.1% Ramp | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 75.1 | 6.5 |
| Trial 2 | 74.3 | 6.4 |
| Trial 3 | 74.9 | 6.6 |
| Trial 4 | 71.1 | 6.6 |
| Trial 5 | 74.4 | 6.9 |
| Average work per meter (n=3) 74.5 N*m | | |

| Turning on 7.1% Ramp | | |
|---|---|---|
| | **Work per meter (N*m)** | **Trial Time (sec)** |
| Trial 1 | 57.1 | 7.7 |
| Trial 2 | 59.7 | 6.5 |
| Trial 3 | 59.6 | 7.2 |
| Trial 4 | 59.8 | 7.4 |
| Trial 5 | 59.7 | 7.3 |
| Average work per meter (n=3) 59.7 N*m | | |

Straight Propulsion Work Ratio 0.727

Turning Work Ratio 0.878

# Contribution to LEED

EZ Roll™ Gravel Pavers can be used in a number of categories that contribute points to LEED certification according to LEED v3.

## Category: Sustainable Sites

**Credit 5.1 Site Development – Protect or Restore Habitat (1 credit):**
**Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.**

- To attain this credit, all site disturbances during construction must be limited to within a certain distance from the building perimeter. Use of EZ Roll™ Gravel Paver extends the allowed area of site disturbance from 10 ft to 25 ft, thus providing more area to work during construction.
- EZ Roll™ Gravel Paver seeded with native plants in place of asphalt or other non-pervious surfaces will contribute to the overall percentage of habitat restored.
- For projects that qualify for 5.2 (below), use of EZ Roll™ Gravel Paver on a vegetated roof with native or adapted plants can contribute to overall percentage of habitat restored or protected.

**Credit 5.2 Site Development – Maximize Open Space (1 credit):**
**Provide a high ratio of open space to development footprint to promote biodiversity.**

- Application of EZ Roll™ Gravel Paver provides vegetated open space that will contribute to the open space requirements.
- Use of EZ Roll™ Gravel Paver on a vegetated roof can contribute to credit compliance.

**Credit 6.1 Stormwater Design – Quantity Control (1 credit):**
**Limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants.**

- EZ Roll™ Gravel Paver can be utilized as part of a stormwater management plan as it reduces impervious cover, increases on-site infiltration, and reduces pollution from stormwater runoff.
- EZ Roll™ Gravel Paver can be used to maintain a vegetated roof, which will minimize impervious surface area onsite.

**Credit 6.2 Stormwater Design – Quality Control (1 credit):**
**To limit disruption and pollution of natural water flows by managing stormwater runoff.**

- EZ Roll™ Gravel Paver can be utilized as part of a stormwater management plan as it reduces impervious cover, increases on-site infiltration, and reduces pollution from stormwater runoff.

**Credit 7.1 Heat Island Effect – Nonroof (1 credit):**
**To reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.**

- As open grid pavement systems, the use of EZ Roll™ Gravel Paver reduces heat absorption and contributes to the overall hardscaped area calculation for this credit.

**Credit 7.2 Heat Island Effect – Roof (1 credit):**
**To reduce heat islands to minimize impacts on microclimates and human and wildlife habitats.**

- EZ Roll™ Gravel Paver utilized on a vegetated roof can reduce heat absorption.

## Category: Materials and Resources

**Credit 4.1 Recycled Content: 10% (post-consumer + ½ pre-consumer) (1 credit):**
**Increase demand for the building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.**

- EZ Roll™ Gravel Paver is made from 100% recycled HPPE (approximate blend is 50% post-consumer, 50% pre-consumer material). Utilization of this product will increase the proportion of materials used on site that are recycled, and can contribute towards attainment of this credit.

**Credit 4.2 Recycled Content: 20% (post-consumer + ½ pre-consumer) (1 credit):**
**Increase demand for the building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.**

- As cited in credit 4.1 (above), utilizing EZ Roll™ Gravel Paver can contribute to the attainment of this credit, if used in a larger proportion on site relative to the proportion of materials that are not recycled.

## Pre-Installation

1. The installation of EZ Roll™ Gravel pavers should occur after the completion of any nearby sprinkler systems or hardscape elements.
2. It is recommended to order approximately 5% additional product to the total required to offset for curves and other unforeseen variances.
3. Check with local fire authority for any inspection requirements for areas that may provide emergency vehicle access.
4. Reclaimed and back-filled areas may require compaction and testing before the base course is installed.
5. Percolation rates of underlying soil should be at least .25 inches of water per hour.
6. Water table should be at minimum 3 feet below base course.
7. Surrounding hardscape should be 1-2 inches higher than paver surface to allow for gravel to cover the top of the paver structure.
8. Define the boundary of the proposed grid using string line.

