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November 15, 2022

Mr. Brian Groth, AICP
Town Planner
Town of Hudson
12 School Street
Hudson, New Hampshire 03051

Subject: ASM Facility (Tax Map 215 / Lot 18) – Drainage Analysis
Hudson, NH

Dear Mr. Groth:

On behalf of the Applicant, JMC Hudson Properties, Gale Associates, Inc. (Gale) is pleased to provide the following Drainage Analysis services for the proposed site improvements of the existing ASM Facility located at 7 Security Drive in Hudson, New Hampshire.

1.1 General Methodology. In accordance with Section 275-9.A of the Town of Hudson Site Plan Regulations, a stormwater runoff model of pre- and post-development conditions was prepared to determine peak discharge rates for the 2-, 10-, and 25-year, 24-hour storm events. A computer-aided design software, HydroCAD, was used to model the various characteristics and physical properties to determine peak discharge rates. HydroCAD closely mimics the standard methodologies of Technical Release (TR)-20 and TR-55, as developed by the US Department of Agriculture (USDA) – Natural Resources Conservation Services (NRCS). Simulating the TR-20 and TR-55 methodologies, HydroCAD models each subcatchment(s) of the watershed, calculates the hydrologic analysis, and develops peak rates of runoff under various storm events. All calculations of the subcatchment model(s) within the watershed are carried to the site-specific analysis points (aka point-of-interest), which are intended to simulate a positive outfall to accurately compare project impacts.

In accordance with the New Hampshire Department of Environmental Services (NHDES) New Hampshire Stormwater Manual (dated December 2008), rainfall data was obtained by the Northeast Regional Climate Center's Extreme Precipitation in New York & New England (website http://precip.eas.cornell.edu/) for the Longitude (71,419 degrees west) and Latitude (42,703 degrees north) coordinates. According to the precipitation table, rainfall for the 2-, 10-, and 25-year, 24-hour storm events are 2.99, 4.49, and 5.68 inches per hour (in/hr), respectively. The precipitation table has been included as part of this drainage report.

Soil conditions of the project site were obtained from the USDA – NRCS for the project area (website https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm). A custom soils report titled "Custom Soil Resource Report for Hillsborough County, New Hampshire, Eastern Part – ASM Facility, 7 Security Drive" has been included with this report. According to the soils report, existing soil conditions are labeled as Windsor soils. The Ksat Values for New Hampshire Soils as published by the Society of Soil Scientists of Northern New England (SSSNNE) Special Publication No. 5 (dated September 2009), characterizes the Windsor soil as being well-draining, a hydrologic soil group (HSG) 'A' and having an infiltration (Ksat) rate between 6 to 20 in/hr; please see Ksat Value publication.

1.2 Site Hydraulics. Modeled within the existing drainage analysis are detailed descriptions of the various open and closed drainage systems to demonstrate pre- and post-development stormwater control characteristics. While overland drainage paths were included within the subcatchment(s) of the analysis, drainage swales were modeled separately as reaches to evaluate the effects and capacities of the drainage swales. All drainage culverts and/or closed drainage systems were modeled as small ponds to calculate surcharge, account for tailwater conditions, and analyze inlet/outlet controls that alter "full barrel" performance of the specific outlet drainage infrastructure. Calculations of the site hydraulics have been included as part of this drainage report.

1.3 Pre-development Runoff Analysis. Identified on the Town of Hudson's assessor's map as Parcel ID 251-018-000, the 123,824 square foot (2.84 Ac) site is located within the Town's G1 – General zoning district. The existing site consists of a 20,160 square foot, light industrial, slab-on-grade building; 40 parking spaces (two of which are ADA Van accessible); consists of two (2) loading docks located along the rear (south side) of the facility; a 25' x 50' equipment pad; and, is supported by a combination of public and private utilities – including public water service, private sanitary septic, underground electric, underground telephone, and a closed drainage system. The total impervious area of the existing site is approximately 47,730 square feet, resulting in 61.5% of open space.

The watershed area of the project matches that of the property boundary limits and consists of both open space (i.e., woodlands and grass areas) and impervious areas (i.e., buildings, concrete pads, concrete sidewalks, and pavement surfaces). Field visits were performed to verify existing topography information that resulted in the delineation of the subcatchment drainage areas. The approximate areas for open space and impervious areas are 76,094 and 47,730 square feet, respectively. The watershed area has been divided into two (2) subcatchment areas – east and west.

The associated stormwater runoff flows of the pre-development subcatchments were evaluated and determined to flow in separate directions. Ultimately, runoff from the site flows overland in a northerly direction toward Security Drive. For the purpose of this analysis, a single point-of-interest (POI) was established based on the direction of the ultimate runoff discharge point and area of concern. The POI for this analysis has been established as the existing drain manhole (DMH) located along Security Drive. Below are the results of the pre-development peak flow rates for the associated 24-hour storm events.

Table 1 – Point-of-Interest 'A' Pre-development Conditions Summary Storm Frequency Quantities				
Item	**2-Year**	**10-Year**	**25-Year**	**50-Year**
Runoff Flow (cfs)	1.34	3.25	5.01	6.83

*cfs = cubic feet/second

1.4 Post-development Runoff Analysis. The proposed site improvements include enclosing the 25' x 50' concrete equipment pad, extending the existing 24-foot-wide driveway to improve truck movements, replacing the existing 41 impervious parking stalls with a porous surface area, and adding 13 porous surface parking stalls. The total impervious area of the proposed site is approximately 51,524 square feet, resulting in 58.4% of open space.

The proposed post-development stormwater model includes combination of stormwater runoff control measures to keep flows under the pre-development rates. As required by the Town of Hudson Chapter

290-5.A.1 and 290-5.A.3, major features of the stormwater management plan developed for the site includes converting existing impervious parking areas to pre-cast concrete porous pavers, installing pre-cast concrete porous pavers for the added parking areas, installing a subsurface infiltration system that parallels the driveway extension, and minimizing the amount of additional mature vegetation to be disturbed. The existing closed-drainage system was maintained as a secondary measure to control stormwater runoff.

Post-development subcatchment areas mimicked pre-development areas but were modified to model post-development surface conditions. The proposed pre-cast concrete porous pavers were included in the post-development subcatchments and modeled with a curve number (CN) similar to a "good condition grass cover" of 39. A CN value of 39 was selected to model the proposed pre-cast concrete porous pavers based on the following factors:

1. Table 2-2a located in Appendix A2 of the HydroCAD Stormwater Modeling System Manual (version 10) lists an open space, good condition, Hydrologic Soil Group (HSG) 'A' soils to have a CN value of 39;

2. According to Stormcrete's website, the pre-cast porous concrete surface has a minimum infiltration rate of 250 inches/hour; and,

3. The infiltration rate for a Windor soils (Ksat Values for New Hampshire, dated September 2009), is 20 inches/hour.

Therefore, the pre-cast porous concrete surface is not the limiting factor and the CN value of 39 was used to closely mimic existing soil conditions.

The proposed subsurface infiltration system paralleling the driveway extension along the east side of the site was modeled utilizing a Ksat value of 3 in/hr, a factor safety of two (2) of the lowest Ksat rate of 6 in/hr, in accordance with *Evaluation of Specific Infiltration Areas, Section A – Default Rate* outlined in Chapter 2-4 of the NH Stormwater Manual Volume II. Below are the results of the post-development peak flow rates for the associated 24-hour storm events.

Table 1 – Point-of-Interest 'A' Post-development Conditions Summary Storm Frequency Quantities				
Item	**2-Year**	**10-Year**	**25-Year**	**50-Year**
Runoff Flow (cfs)	1.04	2.82	4.45	6.06

*cfs = cubic feet/second

1.5 Summary. This drainage analysis has demonstrated that post-development stormwater runoff for the proposed site improvements have been designed to maintain the pre-development runoff conditions during the 2-, 10-, and 25-year, 24-hour storm events. The proposed site improvements are not anticipated to adversely affect the neighboring properties or municipal stormwater infrastructure.

1.6 Operation and Maintenance Plan. Implementation of an Operation and Maintenance (O&M) Plan will be the responsibility of the Owner. At a minimum, the following standards will be met after construction is complete:

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- Documentation: A maintenance log (i.e., report) will be kept on the premises. The maintenance log will summarize inspections, maintenance, and corrective actions taken. The log will include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the cleanout of any sediments or debris, the location of the sediment and debris was disposed after removal will be included in the log. It is the opinion of this report, the Owner (or their assigned heirs) maintain a binder that contains divider of each stormwater feature so that an accurate history of inspection and corrective measures could be retained.

- Inspection and Maintenance Frequency and Corrective Measures: The following areas, facilities, and measures will be inspected and the identified deficiencies will be corrected. Clean-out must include the removal and legal disposal of any accumulated sediments and debris.
  - <u>Porous Pre-cast Concrete Surfaces:</u> Inspect porous pre-cast concrete surfaces two (2) times per year (preferably in spring and fall seasons) to ensure the structures are working in their intended fashion and that they are free of debris and oils in accordance with manufacturer's recommendations. At a minimum, the areas are to be swept and vacuumed two (2) times per year (preferably in spring and fall seasons) to maintain surface porosity. Winter deicing are to be performed in accordance with manufacturer's guidelines.

  - <u>Parking Surfaces:</u> Clear accumulations of winter sand in parking lots and along roadways at least twice (2) per year, preferably in the spring. Accumulations on pavement may be removed by pavement sweeping. Accumulations of sand along road shoulders may be removed by grading excess sand to the pavement edge and removing it manually or by front-end loader.

  - <u>Catch Basins, Oil/Water Separators, and Drain Manholes:</u> Inspect catch basin, oil/water separator, and drain manhole structures two (2) times per year (preferably in spring and fall seasons) to ensure the structures are working in their intended fashion and that they are free of debris and oils. Clean structures when sediment depths reach 12-inches from the invert of the outlet. If the structure is designed with an oil/water separator hood to trap floatable materials, clean structures when sediment depths reach 12-inches from the bottom of separator hood and check to ensure watertight seal is working. At a minimum, remove floating debris and hydrocarbons at the time of the inspection.

  - <u>Subsurface Infiltration System:</u> The infiltration facility will be inspected within the first three months after construction; thereafter the filter will be inspected two (2) times per year (preferably in Spring and Fall) via the drain manholes. Inspect outlet control structure to ensure the structure is in good working order and are not obstructed from trash and debris.

  - <u>Culverts:</u> Inspect culverts two (2) times per year (preferably in Spring and Fall) to ensure that the culverts are working in their intended fashion and that they are free of debris. Remove any obstructions to flow, remove accumulated sediments and debris at the inlet, at the outlet, and within the conduit and to repair any erosion damage at the culvert's inlet and outlet.

- Vegetated Areas: Inspect vegetated areas early in the growing season to identify active or potential erosion problems, destabilization of side slopes, embankment settling, and other signs of structural failures. Replant bare areas or areas with sparse growth. Where erosion is evident, armor the area with an appropriate lining or divert the erosive flows to on-site areas able to withstand the concentrated flows.

- Ditches, Swales and other Open Stormwater Channels: Inspect two (2) times per year (preferably in Spring and Fall to ensure they are working in their intended fashion and that they are free of sediment and debris. Remove any obstructions to flow, including accumulated sediments and debris and vegetated growth. Repair any erosion of the ditch lining. Vegetated ditches will be mowed at least annually or otherwise maintained to control the growth of woody vegetation and maintain flow capacity. Any woody vegetation growing through riprap linings must also be removed. Repair any slumping side slopes as soon as practicable. If the ditch has a riprap lining, replace riprap on areas where any underlying filter fabric or underdrain gravel is showing through the stone or where stones have dislodged. Correct any erosion of the channel's bottom or side slopes.

- Riprap Outlet Protection Areas: Inspect two (2) times per year (preferably in Spring and Fall) to ensure they are working in their intended fashion and that they are free of sediment and debris. Replace riprap on areas where any underlying filter fabric or underdrain gravel is showing through the stone or where stones have dislodged.

We hope that the Hudson Planning Board find this stormwater acceptable. If you have any questions or concerns, please do not hesitate to contact us.

Best regards,
Gale Associates, Inc.

STATE OF NEW HAMPSHIRE
SCOTT M. BOURCIER
No. 11910
LICENSED
PROFESSIONAL ENGINEER

SMB/slr

Enclosure: Northeast Regional Climate Center's Extreme Precipitation Data Table
USDA – NRCS Custom Soils Report
Ksat Values for New Hampshire Soils Publication
Pre-development Stormwater Model (2-, 10-, 25, and 50-year storm events)
Pre-development Subcatchment Areas and Runoff Flow Paths – Figure 1
Impervious Areas and Open Space Calculations Memorandum
NHDES Groundwater Recharge Volume (GRV) Calculation
Post-development Stormwater Model (2-, 10-, 25-, and 50-year storm events)
NHDES Infiltration Practice Criteria Calculation
Riprap Outlet Protection Calculation
Post-Development Subcatchment Areas and Runoff Flow Paths – Figure 2
Disturbed Area Plan – Figure 3
Stormcrete Specification
Stormcrete Handling and Installation Manual
Stormcrete Operation and Maintenance Manual

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	New Hampshire
Location	
Longitude	71.419 degrees West
Latitude	42.703 degrees North
Elevation	0 feet
Date/Time	Tue, 13 Sep 2022 16:05:00 -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	0.42	0.52	0.69	0.86	1.08	**1yr**	0.74	1.02	1.25	1.57	1.98	2.50	2.74	**1yr**	2.21	2.64	3.08	3.77	4.39	**1yr**
2yr	0.33	0.51	0.64	0.84	1.06	1.33	**2yr**	0.92	1.22	1.54	1.92	2.40	2.99	3.31	**2yr**	2.64	3.19	3.70	4.43	5.03	**2yr**
5yr	0.40	0.62	0.77	1.03	1.32	1.68	**5yr**	1.14	1.53	1.95	2.44	3.03	3.77	4.21	**5yr**	3.33	4.05	4.68	5.56	6.29	**5yr**
10yr	0.45	0.70	0.89	1.20	1.56	2.00	**10yr**	1.35	1.81	2.33	2.92	3.63	4.49	5.05	**10yr**	3.98	4.85	5.59	6.61	7.44	**10yr**
25yr	0.53	0.84	1.07	1.47	1.95	2.52	**25yr**	1.69	2.26	2.94	3.70	4.60	5.68	6.42	**25yr**	5.02	6.17	7.08	8.32	9.31	**25yr**
50yr	0.59	0.95	1.22	1.72	2.32	3.02	**50yr**	2.00	2.68	3.54	4.45	5.52	6.78	7.70	**50yr**	6.00	7.40	8.47	9.90	11.03	**50yr**
100yr	0.68	1.11	1.42	2.02	2.75	3.60	**100yr**	2.37	3.18	4.23	5.32	6.60	8.10	9.24	**100yr**	7.17	8.89	10.14	11.78	13.08	**100yr**
200yr	0.78	1.27	1.64	2.36	3.26	4.30	**200yr**	2.81	3.77	5.06	6.38	7.90	9.68	11.10	**200yr**	8.56	10.68	12.14	14.03	15.51	**200yr**
500yr	0.93	1.54	2.01	2.92	4.09	5.44	**500yr**	3.53	4.73	6.42	8.10	10.03	12.26	14.16	**500yr**	10.85	13.61	15.40	17.67	19.44	**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	0.57	0.70	0.80	**1yr**	0.61	0.79	1.07	1.34	1.69	2.33	2.56	**1yr**	2.06	2.46	2.74	3.07	3.94	**1yr**
2yr	0.32	0.49	0.60	0.82	1.01	1.21	**2yr**	0.87	1.18	1.38	1.80	2.31	2.92	3.24	**2yr**	2.59	3.11	3.61	4.32	4.92	**2yr**
5yr	0.36	0.56	0.69	0.95	1.21	1.43	**5yr**	1.05	1.40	1.64	2.13	2.72	3.52	3.95	**5yr**	3.12	3.80	4.35	5.20	5.91	**5yr**
10yr	0.40	0.61	0.76	1.06	1.37	1.61	**10yr**	1.19	1.58	1.83	2.41	3.07	4.06	4.59	**10yr**	3.60	4.41	5.01	5.97	6.79	**10yr**
25yr	0.45	0.69	0.86	1.23	1.62	1.89	**25yr**	1.39	1.85	2.14	2.84	3.58	4.91	5.61	**25yr**	4.35	5.39	6.04	7.16	8.15	**25yr**
50yr	0.49	0.75	0.94	1.35	1.81	2.14	**50yr**	1.57	2.09	2.41	3.22	4.03	5.67	6.54	**50yr**	5.02	6.29	6.97	8.23	9.34	**50yr**
100yr	0.54	0.82	1.03	1.48	2.03	2.42	**100yr**	1.75	2.36	2.72	3.46	4.54	6.56	7.65	**100yr**	5.81	7.36	8.04	9.46	10.72	**100yr**
200yr	0.60	0.90	1.14	1.64	2.29	2.74	**200yr**	1.98	2.68	3.05	3.90	5.15	7.61	8.96	**200yr**	6.73	8.62	9.29	10.86	12.31	**200yr**
500yr	0.68	1.01	1.29	1.88	2.67	3.23	**500yr**	2.31	3.16	3.58	4.57	6.09	9.24	11.09	**500yr**	8.18	10.66	11.24	13.04	14.77	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.31	0.48	0.58	0.79	0.97	1.13	**1yr**	0.83	1.11	1.29	1.68	2.12	2.65	2.92	**1yr**	2.35	2.81	3.38	4.16	4.77	**1yr**
2yr	0.35	0.55	0.67	0.91	1.13	1.32	**2yr**	0.97	1.29	1.50	1.95	2.50	3.07	3.41	**2yr**	2.72	3.28	3.81	4.55	5.17	**2yr**
5yr	0.44	0.67	0.84	1.15	1.46	1.69	**5yr**	1.26	1.65	1.92	2.46	3.09	4.04	4.51	**5yr**	3.57	4.34	5.01	5.95	6.68	**5yr**
10yr	0.53	0.81	1.00	1.40	1.81	2.07	**10yr**	1.56	2.02	2.35	2.94	3.67	4.99	5.60	**10yr**	4.42	5.39	6.19	7.29	8.13	**10yr**
25yr	0.68	1.03	1.28	1.83	2.41	2.69	**25yr**	2.08	2.63	3.05	3.74	4.60	6.59	7.44	**25yr**	5.83	7.15	8.19	9.56	10.57	**25yr**
50yr	0.82	1.24	1.55	2.23	3.00	3.29	**50yr**	2.59	3.21	3.72	4.49	5.45	8.13	9.22	**50yr**	7.19	8.86	10.12	11.74	12.89	**50yr**
100yr	1.00	1.51	1.89	2.72	3.74	4.02	**100yr**	3.22	3.93	4.55	5.64	6.47	10.04	11.41	**100yr**	8.88	10.97	12.50	14.44	15.72	**100yr**
200yr	1.21	1.82	2.31	3.34	4.66	4.91	**200yr**	4.02	4.80	5.55	6.81	7.69	12.39	14.12	**200yr**	10.97	13.58	15.46	17.75	19.20	**200yr**
500yr	1.57	2.34	3.02	4.38	6.23	6.39	**500yr**	5.38	6.25	7.23	8.75	9.64	16.37	18.68	**500yr**	14.49	17.96	20.49	23.33	24.99	**500yr**

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Northeast Regional Climate Center

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 Hillsborough County, New Hampshire, Eastern Part

ASM Facility, 7 Security Drive, Hudson, NH

September 13, 2022

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

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.

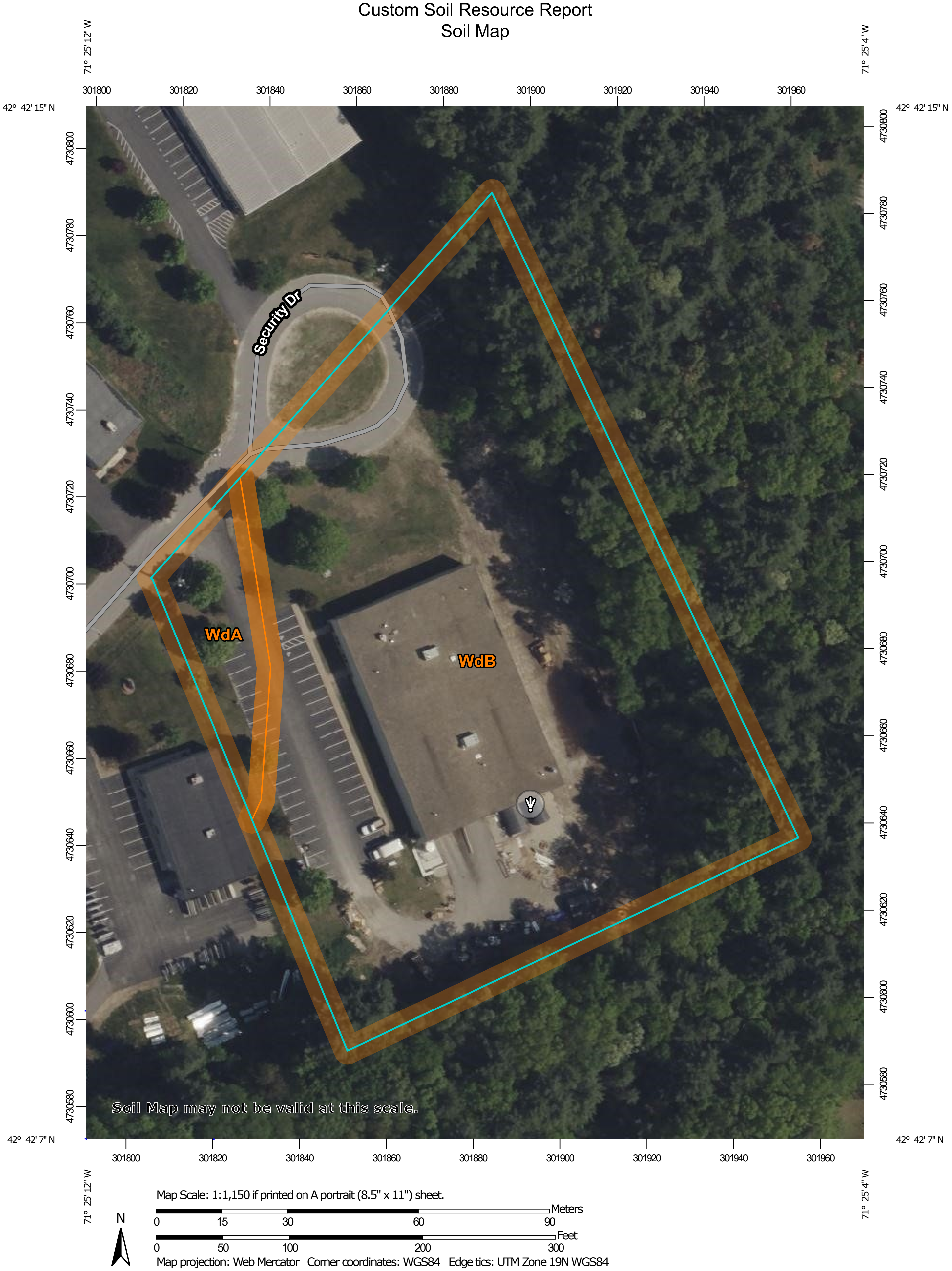
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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 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 1:20,000.

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: Hillsborough County, New Hampshire, Eastern Part
Survey Area Data: Version 24, Aug 31, 2021

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	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
WdA	Windsor loamy sand, 0 to 3 percent slopes	0.3	6.9%
WdB	Windsor loamy sand, 3 to 8 percent slopes	3.6	93.1%
Totals for Area of Interest		**3.9**	**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.