## Base Course

The first decision in project planning must address the correct base construction that will support the maximum traffic load weight anticipated on the site. **The successful installation of EZ Roll™ Gravel Pavers is directly correlated to the quality of the base foundation upon which it is installed.** To calculate the depth and composition of material for the base course consider: Load bearing capacity of subsoil, plasticity or impact of moisture, frost-heave potential, and volume of traffic.

**There are three basic options:**

1. Light Load – base shall be min. 4" of engineered road base or to engineer's specification and local code.
2. Medium Load – base shall be min. 6" of engineered road base or to engineer's specification and local code.
3. Heavy Load – base shall be min. 8" of engineered road base or to engineer's specification and local code, and fire authority's requirements.

## Base course options

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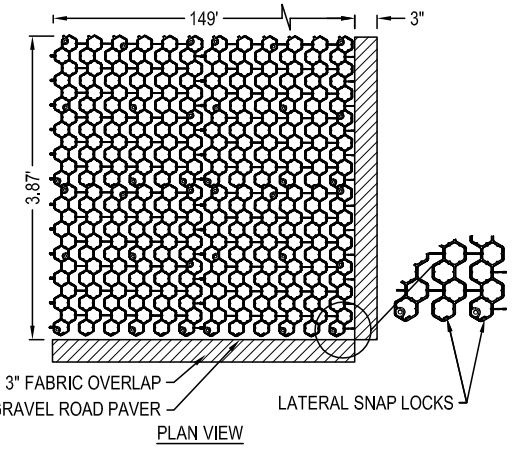
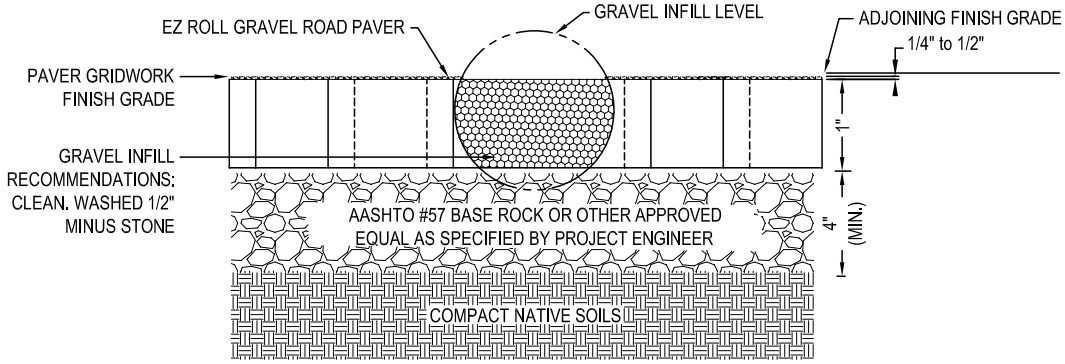
FAX: (559) 562-4488
www.ndspro.com

**EZ ROLL™ GRAVEL PAVER PRODUCT DESCRIPTION**

| | |
|---|---|
| **CELL SIZE:** | 2-1/4" HEXAGONAL CELLS |
| **STOCK ROLL SIZE'S:** | 3.87'W X 149'L (577 SQ. FT.) |
| **NESTED HONEYCOMB CELL:** | 57, 888 PSF |
| **LAYOUT COMPRESSIVE** | 402 PSI |
| **STRENGTH (OPEN CELL NO FILL)** | EXCEEDS H2O LOADING |




PLAN VIEW




SECTION

NOTES:
1. EXISTING SOILS SHOULD BE EVALUATED TO ENSURE PROPER STRUCTURAL AND PERMEABILITY PROPERTIES.
2. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
3. DO NOT SCALE DRAWING.
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EZ ROLL GRAVEL PAVERS

LIGHT LOAD

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REVISION DATE 8-24-2015

**Base course options (cont.):**

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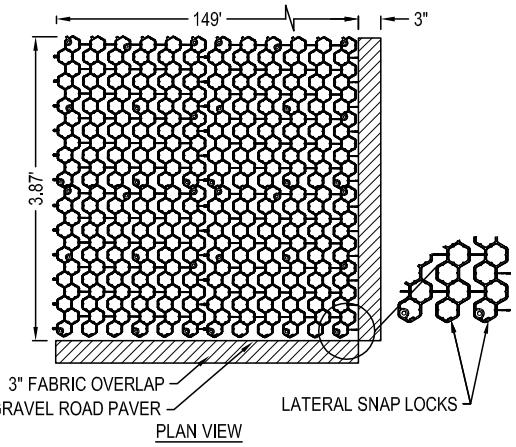