Hillsborough County, New Hampshire, Eastern Part

WdA—Windsor loamy sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkg
Elevation: 0 to 990 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: Farmland of local importance

Map Unit Composition

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

Description of Windsor, Loamy Sand

Setting

Landform: Outwash plains, outwash terraces, deltas, dunes
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex
Parent material: Loose sandy glaciofluvial deposits derived from granite and/or loose sandy glaciofluvial deposits derived from schist and/or loose sandy glaciofluvial deposits derived from gneiss

Typical profile

O - 0 to 1 inches: moderately decomposed plant material
A - 1 to 3 inches: loamy sand
Bw - 3 to 25 inches: loamy sand
C - 25 to 65 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: 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 supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Deerfield, loamy sand

Percent of map unit: 10 percent
Landform: Deltas, terraces, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Hinckley, loamy sand

Percent of map unit: 5 percent
Landform: Deltas, kames, eskers, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, crest, side slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

WdB—Windsor loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2svkf
Elevation: 0 to 1,210 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: Farmland of local importance

Map Unit Composition

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

Description of Windsor, Loamy Sand

Setting

Landform: Dunes, outwash plains, deltas, outwash terraces
Landform position (three-dimensional): Tread, riser
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Loose sandy glaciofluvial deposits derived from granite and/or loose sandy glaciofluvial deposits derived from schist and/or loose sandy glaciofluvial deposits derived from gneiss

Typical profile

O - 0 to 1 inches: moderately decomposed plant material
A - 1 to 3 inches: loamy sand

Bw - 3 to 25 inches: loamy sand
C - 25 to 65 inches: sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: 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 supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Hinckley, loamy sand

Percent of map unit: 10 percent
Landform: Deltas, kames, eskers, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Head slope, nose slope, crest, side slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Deerfield, loamy sand

Percent of map unit: 5 percent
Landform: Deltas, terraces, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

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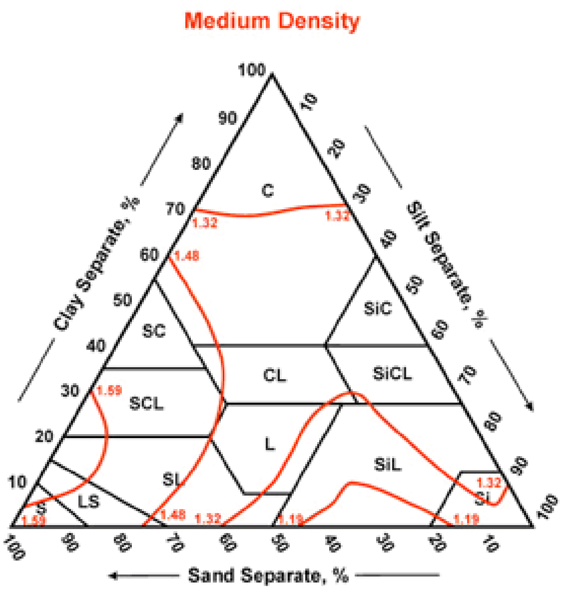
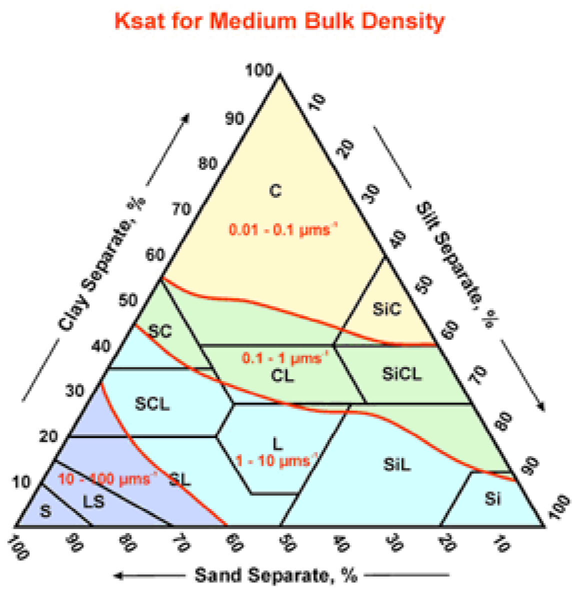
K_{sat} VALUES
FOR
NEW HAMPSHIRE SOILS
(Including Hydrologic and DES Soil Lot Sizing Groups)





From: Guide for Estimating Ksat from Soil Properties (**Exhibit 618-9**). (http://soils.usda.gov/technical/handbook/contents/part618ex.html)

Sponsored by the Society of Soil Scientists of Northern New England
SSSNNE Special Publication No. 5
September, 2009

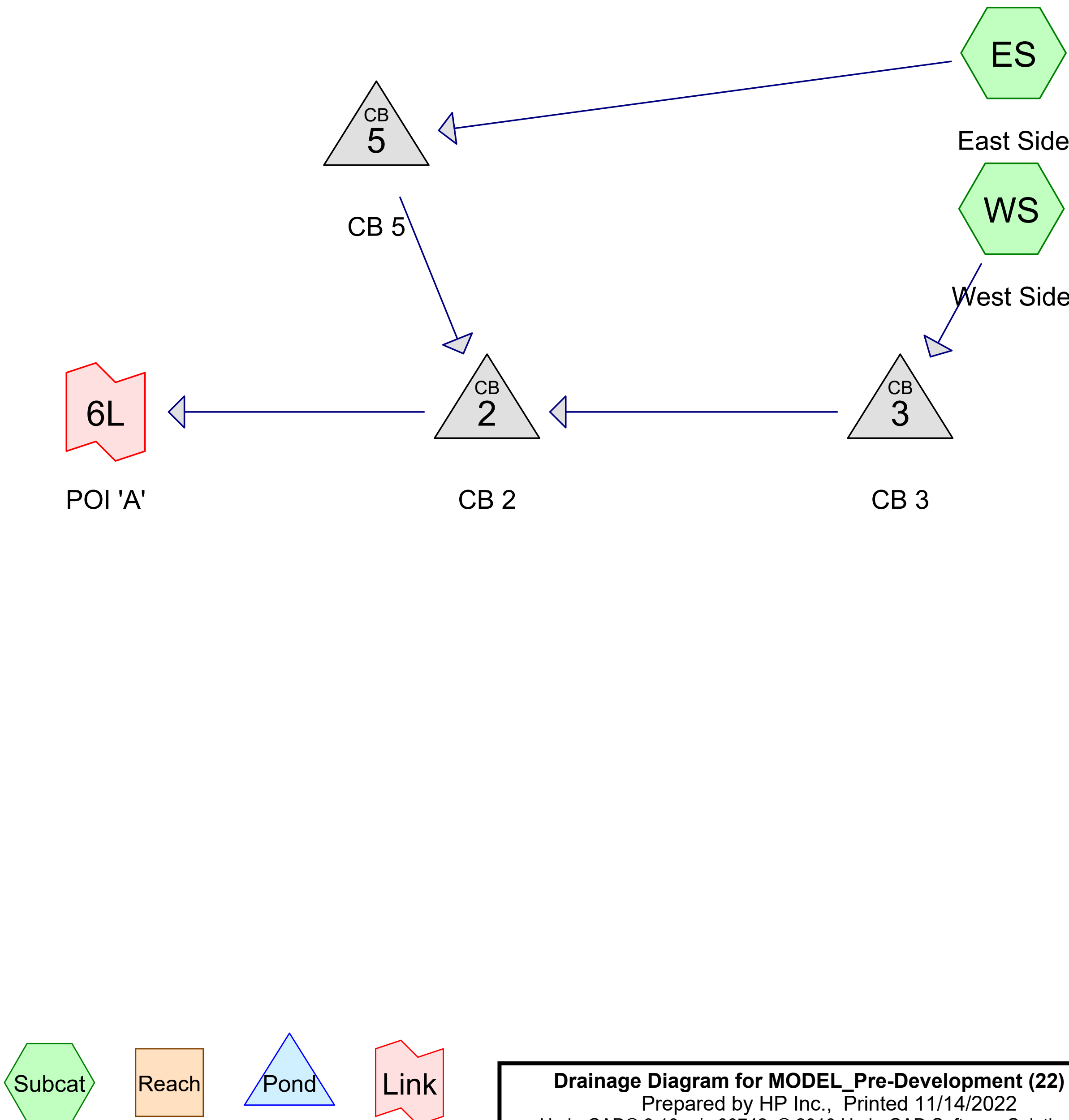
Soil Series	legend number	Ksat low - B in/hr	Ksat high - B in/hr	Ksat low - C in/hr	Ksat high - C in/hr	Hyd. Grp.	Group	Land Form	Temp.	Soil Textures	Spodosol ?	Other
Abenaki	501	0.6	2.0	6.00	99.0	B	2	Outwash and Stream Terraces	frigid	loamy over sandy-skeletal	no	loamy over gravelly
Acton	146	2.0	20.0	2.00	20.0	B	3	Loose till, sandy textures	mesic	sandy-skeletal	no	cobbly loamy sand
Adams	36	6.0	20.0	20.00	99.0	A	1	Outwash and Stream Terraces	frigid	sandy	yes	
Agawam	24	6.0	20.0	20.00	100.0	B	2	Outwash and Stream Terraces	mesic	loamy over sandy	no	loamy over sand/gravel
Allagash	127	0.6	2.0	6.00	20.0	B	2	Outwash and Stream Terraces	frigid	loamy over sandy	yes	loamy over sandy
Au Gres	516					B	5	Outwash and Stream Terraces	frigid	sandy	yes	single grain, loose
Bangor	572	0.6	2.0	0.60	2.0	B	2	Friable till, silty, schist & phyllite	frigid	loamy	yes	silt loam
Becket	56	0.6	2.0	0.06	0.6	C	3	Firm, platy, sandy till	frigid	loamy	yes	gravelly sandy loam in Cd
Belgrade	532	0.6	2.0	0.06	2.0	B	3	Terraces and glacial lake plains	mesic	silty	no	strata of fine sand
Bemis	224	0.6	0.2	0.00	0.2	C	5	Firm, platy, loamy till	cryic	loamy	no	
Berkshire	72	0.6	6.0	0.60	6.0	B	2	Loose till, loamy textures	frigid	loamy	yes	fine sandy loam
Bernardston	330	0.6	2.0	0.06	0.2	C	3	Firm, platy, silty till, schist & phyllite	mesic	loamy	no	channery silt loam in Cd
Bice	226	0.6	6.0	0.60	6.0	B	2	Loose till, loamy textures	frigid	loamy	no	sandy loam
Biddeford	234	0.0	0.2	0.00	0.2	D	6	Silt and Clay Deposits	frigid	fine	no	organic over clay
Binghamville	534	0.2	2.0	0.06	0.2	D	5	Terraces and glacial lake plains	mesic	silty	no	
Boscawen	220	6.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	frigid	sandy-skeletal	no	loamy cap
Boxford	32	0.1	0.2	0.00	0.2	C	3	Silt and Clay Deposits	mesic	fine	no	silty clay loam
Brayton	240	0.6	2.0	0.06	0.6	C	5	Firm, platy, silty till, schist & phyllite	frigid	loamy	no	
Buckland	237	0.6	2.0	0.06	0.2	C	3	Firm, platy, loamy till	frigid	loamy	no	loam in Cd
Bucksport	895					D	6	Organic Materials - Freshwater	frigid	sapric	no	deep organic
Burnham	131	0.2	6.0	0.02	0.2	D	6	Firm, platy, silty till, schist & phylitte	frigid	loamy	no	organic over silt
Buxton	232	0.1	0.6	0.00	0.2	C	3	Silt and Clay Deposits	frigid	fine	no	silty clay
Cabot	589	0.6	2.0	0.06	0.2	D	5	Firm, platy, silty till, schist & phyllite	frigid	loamy	no	
Caesar	526	20.0	100.0	20.00	100.0	A	1	Outwash and Stream Terraces	mesic	coarse sand	no	
Canaan	663	2.0	20.0	2.00	20.0	C	4	Weathered Bedrock Till	frigid	loamy-skeletal	yes	less than 20 in. deep
Canterbury	166	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	no	loam in Cd
Canton	42	2.0	6.0	6.00	20.0	B	2	Loose till, sandy textures	mesic	loamy over sandy	no	loamy over loamy sand
Cardigan	357	0.6	2.0	0.60	2.0	B	4	Friable till, silty, schist & phyllite	mesic	loamy	no	20 to 40 in. deep
Catden	296					A/D	6	Organic Materials - Freshwater	mesic	sapric	no	deep organic
Champlain	35	6.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	frigid	gravelly sand	no	
Charles	209	0.6	100.0	0.60	100.0	C	5	Flood Plain (Bottom Land)	frigid	silty	no	
Charlton	62	0.6	6.0	0.60	6.0	B	2	Loose till, loamy textures	mesic	loamy	no	fine sandy loam
Chatfield	89	0.6	6.0	0.60	6.0	B	4	Loose till, bedrock	mesic	loamy	no	20 to 40 in. deep
Chatfield Var.	289	0.6	6.0	0.60	6.0	B	3	Loose till, bedrock	mesic	loamy	no	mwd to swpd
Chesuncook	126	0.6	2.0	0.02	0.2	C	3	Firm, platy, silty till, schist & phyllite	frigid	loamy	yes	channery silt loam in Cd
Chichester	442	0.6	2.0	2.00	6.0	B		Loose till, sandy textures	frigid	loamy over sandy	no	loamy over loamy sand
Chocorua	395			6.00	20.0	D	6	Organic Materials - Freshwater	frigid	sandy or sandy-skeletal	no	organic over sand
Cohas	505	0.6	2.0	0.60	100.0	C	5	Flood Plain (Bottom Land)	frigid	co. loamy over sandy (skeletal)	no	
Colonel	927	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	yes	loam in Cd
Colton	22	6.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	frigid	sandy-skeletal	yes	
Colton, gravelly	21	6.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	frigid	sandy-skeletal	yes	gravelly surface
Croghan	613	20.0	100.0	20.00	100.0	B	3	Outwash and Stream Terraces	frigid	sandy	yes	single grain in C
Dartmouth	132	0.6	2.0	0.06	0.6	B	3	Terraces and glacial lake plains	mesic	silty	no	thin strata silty clay loam
Deerfield	313	6.0	20.0	20.00	100.0	B	3	Outwash and Stream Terraces	mesic	sandy	no	single grain in C
Dixfield	378	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	yes	fine sandy loam in Cd
Dixmont	578	0.6	2.0	0.60	2.0	C	3	Friable till, silty, schist & phyllite	frigid	loamy	yes	silt loam, platy in C
Duane	413	6.0	20.0	6.00	20.0	B	3	Outwash and Stream Terraces	frigid	sandy-skeletal	yes	cemented (ortstein)
Dutchess	366	0.6	2.0	0.60	2.0	B	2	Friable till, silty, schist & phyllite	mesic	loamy	no	very channery
Eldridge	38	6.0	20.0	0.06	0.6	C	3	Sandy/loamy over silt/clay	mesic	sandy over loamy	no	
Elliottsville	128	0.6	2.0	0.60	2.0	B	4	Friable till, silty, schist & phyllite	frigid	loamy	yes	20 to 40 in. deep
Elmridge	238	2.0	6.0	0.00	0.2	C	3	Sandy/loamy over silt/clay	mesic	loamy over clayey	no	
Elmwood	338	2.0	6.0	0.00	0.2	C	3	Sandy/loamy over silt/clay	frigid	loamy over clayey	no	
Finch	116					C	3	Outwash and Stream Terraces	frigid	sandy	yes	cemented (ortstein)

Soil Series	legend number	Ksat low - B in/hr	Ksat high - B in/hr	Ksat low - C in/hr	Ksat high - C in/hr	Hyd. Grp.	Group	Land Form	Temp.	Soil Textures	Spodosol ?	Other
Fryeburg	208	0.6	2.0	2.00	6.0	B	2	Flood Plain (Bottom Land)	frigid	silty	no	very fine sandy loam
Gilmanton	478	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	no	fine sandy loam in Cd
Glebe	671	2.0	6.0	2.00	6.0	C	4	Loose till, bedrock	cryic	loamy	yes	20 to 40 in. deep
Gloucester	11	6.0	20.0	6.00	20.0	A	1	Sandy Till	mesic	sandy-skeletal	no	loamy cap
Glover	NA	0.6	2.0	0.60	2	D	4	Friable till, silty, schist & phyllite	frigid	loamy	no	less than 20 in. deep
Grange	433	0.6	2.0	0.60	2.0	C	5	Outwash and Stream Terraces	frigid	co. loamy over sandy (skeletal)	no	
Greenwood	295					A/D	6	Organic Materials - Freshwater	frigid	hemic	no	deep organic
Groveton	27	0.6	2.0	0.60	6.0	B	2	Outwash and Stream Terraces	frigid	loamy	yes	loamy over sandy
Hadley	8	0.6	2.0	0.60	6.0	B	2	Flood Plain (Bottom Land)	mesic	silty	no	strata of fine sand
Hadley	108	0.6	2.0	0.60	6.0	B	2	Flood Plain (Bottom Land)	mesic	silty	no	strata of fine sand, occ flooded
Hartland	31	0.6	2.0	0.20	2.0	B	2	Terraces and glacial lake plains	mesic	silty	no	very fine sandy loam
Haven	410	0.6	2.0	20.00	100.0	B	2	Outwash and Stream Terraces	mesic	loamy over sandy	no	loamy over sand/gravel
Henniker	46	0.6	2.0	0.06	0.6	C	3	Firm, platy, sandy till	frigid	loamy	no	loamy sand in Cd
Hermon	55	2.0	20.0	6.00	20.0	A	1	Sandy Till	frigid	sandy-skeletal	yes	loamy cap
Hinckley	12	6.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	mesic	sandy-skeletal	no	
Hitchcock	130	0.6	2.0	0.06	0.6	B	3	Terraces and glacial lake plains	mesic	silty	no	silt loam to silt in C
Hogback	91	2.0	6.0	2.00	6.0	C	4	Loose till, bedrock	frigid	loamy	yes	less than 20 in. deep
Hollis	86	0.6	6.0	0.60	6.0	C/D	4	Loose till, bedrock	mesic	loamy	no	less than 20 in. deep
Hoosic	510	2.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	mesic	sandy-skeletal	no	slate, loamy cap
Houghtonville	795	0.6	6.0	0.60	6.0	B	2	Loose till, loamy textures	frigid	loamy	yes	cobbly fine sandy loam
Howland	566	0.6	2.0	0.06	0.2	C	3	Firm, platy, silty till, schist & phyllite	frigid	loamy	yes	silt loam, platy in Cd
Ipswich	397					D	6	Tidal Flat	mesic	hemic/sapric	no	deep organic
Kearsarge	359	0.6	2.0	0.60	2.0	B	4	Friable till, silty, schist & phyllite	mesic	loamy	no	less than 20 in. deep
Kinsman	614	6.0	20.0	6.00	20.0	C	5	Outwash and Stream Terraces	frigid	sandy	yes	
Lanesboro	228	0.6	2.0	0.06	0.2	C	3	Firm, platy, silty till, schist & phyllite	frigid	loamy	no	channery silt loam in Cd
Leicester	514	0.6	6.0	0.60	20.0	C	5	Loose till, loamy textures	mesic	loamy	no	
Lim	3	0.6	2.0	6.00	20.0	C	5	Flood Plain (Bottom Land)	mesic	loamy	no	
Limerick	109	0.6	2.0	0.60	2.0	C	5	Flood Plain (Bottom Land)	mesic	silty	no	
Lombard	259	0.6	6.0	2.00	20.0	C/D	2	Weathered bedrock, phyllite	frigid	loamy	no	very channery
Lovewell	307	0.6	2.0	0.60	2.0	B	3	Flood Plain (Bottom Land)	frigid	silty	no	very fine sandy loam
Lyman	92	2.0	6.0	2.00	6.0	A/D	4	Loose till, bedrock	frigid	loamy	yes	less than 20 in. deep
Lyme	246	0.6	6.0	0.60	6.0	C	5	Loose till, sandy textures	frigid	loamy	no	
Machias	520	2.0	6.0	6.00	20.0	B	3	Outwash and Stream Terraces	frigid	sandy or sandy-skeletal	yes	strata sand/gravel in C
Macomber	252	0.6	2.0	0.60	2.0	C	4	Friable till, silty, schist & phyllite	frigid	loamy-skeletal	yes	20 to 40 in. deep
Madawaska	28	0.6	2.0	6.00	20.0	B	3	Outwash and Stream Terraces	frigid	loamy over sandy	yes	sandy or sandy-skeletal
ladawaska, aquer	48	0.6	2.0	6.00	20.0	B	3	Outwash and Stream Terraces	frigid	loamy over sandy	yes	sandy or sandy-skeletal
Marlow	76	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	yes	fine sandy loam in Cd
Masardis	23	6.0	20.0	6.00	20.0	A	1	Outwash and Stream Terraces	frigid	sandy-skeletal	yes	slate, loamy cap
Mashpee	315	6.0	20.0	6.00	20.0	B	5	Outwash and Stream Terraces	mesic	sandy	yes	
Matunuck	797			20.00	100.0	D	6	Tidal Flat	mesic	sandy	no	organic over sand
Maybid	134	0.0	0.2	0.00	0.2	D	6	Silt and Clay Deposits	mesic	fine	no	silt over clay
Meadowsedge	894					D	6	Organic Materials - Freshwater	frigid	peat	no	deep organic
Medomak	406	0.6	2.0	0.60	2.0	D	6	Flood Plain (Bottom Land)	frigid	silty	no	organic over silt
Melrose	37	2.0	6.0	0.00	0.2	C	3	Sandy/loamy over silt/clay	frigid	loamy over clayey	no	silty clay loam in C
Merrimac	10	2.0	20.0	6.00	20.0	A	1	Outwash and Stream Terraces	mesic	gravelly sand	no	loamy cap
Metacomet	458	0.6	2.0	0.06	0.6	C	3	Firm, platy, sandy till	frigid	loamy	no	loamy sand in Cd
Metallak	404	6.0	100.0	6.00	100.0	B	3	Flood Plain (Bottom Land)	frigid	loamy over sandy	no	sandy or sandy-skeletal
Millis	39					C	3	Firm, platy, sandy till	frigid	loamy	yes	loamy sand in Cd
Millsite	251	0.6	6.0	0.60	6.0	C	4	Loose till, bedrock	frigid	loamy	no	20 to 40 in. deep
Monadnock	142	0.6	2.0	2.00	6.0	B	2	Loose till, sandy textures	frigid	oamy over sandy, sandy-skeleta	yes	gravelly loamy sand in C
Monarda	569	0.2	2.0	0.02	0.2	D	5	Firm, platy, silty till, schist & phyllite	frigid	loamy	no	
Monson	133	0.6	2.0	0.60	2.0	D	4	Friable till, silty, schist & phyllite	frigid	loamy	yes	less than 20 in. deep
Montauk	44	0.6	6.0	0.06	0.6	C	3	Firm, platy, sandy till	mesic	loamy	no	loamy sand in Cd
Moosilauke	414	6.0	20.0	6.00	20.0	C	5	Loose till, sandy textures	frigid	sandy	no	

Soil Series	legend number	Ksat low - B in/hr	Ksat high - B in/hr	Ksat low - C in/hr	Ksat high - C in/hr	Hyd. Grp.	Group	Land Form	Temp.	Soil Textures	Spodosol ?	Other
Mundal	610	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	yes	gravelly sandy loam in Cd
Natchaug	496			0.20	2.0	D	6	Organic Materials - Freshwater	mesic	loamy	no	organic over loam
Naumburg	214	6.0	20.0	6.00	20.0	C	5	Outwash and Stream Terraces	frigid	sandy	yes	
Newfields	444	0.6	2.0	0.60	2.0	B	3	Loose till, sandy textures	mesic	loamy over sandy	no	sandy or sandy-skeletal
Nicholville	632	0.6	2.0	0.60	2.0	C	3	Terraces and glacial lake plains	frigid	silty	yes	very fine sandy loam
Ninigret	513	0.6	6.0	6.00	20.0	B	3	Outwash and Stream Terraces	mesic	loamy over sandy	no	sandy or sandy-skeletal
Occum	1	0.6	2.0	6.00	20.0	B	2	Flood Plain (Bottom Land)	mesic	loamy	no	loamy over loamy sand
Ondawa	101	0.6	6.0	6.00	20.0	B	2	Flood Plain (Bottom Land)	frigid	loamy	no	loamy over loamy sand
Ondawa	201	0.6	6.0	6.00	20.0	B	2	Flood Plain (Bottom Land)	frigid	loamy	no	occ flood, loamy over l. sand
Ossipee	495			0.20	2.0	D	6	Organic Materials - Freshwater	frigid	loamy	no	organic over loam
Pawcatuck	497			20.00	100.0	D	6	Tidal Flat	mesic	sandy or sandy-skeletal	no	organic over sand
Paxton	66	0.6	2.0	0.00	0.2	C	3	Firm, platy, loamy till	mesic	loamy	no	
Peacham	549	0.6	2.0	0.00	0.2	D	6	Firm, platy, silty till, schist & phylitte	frigid	loamy	no	organic over loam
Pemi	633	0.6	2.0	0.06	0.6	C	5	Terraces and glacial lake plains	frigid	silty	no	
Pennichuck	460	0.6	2.0	0.60	2.0	B	4	Friable till, silty, schist & phyllite	mesic	loamy-skeletal	no	20 to 40 in. deep
Peru	78	0.6	2.0	0.06	0.6	C	3	Firm, platy, loamy till	frigid	loamy	yes	
Pillsbury	646	0.6	2.0	0.06	0.2	C	5	Firm, platy, loamy till	frigid	silty	no	
Pipestone	314					B	5	Outwash and Stream Terraces	mesic	sandy	yes	
Pittstown	334	0.6	2.0	0.06	0.2	C	3	Firm, platy, silty till, schist & phyllite	mesic	loamy	no	channery silt loam in Cd
Plaisted	563	0.6	2.0	0.06	0.6	C	3	Firm, platy, silty till, schist & phyllite	frigid	loamy	yes	channery silt loam in Cd
Podunk	104	0.6	6.0	6.00	20.0	B	3	Flood Plain (Bottom Land)	frigid	loamy	no	loamy to coarse sand in C
Pondicherry	992			6.00	20.0	D	6	Organic Materials - Freshwater	frigid	sandy or sandy-skeletal	no	organic over sand
Poocham	230	0.6	2.0	0.20	2.0	B	3	Terraces and glacial lake plains	mesic	silty	no	silt loam in C
Pootatuck	4	0.6	6.0	6.00	20.0	B	3	Flood Plain (Bottom Land)	mesic	loamy	no	single grain in C
Quonset	310	2.0	20.0	20.00	100.0	A	1	Outwash and Stream Terraces	mesic	sandy-skeletal	no	shale
Rawsonville	98	0.6	6.0	0.60	6.0	C	4	Loose till, bedrock	frigid	loamy	yes	20 to 40 in. deep
Raynham	533	0.2	2.0	0.06	0.2	C	5	Terraces and glacial lake plains	mesic	silty	no	
Raypol	540	0.6	2.0	6.00	100.0	D	5	Outwash and Stream Terraces	mesic	co. loamy over sandy (skeletal)	no	
Redstone	665	2.0	6.0	6.00	20.0	A	1	Weathered Bedrock Till	frigid	fragmental	yes	loamy cap
Ricker	674	2.0	6.0	2.00	6.0	A	4	rganic over bedrock (up to 4" of minera	cryic	fibric to hemic	no	well drained, less than 20 in. deep
Ridgebury	656	0.6	6.0	0.00	0.2	C	5	Firm, platy, loamy till	mesic	loamy	no	
Rippowam	5	0.6	6.0	6.00	20.0	C	5	Flood Plain (Bottom Land)	mesic	loamy	no	
Roundabout	333	0.2	2.0	0.06	0.6	C	5	Terraces and glacial lake plains	frigid	silty	no	silt loam in the C
Rumney	105	0.6	6.0	6.00	20.0	C	5	Flood Plain (Bottom Land)	frigid	loamy	no	
Saco	6	0.6	2.0	6.00	20.0	D	6	Flood Plain (Bottom Land)	mesic	silty	no	strata
Saddleback	673	0.6	2.0	0.60	2.0	C/D	4	Loose till, bedrock	cryic	loamy	yes	less than 20 in. deep
Salmon	630	0.6	2.0	0.60	2.0	B	2	Terraces and glacial lake plains	frigid	silty	yes	very fine sandy loam
Saugatuck	16	0.06	0.2	6.00	20.0	C	5	Outwash and Stream Terraces	mesic	sandy	yes	ortstein
Scantic	233	0.0	0.2	0.00	0.2	D	5	Silt and Clay Deposits	frigid	fine	no	
Scarboro	115	6.0	20.0	6.00	20.0	D	6	Outwash and Stream Terraces	mesic	sandy	no	organic over sand, non stony
Scio	531	0.6	2.0	0.60	2.0	B	3	Terraces and glacial lake plains	mesic	silty	no	gravelly sand in 2C
Scitico	33	0.0	0.2	0.00	0.2	C	5	Silt and Clay Deposits	mesic	fine	no	
Scituate	448	0.6	2.0	0.06	0.2	C	3	Firm, platy, sandy till	mesic	loamy	no	loamy sand in Cd
Searsport	15	6.0	20.0	6.00	20.0	D	6	Outwash and Stream Terraces	frigid	sandy	no	organic over sand
Shaker	439	2.0	6.0	0.00	0.2	C	5	Sandy/loamy over silt/clay	mesic	co. loamy over clayey	no	
Shapleigh	136					C/D	4	Sandy Till	mesic	sandy	yes	less than 20 in. deep
Sheepscot	14	6.0	20.0	6.00	20.0	B	3	Outwash and Stream Terraces	frigid	sandy-skeletal	yes	gravelly coarse sand
Sisk	667	0.6	2.0	0.00	0.6	C	3	Firm, platy, loamy till	cryic	loamy	yes	sandy loam in Cd
Skerry	558	0.6	2.0	0.06	0.6	C	3	Firm, platy, sandy till	frigid	loamy	yes	loamy sand in Cd
Squamscott	538	6.0	20.0	0.06	0.6	C	5	Sandy/loamy over silt/clay	mesic	sandy over loamy	yes	
Stetson	523	0.6	6.0	6.00	20.0	B	2	Outwash and Stream Terraces	frigid	sandy-skeletal	yes	loamy over gravelly
Stissing	340	0.6	2.0	0.06	0.2	C	5	Firm, platy, silty till, schist & phyllite	mesic	loamy	no	
Success	154	2.0	6.0	6.00	20.0	A	1	Sandy Till	frigid	sandy-skeletal	yes	cemented
Sudbury	118	2.0	6.0	2.00	20.0	B	3	Outwash and Stream Terraces	mesic	sandy	no	loam over gravelly sand

Soil Series	legend number	Ksat low - B in/hr	Ksat high - B in/hr	Ksat low - C in/hr	Ksat high - C in/hr	Hyd. Grp.	Group	Land Form	Temp.	Soil Textures	Spodosol ?	Other
Suffield	536	0.6	2.0	0.00	0.2	C	3	Sandy/loamy over silt/clay	mesic	silty over clayey	no	deep to clay C
Sunapee	168	0.6	2.0	0.60	6.0	B	3	Loose till, loamy textures	frigid	loamy	yes	
Sunapee var	269	0.6	2.0	0.60	6.0	B	3	Loose till, loamy textures	frigid	loamy	yes	frigid dystrudept
Suncook	2	6.0	20.0	6.00	20.0	A	1	Flood Plain (Bottomland)	mesic	sandy	no	occasionally flooded
Suncook	402	6.0	20.0	6.00	20.0	A	1	Flood Plain (Bottomland)	mesic	sandy	no	frequent flooding
Sunday	102	6.0	20.0	6.00	20.0	A	1	Flood Plain (Bottomland)	frigid	sandy	no	occasionally flooded
Sunday	202	6.0	20.0	6.00	20.0	A	1	Flood Plain (Bottomland)	frigid	sandy	no	frequently flooded
Surplus	669	0.6	2.0	0.00	0.6	C	3	Firm, platy, loamy till	cryic	loamy	yes	mwd, sandy loam in Cd
Sutton	68	0.6	6.0	0.60	6.0	B	3	Loose till, loamy textures	mesic	loamy	no	
Swanton	438	2.0	6.0	0.00	0.2	C	5	Sandy/loamy over silt/clay	frigid	co. loamy over clayey	no	
Telos	123	0.6	2.0	0.02	0.2	C	3	Firm, platy, silty till, schist & phyllite	frigid	loamy	yes	channery silt loam in Cd
Thorndike	84	0.6	2.0	0.60	2.0	C/D	4	Friable till, silty, schist & phyllite	frigid	loamy-skeletal	yes	less than 20 in. deep
Timakwa	393			6.00	100.0	D	6	Organic Materials - Freshwater	mesic	sandy or sandy-skeletal	no	organic over sand
Tunbridge	99	0.6	6.0	0.60	6.0	C	4	Loose till, bedrock	frigid	loamy	yes	20 to 40 in. deep
Unadilla	30	0.6	2.0	2.00	20.0	B	2	Terraces and glacial lake plains	mesic	silty	no	silty over gravelly
Vassalboro	150					D	6	Organic Materials - Freshwater	frigid	peat	no	deep organic
Walpole	546	2.0	6.0	6.00	20.0	C	5	Outwash and Stream Terraces	mesic	sandy	no	
Wareham	34	6.0	20.0	6.00	20.0	C	5	Outwash and Stream Terraces	mesic	sandy	no	
Warwick	210	2.0	6.0	20.00	100.0	A	1	Outwash and Stream Terraces	mesic	loamy-skeletal	no	loamy over slate gravel
Waskish	195					D	6	Organic Materials - Freshwater	frigid	peat	no	deep organic
Waumbeck	58	2.0	20.0	6.00	20.0	B	3	Loose till, sandy textures	frigid	sandy-skeletal	yes	very cobbly loamy sand
Westbrook	597			0.00	2.0	D	6	Tidal Flat	mesic	loamy	no	organic over loam
Whitman	49	0.0	0.2	0.00	0.2	D	6	Firm, platy, loamy till	mesic	loamy	no	mucky loam
Windsor	26	6.0	20.0	6.00	20.0	A	1	Outwash and Stream Terraces	mesic	sandy	no	
Winnecook	88	0.6	2.0	0.60	2.0	C	4	Friable till, silty, schist & phyllite	frigid	loamy-skeletal	yes	20 to 40 in. deep
Winooski	9	0.6	6.0	0.60	6.0	B		Flood Plain (Bottom Land)	mesic	silty over loamy	no	
Winooski	103	0.6	6.0	0.60	6.0	B	3	Flood Plain (Bottom Land)	mesic	silty	no	very fine sandy loam
Wonsqueak	995			0.20	2.0	D	6	Organic Materials - Freshwater	frigid	loamy	no	organic over loam
Woodbridge	29	0.6	2.0	0.00	0.6	C	3	Firm, platy, loamy till	mesic	loamy	no	sandy loam in Cd
Woodstock	93	2.0	6.0	2.00	6.0	C/D	4	Loose till, bedrock	frigid	loamy	no	less than 20 in. deep

(gray)	no longer recognized
(stippled)	organic materials



Drainage Diagram for MODEL_Pre-Development (22) 11-15
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.309	30	Woods, Good, HSG A (ES)
1.438	39	>75% Grass cover, Good, HSG A (ES, WS)
0.009	98	Concrete Pads, HSG A (ES)
0.035	98	Concrete Sidewalk and Pads, HSG A (WS)
0.560	98	Paved parking, HSG A (ES, WS)
0.492	98	Roofs, HSG A (ES, WS)
2.843	61	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
2.843	HSG A	ES, WS
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
2.843		**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 21.17% Impervious Runoff Depth>0.07"
Flow Length=350' Slope=0.0100 '/' Tc=26.9 min CN=50 Runoff=0.02 cfs 0.008 af

Subcatchment WS: West Side Runoff Area=61,638 sf 56.07% Impervious Runoff Depth>0.73"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=72 Runoff=1.34 cfs 0.086 af

Pond 2: CB 2 Peak Elev=130.31' Inflow=1.34 cfs 0.094 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=1.34 cfs 0.094 af

Pond 3: CB 3 Peak Elev=131.59' Inflow=1.34 cfs 0.086 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=1.34 cfs 0.086 af

Pond 5: CB 5 Peak Elev=132.36' Inflow=0.02 cfs 0.008 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=0.02 cfs 0.008 af

Link 6L: POI 'A' Inflow=1.34 cfs 0.094 af
Primary=1.34 cfs 0.094 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.094 af Average Runoff Depth = 0.39"
61.45% Pervious = 1.747 ac 38.55% Impervious = 1.096 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 21.17% Impervious Runoff Depth>0.42"
Flow Length=350' Slope=0.0100 '/' Tc=26.9 min CN=50 Runoff=0.29 cfs 0.050 af

Subcatchment WS: West Side Runoff Area=61,638 sf 56.07% Impervious Runoff Depth>1.67"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=72 Runoff=3.25 cfs 0.197 af

Pond 2: CB 2 Peak Elev=130.48' Inflow=3.25 cfs 0.247 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=3.25 cfs 0.247 af

Pond 3: CB 3 Peak Elev=131.98' Inflow=3.25 cfs 0.197 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=3.25 cfs 0.197 af

Pond 5: CB 5 Peak Elev=132.55' Inflow=0.29 cfs 0.050 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=0.29 cfs 0.050 af

Link 6L: POI 'A' Inflow=3.25 cfs 0.247 af
Primary=3.25 cfs 0.247 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.247 af Average Runoff Depth = 1.04"
61.45% Pervious = 1.747 ac 38.55% Impervious = 1.096 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 21.17% Impervious Runoff Depth>0.87"
Flow Length=350' Slope=0.0100 '/' Tc=26.9 min CN=50 Runoff=0.75 cfs 0.103 af

Subcatchment WS: West Side Runoff Area=61,638 sf 56.07% Impervious Runoff Depth>2.54"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=72 Runoff=4.96 cfs 0.299 af

Pond 2: CB 2 Peak Elev=130.60' Inflow=5.01 cfs 0.402 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=5.01 cfs 0.402 af

Pond 3: CB 3 Peak Elev=132.30' Inflow=4.96 cfs 0.299 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=4.96 cfs 0.299 af

Pond 5: CB 5 Peak Elev=132.71' Inflow=0.75 cfs 0.103 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=0.75 cfs 0.103 af

Link 6L: POI 'A' Inflow=5.01 cfs 0.402 af
Primary=5.01 cfs 0.402 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.402 af Average Runoff Depth = 1.70"
61.45% Pervious = 1.747 ac 38.55% Impervious = 1.096 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 21.17% Impervious Runoff Depth>1.37"
Flow Length=350' Slope=0.0100 '/' Tc=26.9 min CN=50 Runoff=1.31 cfs 0.163 af

Subcatchment WS: West Side Runoff Area=61,638 sf 56.07% Impervious Runoff Depth>3.40"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=72 Runoff=6.63 cfs 0.400 af

Pond 2: CB 2 Peak Elev=130.70' Inflow=6.83 cfs 0.564 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=6.83 cfs 0.564 af

Pond 3: CB 3 Peak Elev=132.72' Inflow=6.63 cfs 0.400 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=6.63 cfs 0.400 af

Pond 5: CB 5 Peak Elev=132.85' Inflow=1.31 cfs 0.163 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=1.31 cfs 0.163 af

Link 6L: POI 'A' Inflow=6.83 cfs 0.564 af
Primary=6.83 cfs 0.564 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.564 af Average Runoff Depth = 2.38"
61.45% Pervious = 1.747 ac 38.55% Impervious = 1.096 ac

Summary for Subcatchment ES: East Side

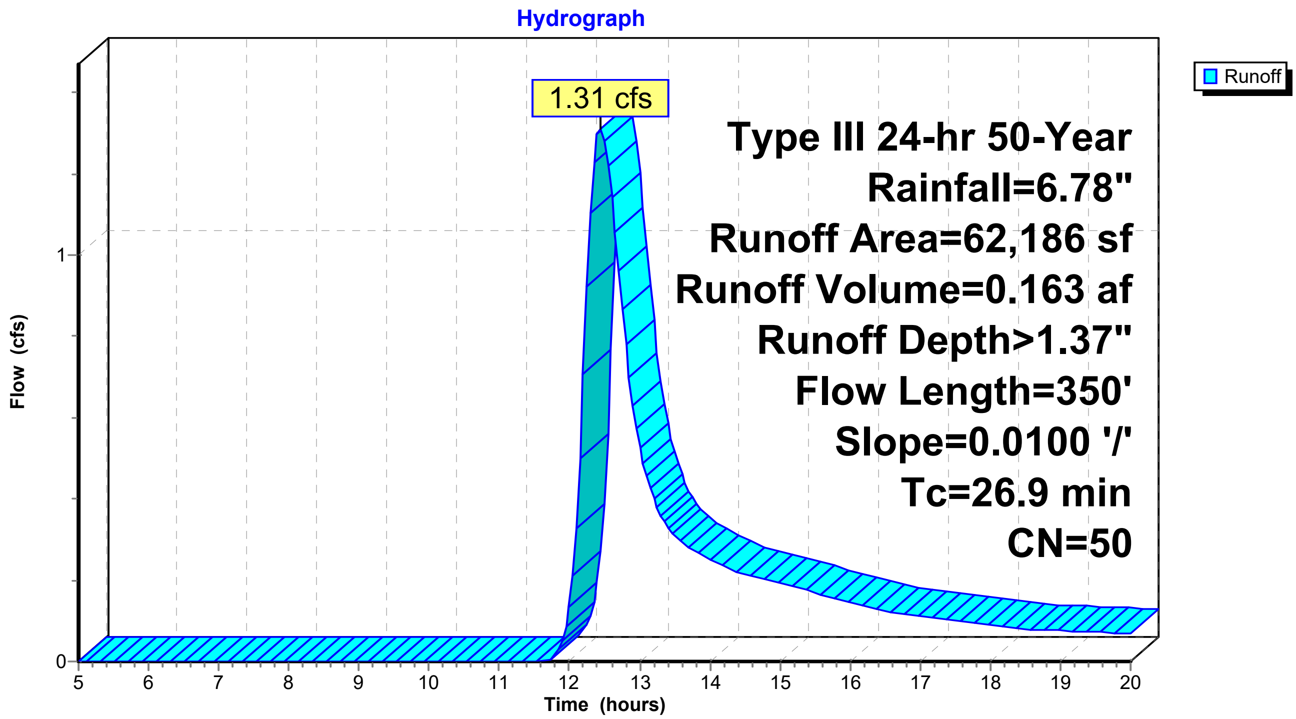
Runoff = 1.31 cfs @ 12.44 hrs, Volume= 0.163 af, Depth> 1.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=6.78"

Area (sf)	CN	Description
13,455	30	Woods, Good, HSG A
35,564	39	>75% Grass cover, Good, HSG A
11,330	98	Roofs, HSG A
1,442	98	Paved parking, HSG A
395	98	Concrete Pads, HSG A
62,186	50	Weighted Average
49,019		78.83% Pervious Area
13,167		21.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.3	200	0.0100	0.14		**Sheet Flow, ES.1 to ES.2** Grass: Short n= 0.150 P2= 2.99"
3.6	150	0.0100	0.70		**Shallow Concentrated Flow, ES.2 to ES.3** Short Grass Pasture Kv= 7.0 fps
26.9	350	Total			

Subcatchment ES: East Side



Summary for Subcatchment WS: West Side

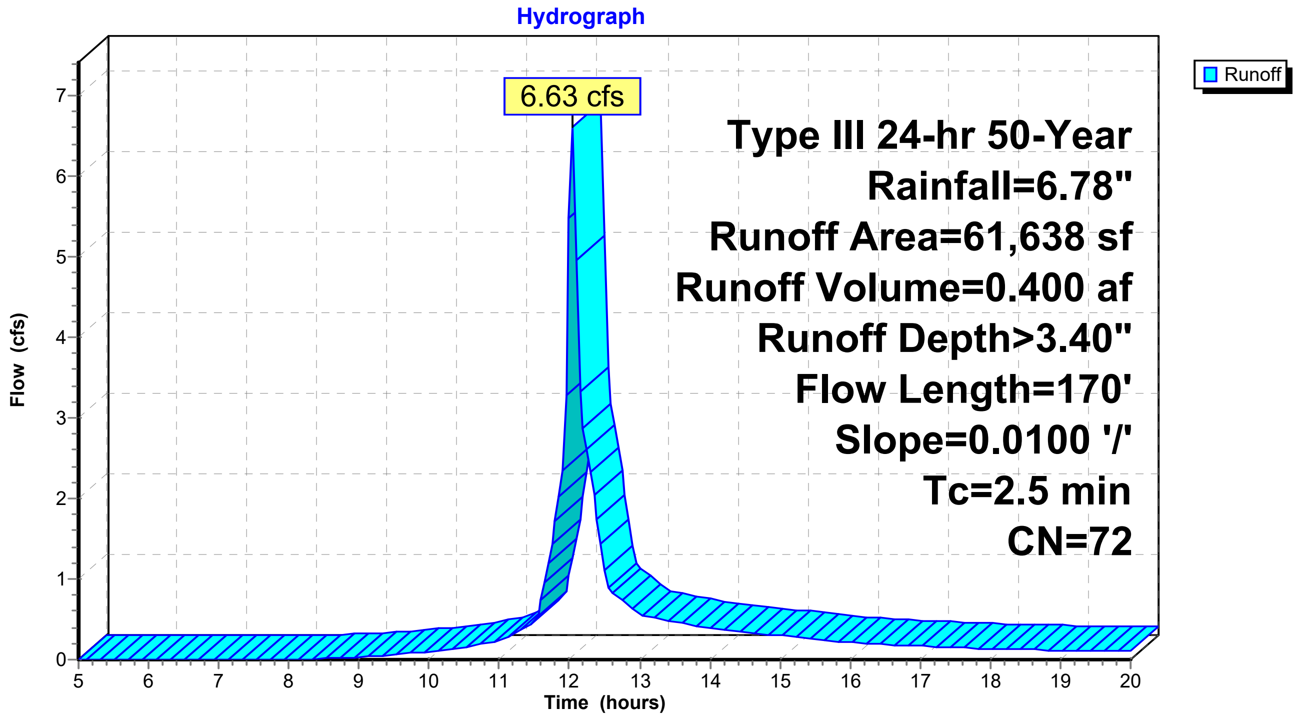
Runoff = 6.63 cfs @ 12.05 hrs, Volume= 0.400 af, Depth> 3.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=6.78"

	Area (sf)	CN	Description
	27,075	39	>75% Grass cover, Good, HSG A
	10,080	98	Roofs, HSG A
	22,973	98	Paved parking, HSG A
*	1,510	98	Concrete Sidewalk and Pads, HSG A
	61,638	72	Weighted Average
	27,075		43.93% Pervious Area
	34,563		56.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	170	0.0100	1.12		**Sheet Flow, WS.1 to WS.2** Smooth surfaces n= 0.011 P2= 2.99"

Subcatchment WS: West Side



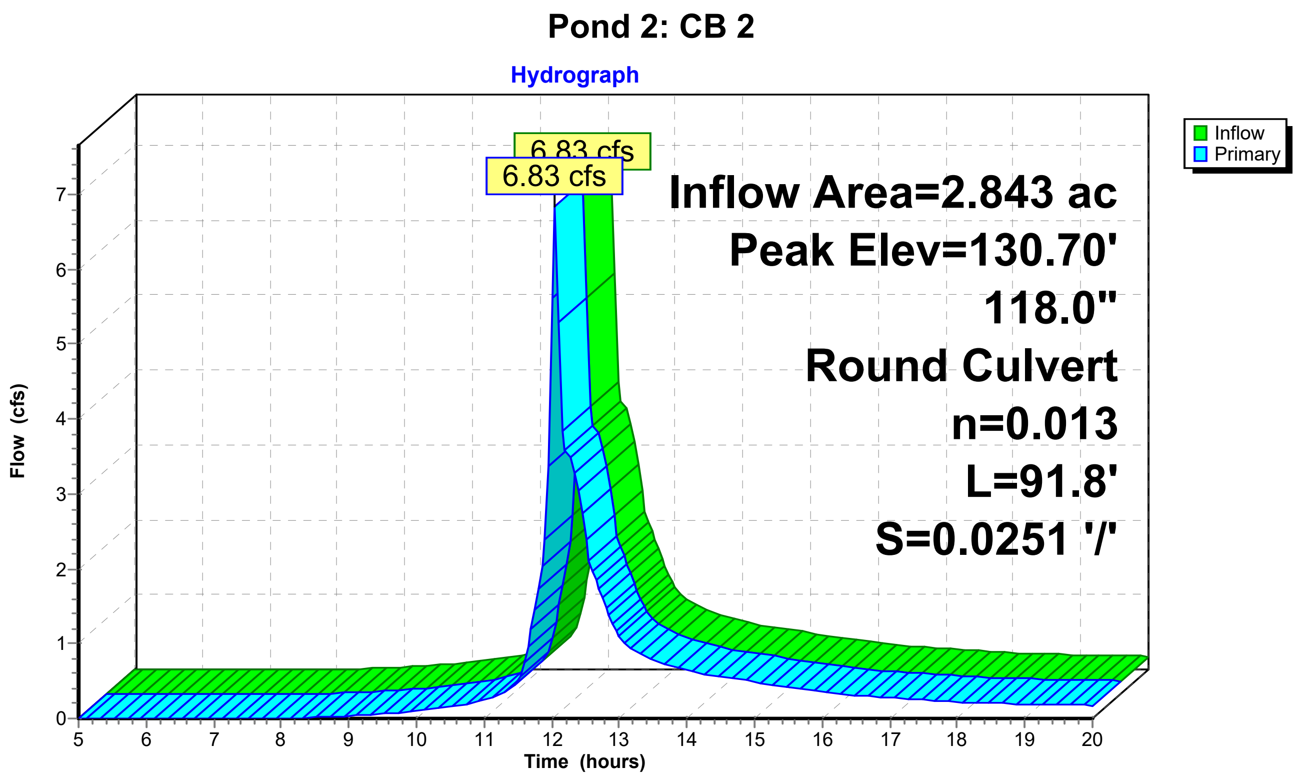
Summary for Pond 2: CB 2

Inflow Area = 2.843 ac, 38.55% Impervious, Inflow Depth > 2.38" for 50-Year event
Inflow = 6.83 cfs @ 12.05 hrs, Volume= 0.564 af
Outflow = 6.83 cfs @ 12.05 hrs, Volume= 0.564 af, Atten= 0%, Lag= 0.0 min
Primary = 6.83 cfs @ 12.05 hrs, Volume= 0.564 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 130.70' @ 12.05 hrs
Flood Elev= 133.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	130.00'	**118.0" Round Culvert** L= 91.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 130.00' / 127.70' S= 0.0251 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=6.74 cfs @ 12.05 hrs HW=130.70' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 6.74 cfs @ 2.84 fps)



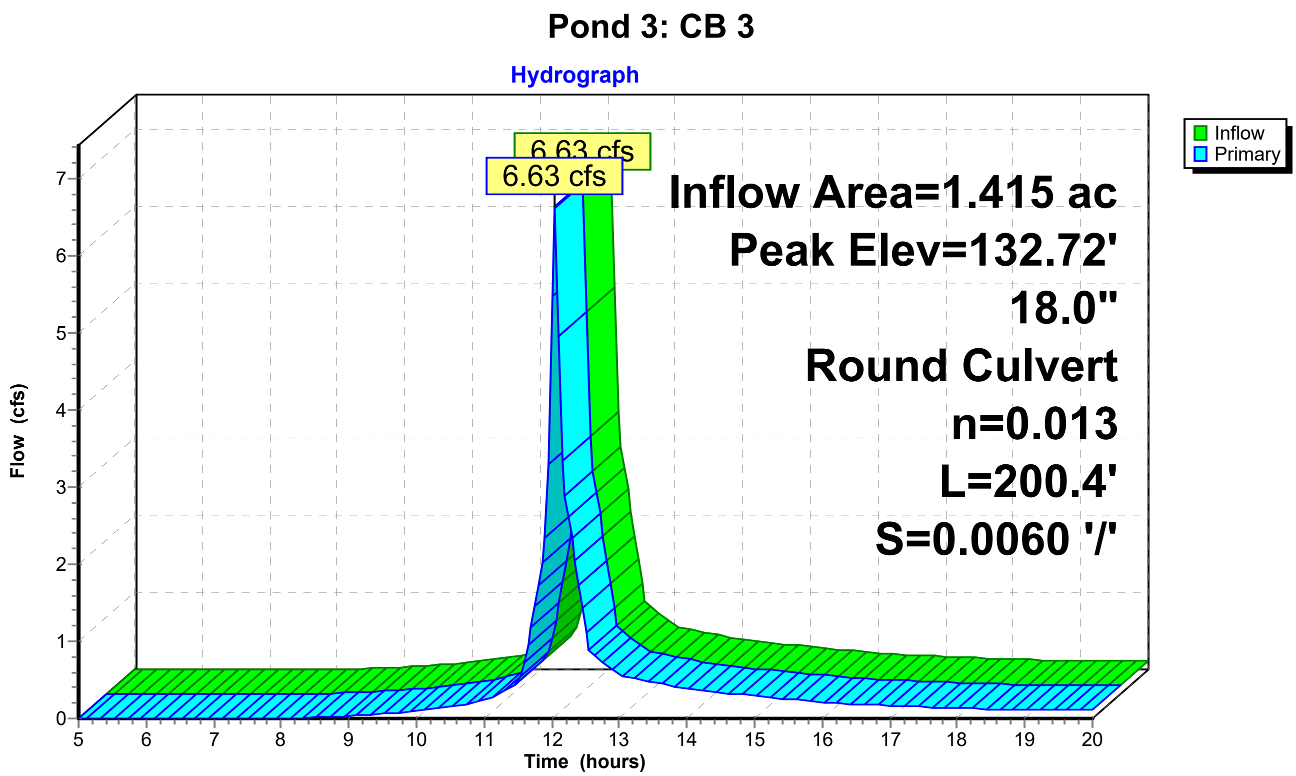
Summary for Pond 3: CB 3

Inflow Area =	1.415 ac, 56.07% Impervious, Inflow Depth > 3.40" for 50-Year event			
Inflow =	6.63 cfs @	12.05 hrs, Volume=	0.400 af	
Outflow =	6.63 cfs @	12.05 hrs, Volume=	0.400 af,	Atten= 0%, Lag= 0.0 min
Primary =	6.63 cfs @	12.05 hrs, Volume=	0.400 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 132.72' @ 12.05 hrs
Flood Elev= 134.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	131.00'	**18.0" Round Culvert** L= 200.4' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 131.00' / 129.80' S= 0.0060 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=6.51 cfs @ 12.05 hrs HW=132.69' (Free Discharge)
└─**1=Culvert** (Inlet Controls 6.51 cfs @ 3.69 fps)