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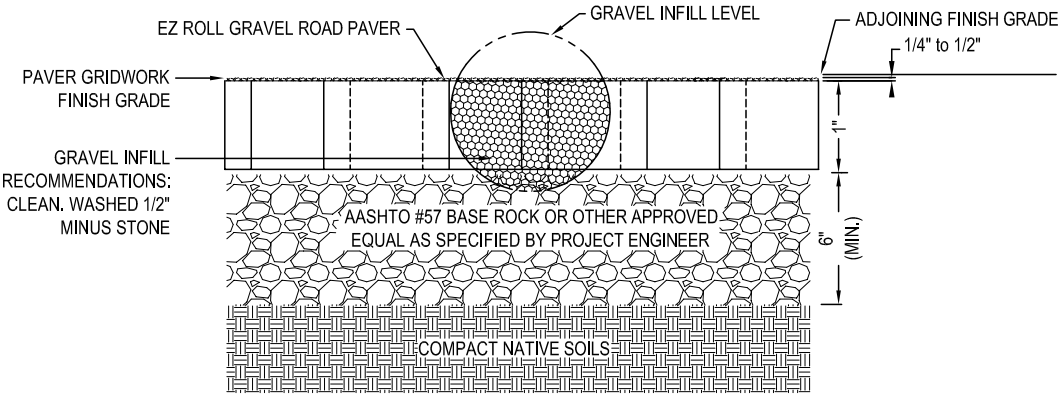


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EZ ROLL GRAVEL PAVERS

MEDIUM LOAD

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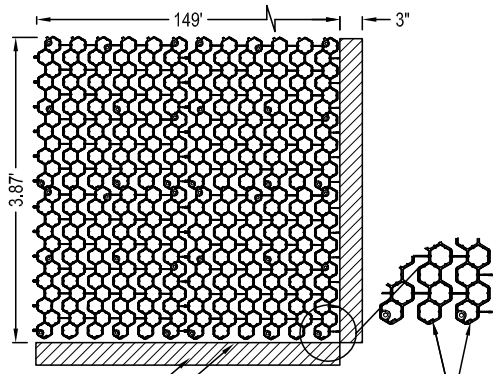


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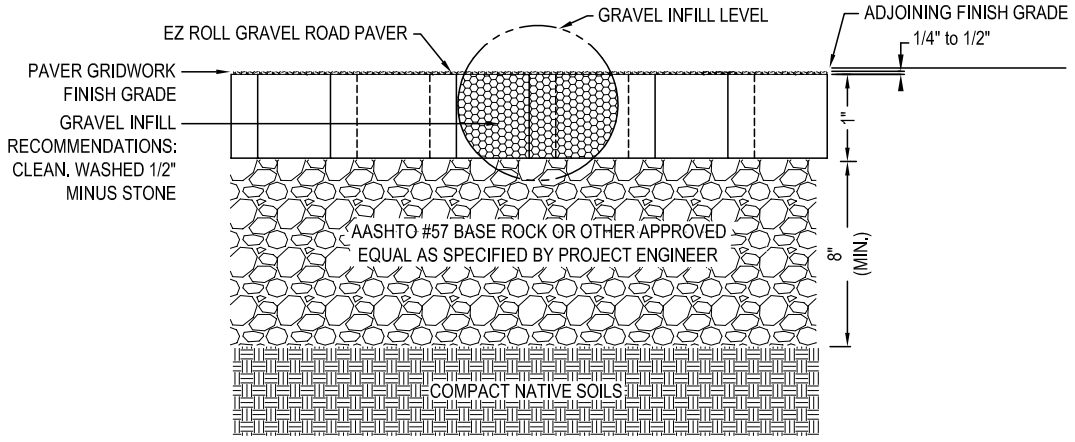