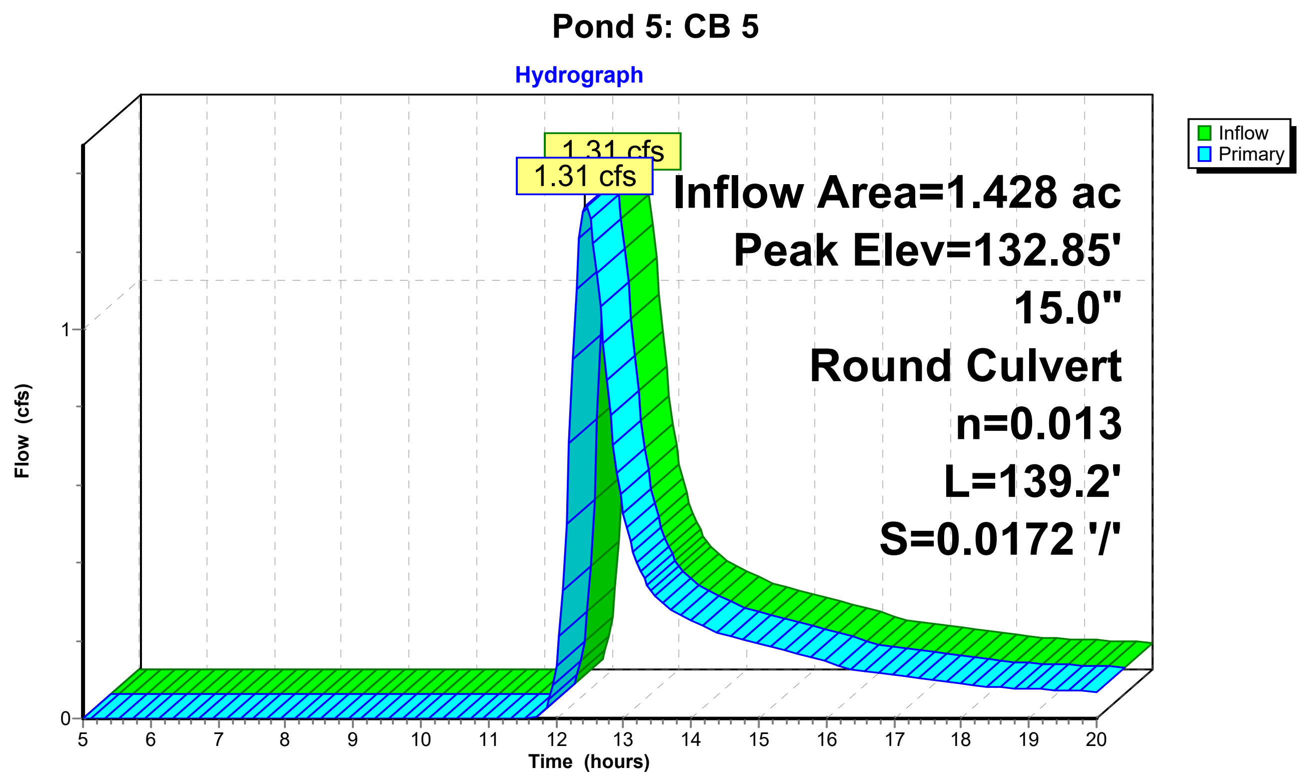
Summary for Pond 5: CB 5

Inflow Area = 1.428 ac, 21.17% Impervious, Inflow Depth > 1.37" for 50-Year event
Inflow = 1.31 cfs @ 12.44 hrs, Volume= 0.163 af
Outflow = 1.31 cfs @ 12.44 hrs, Volume= 0.163 af, Atten= 0%, Lag= 0.0 min
Primary = 1.31 cfs @ 12.44 hrs, Volume= 0.163 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 132.85' @ 12.44 hrs
Flood Elev= 135.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	132.30'	**15.0" Round Culvert** L= 139.2' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 132.30' / 129.90' S= 0.0172 '/' Cc= 0.900 n= 0.013

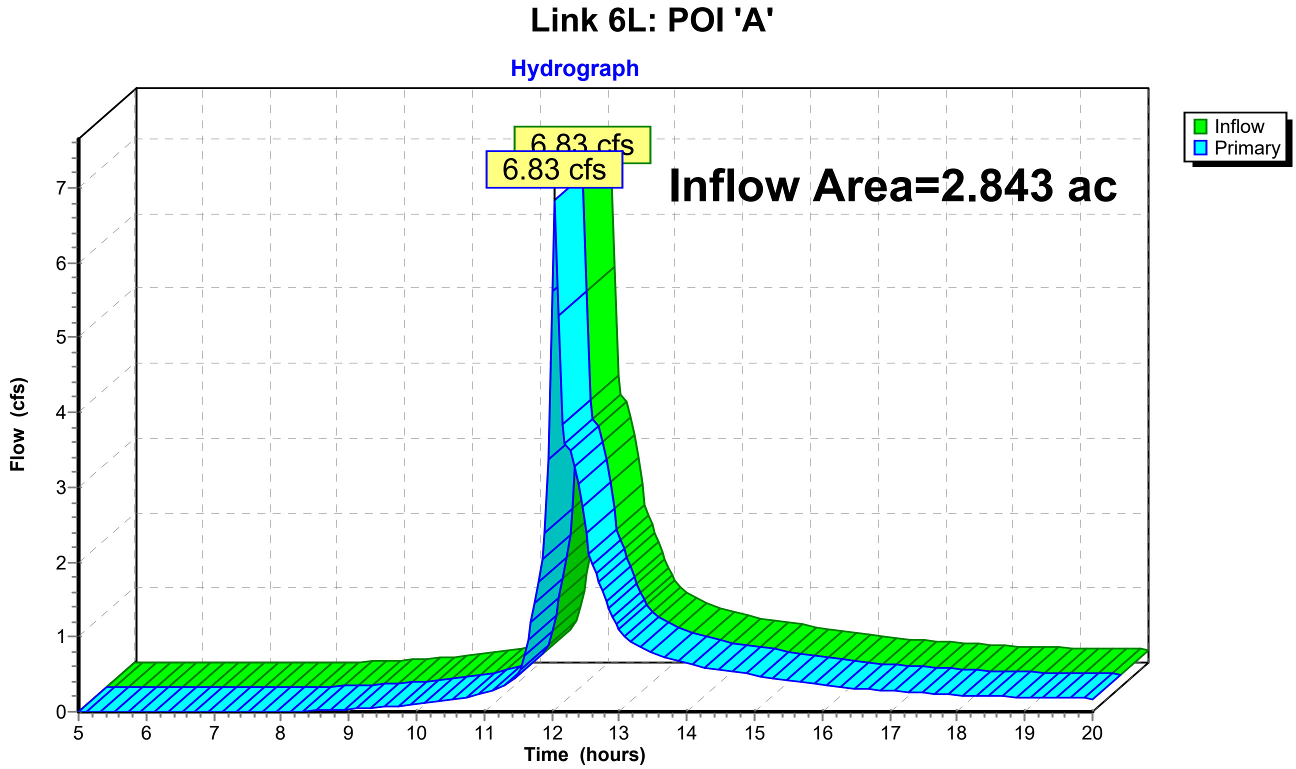
Primary OutFlow Max=1.31 cfs @ 12.44 hrs HW=132.85' (Free Discharge)
└─**1=Culvert** (Inlet Controls 1.31 cfs @ 2.52 fps)

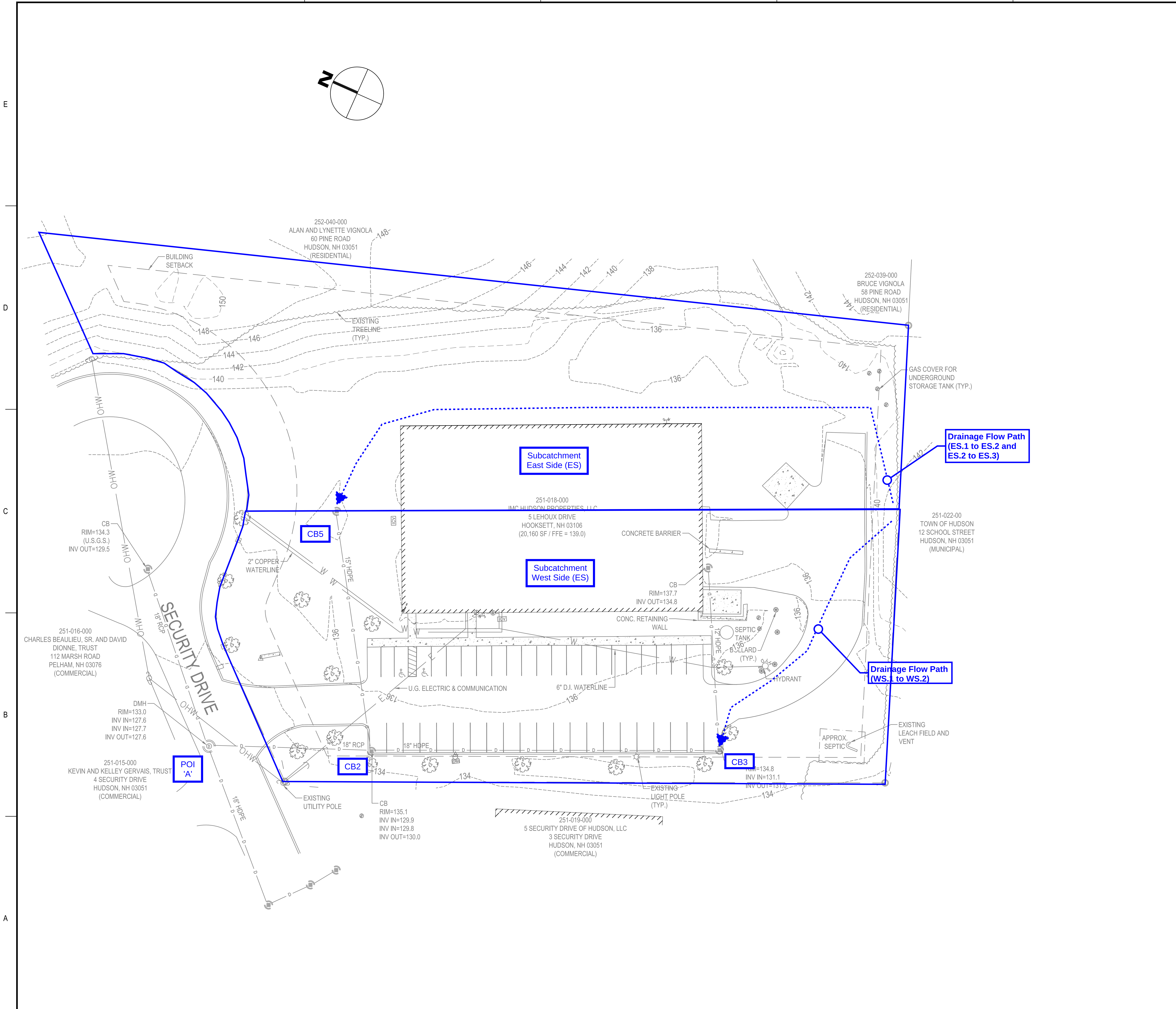


Summary for Link 6L: POI 'A'

Inflow Area = 2.843 ac, 38.55% Impervious, Inflow Depth > 2.38" for 50-Year event
Inflow = 6.83 cfs @ 12.05 hrs, Volume= 0.564 af
Primary = 6.83 cfs @ 12.05 hrs, Volume= 0.564 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs





GRADING AND DRAINAGE LEGEND

EXISTING	ITEM	NEW
140	MAJOR CONTOUR	140
138	MINOR CONTOUR	138
	FLARED END SECTION	
	CATCH BASIN	
	TREELINE	
	PAVEMENT SHOULDER STONE	
	INFILTRATION TRENCH STONE	
	PAVEMENT	
	CONCRETE PADS AND SIDEWALK	
	PERVIOUS CONCRETE PAVERS	
	DRAINAGE PIPE	
	PAVEMENT MARKINGS	

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Boston Baltimore Orlando Hartford Bedford

NOT FOR CONSTRUCTION

PROJECT
ASM FACILITY
7 SECURITY DRIVE
HUDSON, NH 03051

OWNER
JMC HUDSON PROPERTIES, LLC
5 LEHOUX DRIVE
HOOKSETT, NH 03106

NO.	DATE	DESCRIPTION	BY
1	11/2/22	TOWN REVIEW	APL

PROJECT NO.	718770
CADD FILE	718770_Drainage Plan
DESIGNED BY	APL
DRAWN BY	APL
CHECKED BY	SMB
DATE	9/19/2022
DRAWING SCALE	1" = 30'

GRAPHIC SCALE

SHEET TITLE

PRE-DEVELOPMENT DRAINAGE PLAN

DRAWING NO.

FIG 1

1 OF 1

Plan | Engineer | Construct | Maintain

Scott M. Bourcier, P.E.
Project Manager

MEMORANDUM

TO: File

RE: ASM Facility (Tax Map 215 / Lot 18)
Impervious Areas and Open Space Calculations

DATE: November 15, 2022

The purpose of this memorandum is to outline impervious and open space site conditions with respect to the above-referenced project.

Existing Site Conditions		
Description		Area (SF)
Total Site		**123,824**
Impervious Areas		
Buildings		21,410
Pavement		23,775
Pavement Curb		640
Concrete Sidewalk		1,200
Concrete Pads		705
	total	**47,730**
Open Space		**76,094**
		61.5%

Proposed Site Conditions		
Description		Area (SF)
Total Site		**123,824**
Impervious Areas		
Buildings		21,410
Pavement		24,107
Pavement Curb		528
Concrete Sidewalk		2,112
Concrete Pads		751
	total	**48,908**
Porous Parking Area (not incl. in Open Space calc.)		**11,043**
Open Space		**74,916**
		60.5%

End of Memorandum

GROUNDWATER RECHARGE VOLULME (GRV) CALCULATION
(Env-Wq 1507.04)

1.12	ac	Area of HSG A soil that was replaced by impervious cover	0.40"
-	ac	Area of HSG B soil that was replaced by impervious cover	0.25"
-	ac	Area of HSG C soil that was replaced by impervious cover	0.10"
-	ac	Area of HSG D soil or impervious cover that was replaced by impervious cover	0.0"
0.40	inches	Rd = Weighted groundwater recharge depth	
0.448	ac-in	GRV = AI * Rd	
1,626	cf	GRV conversion (ac-in x 43,560 sf/ac x 1ft/12”)	

Provide calculations below showing that the project meets the groundwater recharge requirements (Env-Wq 1507.04):

1. Total (existing and proposed) impervious area = 48,908 SF = 1.12 Ac

2. Stormcrete Pre-cast Porous Concrete parking area:

2a. Stormcrete east side = 3,148 SF x 1-foot depth x 20% void = 630 CF (not including porous concrete)

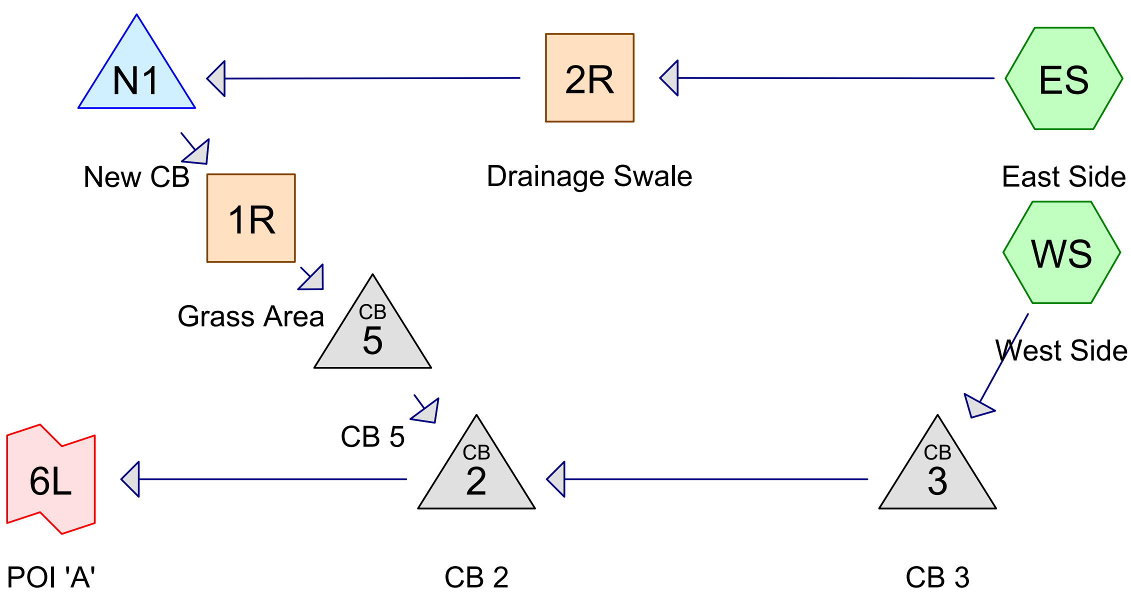
2b. Stormcrete west side = 7,880 SF x 1-foot depth x 20% void = 1,576 CF (not including porous concrete)

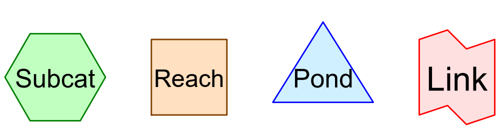
3. Subsurface Infiltration System

3a. 24-inch diameter pipe = 3.14 SF x 300 L.F. = 942 CF

3b. 6-inch surrounding stone = 9 SF x 300 L.F. x 40% void - 24-inch diameter pipe (942 CF) = 703 CF

4. Total volume = 630 + 1,576 + 942 + 703 = 3,851 CF potential groundwater recharge volume





Drainage Diagram for MODEL_Post-Development (22) 11-15
Prepared by HP Inc., Printed 11/14/2022
HydroCAD® 9.10 s/n 00742 © 2010 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.267	30	Woods, Good, HSG A (ES)
0.566	39	>75% Grass cover, Good, HSG A (ES)
0.253	39	Pre-Cast Concrete Porous Pavers, Good, HSG A (ES, WS)
0.634	49	50-75% Grass cover, Fair, HSG A (WS)
0.031	98	Concrete Pads, HSG A (ES)
0.035	98	Concrete Sidewalk and Pads, HSG A (WS)
0.566	98	Paved parking, HSG A (ES, WS)
0.492	98	Roofs, HSG A (ES, WS)
2.843	64	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
2.843	HSG A	ES, WS
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
2.843		**TOTAL AREA**

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 36.58% Impervious Runoff Depth>0.26"
Flow Length=50' Slope=0.0100 '/' Tc=7.7 min CN=59 Runoff=0.20 cfs 0.030 af

Subcatchment WS: West Side Runoff Area=61,638 sf 42.44% Impervious Runoff Depth>0.60"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=69 Runoff=1.04 cfs 0.070 af

Reach 1R: Grass Area Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.150 L=50.0' S=0.0100 '/' Capacity=7.94 cfs Outflow=0.00 cfs 0.000 af

Reach 2R: Drainage Swale Avg. Flow Depth=0.16' Max Vel=0.40 fps Inflow=0.20 cfs 0.030 af
n=0.030 L=350.0' S=0.0009 '/' Capacity=5.41 cfs Outflow=0.16 cfs 0.029 af

Pond 2: CB 2 Peak Elev=130.27' Inflow=1.04 cfs 0.070 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=1.04 cfs 0.070 af

Pond 3: CB 3 Peak Elev=131.52' Inflow=1.04 cfs 0.070 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=1.04 cfs 0.070 af

Pond 5: CB 5 Peak Elev=132.30' Inflow=0.00 cfs 0.000 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=0.00 cfs 0.000 af

Pond N1: New CB Peak Elev=133.94' Storage=428 cf Inflow=0.16 cfs 0.029 af
Discarded=0.04 cfs 0.024 af Primary=0.00 cfs 0.000 af Outflow=0.04 cfs 0.024 af

Link 6L: POI 'A' Inflow=1.04 cfs 0.070 af
Primary=1.04 cfs 0.070 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.101 af Average Runoff Depth = 0.43"
60.50% Pervious = 1.720 ac 39.50% Impervious = 1.123 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 36.58% Impervious Runoff Depth>0.85"
Flow Length=50' Slope=0.0100 '/' Tc=7.7 min CN=59 Runoff=1.22 cfs 0.102 af

Subcatchment WS: West Side Runoff Area=61,638 sf 42.44% Impervious Runoff Depth>1.46"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=69 Runoff=2.82 cfs 0.173 af

Reach 1R: Grass Area Avg. Flow Depth=0.09' Max Vel=0.16 fps Inflow=0.23 cfs 0.017 af
n=0.150 L=50.0' S=0.0100 '/' Capacity=7.94 cfs Outflow=0.21 cfs 0.017 af

Reach 2R: Drainage Swale Avg. Flow Depth=0.42' Max Vel=0.67 fps Inflow=1.22 cfs 0.102 af
n=0.030 L=350.0' S=0.0009 '/' Capacity=5.41 cfs Outflow=0.91 cfs 0.100 af

Pond 2: CB 2 Peak Elev=130.45' Inflow=2.82 cfs 0.189 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=2.82 cfs 0.189 af

Pond 3: CB 3 Peak Elev=131.90' Inflow=2.82 cfs 0.173 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=2.82 cfs 0.173 af

Pond 5: CB 5 Peak Elev=132.51' Inflow=0.21 cfs 0.017 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=0.21 cfs 0.017 af

Pond N1: New CB Peak Elev=135.36' Storage=1,400 cf Inflow=0.91 cfs 0.100 af
Discarded=0.13 cfs 0.065 af Primary=0.23 cfs 0.017 af Outflow=0.36 cfs 0.082 af

Link 6L: POI 'A' Inflow=2.82 cfs 0.189 af
Primary=2.82 cfs 0.189 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.274 af Average Runoff Depth = 1.16"
60.50% Pervious = 1.720 ac 39.50% Impervious = 1.123 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 36.58% Impervious Runoff Depth>1.48"
Flow Length=50' Slope=0.0100 '/' Tc=7.7 min CN=59 Runoff=2.34 cfs 0.177 af

Subcatchment WS: West Side Runoff Area=61,638 sf 42.44% Impervious Runoff Depth>2.28"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=69 Runoff=4.45 cfs 0.269 af

Reach 1R: Grass Area Avg. Flow Depth=0.22' Max Vel=0.27 fps Inflow=1.42 cfs 0.076 af
n=0.150 L=50.0' S=0.0100 '/' Capacity=7.94 cfs Outflow=1.27 cfs 0.076 af

Reach 2R: Drainage Swale Avg. Flow Depth=0.60' Max Vel=0.82 fps Inflow=2.34 cfs 0.177 af
n=0.030 L=350.0' S=0.0009 '/' Capacity=5.41 cfs Outflow=1.83 cfs 0.174 af

Pond 2: CB 2 Peak Elev=130.56' Inflow=4.45 cfs 0.344 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=4.45 cfs 0.344 af

Pond 3: CB 3 Peak Elev=132.20' Inflow=4.45 cfs 0.269 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=4.45 cfs 0.269 af

Pond 5: CB 5 Peak Elev=132.84' Inflow=1.27 cfs 0.076 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=1.27 cfs 0.076 af

Pond N1: New CB Peak Elev=135.88' Storage=1,603 cf Inflow=1.83 cfs 0.174 af
Discarded=0.17 cfs 0.076 af Primary=1.42 cfs 0.076 af Outflow=1.58 cfs 0.151 af

Link 6L: POI 'A' Inflow=4.45 cfs 0.344 af
Primary=4.45 cfs 0.344 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.445 af Average Runoff Depth = 1.88"
60.50% Pervious = 1.720 ac 39.50% Impervious = 1.123 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment ES: East Side Runoff Area=62,186 sf 36.58% Impervious Runoff Depth>2.15"
Flow Length=50' Slope=0.0100 '/' Tc=7.7 min CN=59 Runoff=3.51 cfs 0.256 af

Subcatchment WS: West Side Runoff Area=61,638 sf 42.44% Impervious Runoff Depth>3.10"
Flow Length=170' Slope=0.0100 '/' Tc=2.5 min CN=69 Runoff=6.06 cfs 0.365 af

Reach 1R: Grass Area Avg. Flow Depth=0.30' Max Vel=0.33 fps Inflow=3.01 cfs 0.144 af
n=0.150 L=50.0' S=0.0100 '/' Capacity=7.94 cfs Outflow=2.54 cfs 0.144 af

Reach 2R: Drainage Swale Avg. Flow Depth=0.74' Max Vel=0.92 fps Inflow=3.51 cfs 0.256 af
n=0.030 L=350.0' S=0.0009 '/' Capacity=5.41 cfs Outflow=2.86 cfs 0.253 af

Pond 2: CB 2 Peak Elev=130.66' Inflow=6.06 cfs 0.510 af
118.0" Round Culvert n=0.013 L=91.8' S=0.0251 '/' Outflow=6.06 cfs 0.510 af

Pond 3: CB 3 Peak Elev=132.56' Inflow=6.06 cfs 0.365 af
18.0" Round Culvert n=0.013 L=200.4' S=0.0060 '/' Outflow=6.06 cfs 0.365 af

Pond 5: CB 5 Peak Elev=133.10' Inflow=2.54 cfs 0.144 af
15.0" Round Culvert n=0.013 L=139.2' S=0.0172 '/' Outflow=2.54 cfs 0.144 af

Pond N1: New CB Peak Elev=136.54' Storage=1,645 cf Inflow=2.86 cfs 0.253 af
Discarded=0.19 cfs 0.082 af Primary=3.01 cfs 0.144 af Outflow=3.20 cfs 0.227 af

Link 6L: POI 'A' Inflow=6.06 cfs 0.510 af
Primary=6.06 cfs 0.510 af

Total Runoff Area = 2.843 ac Runoff Volume = 0.621 af Average Runoff Depth = 2.62"
60.50% Pervious = 1.720 ac 39.50% Impervious = 1.123 ac

Summary for Subcatchment ES: East Side

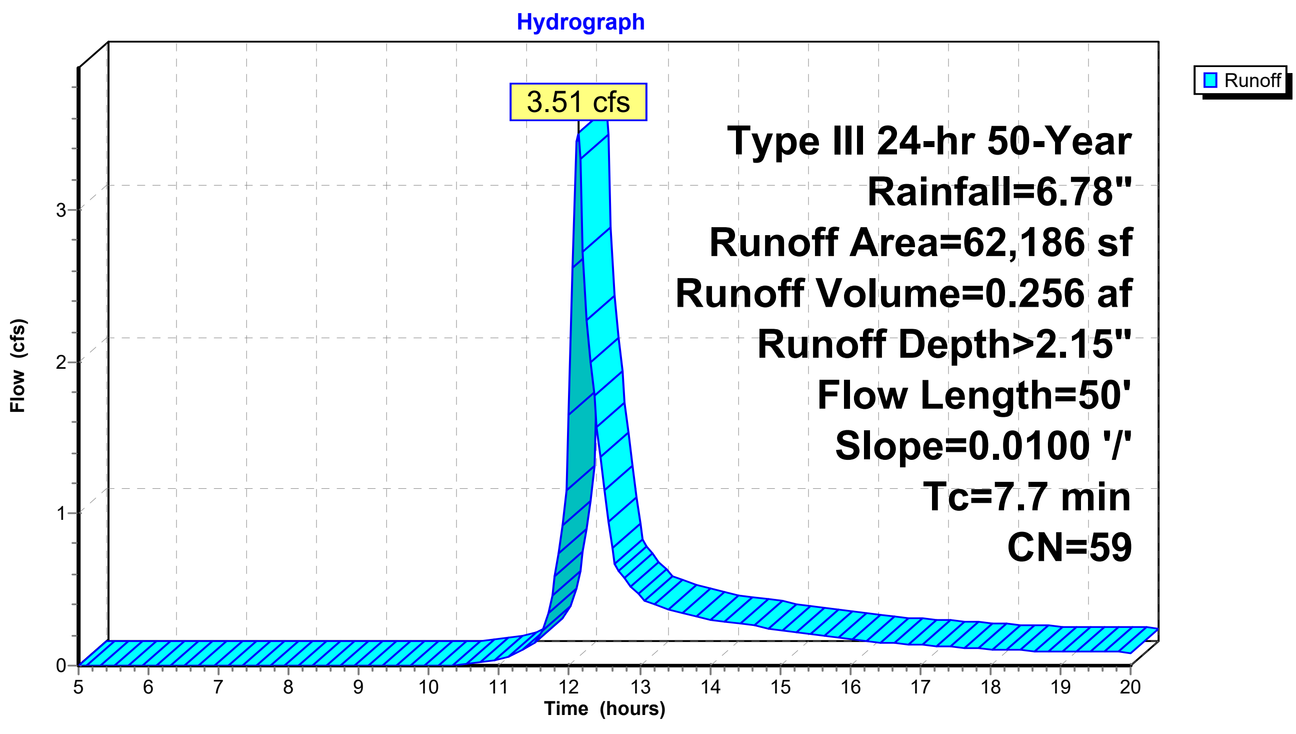
Runoff = 3.51 cfs @ 12.12 hrs, Volume= 0.256 af, Depth> 2.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=6.78"

	Area (sf)	CN	Description
	11,629	30	Woods, Good, HSG A
	24,659	39	>75% Grass cover, Good, HSG A
	11,330	98	Roofs, HSG A
	10,067	98	Paved parking, HSG A
*	1,353	98	Concrete Pads, HSG A
	3,148	39	Pre-Cast Concrete Porous Pavers, Good, HSG A
	62,186	59	Weighted Average
	39,436		63.42% Pervious Area
	22,750		36.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.7	50	0.0100	0.11		**Sheet Flow, ES.1 to ES.2** Grass: Short n= 0.150 P2= 2.99"

Subcatchment ES: East Side



Summary for Subcatchment WS: West Side

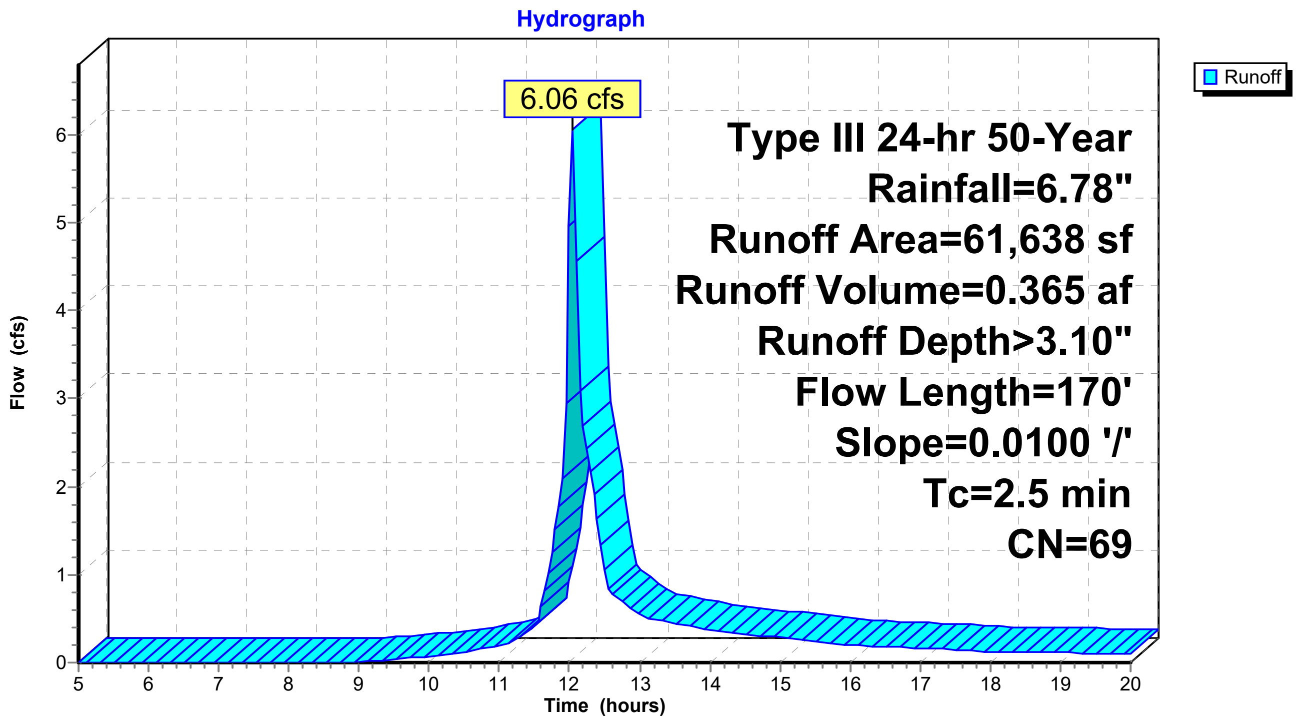
Runoff = 6.06 cfs @ 12.05 hrs, Volume= 0.365 af, Depth> 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=6.78"

	Area (sf)	CN	Description
	27,600	49	50-75% Grass cover, Fair, HSG A
	10,080	98	Roofs, HSG A
	14,568	98	Paved parking, HSG A
*	1,510	98	Concrete Sidewalk and Pads, HSG A
*	7,880	39	Pre-Cast Concrete Porous Pavers, Good, HSG A
	61,638	69	Weighted Average
	35,480		57.56% Pervious Area
	26,158		42.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	170	0.0100	1.12		**Sheet Flow, WS.1 to WS.2** Smooth surfaces n= 0.011 P2= 2.99"

Subcatchment WS: West Side



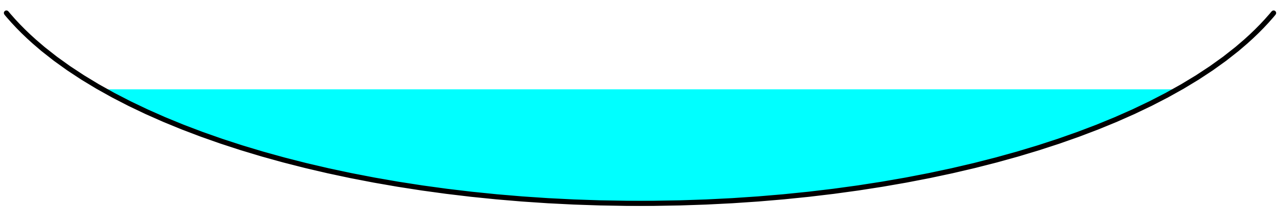
Summary for Reach 1R: Grass Area

Inflow Area = 1.428 ac, 36.58% Impervious, Inflow Depth = 1.21" for 50-Year event
Inflow = 3.01 cfs @ 12.32 hrs, Volume= 0.144 af
Outflow = 2.54 cfs @ 12.42 hrs, Volume= 0.144 af, Atten= 16%, Lag= 6.4 min

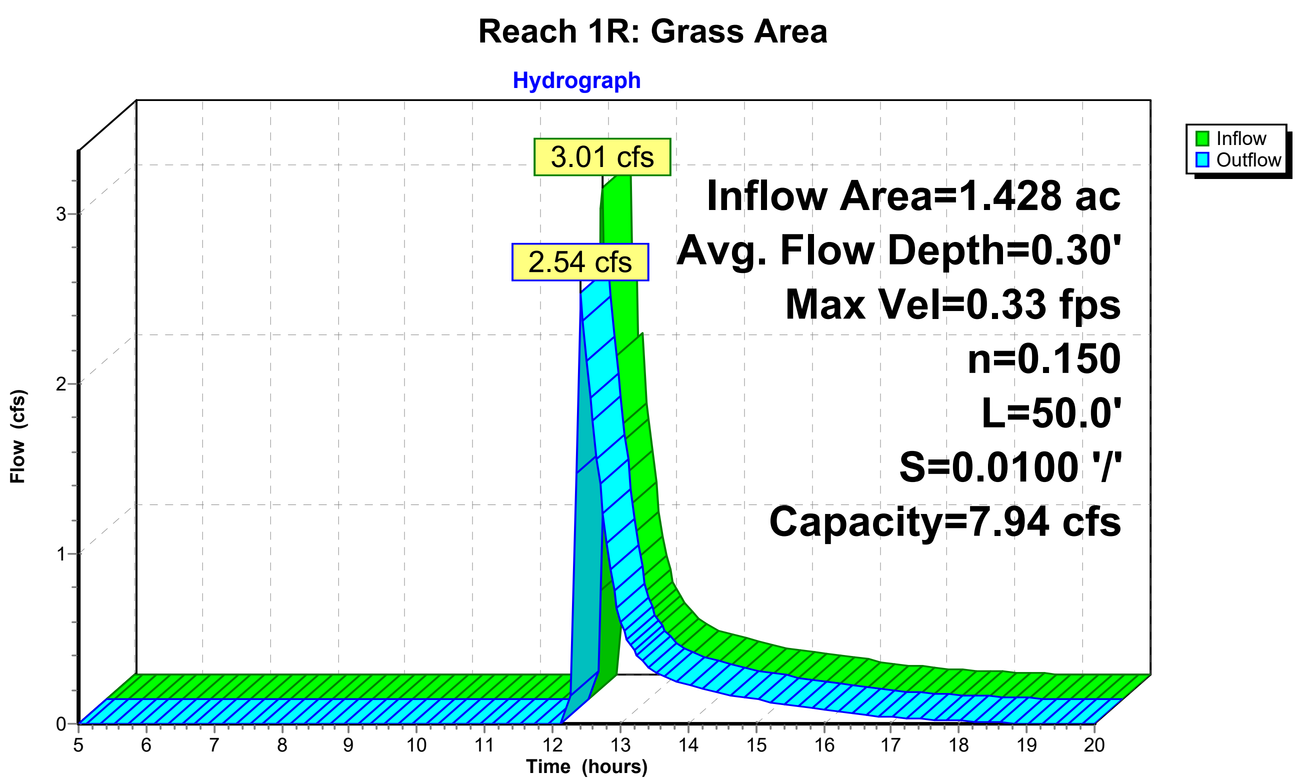
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.33 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.12 fps, Avg. Travel Time= 7.0 min

Peak Storage= 384 cf @ 12.37 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 7.94 cfs

50.00' x 0.50' deep Parabolic Channel, n= 0.150 Sheet flow over Short Grass
Length= 50.0' Slope= 0.0100 '/'
Inlet Invert= 135.00', Outlet Invert= 134.50'



‡



Summary for Reach 2R: Drainage Swale

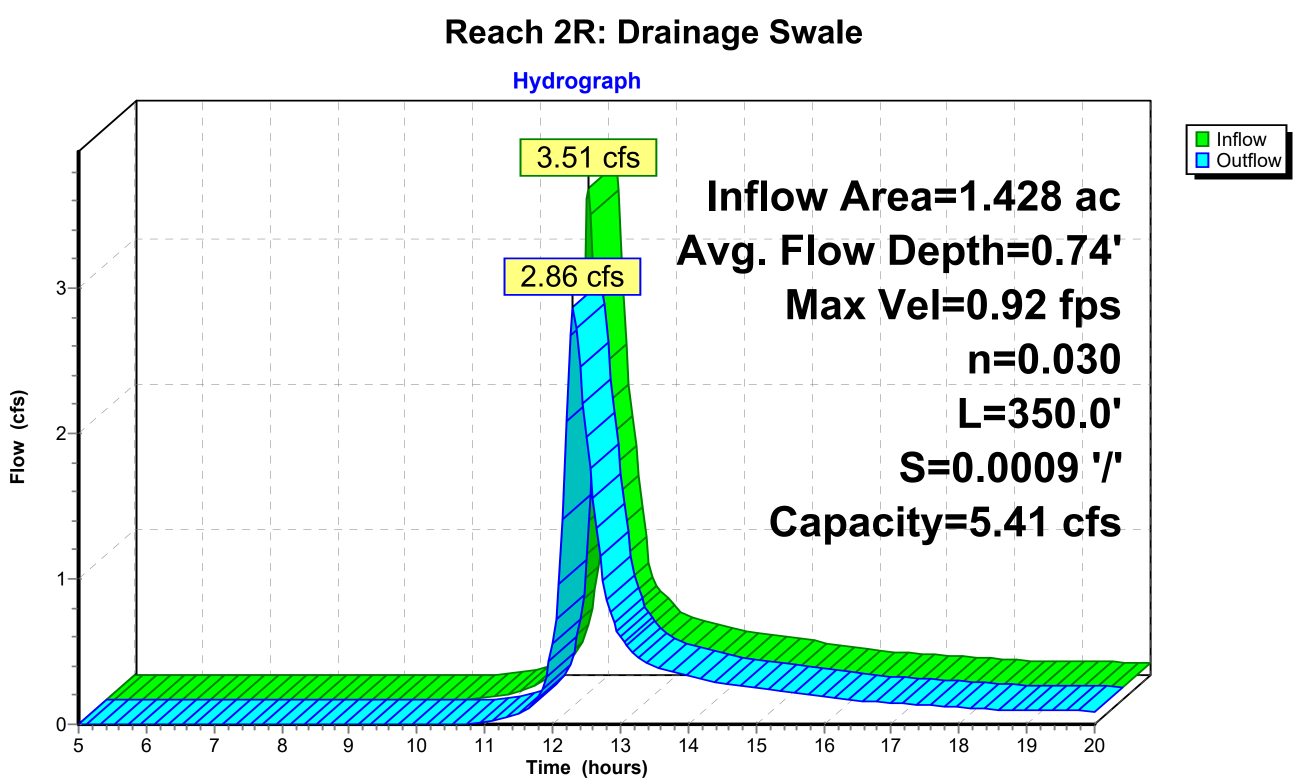
Inflow Area = 1.428 ac, 36.58% Impervious, Inflow Depth > 2.15" for 50-Year event
Inflow = 3.51 cfs @ 12.12 hrs, Volume= 0.256 af
Outflow = 2.86 cfs @ 12.30 hrs, Volume= 0.253 af, Atten= 18%, Lag= 11.1 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.92 fps, Min. Travel Time= 6.4 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 13.9 min

Peak Storage= 1,098 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.74'
Defined Flood Depth= 137.67', Capacity at Flood Depth= 1,593.43 cfs
Bank-Full Depth= 1.00', Capacity at Bank-Full= 5.41 cfs

2.00' x 1.00' deep channel, n= 0.030 Short grass
Side Slope Z-value= 3.0 '/' Top Width= 8.00'
Length= 350.0' Slope= 0.0009 '/'
Inlet Invert= 137.00', Outlet Invert= 136.67'

‡



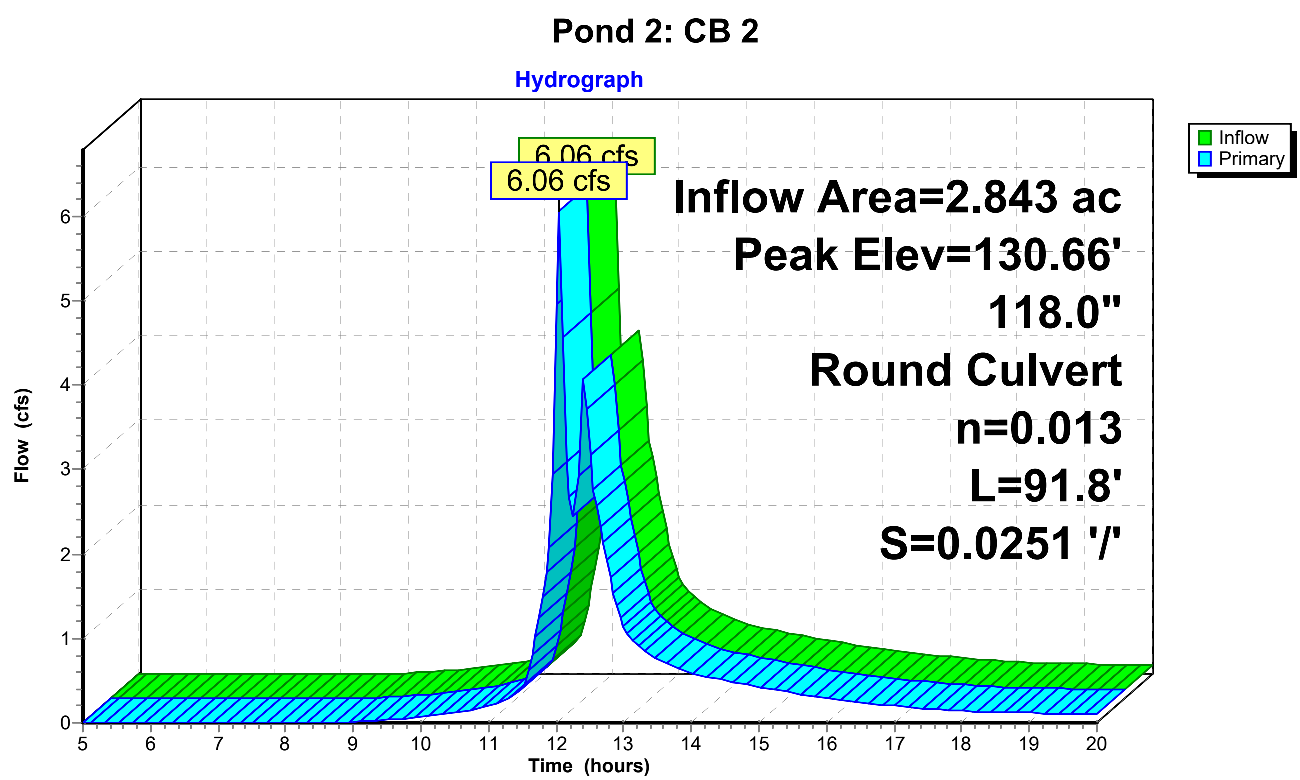
Summary for Pond 2: CB 2

Inflow Area =	2.843 ac,	39.50% Impervious,	Inflow Depth > 2.15"	for 50-Year event	
Inflow =	6.06 cfs @	12.05 hrs,	Volume=	0.510 af	
Outflow =	6.06 cfs @	12.05 hrs,	Volume=	0.510 af,	Atten= 0%, Lag= 0.0 min
Primary =	6.06 cfs @	12.05 hrs,	Volume=	0.510 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 130.66' @ 12.05 hrs
Flood Elev= 133.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	130.00'	**118.0" Round Culvert** L= 91.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 130.00' / 127.70' S= 0.0251 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=5.94 cfs @ 12.05 hrs HW=130.65' (Free Discharge)
↑**1=Culvert** (Inlet Controls 5.94 cfs @ 2.75 fps)



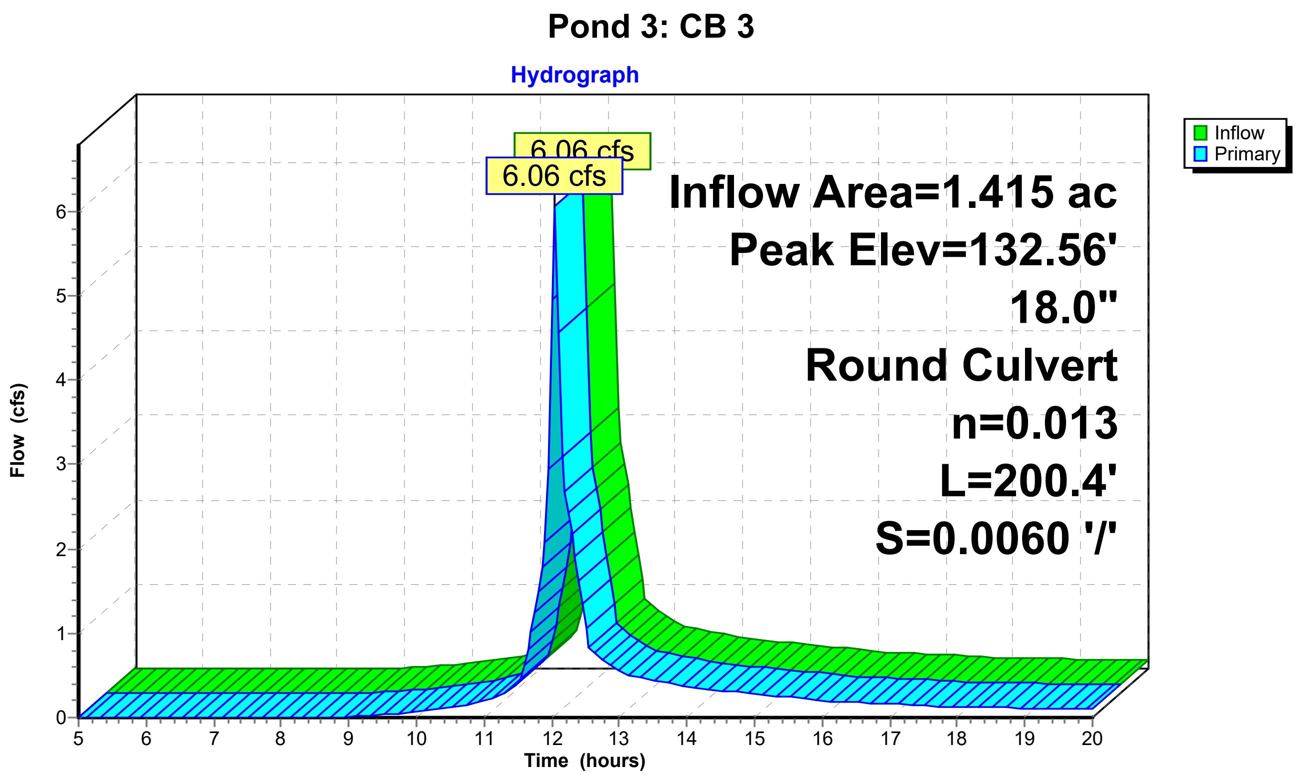
Summary for Pond 3: CB 3

Inflow Area =	1.415 ac,	42.44% Impervious,	Inflow Depth > 3.10"	for 50-Year event	
Inflow =	6.06 cfs @	12.05 hrs,	Volume=	0.365 af	
Outflow =	6.06 cfs @	12.05 hrs,	Volume=	0.365 af,	Atten= 0%, Lag= 0.0 min
Primary =	6.06 cfs @	12.05 hrs,	Volume=	0.365 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 132.56' @ 12.05 hrs
Flood Elev= 134.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	131.00'	**18.0" Round Culvert** L= 200.4' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 131.00' / 129.80' S= 0.0060 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=5.98 cfs @ 12.05 hrs HW=132.54' (Free Discharge)
└─**1=Culvert** (Inlet Controls 5.98 cfs @ 3.38 fps)