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EZ ROLL GRAVEL PAVERS

FIRE/HEAVY LOAD

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KEY COMPONENT
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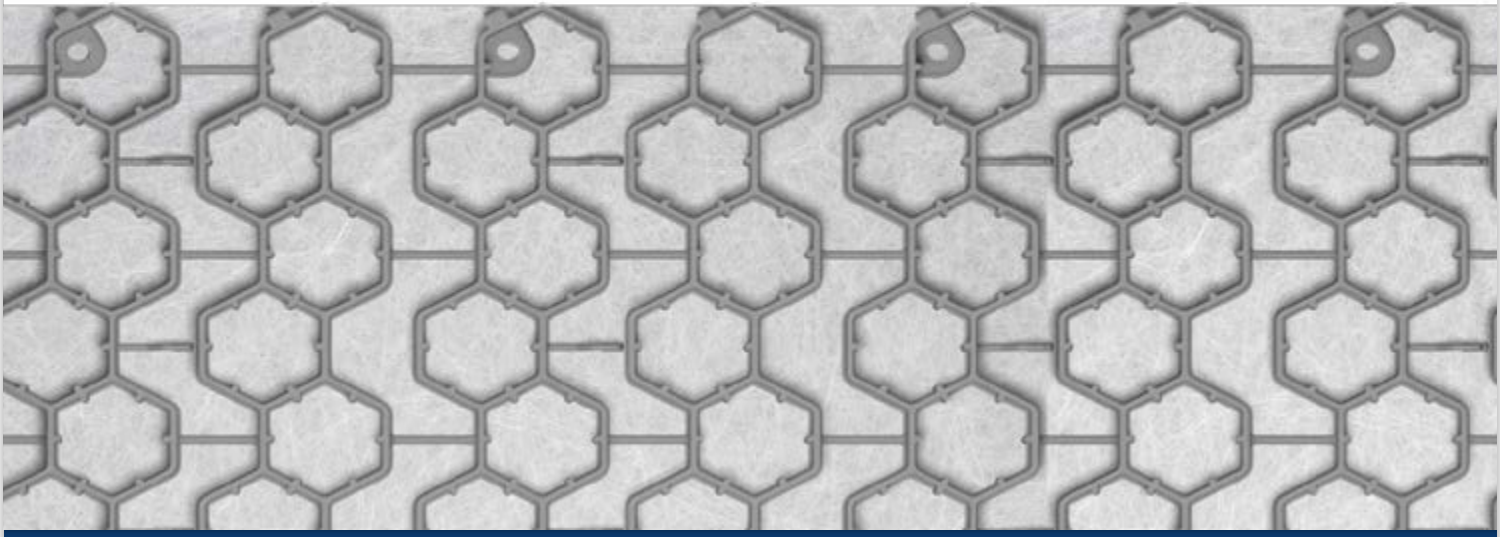
REVISION DATE 8-24-2015

## Staking Recommendations

Due to difficulty maintaining traction for motor vehicles on vegetated slopes, installing Pavers on slopes between 5-10% requires staking. Installation on slopes greater than 10% should only be used for erosion control applications.



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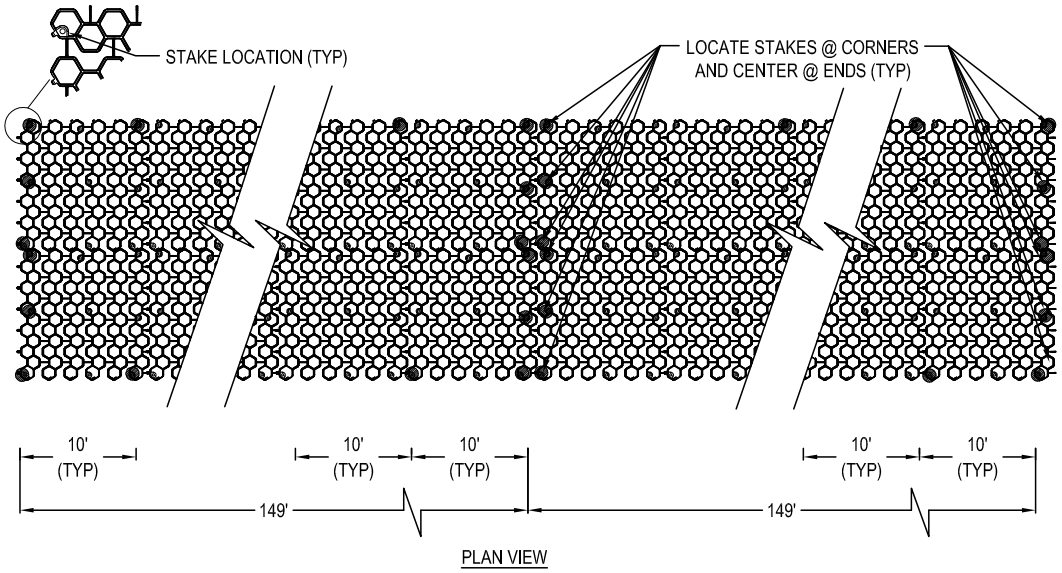