Summary for Pond 5: CB 5

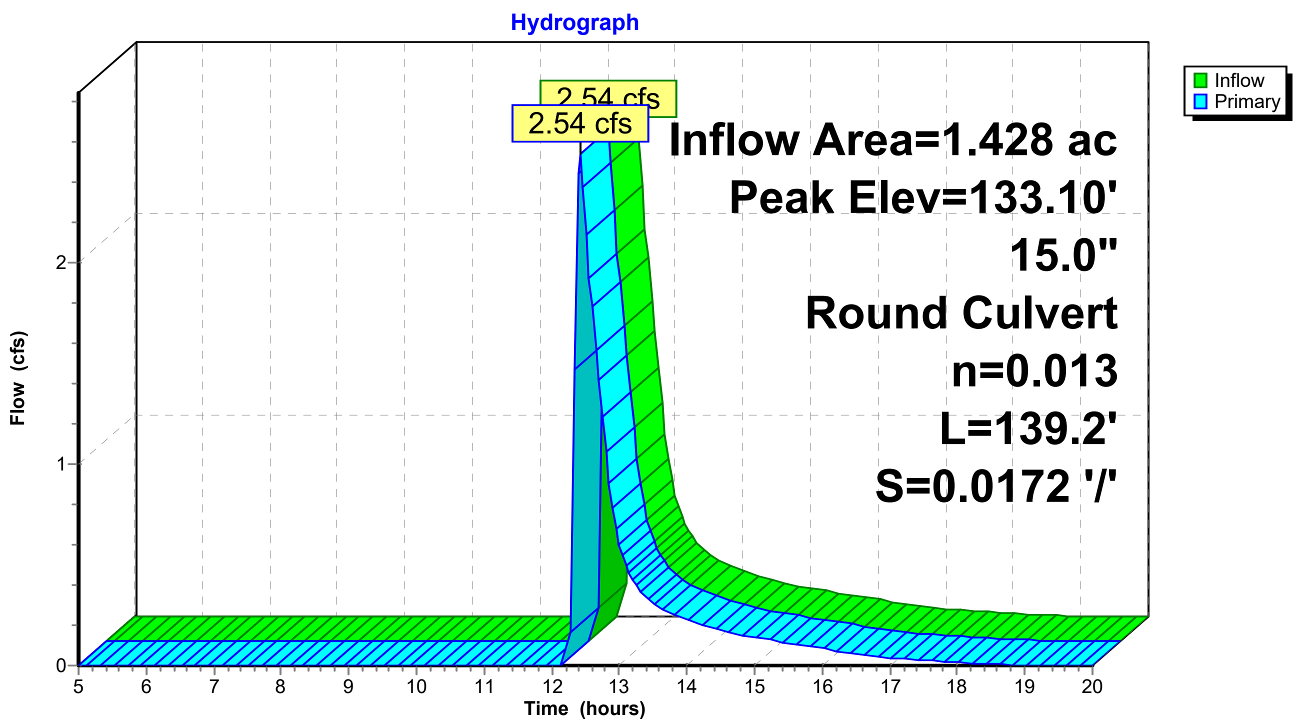
Inflow Area =	1.428 ac,	36.58% Impervious,	Inflow Depth > 1.21"	for 50-Year event
Inflow =	2.54 cfs @	12.42 hrs, Volume=	0.144 af	
Outflow =	2.54 cfs @	12.42 hrs, Volume=	0.144 af, Atten= 0%, Lag= 0.0 min	
Primary =	2.54 cfs @	12.42 hrs, Volume=	0.144 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 133.10' @ 12.42 hrs
Flood Elev= 134.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	132.30'	**15.0" Round Culvert** L= 139.2' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 132.30' / 129.90' S= 0.0172 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=2.41 cfs @ 12.42 hrs HW=133.08' (Free Discharge)
└─**1=Culvert** (Inlet Controls 2.41 cfs @ 3.00 fps)

Pond 5: CB 5



Summary for Pond N1: New CB

Inflow Area = 1.428 ac, 36.58% Impervious, Inflow Depth > 2.13" for 50-Year event
Inflow = 2.86 cfs @ 12.30 hrs, Volume= 0.253 af
Outflow = 3.20 cfs @ 12.32 hrs, Volume= 0.227 af, Atten= 0%, Lag= 0.7 min
Discarded = 0.19 cfs @ 12.30 hrs, Volume= 0.082 af
Primary = 3.01 cfs @ 12.32 hrs, Volume= 0.144 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 136.54' @ 12.31 hrs Surf.Area= 900 sf Storage= 1,645 cf
Flood Elev= 136.67' Surf.Area= 900 sf Storage= 1,645 cf

Plug-Flow detention time= 53.3 min calculated for 0.227 af (90% of inflow)
Center-of-Mass det. time= 21.2 min (850.1 - 828.8)

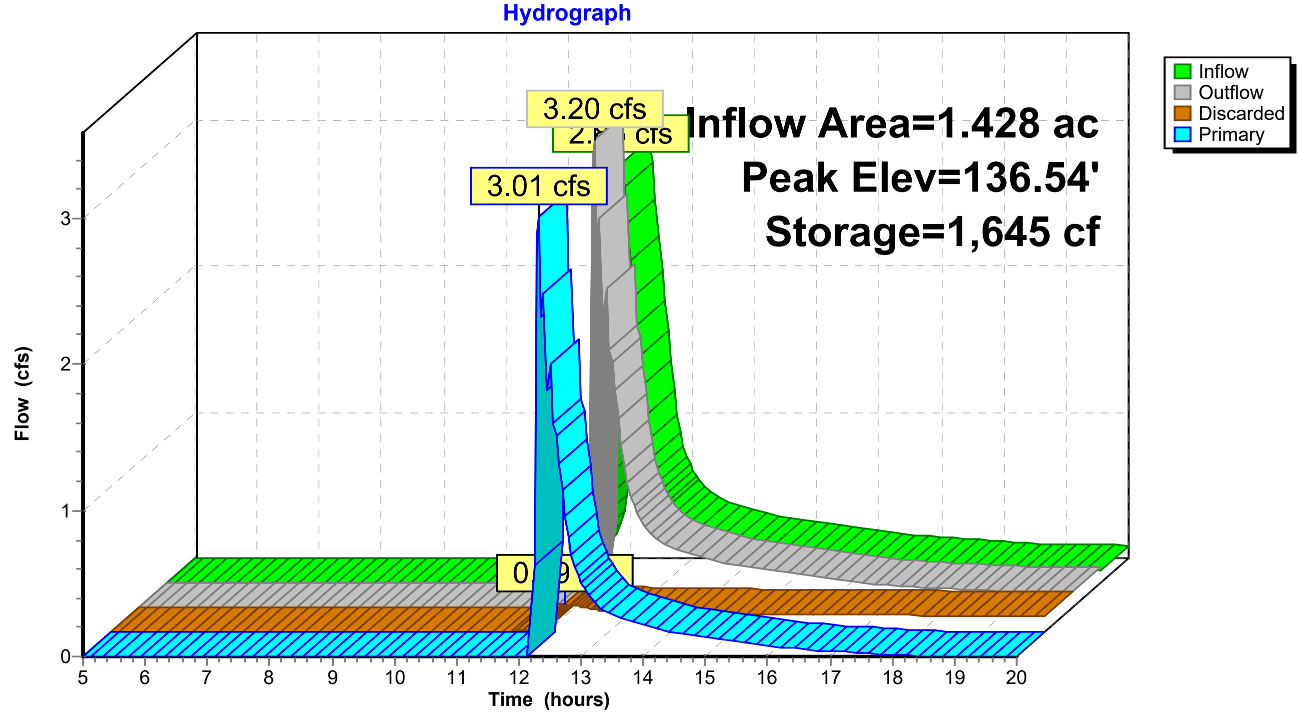
Volume	Invert	Avail.Storage	Storage Description
#1	133.00'	703 cf	**3.00'W x 300.00'L x 3.00'H Prismatoid** 2,700 cf Overall - 942 cf Embedded = 1,758 cf x 40.0% Voids
#2	133.50'	942 cf	**24.0" D x 300.0'L Pipe Storage** Inside #1
		1,645 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	135.00'	**12.0" Round Culvert** L= 37.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 135.00' / 135.00' S= 0.0000 '/' Cc= 0.900 n= 0.013
#2	Discarded	133.00'	**3.000 in/hr Exfiltration over Wetted area above 133.00'** Conductivity to Groundwater Elevation = 130.00' Excluded Wetted area = 900 sf

Discarded OutFlow Max=0.19 cfs @ 12.30 hrs HW=136.49' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.19 cfs)

Primary OutFlow Max=2.65 cfs @ 12.32 hrs HW=136.42' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 2.65 cfs @ 3.38 fps)

Pond N1: New CB

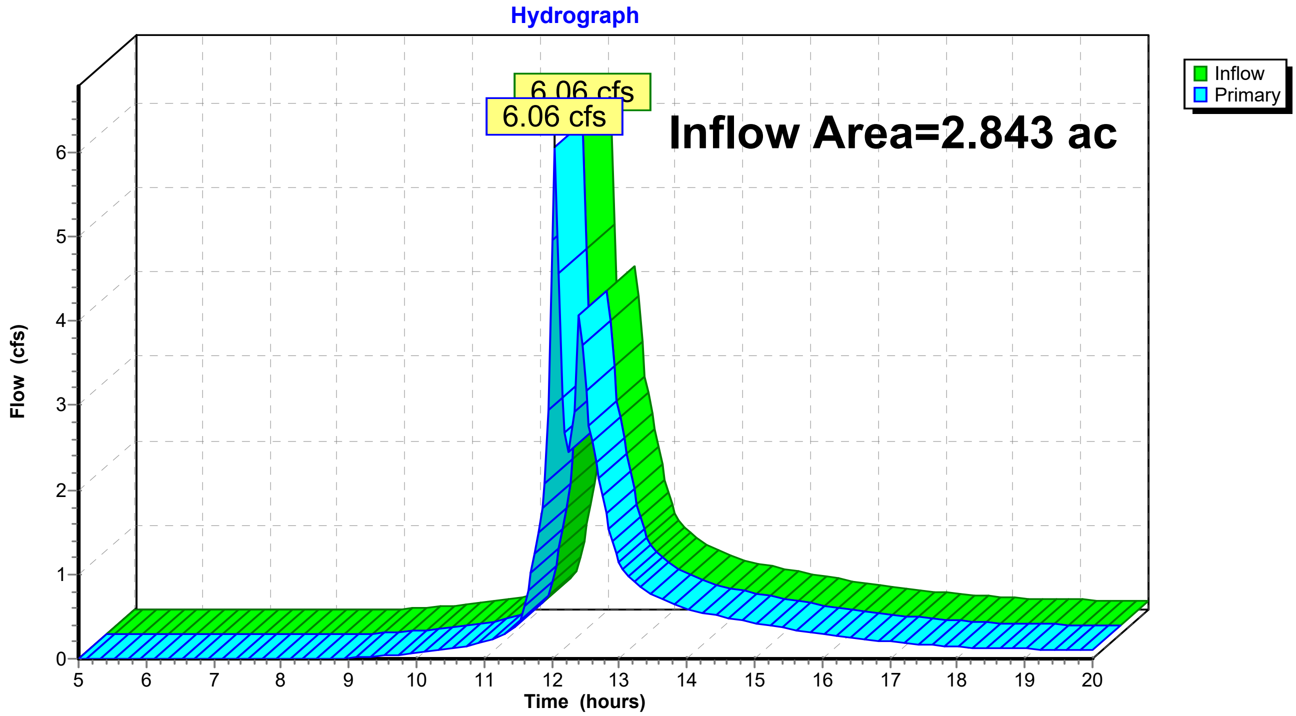


Summary for Link 6L: POI 'A'

Inflow Area = 2.843 ac, 39.50% Impervious, Inflow Depth > 2.15" for 50-Year event
Inflow = 6.06 cfs @ 12.05 hrs, Volume= 0.510 af
Primary = 6.06 cfs @ 12.05 hrs, Volume= 0.510 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Link 6L: POI 'A'



INFILTRATION PRACTICE CRITERIA
(Env-Wq 1508.06)

Type/Node Name: **24-inch Diameter Subsurface Infiltration Basin**

Enter the type of infiltration practice (e.g., basin, trench) and the node name in the drainage analysis, if applicable.

yes		Have you reviewed Env-Wq 1508.06(a) to ensure that infiltration is allowed?	← yes
1.43	ac	A = Area draining to the practice	
0.33	ac	A_I = Impervious area draining to the practice	
0.23	decimal	I = Percent impervious area draining to the practice, in decimal form	
0.26	unitless	Rv = Runoff coefficient = 0.05 + (0.9 x I)	
0.37	ac-in	WQV= 1” x Rv x A	
1,338	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12”)	
334	cf	25% x WQV (check calc for sediment forebay volume)	
Oil/water separtor		Method of pretreatment? (not required for clean or roof runoff)	
71	cf	V_{SED} = Sediment forebay volume, if used for pretreatment	**≥ 25%WQV**
1,092	cf	V = Volume[1] (attach a stage-storage table)	**≥ WQV**
900	sf	A_{SA} = Surface area of the bottom of the pond	
3.00	iph	$Ksat_{DESIGN}$ = Design infiltration rate[2]	
5.9	hours	T_{DRAIN} = Drain time = V / (A_{SA} * I_{DESIGN})	**≤ 72-hrs**
133.50	feet	E_{BTM} = Elevation of the bottom of the basin	
130.00	feet	E_{SHWT} = Elevation of SHWT (if none found, enter the lowest elevation of the test pit)	
130.00	feet	E_{ROCK} = Elevation of bedrock (if none found, enter the lowest elevation of the test pit)	
3.50	feet	D_{SHWT} = Separation from SHWT	**≥ *** [3]
3.5	feet	D_{ROCK} = Separation from bedrock	**≥ *** [3]
-	ft	D_{amend} = Depth of amended soil, if applicable due high infiltation rate	**≥ 24"**
-	ft	D_T = Depth of trench, if trench proposed	**4 - 10 ft**
yes	Yes/No	If a trench or underground system is proposed, has observation well been provided?	**←yes**
yes		If a trench is proposed, does materialmeet Env-Wq 1508.06(k)(2) requirements.[4]	**← yes**
	Yes/No	If a basin is proposed, Is the perimeter curvilinear, and basin floor flat?	**← yes**
	:1	If a basin is proposed, pond side slopes.	**≥3:1**
135.36	ft	Peak elevation of the 10-year storm event (infiltration can be used in analysis)	
136.54	ft	Peak elevation of the 50-year storm event (infiltration can be used in analysis)	
136.67	ft	Elevation of the top of the practice (if a basin, this is the elevation of the berm)	
YES		10 peak elevation ≤ Elevation of the top of the trench?[5]	**← yes**
YES		If a basin is proposed, 50-year peak elevation ≤ Elevation of berm?	**← yes**

1. Volume below the lowest invert of the outlet structure and excludes forebay volume
2. $Ksat_{DESIGN}$ includes a factor of safety. See Env-Wq 1504.14 for requirements for determining the infiltr. rate
3. 1' separation if treatment not required; 4' for treatment in GPAs & WSIPAs; & 3' in all other areas.
4. Clean, washed well graded diameter of 1.5 to 3 inches above the in-situ soil.
5. If 50-year peak elevation exceeds top of trench, the overflow must be routed in HydroCAD as secondary discharge.

Designer's Notes:

GALE

GALE ASSOCIATES, INC
6 Bedford Farms Dr. Ste. 101
Bedford, NH 03110
603-471-1887

JOB ASM FACILITY - HUDSON, NH
SHEET NO. 1 OF 1
CALCULATED BY SMB DATE 11/10/22
CHECKED BY ______ DATE ______
SCALE - NTS -

* RIPRAP OUTLET PROTECTION

→ OUTLET PROTECTION FOR 12 INCH OUTLET PIPE UNDER THE DRIVEWAY EXTENSION

→ NHDES STORMWATER MANUAL REQUIRES DESIGN TO BE BASED ON 25-YEAR STORM, FLOWING FULL. THIS OUTLET PIPE FLOWS FULL DURING 50-YEAR STORM EVENT; HENCE WILL BE THE BASE DESIGN.

→ APRON LENGTH ($TW > D_0/2$)

$$L_A = 3Q / D_0^{3/2} + 7D_0$$

Q = FLOW = 3.01 CFS
D_0 = PIPE DIA. = 1 FT

$$= \frac{(3)(3.01)}{1^{3/2}} + (7)(1)$$

$$= \underline{16 \text{ FT}}$$

→ WIDTH AT CULVERT

$$W_1 = 3D_0 = \underline{3 \text{ FT}}$$

→ WIDTH AT APRON

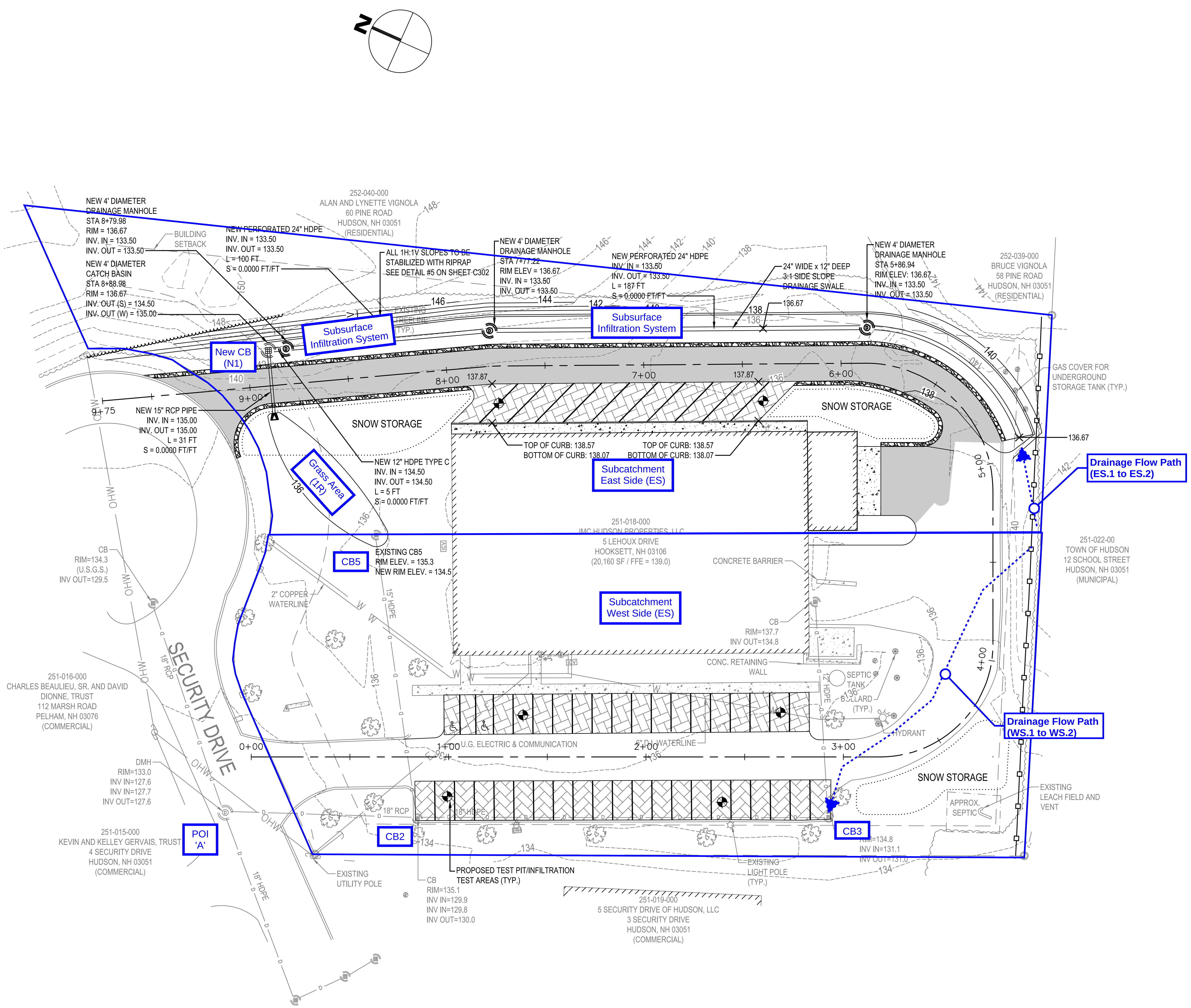
$$W_2 = 3D_0 + 0.4L_A$$

$$= (3)(1) + (0.4)(15 \text{ FT}) = \underline{\underline{9 \text{ FT}}}$$

→ RIPRAP DIAMETER

$$D_{50} = 0.02Q^{4/3} / TW\, D_0$$

$$= (0.02)(3.01^{4/3}) / (0.1)(1) = 0.86 \text{ FT} = \underline{10 \text{ INCH}}$$



GRADING AND DRAINAGE LEGEND

EXISTING	ITEM	NEW
140	MAJOR CONTOUR	140
138	MINOR CONTOUR	138
	FLARED END SECTION	
	CATCH BASIN	
	TREELINE	
	PAVEMENT SHOULDER STONE	
	INFILTRATION TRENCH STONE	
	PAVEMENT	
	CONCRETE PADS AND SIDEWALK	
	PERVIOUS CONCRETE PAVERS	
	DRAINAGE PIPE	
	PAVEMENT MARKINGS	

GALE

Gale Associates, Inc.
Engineers and Planners

6 BEDFORD FARMS DRIVE | BEDFORD, NH 03110
P 603.471.1887 F 603.471.1809
www.gainc.com
Boston Baltimore Orlando Hartford Bedford

NOT FOR CONSTRUCTION

PROJECT: ASM FACILITY 7 SECURITY DRIVE HUDSON, NH 03051

OWNER: JMC HUDSON PROPERTIES, LLC 5 LEHOUX DRIVE HOOKSETT, NH 03106

NO.	DATE	DESCRIPTION	BY
1	11/2/22	TOWN REVIEW	APL

PROJECT NO.	718770
CADD FILE	718770_Drainage Plan
DESIGNED BY	APL
DRAWN BY	APL
CHECKED BY	SMB
DATE	9/19/2022
DRAWING SCALE	1" = 30'

GRAPHIC SCALE 0' 15' 30' 60'

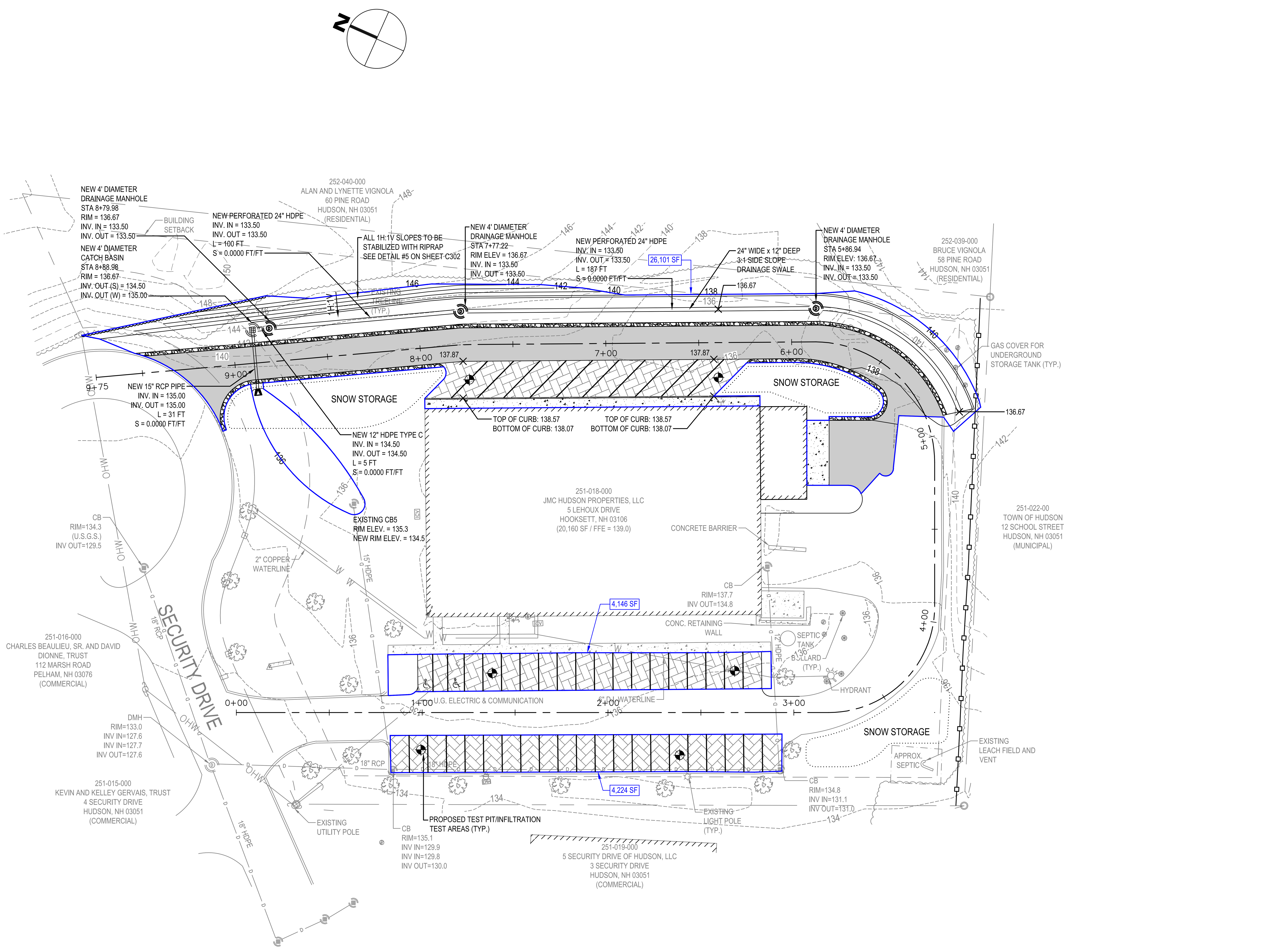
SHEET TITLE

POST-DEVELOPMENT DRAINAGE PLAN

DRAWING NO.

FIG 2

1 OF 1



GRADING AND DRAINAGE LEGEND

EXISTING	ITEM	NEW
140	MAJOR CONTOUR	140
138	MINOR CONTOUR	138
	FLARED END SECTION	
	CATCH BASIN	
	TREELINE	
	PAVEMENT SHOULDER STONE	
	INFILTRATION TRENCH STONE	
	PAVEMENT	
	CONCRETE PADS AND SIDEWALK	
	PERVIOUS CONCRETE PAVERS	
	DRAINAGE PIPE	
	PAVEMENT MARKINGS	

GALE

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Engineers and Planners

6 BEDFORD FARMS DRIVE | BEDFORD, NH 03110
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www.gainc.com
Boston Baltimore Orlando Hartford Bedford

NOT FOR CONSTRUCTION

PROJECT: ASM FACILITY 7 SECURITY DRIVE HUDSON, NH 03051

OWNER: JMC HUDSON PROPERTIES, LLC 5 LEHOUX DRIVE HOOKSETT, NH 03106

NO.	DATE	DESCRIPTION	BY
1	11/2/22	TOWN REVIEW	APL

PROJECT NO.	718770
CADD FILE	718770_Drainage Plan
DESIGNED BY	APL
DRAWN BY	APL
CHECKED BY	SMB
DATE	9/19/2022
DRAWING SCALE	1" = 30'

GRAPHIC SCALE 0' 15' 30' 60'

SHEET TITLE

DISTURBED AREA PLAN

DRAWING NO.

FIG 3

1 OF 1

PRECAST POROUS CONCRETE PAVING SLABS/SYSTEM

NOTE: This guide specification shall govern the materials, methods of installation and performance of the Stormcrete® Precast Porous Concrete Stormwater System (Stormcrete® System) supplied by Porous Technologies, LLC, 163 Thadeus Street, South Portland, ME 04106 (telephone 888-357-1161) in all applications. The Stormcrete® System includes precast porous concrete paving slabs, edge restraints, un-compacted/screed crushed stone levelling layer (base) and compacted crushed stone storage reservoir (subbase) layer over a prepared subgrade. System installations may also include drainage pipe, and separation geotextile and/or membrane, as specified by the project design professional.

PART 1 GENERAL

Section Includes:
1.00 Summary
1.01 References
1.02 Submittals
1.03 Quality Assurance
1.04 Weather Considerations
1.05 Delivery, Handling and Storage

1.0 SUMMARY

Furnish all labor, materials, equipment and incidentals required and install the precast pervious concrete paving slab units, edge restraint, and subbase materials as shown on the drawings and as specified herein.

Before slab units are installed, ensure all materials and preparation for subbase and edge restraints are acceptable to owner and manufacturer of precast pervious concrete paving slabs.
Preparation of subbase materials shall include proper compaction procedures, placement of geotextiles (if required), conditions of subgrade soils, and any other potential obstructions to ensure a satisfactory installation as specified herein.

1.01 REFERENCES

1. American Society for Testing and Materials(ASTM) and other testing standards, in any case the Current Edition shall be the reference:

    a) ASTM C33/C33M Standard Specification for Concrete Aggregates
    b) ASTM C42/C42M Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
    c) ASTM C78 Flexural Strength of Concrete Three Point Loading.
    d) ASTM C 136/136M Standard Test Method for Sieve Analysis of Fine and Coarse

Aggregates

e) ASTM C 1701/1701M Standard Test Method for Infiltration Rate of In Place Pervious Concrete.

f) ASTM D1751, Standard Specification for Preformed Expansion Joint Filler or Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

g) ASTM D1754/1754M Standard Test Method for Density and Void Content of Hardened Pervious Concrete

1.02 SUBMITTALS

1. Shop drawings; including installation plan showing layout of each full and partial precast porous concrete paving slab, individual slab drawings detailing lifting points in surface and all dimensions, edge restraint detail(s), and liner, geotextile and geogrid manufacturer data specification sheets.

2. Test results performed by an independent testing laboratory of the following:

a) Particle-size analysis in accordance with ASTM C 136/136M Testing methods for Sieve Analysis of Fine and Coarse Aggregates for the crushed stone storage reservoir (subbase) and un-compacted/screed crushed stone levelling layer with source(s) of supply(s) noted.

b) Infiltration rate of Precast Porous Concrete Paving Slabs in accordance with ASTM C 1701/C 1701M Standard Test Method for Infiltration Rate of In Place Pervious Concrete

c) Density and void content results for the Precast Porous Concrete Paving Slabs in accordance with ASTM D1754/1754M Standard Test Method for Density and Void Content of Hardened Pervious Concrete.

d) Flexural strength test results for the Precast Porous Concrete Paving Slabs when tested in accordance with ASTM C78 Flexural Strength of Concrete.

e) Biaxial Geogrid Radial Stiffness when tested in accordance with ASTM D 6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method, product Flexural Stiffness results when tested in accordance with ASTM D 7748 Standard Test Method for Flexural Rigidity of Geogrids, Geotextiles and Related Products and Ultraviolet Resistance when tested in accordance with ASTM D 4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus

3. Results of other tests specified by the project design professional.

1.03 QUALITY ASSURANCE: Installation Contractor Qualifications

1. Installation Contractor (Superintendent and Foreman) shall successfully complete the "Stormcrete® Precast Porous Concrete Installation Training Program" and shall be certified as successfully completing said program prior to the commencement of installation, or Mock-up creation procedures. Personnel who have successfully completed the Stormcrete® Precast Porous Concrete Installation Training Program shall be responsible for reviewing

the Stormcrete® Handling and Installation manual and the completed Program Examination (and correct test answers) with laborers under their employ. An individual who has successfully completed the Training Program shall be onsite providing supervision during all phases of the Stormcrete® System Installation, including the reservoir course and screeding layer installations.

2. The installation contractor shall use adequate forces including equipment and skilled workers. Workers shall be trained and experienced in the necessary crafts and completely familiar with the specified methods needed for proper performance of this Specification.
3. Installation shall include planning the work, horizontal and vertical layout, fine grading of subgrades, installing membrane, geotextile, geogrid or microgrid in accordance with the respective manufacturer's recommendations, placing and compacting crushed stone reservoir storage (subbase), place and screed crushed stone leveling course (base), installation of edge restraint, and placing precast porous concrete paving slabs.
4. All materials, methods of installation and workmanship shall conform to requirements of ASTM, ACI, Department of Transportation, or other applicable Standards.
5. The contractor shall all Obtain Federal, State and/or Municipal approvals that may be required for this project.
6. Contractor's installation plan shall be reviewed in a pre-construction meeting with Precast Porous Concrete Panel manufacturer's representatives, paving slab installation contractor, general contractor and project design professional.

1.04 WEATHER CONSIDERATIONS

1. Crushed stone subbase shall not be placed and/or compact in rain or snow, or on saturated or frozen subgrade.
2. Crushed stone base shall not be placed and/or screeded in rain or snow, or on saturated or frozen subbase.
3. Precast porous concrete slabs shall not be placed in heavy rain or snow, or on saturated or frozen base.

1.05 DELIVERY, HANDLING AND STORAGE

1. Delivery shall be coordinated so as not to interfere with other construction and to avoid delays.
2. Slabs shall be offloaded by a forklift of required capacity operated by a trained and certified operator. Forklift shall be equipped with 6-ft. long forks as required to safely offload slabs. Slabs delivered on pallets can be offloaded in its entirety.
3. Safe load capacity of forklift shall be in accordance with Occupational Safety & Health Administration (OSHA) recommended practices. Forklift capacity shall be verified to ensure that the machine is operating at a safe load capacity.
4. 5'x 4' slabs: store slabs on level ground and with 4-in. by 4-in. (minimum), timbers placed as dunnage parallel to one another and located directly beneath imbedded lifting points. Dunnage shall be placed between each (3) slabs. Slabs may be stored in stacks of no higher than (6) slabs with dunnage beneath every (3) slabs.
5. For 5' x 2' and 4' x 2.5' slabs: slabs shall be stored in stacks no more than 6 slabs high. Slabs delivered on pallets may be stored in their entirety.

6. Slabs shall be stored such that they are kept free from mud, dirt, grass cuttings, accumulation of foliage and debris.
7. Geogrid, microgrid and liner materials shall be kept clean and prepared for installation.

PART 2 PRODUCTS

2.00 SUMMARY

Section Includes:
2.01 Precast Porous Concrete Paving Slab
2.02 Edge Material/Joint Filler
2.03 Crushed Stone Storage Reservoir (Subbase) and Leveling Course
2.04 Geotextile
2.05 Biaxial Geogrid
2.06 Impermeable Liner

2.01 PRECAST POROUS CONCRETE PAVING SLAB

1. Precast Porous Concrete Paving Slab shall be: Stormcrete® Precast Porous Concrete Paving Slab System supplied by Porous Technologies, LLC, 163 Thadeus Street, South Portland, ME 04106 (888-357-1161).
2. The Precast Porous Concrete Paving Slab shall be supplied by a manufacturer having at least five (5) years of experience in the manufacture and sale of the product.
3. The Contractor shall indemnify and save harmless the Owner from all suits, actions and damages or costs to which the Owner may be subjected by reason of the use of any patented article or process in the work under this Contract.
4. Permanent lifting points shall be imbedded in the slab surface for ease of slab installation, maintenance, removal and reinstallation.
5. Slabs shall be reinforced with Monofilament Microsynthetic microfibers such as BASF MasterFiber M 100 or approved equal.
6. Typical dimensions of precast porous concrete slabs provided shall be;
   i) 5 ft. by 4 ft.
   ii) 5 ft. by 2 ft.
   iii) 4 ft. by 2.5 ft.

   All slabs shall be 6” thick unless otherwise specified. Refer to project specific drawing(s) for required Precast Porous Concrete slab sizing and numbers.
7. Slabs shall be manufactured for field placement with butt joints. Ship-lap joints shall not be permitted.
8. A minimum average infiltration rate of 250 in./hr. shall be demonstrated in accordance with ASTM C 1701/C 1701M..
9. Slabs shall have a void ratio of 15-25% when tested in conformance with ASTM C 1688: Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.
10. Concrete average unit weight shall be 122 LB/CF (+/- 5%) when tested in conformance with ASTM C 1688: Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.
11. Three Concrete Beams cut from three different Precast Porous Slabs shall have an average

Flexural Strength of 400 p.s.i. when tested in accordance with ASTM C78 Flexural Strength of Concrete Three Point Loading.

12. Each individual Precast Porous Slab shall be weighed, and the unit shall be labelled with the weight, size and date of manufacture.
13. Precast porous concrete slabs shall be cured by the manufacturer's approved methods.
14. All slabs shall be provided with a self-stick adhesive label which includes the date of manufacture and slab weight.
15. All slabs shall be provided with 1/8" spacers (preventing slab to slab contact) and approved ½" dia. lifting swivels for use with the imbedded lifting points.
16. All slabs shall be provided with ½" Nylon Stormcrete® lifting point protection caps (Part No. 12NC) and approved ½" dia. lifting swivels for use in covering the imbedded lifting points.
17. Precast porous concrete shall be cast upside down against a steel form and shall be vibrated throughout their entire section during the manufacturing process.

2.02 EDGE MATERIAL/JOINT FILLER

Note: Edge restraint should be provided (by contractor) on all perimeter sides of precast porous concrete pavement installations. Edge restraint may be mounted in asphalt pavement, but use of asphalt pavement as edge restraint shall not be permitted.

1. Edge restraint installed at exterior sides of precast porous concrete paving slabs shall be as follows:

    a) Material: 1/2 –inch thick, minimum 6" height, pre-molded expansion joint filler conforming to ASTM D1751 [aluminum, plastic, concrete edge restraint material or other expansion joint material.] or joint filler consisting of closed cell foam backer rod and polyurethane non-sag elastomeric sealant. [Sikaflex-1C self levelling joint sealant as manufactured by Sika Corp. or approved equal].
    b) Manufacturer: [State approved edge restraint manufacturers acceptable to the owner and precast porous concrete paving slab manufacturer.]
    c) Material Standards: [Specify applicable edge restraint material standards.].

2.03 CRUSHED STONE STORAGE RESERVOIR (SUBBASE) AND LEVELING COURSE

1. Use of screened rounded gravel is prohibited.
2. All crushed stone shall be double-washed and clean and free of all fines and debris.
3. Compacted crushed stone for storage reservoir (subbase) shall conform to ASTM C 33 Size No. 57 Grading Requirements for Coarse Aggregates. Minimum thickness of compacted storage reservoir (subbase) layer shall be 6 in.
4. Un-compacted/screed crushed stone for leveling course (base) shall conform to ASTM C 33 Size No. 8 Grading Requirements for Coarse Aggregates. Thickness of un-compacted/screed leveling course layer shall be 2 in.

2.04 GEOTEXTILE

1. Subgrade shall not be compacted or permanently covered with geotextile unless approved by the Engineer of Record and shall be as follows:

    a) Material Type: Geotextile shall be Non-Woven geotextile.
    b) Manufacturer: [State approved geotextile manufacturers acceptable to the owner/designer].
    c) Material Standards: [AASHTO M288 Class 2]

2.05 BIAXIAL GEOGRID

1. Biaxial Geogrid shall have a Unit Weight of 10.5 oz./s.y., an Aperture size of 1.3 in.,a Rib Thickness of 2.5 mm, a minimum Radial Stiffness @ 0.5% Strain of 657 kN/M (45,000 lbs./s.f.) when tested in accordance with ASTM D 6637, and a Flexural Stiffness of 3,250,000 mg-cm when tested in accordance with ASTM D 7748. It shall have an Ultraviolet Resistance of 100% when tested in accordance with ASTM D 4355.

2.06 IMPERMEABLE LINER

1. Impermeable liner shall be transported, stored, and placed in a manner to eliminate any possibility of puncture or penetration.

    a) Material Type: 30 mil Grey Poly Vinyl Chloride sheeting, 30 +/- mil., 73 lbs/in Tensile Strength, 8 lbs. tear strength, 3% Dimensional Stability, Low Temperature Impact -20 degrees F.
    b) Manufacturer: [State approved geotextile manufacturers].
    c) Material Standards: Thickness Conforming to ASTM D-1599, Tensile Strength ASTM D-882, Tear Strength ASTM D-882, Dimensional Stability ASTM D 1204, Low Temperature Impact ASTM D-1790

PART 3 EXECUTION

Section Includes:

3.00 Summary
3.01 Site Preparation
3.02 Examination
3.03 Installation
3.04 Edge Restraint
3.05 Protection
3.06 Maintenance

3.00 Summary

Note: Compaction of subgrade to at least 95% Modified Proctor relative compaction per ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)) is recommended for detention or non-infiltration storm water systems beneath light-duty parking lots and pedestrian sidewalks. Excavation and replacement of the subgrade, possibly with geotextile or geogrid reinforcement, may be necessary where weak, disturbed and/or saturated subgrade soils are present. State Department of Transportation aggregate materials used for roadway and highway flexible pavements are recommended for replacement of weak, disturbed and/or saturated subgrade soils. Compaction of aggregate to a minimum of 95% ASTM D 1557 relative compaction is recommended. Manually operated compactors may be used in areas not accessible to self-propelled rollers. Such areas might include around light pole bases, utility structures, buildings, tree wells and other site improvements.

3.01 SITE PREPARATION

1. Infiltration System Subgrade Preparation
   a) Verify that all field infiltration and permeability testing of the subgrade has been performed, that test results meet the project design requirements and [construction of the infiltration beds] has been approved by the project design professional and accepted by the owner.
   b) The subgrade under all infiltration [bed] areas shall not be compacted or permanently covered with geotextile unless approved by the project design professional.
   c) Prepared subgrades shall not be subject to construction equipment traffic.
   d) Temporary haul roads consisting of crushed stone over a reinforcing geotextile shall be provided as required to prevent the over-compaction of Subgrade Soils.
   e) Where erosion has caused accumulation of sediment or ponding on the subgrade, remove sediment with light equipment [and/or manually]. Scarify the underlying soils to a minimum depth of 6 inches with a York rake, or equivalent equipment, and a small/light tractor.
   f) Restore any subgrade areas damaged by erosion, ponding, or traffic compaction to design line and grades prior to installation of [filter fabric,] [filter sand layer or] storage reservoir layer.

3.02 EXAMINATION: Acceptance of Site Conditions

1. General contractor shall inspect, accept and document in writing to the slab installation subcontractor that site conditions meet specifications for the following items prior to installation of concrete paving slabs.

   a) Verify that subgrade is dry and relative compaction, surface tolerances and elevations conform to construction drawings and specified requirements.
   b) Verify location, type, and elevations of edge restraints, utility structures, and manholes.

2. Precast porous concrete paving system installation shall not proceed until nonconforming site installations conditions are corrected by the general contractor or designated subcontractor.

3.03 INSTALLATION:

1. General

    a) Any excess thickness of soil placed over the soil subgrade to trap sediment transported by runoff from adjacent construction areas shall be removed before placement of [geotextile and] storage reservoir layer.
    b) Keep area where precast porous concrete paving slabs are to be installed free of sediment during the entire construction period. [Geotextiles and] Storage reservoir crushed stone contaminated with sediment shall be removed and replaced with clean materials.
    c) Do not damage drainpipes, underdrains, observation wells, roadway boxes, manholes or any other utilities during installation. Report any damage immediately to the project design professional. Any damage shall be replaced or repaired as part of the bid price of this item (by the contractor)
    d) Installation of Precast Porous Concrete slabs shall be in strict accordance with the manufacturer's recommendations, all information contained in this specification, and all related drawings.
    e) Subbase crushed stone materials contaminated with sediment shall be removed and replaced with clean materials.

2. Geotextiles and Impermeable Liner

    a) Place geotextile on prepared subgrade and secure in place to prevent wrinkling.
    b) Overlap geotextile edges in accordance with the manufacturer's requirements, and a minimum of 12 in. in the direction of drainage flow.
    c) Place impermeable liner as shown on plans after all material that may potentially puncture the liner have been removed from the excavated area.
    d) Overlap impermeable liner a minimum of 12 in. in the direction of drainage flow.
    e) Firmly secure the impermeable liner at the top of excavation prior to the placement of reservoir material.

3. Biaxial Geogrid
    4) Install Biaxial Geotextile at bottom of excavation and 6" below the screeding course or as may otherwise be shown on design plans and in accordance with manufacturer's instructions.

5. Compacted Reservoir Storage Layer (Subbase)

    a) Coordinate and construct all required concrete footings and foundation for all utility posts and signage posts with inserted post sleeves.
    b) Place open graded stone base/reservoir conforming to ASTM C33 No. 57 (or stone size as Local Regulations may require) washed crushed stone over prepared subgrade;

spread and level evenly by raking to specified thickness. Do not disturb prepared subgrade or shift, wrinkle or fold the geotextile or geogrid. Place crushed stone to protect geotextile from tearing under equipment tires and tracks.

c) Compact reservoir storage layer in maximum 12” lifts, with a minimum of two complete coverages, one pass each in mutually perpendicular directions, with a 1 to 3 ton smooth, double or single, drum roller operated in vibratory mode. Following vibratory compaction, apply two complete coverages, one pass each in mutually perpendicular directions, with the roller operated in static mode. Continue static rolling until there is no visible movement, weaving or deflection in the surface of the storage reservoir layer. In areas that are too small to permit the use of a 1 to 3 ton drum roller a walk behind plate compactor shall be used on each lift of 6”. Compaction using the plate compactor shall require four complete coverages, two passes each in mutually perpendicular directions.
d) The surface tolerance of the compacted storage reservoir layer shall be +/- 3/4 in. under a 10 ft. straightedge. Prior to placing the washed aggregate (custom), the recommended subbase surface tolerance should +/- 3/8 in. under a 10 ft. straight edge.
e) Compacted storage reservoir area shall not substantially exceed that which is covered by paving slabs by the end-of-day.
f) In all cases reservoir stone shall be placed and compacted against rigid lateral boundaries, i.e., in situ, undisturbed native soils, fill materials compacted to 98% Standard Proctor density or concrete curb and headers. Compaction of reservoir stone against any flexible boundaries shall not be allowed.

Note: Geogrid shall be required at the discretion of the design engineer. Excavation and replacement of the subgrade, possibly with geotextile or geogrid reinforcement, might be necessary where weak, disturbed and/or saturated subgrade soils are present. State Department of Transportation aggregate materials used for roadway and highway flexible pavements are recommended for replacement of weak, disturbed and/or saturated subgrade soils.

6. Un-compacted/screed Crushed Stone Levelling Layer (Base)

   a) Place and spread ASTM C 33 Size Number 8 (3/8”) crushed stone evenly over screed rails to achieve a thickness of 2 inches minimum. Level the surface of crushed stone with a screed.
   b) Do not compact or disturb screeded leveling layer.
   c) The surface tolerance of the screed leveling layer shall be + 1/4 in. under a 10 ft. straightedge.
   d) Screed leveling layer placed shall not substantially exceed that which is covered by paving slabs by the end-of-day.

7. Precast Porous Concrete Paving Slab Placement

   a) Lay slabs in pattern(s) shown on approved drawings and manufacturer’s layout plan. Cut slabs as indicated to complete pattern.
   b) For gutter applications, slabs shall be placed perpendicular to the adjacent curb. The angle between the curb and slab shall be greater than or equal to 90^{o}.
   c) Slabs shall only be lifted and placed using lifting swivels (Part No.12LS) and spreader chains. Chains, cables or slings should never be wrapped around slabs for lifting under any circumstances. Lifting swivel bolts shall be securely bolted snug but not over-tightened to avoid damage to the surface.
   d) Place Precast porous concrete slabs without using metal hammers, pry bars or drift pins. Make horizontal adjustments to placement of laid slabs with wood wedges and levers, and rubber mallets as needed.
   e) Adjacent slabs shall be separated from each other by 1/8”. Manufacturer supplied spacers (Part No 18SP) shall be used to ensure proper joint spacing.
   f) The porous concrete panels shall be installed so that there is no lippage or surface unevenness greater than 1/8" difference in height between slabs and adjacent surfaces.
   g) Joints between adjacent rows of slabs shall be staggered when possible.
   h) Joints shall never be filled with loose material including but not limited to (sand, stone dust, stone chips, etc.)
   i) Horizontal joint lines shall not deviate more than ±½ in. over 50 ft. from string lines.
   j) Fill gaps at the edges of the paved area with properly-sized cut slabs.
   k) Cut end slabs to be placed along the edge or corners with a diamond blade masonry saw. Cut units shall be no narrower than 18” and cutting shall occur so that a minimum distance of 8” is maintained between embedded lifters and cut edges.
   l) Core drill or cut slabs as may be necessary to fit over, and/or around, existing Utility Structures or Poles, and Sign Posts prior to slab placement.
   m) Cut Slabs using hand-held, or machine driven diamond cut off saw having the required blade diameter to safely cut slabs.
   n) Protect adjacent slabs surfaces from dust infiltration when cutting slabs.
   o) Seal outside edges and around installed new concrete footing and foundations, Utility Structures or Poles and Sign Posts as indicated on the approved Permit Plans with approved materials as per Section 2.02 EDGE MATERIAL/JOINT FILLER of these Specifications.

p) [Adjust bond pattern at pavement edges such that cutting of edge slabs is minimized. Do not expose cut slabs to vehicular traffic.] [Cut slabs at edges as indicated on the drawings.]
q) Keep skid steer and forklift equipment off unrestrained paving slabs.
r) After an area is completely paved, set the precast porous concrete slabs into the screed crushed stone leveling course layer by trafficking with light rubber-tired equipment.
s) Remove and replace any slabs cracked or damaged during installation with new ones. Reset slabs not in conformance with specified installation tolerances.
t) Installer shall warranty for a period of one year from the date of installation that installed slabs shall be free of rocking or pumping evidenced by visible vertical movement. Any slabs observed to be moving shall be removed and the screeding course shall be re-screeded and the slabs reset.
u) Check final surface elevations of set slabs for conformance to design drawings. The final surface tolerance from grade elevations shall not deviate more than ± 1/4 in. under a 10 ft. straightedge.
v) The surface elevation of set slabs shall be flush with manholes or the top of utility structures.
w) Hairline cracks in placed slabs shall be considered as to not interfere with the proper functioning or performance of the system. Where approved by the Engineer, larger cracks or occasional imperfections may be repaired under the direction of the manufacturer. The repairs must be properly finished and cured. The color of the repair area must match as closely as possible with the rest of the element color. Repairs shall be made with a mixture of sand and cement, as directed by the manufacturer
y) In all cases reservoir stone shall be placed and compacted against rigid lateral boundaries, i.e., in situ, undisturbed native soils, fill materials compacted to 98% Standard Proctor density or concrete curb and headers. Compaction of reservoir stone against any flexible boundaries shall not be allowed.

Note: The uniformity of the un-compacted/screed crushed stone levelling base layer determines the differential settlement between precast porous concrete paving slabs. The slab installation contractor should not correct deficiencies in the smoothness of the leveling layer surface by randomly placing additional stone, raking, compaction or by other similar means

3.04 EDGE RESTRAINT

1. Install edge restraints per the drawings and manufacturer's recommendations at the indicated locations and elevations.

Edge restraint should be provided (by contractor) on all perimeter sides of precast porous concrete pavement installations. Edge restraint may be mounted in asphalt pavement, but use of asphalt pavement as edge restraint is not allowed.

3.05 PROTECTION

1. Immediately after Precast porous concrete slabs have been placed; use provided (by manufacturer) plastic caps to fill imbedded lifting points. Care should be taken to make sure the plastic caps are flush with the surface; do not press caps down into the imbedded lifting points.
2. After work in this section is complete, the general contractor shall be responsible for protecting the Precast porous paving slab system from damage and/or contamination with mud, dirt, grass cuttings, accumulation of foliage and debris.
3. The surface of the Precast porous paving slabs shall be covered during the placement of adjacent soils or paving materials.

3.06 MAINTENANCE

1. Conduct periodic inspections and maintenance per procedures as recommended in Stormcrete® Operation and Maintenance Manual.