PLAN VIEW

NOTES:
1. STAKES TO BE INSERTED IN MOLDED STAKE LOCATION AS SHOWN ABV.
2. THE DIAGRAM ABV. IS DESIGNED FOR STRAIGHT LINE RUNS. MITERS, CUTS AND DIRECTIONAL CHANGES MAY REQUIRE ADDITIONAL STAKES. CONSULT YOUR LOCAL NDS DISTRIBUTOR, NDS REPRESENTATIVE OR CONTACT NDS TECHNICAL SERVICES @ NUMBER LISTED BLW.
3. STAKES WILL BE PROVIDED BY NDS AT A QUANTITY OF 40 PER 3.87' x 149' ROLL. IF ADDITIONAL STAKES ARE REQUIRED ORDER THROUGH YOUR AUTHORIZED NDS REPRESENTATIVE USING PART # GP STAKE.
4. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
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EZ ROLL GRAVEL PAVERS

STAKING

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KEY COMPONENT
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REVISION DATE 8-24-2015

## Markers

EZ Marker™ by NDS® is a modular solution to outline drive lanes, parking stalls, and fire lane edges for the EZ Roll™ family of permeable paver systems. After the pavers have been unrolled, pinned, and secured, EZ Marker™ snaps into the appropriate empty cells to outline whatever pattern necessary to properly direct vehicular traffic.

## Site Selection and Preparation

1. Remove all foreign top grade structures or objects, and excavate existing site soil to accommodate the base specified.
2. Install the base per architectural and/or engineering drawings and written specifications describing depth, load rating, construction materials, and required compaction.
3. Install with no more than a 6% grade for emergency access lanes or heavy vehicle access.
4. Install with no more than 10% grade when used for light vehicular traffic. Retention stakes must be installed in this application in a manner specified by a qualified architect or soils engineer.
5. Installations over 10% grades are for erosion resistance only. The installation of EZ Roll™ Gravel Pavers on any type of slope should be pinned or staked to the soil in a manner specified by a qualified architect or soils engineer.

## Paver Assembly and Installation

1. The installation of EZ Roll™ Gravel Pavers is generally done at the same time as other gravel installation on the site and after the completion major area construction.
2. Ensure that the paver is installed right-side-up with the open cells facing up. Warranties are voided for pavers installed face down.
3. Roll out the first section of pavers where there is an available straight border or where there is the longest available single run.
4. Roll out additional rolls of pavers as needed to cover large areas and securely connect the lateral snap locks to create an integral paver mat.
5. Smaller areas can be filled in by attaching single sections of pavers (detached from another roll) to the already laid out paver mat.
6. Be sure to leave the recommended 1" clearance between the paver mat and any preinstalled fixed objects or surface structures.
7. The paver can be trimmed to fit any fixed object using garden shears, a hand saw, PVC pipe cutter, utility cutter, or appropriate power saw. Be sure to follow all manufactures' operation and safety.
8. For side-to-side clips, thread the clips from one panel to the slots in the adjacent panel, apply pressure until they snap in place.
9. For end-to-end clips, push down on butterfly tabs of clip with your thumb until clip snaps into receiving slot of the next panel.
10. After assembling the paver network, re-examine all paver fittings around surface utilities and bordering structures to assure 1" clearance.
11. Fill with clean, washed gravel that is uniform in size between 3/16" and 3/8". Angular stones work best, as they do not migrate as much as rounded stones do.

## Maintenance Tips

- Do not aerate
- Utilizing skid shoes or raising the snow plow a minimum 2" above paver surface
- Do not use equipment intended for operation for thatching or scalping over the paver

# Product Guide Specification

**NDS, Inc. / April 2015**

851 North Harvard Avenue Lindsay, California 93247

Toll Free: 800-726-1994

Phone: 559-562-9888

Toll Free Fax: 800-726-1998

Fax: 559-562-4488

Website: www.ndspro.com

Email: nds@ndspro.com

Specifier Notes: This product guide specification is written in Construction Specifications Institute (CSI) 3-Part Format in accordance with *The CSI Construction Specifications Practice Guide*, including *MasterFormat, SectionFormat,* and *PageFormat.*

This section must be carefully reviewed and edited by the Architect to meet the requirements of the project and local building code. Coordinate this section with Division 1, other specification sections, and the Drawings. Delete all Specifier Notes after editing this section.

*Section numbers and titles are based on MasterFormat 2014 Update.*

# Section 32 12 43

**POROUS FLEXIBLE PAVING**

Specifier Notes: This section covers NDS, Inc. "EZ Roll" gravel pavers to construct porous flexible paving. Consult NDS, Inc. for assistance in editing this section for the specific application.

Use of "EZ Roll" gravel pavers may contribute to LEED credits. Consult NDS, Inc. for more information.

# Part 1 General

### 1.1 SECTION INCLUDES

A. Porous flexible paving using gravel pavers.

### 1.2 RELATED REQUIREMENTS

Specifier Notes: Edit the following list of related sections as necessary. Limit the list to sections with specific information that the reader might expect to find in this section, but is specified elsewhere.