Stormcrete® Modular Precast Porous Concrete Stormwater System

Handling and Installation Manual

1. Recommended Equipment

In addition to the typical earthmoving, materials handling and grading equipment, the following hand tools should also be available –

- 2 or 4-way chains, cables or straps rated to lift the slabs – refer to Table 2 for the number of lifting points and the slab weights
- Cordless impact wrench or ratchet wrench with 3/4" socket for installing and removing lifting swivel bolts
- Lifting swivels supplied by manufacturer
- Rakes and shovels for levelling screed stone
- 1.25" minimum diameter screed rails
- 2"x4" or other material to use as a screed
- Plastic plugs and slab spacers supplied by manufacturer.
- Backpack blower to keep slabs surface clean during and after installation.
- Diamond Bladed Masonry Cutoff Saw (6" cutting depth min. – typically requires a minimum 16" diameter blade – check saw specifications).

2. Offloading and Storage

- Prior to offloading a delivery truck the slabs on the truck shall be carefully inspected for any damage. **Any observed damage shall be immediately reported to the delivery driver and to Porous Technologies, LLC (1-888-357-1161) and the quantity and type of damage shall be noted on the delivery ticket.** Claims for damages reported more than 8 hours after a delivery will not be considered.

- Offloading should be performed by a **trained** and **experienced** equipment operator. Due to the unique structural properties of porous concrete, extra care should be taken when handling the slabs.

- A forklift or similar equipment should be used when offloading *Stormcrete®* slabs. It is recommended that the equipment be fitted with forks. ***Chains, cables or slings should never be wrapped around slabs for offloading or installation.***

- Slabs should be offloaded evenly from both sides of the truck to ensure that the trailer does not become unstable.

- Slabs delivered on pallets should be offloaded as shipped. Slabs delivered on dunnage must be picked from the highest level of dunnage. **Never pick up slabs with more than one layer of dunnage.** (*Please see Table 1 for Stormcrete® slab sizes, shipping configurations and corresponding weights*).

Slab Size	Number of slabs per pallet/dunnage	Number of slabs per stack	Approx. Slab Weight (lbs.)	Approx. Lift Weight (lbs.)
5’ x 4’ x 6”	3	9	1290	3870
5’ x 2’ x 6”	6	9	645	3870
4’ x 2.5’ x 6”	6	9	645	3870

Table 1

- Stored slabs must be placed on a level or nearly level stable surface. In dusty environments slabs should be covered to prevent dust and debris from settling on slab surfaces.

- Allow approximately 1 s.f. of storage area for every 3 s.f. of Stormcrete® Slabs purchased.

- When stacking or restacking slabs 4” by 4” timbers should be placed parallel to one another and **located directly beneath imbedded lifting points**. **Do not place timbers in the middle of the slabs or on the ends**. Timbers should be at a minimum 1” thicker than the fork thickness. Place timbers between each double stack of slabs (see image below).

- Lower slabs evenly such that the slab comes into contact with both timbers simultaneously. To prevent edge damage, slabs should be set flat on timbers so that one edge does not contact timbers while opposite edge is supported by forks.

3. Sub-Base Preparation

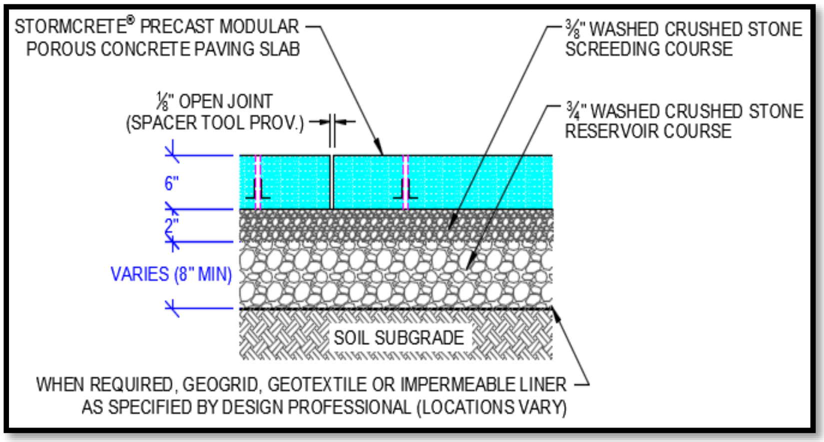
Reservoir Layer Placement:

Reservoir layer shall not be placed and/or compact in rain or snow, or on saturated or frozen subgrade.

In all cases reservoir stone shall be placed and compacted against rigid lateral boundaries, i.e., in situ, undisturbed native soils, fill materials compacted to 98% Standard Proctor density or concrete curb and headers. Compaction of reservoir stone against any flexible boundaries shall not be permitted.

Although the approved plans shall govern over installation details and specifications, the following instructions are provided by the manufacturer as minimum guidelines:

- Reservoir stone layer shall be constructed per approved drawings using ¾" or AASHTO No. 57 crushed angular stone. The stone must be washed and free of fines.



- Compact reservoir storage layer in maximum 12" lifts, with a minimum of two complete coverages, one pass each in mutually perpendicular directions, with a 3 to 5 ton smooth, single or double drum roller operated in vibratory mode. Following vibratory compaction, repeat two complete coverage's, one pass each in mutually perpendicular directions, with the roller operated in static mode. Continue static rolling until there is no visible movement, weaving or deflection in the surface of the storage reservoir layer.

- For small areas inaccessible by large rollers follow the above directions using a walk-behind plate compactor. Repeat two complete coverages in each direction.

- The surface tolerance of the compacted storage reservoir layer shall be +/- 3/4 in. under a 10 ft. straightedge.

- Where specified on the design plans, place geotextile on prepared subgrade side slopes and extend a maximum of 1 foot under the bottom of the storage reservoir. Do not place geotextile under other areas of infiltrating system unless specified on the approved plans. Secure in place to prevent disturbance from vehicles and/or worker foot traffic.

Screeding Layer Placement

It is critical that the crushed stone leveling course surface be SCREEDED flat so that the slabs are fully supported with no bridging or mounding beneath. Crushed stone base shall not be placed and/or screeded in rain or snow, or on saturated or frozen subbase.

- Screeding layer shall be placed per approved drawings using 3/8" crushed angular stone or No. 8 Stone. The stone must be washed and free of fines.
- Place and spread the stone evenly over the reservoir course to a thickness of +/- 2". Level the surface of crushed stone (screeding is strongly recommended).

- Screed using a minimum 1.25" diameter rigid screed rail placed adjacent or below the slab location with the top of the rails set at the screeding level.

- Do not compact or disturb leveled screeding layer (if screed rails are placed in panel locations, carefully remove them to prevent disturbance to the leveling base layer).
- The uniformity of the leveling (base) layer determines the differential settlement between precast porous concrete paving slabs.
- The slab installation contractor **should not correct deficiencies in the leveling layer by shimming** with additional stone rather the slabs should be lifted out and the entire area should be re-leveled.

4. Setting Stormcrete® Porous Concrete Slabs

Recommended Lifting Hardware

- Slabs shall only be lifted and placed using supplied hoist ring swivels. 2 or 4-way chains, wire rope or nylon straps rated for the lift weight shall be used per the manufacturer's recommendations to lift slabs – do not exceed minimum recommended angle for lifting chains.

- Swivels shall be securely bolted snug to the slab. Check to ensure that the bolt extends the full depth of the lifting socket. To avoid damage to the surface do not over-tightened bolts. (An electric impact wrench with a 3/4" socket is the most efficient way to attach and remove the swivels).

Individual slabs should only be lifted by equipment that is rated for the slab weights shown in the adjacent table:

Slab Dimension (ft)	Max Slab Weight (lbs.)	Lifting Points
5' x 4' x 6"	1290	4
5' x 2' x 6"	645	2
4' x 2.5' x 6"	645	2

Chains, cables or slings should never be wrapped around slabs for placement under any circumstances.

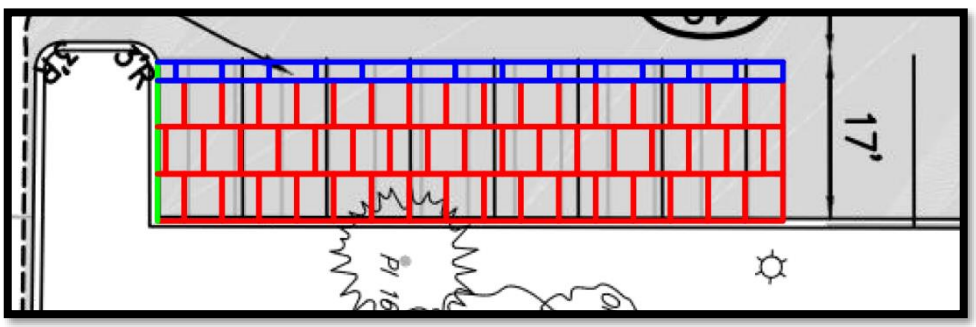
Placing Slabs

Precast porous concrete slabs shall not be placed in heavy rain or snow, or on saturated or frozen base.

Because the units are precast in a controlled environment, they are delivered to the site pre-cured which allows them to be parked or driven on immediately after placement. They may also be placed year-round, in almost any type of weather or temperature conditions.

WARNING! – ENSURE THAT PLASTIC SPACER THAT ARE USED TO SEPARATE SLABS IN A STACK ARE REMOVED FROM THE BOTTOM OF ALL SLABS BEFORE SLAB PLACEMENT.

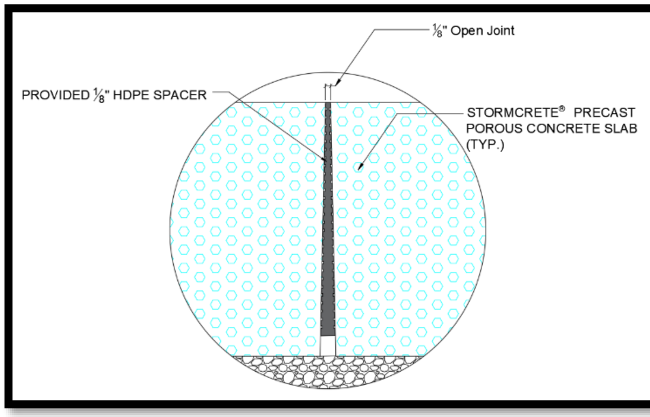
- Whenever possible place slabs in a staggered pattern(s) as shown below or as depicted on approved drawings.



- On gutter applications a string line shall be used to ensure that the curbing is straight enough to allow for proper placement of the slabs. If the existing curbing does not follow a straight alignment then the slabs should follow the alignment of a string line placed mostly parallel to the curb and ½" away from the point that is furthest toward the roadway to allow for a minimum ½" joint. .

- Guide units into place by hand, being careful not to pinch fingers. Horizontal adjustments can be made with wood wedges, levers, and rubber mallets as needed (If pry bars are used they should never come into direct contact with the top corner of the slab).

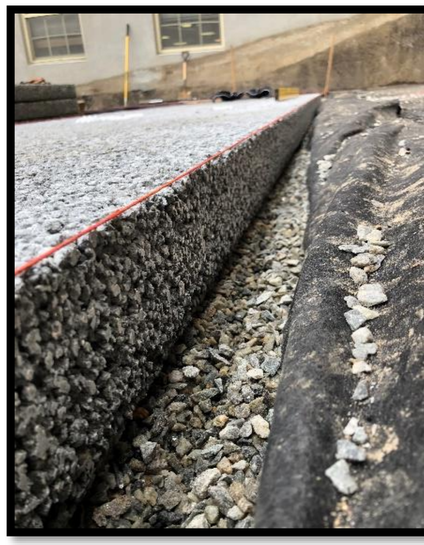
- Adjacent slabs shall be separated from each other by the placement of (2) 3/8" thick High-Density Polyethylene tapered spacers (thick end down) (Part No. 18SP) supplied by the manufacturer. Spacer shall be trimmed to the right height to fit and adhered to previously placed slab with a construction adhesive such as Liquid Nails Heavy Duty Construction Adhesive or approved equal.



- Care should be taken to place adjacent slabs at same elevation (i.e. level to each other). Slab surfaces shall not deviate by more than 1/8" vertically and horizontally from one to the next.

- Placed Slabs should maintain consistent 1/8" joint widths and horizontal and vertical alignments should be continuously straightened as necessary as paving proceeds.

- Joints between adjacent rows of panels shall be staggered when possible.



- Keep slabs covered until all adjacent areas are stabilized to prevent dust and debris from reducing porosity of slabs. A backpack blower should be employed throughout the installation process to keep slab surfaces clean. Place erosion and sediment control barriers to prevent eroding areas from draining onto slabs.

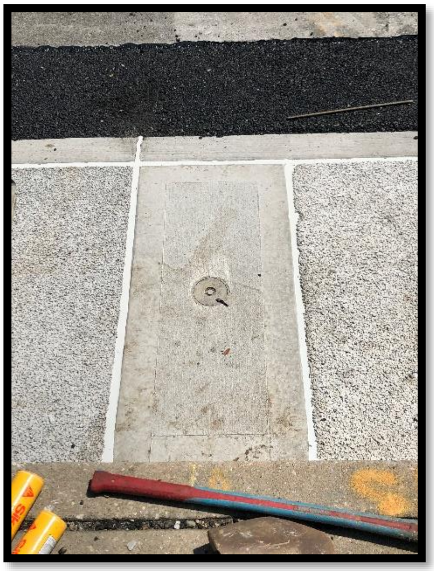
- Whenever possible set slabs with equipment positioned next to slab area and not on previously installed slabs. When it is necessary to position equipment on slabs during setting use only light machines equipped with either rubber tires or rubber tracks. – **installed slabs should not be driven on by heavy construction equipment.** Protect installed slabs from heavy loads by placing plywood beneath steel plates in locations where heavy loads can not be avoided.

- Immediately after the Stormcrete® system has been placed; use provided ½" nylon caps (Part No. 12NC) to fill imbedded lifting points. Care should be taken to make sure the plastic caps are flush with the surface; do not press caps down into the imbedded lifting points.

- Keep equipment off unrestrained paving slabs and subgrade material.
- Report any damage immediately to the project design professional.

Cutting

- When required, cut slabs with a diamond bladed masonry saw with a plunge depth of 6" minimum.
- If field adjustments are required, slabs should be cut as indicated on the approved drawings.
- Cut slabs shall be no narrower than 18" and cutting shall occur so that a minimum of two embedded lifters remain for safe lifting and setting.



- Cutting should be performed away from sub-base material and other slabs. Do not cut slabs while in a stack or on top of another slab.
- Cover adjacent areas of slab being cut to prevent dust and debris or slurry from entering into the porous concrete.
- Slab layouts shall be planned to minimize or eliminate locations where utility structures intersect with slab joints. Whole and half slabs shall be used in combination with cast in place collars to surround utilities.

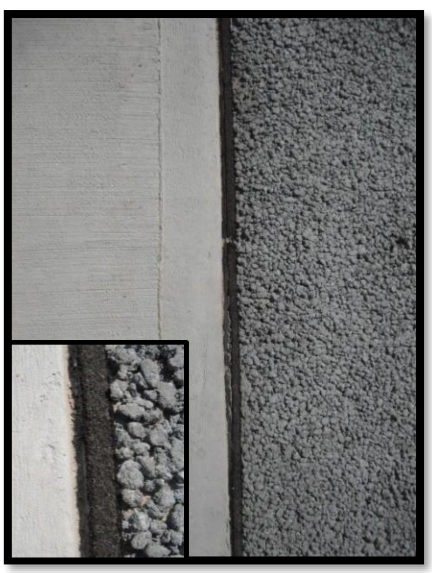
Grade Breaks

- Stormcrete® slabs should be placed on a level sub-base. If grade breaks are present, ensure that they occur at an open joint.

- If a grade break does not occur at an open joint cut the slab to create an open joint at the break. If cutting is required reference the cutting section above.

Edge Restraints

- **NEVER** place fluid material (asphalt, concrete, soil, etc.) directly up against the Stormcrete® slabs. Fluid materials shall be separated from Stormcrete® slabs by the use of a ½" preformed expansion joint material conforming to ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction



- Install edge restraints per approved drawings and manufacturer's recommendations at the indicated locations and elevations.

- Anchor edge restraints directly to finished leveling layer in accordance with the manufacturer's requirements.

- The use of loose stone as a filler material adjacent to slabs should be avoided in favor of expansion joint material conforming to ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (preferred).
- When placing Stormcrete® Precast Porous Concrete slabs against existing concrete structures where it is not possible to pre-install ½" expansion joint material joints may be filled with No.8 clean washed gravel beneath closed cell foam backer rod and a maximum depth of ½" of elastomeric sealant such as

Sikasil 728 RCS Limestone joint filler or approved equal. In all cases the use of a preformed expansion joint material conforming to ASTM D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction is preferred.

5. SLAB PROTECTION & FINAL INSPECTION

- After work in the section is complete, the contractor shall be responsible for protecting the precast porous paving slab system from damage and/or contamination from mud, dirt, grass cuttings and accumulation of foliage and debris through the duration of construction. This should include a regular vacuum sweeping schedule. It is important that you do not attempt to wash the construction area clean. This will result in lose debris draining into the slabs/stone.

- Any slabs cracked or damaged during installation shall be replaced with new ones at the installers cost.

- Reset slabs not in conformance with specified installation tolerances.

- Check for and remove any accumulation of sediment or debris observed. This can be done by manually sweeping, vacuum sweepers, and in some cases, back pack blowers.

- Check final surface elevations of set slabs for conformance to design drawings. Slab surfaces shall not deviate by more than 1/8" vertically from one to the next and to adjacent surfaces.

- The surface elevation of set slabs shall be flush with manholes or the top of utility structures.

6. STORMCRETE® PRECAST POROUS CONCRETE INSTALLATION TRAINING PROGRAM

- Installation contractors are strongly encouraged to participate in the Stormcrete® Precast Porous Concrete Installation Training Program. This program ensures that Installers are properly trained in the installation of Stormcrete® products. Installers successfully completing the Training Program shall receive a certificate valid for 2 years and shall be responsible for reviewing the Handling and Installation Manual and Training Program Test Questions (with correct answers) with Laborers under their employ.

- Deliveries of Stormcrete® System Products will not occur until installers have successfully completed the Stormcrete® Precast Porous Concrete Installation Training Program.

- Warranty claims will only be considered when submitted by installers who have successfully completed the Stormcrete® Precast Porous Concrete Installation Training Program

Stormcrete® Modular Precast Porous Concrete Stormwater System

Operation and Maintenance Manual

Introduction:

Stormcrete® is a modular precast porous concrete stormwater system which provides a low-risk alternative to poured in place porous pavements. Routine operation and maintenance (O&M) procedures are similar to that of conventional porous pavements. However, Stormcrete® provides the security of knowing that the slabs can be easily lifted for maintenance and repairs or in some cases even replaced when standard maintenance practices are insufficient.

Planning / Placement:

Proper planning and placement of porous surfaces is fundamental to their longevity and effectiveness. All projects are unique and careful attention should be taken to each situation. Locate porous surfaces where they will be most effective from a stormwater management perspective and least susceptible to heavy loading of sediment and debris. For example, potential issues can arise in the following locations; site entrances, heavy commercial traffic, and landscaped areas that may erode onto the porous surface.

Particular attention should be given to the amount of run-on flow from contributing impervious areas (Run-on Ratio). To avoid concentrating sediment in one location run-on flow should be consistently introduced across a row of Stormcrete® Slabs and not directed towards a limited number of slabs.

When choosing landscape plantings around a Stormcrete® System installations care should be taken to minimize the potential for heavy organic material loading from surrounding vegetation.

Regular Inspection:

Regular inspection of the Stormcrete® System is critical to developing a site-specific maintenance program. Inspection should be performed several times in the first few months and then 2-4 times per year depending upon the intensity of use. The following should be included in any ongoing inspection program:

- During inspection note the accumulation of sediment and debris. Voids should be checked for accumulation of fine material. This will aid in determining proper vacuum sweeping frequency and the ability to target areas with higher accumulation rates.
- Inspect for evidence of run-on from perimeter unpaved areas or nearby erosion.
- Inspect for evidence of ponding. (i.e. staining or unusual light sediment or debris)
- Confirm "good housekeeping" practices are in place. Do not store materials such as; mulch, soil, yard waste, and other stock piles on Stormcrete® slab surfaces or in such a way that the material can be washed or blown on to the Stormcrete® slab surface.
- During inspection note the accumulation of sediment and debris. Voids should be checked for accumulation of fine material. This will aid in determining proper vacuum sweeping frequency and the ability to target areas with higher accumulation rates.
- Inspect for surface deficiencies. (i.e. raveling, spalling, cracking, etc.)
- Inspect for evidence of ponding. (i.e. staining or unusual light sediment or debris)
- Inspect for evidence of run-on from perimeter unpaved areas or nearby erosion.
- Inspect for evidence of accidental or illicit spillage.
- Maintain a log detailing all inspection and maintenance activities.

Maintenance During Construction:

Installed Stormcrete® System Panels should be properly protected post installation, but before the System is accepted by owners in the following manner:

- **Vehicular Traffic:** Protect slabs from heavy construction equipment loads by using smaller vehicles when possible or protective measures such as steel plates to spread the load experienced by installed Panels.

- **Sediment and Debris:** Use impervious liner material (heavy gauge HDPE sheeting) and plywood as necessary to cover installed Stormcrete® System panels to protect them from dirty tires and sediment and debris deposition. In some installations it may be advisable to maintain a gravel-filled trench immediately adjacent to the Stormcrete® System installation to intercept sediment and debris laden stormwater flows before they run onto the system.
- **Remove sediment and debris from Panels as needed:** A backpack blower should be kept on-site during the construction period to remove sediment and debris before it is ground into the panel surface.

Routine Post Construction Maintenance:

Even with the advantages of the Stormcrete® System, all porous surfaces require some routine maintenance activities to preserve permeability and service life. A minimum amount of planning and regular maintenance is more effective than surface rehabilitation or replacement.

- **Blower:** A high-powered backpack blower (similar to a Stihl BR600) can be used with a swirl pattern to loosen sediment and debris lodged into the Stormcrete® System. A vacuum can be used to remove the material dislodged by the blower.

Vacuum Sweeping: Vacuuming a **minimum of 2 times per year is** recommended for most installations. Site specific conditions (land use, climate, tree cover, slopes, construction activities, etc.) along with data from regular inspections will ultimately determine how frequently the surface should be vacuumed. At a minimum, vacuum cleaning should occur in spring and fall (after leaf drop). Additional cleaning should be scheduled any time accumulated sediment / debris is visible on surface and may be necessary for installations that are prone to heavy sediment and debris loading, such as roadway gutters and parking lots. Sidewalks and pedestrian plazas will most likely require less frequent maintenance.

- **Proper Equipment:** Use of a powerful vacuum for routine maintenance is critical. Regenerative air vacuum sweepers and high-efficiency vacuum only sweepers are recommended. Equipment condition and proper maintenance is also critical to maximize vacuum efficiencies.

- Specialized equipment such as the Stormwater SUV™ may be used for sidewalks, green alleys, pedestrian plazas, etc. for maximum porous surface cleaning effectiveness.

    - **Operator experience and diligence** is critical to maximize vacuum efficiencies. Vehicle speed, equipment settings, timing for proper access, and type of material being removed are only a few of the factors an operator needs to properly gage.

    - **Maintenance Staff / Public awareness:** On-site personnel and contractors should be made aware of the porous surface and proper O&M procedures. (i.e. signage / pavement demarcation, snow removal, etc.)

Rehabilitation, Repairs, and Replacement:

- **Focused Power Washing**: Power-washing can be an effective tool for unclogging plugged areas. Power-washing should be used in conjunction with a focused, high-velocity vacuum head so that debris is removed and not just displaced. Power-washing should occur at moderate pressure and at low angle (<45 degrees) to drive materials into the vacuum head. Care should be taken with water pressure until effect of water pressure on surface is realized.

- **Remove, Restore & Reset**: In the event that focused power-washing does not provide adequate flow capacity, the slab(s) can be lifted, removed, and replaced.
    - Please note: Removal and replacement should be completed using Stormcrete® lifting swivels. Refer to the Stormcrete® Handling & Installation Manual for additional information.

- **Replacement:** In the event that the slab(s) is plugged beyond rehabilitation the slab(s) can easily be removed and replaced.

Winter Maintenance / Snow Removal:

- **De-icing & Chemicals:**
  - If possible, avoid applying sand to Stormcrete® surfaces.
  - A minimum amount of deicing chemicals should be required for use due to the infiltrative capacity of the Stormcrete® System. After thorough snow removal on a Stormcrete® System surface any residual snow melt will infiltrate leaving the surface dry.
    - Due to the low water to cement ratio in porous concrete, Stormcrete® is more resistant to deicing chemicals.
    - Sodium Chloride may be used as necessary.
    - Calcium Chloride may be used in limited amounts in colder environments
    - Because of its corrosive nature Magnesium Chloride should not be used with Stormcrete® Precast Porous Panels

  Permeable pavement owners should realize a savings on deicing salt costs because there will be no thaw and refreeze issues to contend with.

- **Plowing & Snow Removal:**
  - Snow can be removed using conventional plow blades equipped with shoes, although wherever possible plows should be equipped with a plastic or rubber cutting edge. Well maintained plow blades can prevent damage to porous surface. Back dragging is not recommended. Where possible, plow passes should be made at a 45-degree angle to the slab joints.
  - Operator training: Snow removal operators should be aware of the presence of the Stormcrete® System and its importance to the property and environment.
  - Snow within pores of porous pavement can make them appear more snow covered than standard impervious pavements. Porous surface should not be "over worked" or scraped.

Porous Pavement Maintenance:

As Stormwater Professionals we understand that pervious concrete and asphalt surfaces are increasingly being integrated into stormwater management systems (SMS). As site specific needs vary greatly, so do the availability of different sweeping programs.

In cold weather climates, porous surfaces are particularly sensitive to sediment buildup. As an integral part of the SMS, the longevity and effectiveness of this significant capital investment is directly related to its care and maintenance. At Stormwater Compliance, LLC, an affiliate of Porous Technologies, LLC, we manage porous pavement as well as the care of entire stormwater systems on site. Included in our services are complete documentation of condition and performance and the restoration of surfaces to their originally intended function as may be needed.

Please contact Sweeping@StormWaterComp.com ,or 1-877-271-9055 for guidance or a professional services proposal tailored to meet your site-specific O & M needs.