A. Section 31 20 00 – Earth Moving: Subgrade preparation.

B. Section 32 80 00 – Irrigation: Irrigation system.

C. Section 32 91 00 – Planting Preparation: Soil preparation.

Specifier Notes: Provide section number and title for method of planting gravel specified in Part 3 of this section.

D. Section 32 92 _____ – _____: Gravel.

E. Section 33 46 00 – Subdrainage: Subsurface drainage.

### 1.3 PRE-INSTALLATION MEETINGS

Specifier Notes: Edit pre-installation meetings as necessary. Delete if not required.

A. Convene pre-installation meeting [1 week] [2 weeks] before start of Work of this Section.

B. Require attendance of parties directly affecting Work of this Section, including Contractor, Architect, Installer, and Manufacturer's Representative.

C. Review the Following:

1. Materials
2. Protection of in-place conditions
3. Preparation
4. Installation
5. Adjusting
6. Protection
7. Coordination with other work

### 1.4 SUBMITTALS

Specifier Notes: Edit submittal requirements as necessary. Delete submittals not required.

A. Comply with Division 1.

B. Product Data: Submit manufacturer's product data, including preparation and installation instructions.

C. Samples: Submit manufacturer's sample of one 24-inch by 24-inch gravel paver.

D. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

E. Sustainable Design Submittals: Submit manufacturer's sustainable design submittals for gravel pavers.

1. Recycled Content: Certify percentages of post-consumer and pre-consumer recycled content.
2. Regional Materials: Certify distance between manufacturer and project, in miles.

F. Manufacturer's Project References: Submit manufacturer's list of successfully completed gravel paver projects, including project name and location, name of architect, and type and quantity of gravel pavers furnished.

G. Installer's Project References: Submit installer's list of successfully completed gravel paver projects, including project name and location, name of architect, and type and quantity of gravel pavers installed.

H. Warranty Documentation: Submit manufacturer's standard warranty.

### 1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer regularly engaged, for a minimum of 10 years, in the manufacturing of gravel pavers of similar type to that specified.

B. Installer's Qualifications:

1. Installer regularly engaged, for a minimum of 5 years, in installation of gravel pavers of similar type to that specified.
2. Employ persons trained for installation of gravel pavers.

### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery Requirements: Deliver gravel pavers to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage and Handling Requirements:

1. Store and handle gravel pavers in accordance with manufacturer's instructions.
2. Keep gravel pavers in manufacturer's original, unopened containers and packaging until installation.
3. Store gravel pavers in clean areas, protected from exposure to harmful weather conditions.
4. Store gravel pavers out of direct sunlight.
5. Protect gravel pavers during storage, handling, and installation to prevent damage.

### 1.7 AMBIENT CONDITIONS

A. During Cold Weather:

1. Do not use frozen materials.
2. Do not use materials mixed or coated with ice or frost.
3. Do not build on frozen work.

B. During Wet Weather: Do not build on wet, saturated, or muddy subgrade.

## Part 2 Products

### 2.1 MANUFACTURERS

A. Manufacturer: NDS, Inc., 851 North Harvard Avenue, Lindsay, California 93247. Toll Free 800-726-1994. Phone 559-562-9888. Toll Free Fax 800-726-1998. Fax 559-562-4488. Website www.ndspro.com. Email nds@ndspro.com.

| Specifier Notes: Specify if substitutions will be permitted. |
|---|

B. Substitutions: [Not permitted] [Comply with Division 1].

### 2.2 MATERIALS

A. Gravel Pavers: NDS “EZ Roll” Gravel pavers, model “EZ4X150”.

1. Injection-molded, nested-honeycomb, rolled-plastic-panel gravel pavers for permeable, natural-gravel paved environments.
2. Load-transfer paving system.
3. Use full rigid base course to prevent pavers from being pressed into subbase.
4. Material: 100 percent recycled polyolefin plastic with carbon black for UV stabilization.
5. Recyclable Content: 100 percent.
6. Paver Size: Preassembled rolls comprised of 24-inch by 24-inch panels by 1 inch high with integrated connecting cross links.
7. Wall Thickness: 0.12 inch.
8. Cells:
   a. Number per Paver: 72.
   b. Shape: Hexagon.
   c. Size: 2-1/4-inches.
   d. Form: Nested honeycomb.
9. Bottom Surface of Pavers: Flat, without vertical posts or obstructions.
10. Top Surface of Pavers: Smooth, without notches or grooves.
11. Connections:
    a. Connecting Clips per Paver: 24.
    b. Between Panels to Form Rolls: End-to-end clips snap-lock together.
    c. Between Rolls: Side-to-side clips snap-lock together.
    d. Does not require additional parts or tools.
12. Bottom Open Area: Greater than 80 percent.
    a. Total Bottom Open Area per Paver: 478 square inches.
13. Paver Color: Black.
14. Paver Compressive Strength, Empty Cells: 57,888 psf.
15. Nominal Coverage Area per Paver: 4 square feet.
16. Weight per Paver: 2.31 pounds.
17. Chemical Resistance: Superior chemical resistance; totally inert.

**2.2 MATERIALS (CONT.)**

Specifier Notes: Edit the following for the local available base course material and anticipated traffic loads. Consult NDS, Inc. for more information.

B. Base Course: Sandy gravel material from local sources, commonly used for road base construction, passing the following sieve analysis:

| Percent Passing | Sieve Size |
|---|---|
| 100 | 3/4 inch |
| 85 | 3/8 inch |
| 60 | #4 |
| 30 | #40 |
| < 3 | #200 |

1. Sources of the material may include pit run or crusher run.
2. Crusher run material will typically require sand be added (33 percent by volume) to ensure long-term porosity.
3. Should local sources not be available, alternative mixture can be created by mixing 2/3 crushed stone (0.75-inch diameter) with 1/3 sand, as available.
4. Alternative materials, such as washed or clean stone (0.75-inch diameter typical) may be used with soil separator above stone base and below growing medium.
5. Confirm base course sieve analysis by testing material.

Specifier Notes: The selection of sandy loam or loam soil should be made based on the soil requirements of the gravel variety selected for the project.

C. Soil:

1. Sandy loam or loam soil.
2. Sand: Not acceptable.

Specifier Notes: Select a gravel variety well suited to the anticipated traffic frequency and local heat and growing conditions.

D. Gravel: Specified in Section 32 92 _____.

# Part 3 Execution

**3.1 EXAMINATION**

A. Examine areas to receive porous flexible paving.

B. Examine subgrade and base course installed conditions.

C. Check for improperly compacted trenches, debris, and improper gradients.

D. Notify Architect of conditions that would adversely affect installation or subsequent use.

E. Do not begin preparation or installation until unacceptable conditions are corrected.

### 3.2 PREPARATION

A. Protection of In-Place Conditions: Protect adjacent areas and landscaping from installation of porous flexible paving.

B. Place base course material over prepared subbase to grades indicated on the Drawings, in lifts not to exceed 6 inches.

C. Compact each lift separately to minimum 95 percent Modified Proctor.

D. Leave minimum 1-1/2 inches for gravel pavers and soil.

E. Fill to final grade.

### 3.3 INSTALLATION

A. Install gravel pavers in accordance with manufacturer's instructions at locations indicated on the Drawings.

B. Install Gravel pavers by placing units with cells facing up and connecting lateral snap locks together to maintain proper spacing and to interlock units.

C. Clearance: Leave 1-inch-minimum clearance between gravel pavers and fixed objects or surface structures.

D. Anchor gravel pavers placed on curves and slopes to base course as required to secure pavers in place.

E. Top of Cells: Leave top of cells 1/4 inch to 1/2 inch below surface of adjacent hard-surface pavements.

F. Install soil in cells and between cells as gravel pavers are laid in sections.

G. Add soil to gravel pavers from an area already filled with soil.

H. Spread soil to fill gravel pavers to top surface.

Specifier Notes: Specify one of following methods of planting gravel: top dressing with sod, recessed sod planting, seeding, or hydroseeding. Include the section number for the section specifying the appropriate method of planting.

I. Planting: Plant gravel by [top dressing with sod] [recessed sod planting] [seeding] [hydroseeding] as specified in Section 32 92 _____.

J. Fill gravel pavers with soil and plant within 30 days of being installed.

### 3.4 ADJUSTING

A. Remove and replace with new materials, segments of gravel pavers where 3 or more adjacent cells are broken or damaged.

### 3.5 PROTECTION

A. Protect Work of this Section:

1. From traffic until gravel is sufficiently established to handle traffic.
2. From damage or deterioration during construction.

# SUSTAINABLE STORMWATER SOLUTIONS

NDS has an over 40-year history manufacturing quality stormwater management products. In that time our understanding and appreciation for the effects of stormwater runoff on our environment has evolved, culminating in the development of S5 Sustainable Stormwater Solutions. This evolution towards a system-based approach to comprehensive stormwater management represents a paradigm shift reflective of ongoing research, changing attitudes and advancing regulations that aim to reduce runoff and maximize groundwater recharge. NDS is committed to providing effective solutions for the next 40 years and beyond.

**NDS Customer Service**
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Phone: 800.726.1994 • 559.562.9888
Fax: 800.726.1998 • 559.562.4488
**www.ndspro.com**

Visit **ndspro.com** for specs, detail drawings and case studies

NDS®
We put water in its place

ALLEN & MAJOR ASSOCIATES, INC.

| | | | |
|---|---|---|---|
| **Project No.** | 2562-01 | **Sheet** | 1 of 1 |
| **Project Description** | Camp Chickami | | |
| | Wayland, MA | | |
| **Calculated By** | JG | **Date** | 10/29/21 |
| **Checked By** | BDJ | **Revised** | 12/23/21 |

**Standard # 3: Groundwater Recharge**

Proposed recharge system: Permeable Paver Systems

In accordance with *MADEP – Volume 2, Technical Guide for Compliance with Massachusetts Stormwater Management Standards, dated January 2008*

| | | |
|---|---|---|
| A soils require a Volume to recharge of | **0.60** | **inches** |
| B soils require a Volume to recharge of | **0.35** | **inches** |
| C soils require a Volume to recharge of | **0.25** | **inches** |
| D soils require a Volume to recharge of | **0.10** | **inches** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Impervious area within: A-soils = | 3,359 | sf | Weighted Groundwater Recharge Depth | = | **0.60** | **in** |
| Impervious area within: B-soils = | 0 | sf | | | | |
| Impervious area within: C-soils = | 0 | sf | | | | |
| Impervious area within: D-soils = | 0 | sf | | | | |

**Total Site Volume required to be recharged =**

3,359 sf x 1" / 12 x 0.60 in = **168** **cf**

Site volume recharge provided by = Volume of Pervious Driveway 1 & 2

| | | | |
|---|---|---|---|
| Storage Volume of Trench Drain | = | 254 | c.f. |
| Storage Volume of Pervious Driveway 1 | = | 3,234 | c.f. |
| Storage Volume of Pervious Driveway 2 | = | 483 | c.f. |
| Storage Volume of Pervious Driveway 3 | = | 431 | c.f. |
| Storage Volume of Pervious Driveway 4 | = | 1,316 | c.f. |

= **5,718** c.f. Total Volume Recharged > **168** **cf** ( OK )

| Allen & Major Associates, Inc. | | Computation Sheet |
|---|---|---|
| **Title** | ***Water Quality Volume Calculation*** | By: JG |
| **Project** | *Camp Chickami* | Chk'd: BDJ |
| **Location** | 139 Boston Post Road, Wayland, MA | |
| **Date** | 11/2/21 | |
| **Revised** | 12/23/21 | |

**Stormwater Water Quality Volume Table**

***Impervious Area*** *= Pavement & Rooftop Area On-Site*

$A_{WQ}$ *= Required Water Quality Treatment Volume, expressed in* $ft^3$

$D_{WQ}$ *= Water Quality Depth*

$A_{IMP}$ *= Impervious Area*

| | | | | ***Water Quality Volume Required*** | |
|---|---|---|---|---|---|
| **Watershed (Pond 1)** | **Area (Sq. Ft.)** | **Landscaped** | **Impervious Area (SF)** **HSG A (F=.6)** | $D_{WQ}$ *(Inch)* | $A_{WQ}$ |
| P-1 | 9,603 | 9,055 | 548 | 0.5 | 23 |
| P-2 | 8,929 | 7,204 | 1,725 | 0.5 | 72 |
| P-3 | 26,275 | 13,760 | 12,515 | 0.5 | 521 |
| P-4 | 30,386 | 30,316 | 70 | 0.5 | 3 |
| **Total** | **75,193** | **60,335** | **14,858** | | **619** |

ALLEN & MAJOR ASSOCIATES, INC.

| | | | |
|---|---|---|---|
| **Project No.** | 2562-01 | **Sheet** | 1 |
| **Project Description** | Camp Chickami | | |
| | Wayland, MA | | |
| **Calculated By** | JG | **Date** | 10/29/21 |
| **Checked By** | BDJ | | |

**These calculations provide the TSS removal rate of the stormwater management system for runoff directed to the pervious gravel driveway**

| Stormwater Management BMP | TSS Removal rate |
|---|---|
| Pervious Driveway | 80% |

| | | | |
|---|---|---|---|
| Average Annual Load | = | 100% | |
| Pervious Driveway | = | 80% | Removal Rate |
| | | 20% | TSS Load Remains |

| Percentage of TSS Remaining | - | Initial TSS Load | = | Final TSS Removal Rate |
|---|---|---|---|---|
| 100% | - | 20.0% | = | 80.0% |

For this drainage area, this system as designed will remove an estimated
80% of the annual TSS load and therefore will meet the TSS removal standard.