

March 31, 2023

Kathleen Colwell
Planning Division, Director
41 Pleasant Street
Methuen, MA 01844

RE: Taco John's
Drainage Summary Letter
436 Broadway
Methuen, MA 01844
Parcel No.: 610-123-47A

Dear Ms. Colwell:

On behalf of our client, Shri Swamine, LLC, Allen & Major Associates, Inc. (A&M) is pleased to provide this drainage summary in support of the Site Plan application for the proposed Taco John's fast-food restaurant within the existing Village Mall Plaza at 436 Broadway (Route 28). This analysis will demonstrate that the proposed project will match or reduce the rate and volume of runoff for all design storm events.

Existing Conditions

The site is located on the west side of Massachusetts Route 28, approximately $1,000 \pm$ feet north of Massachusetts Route 213, Exit 2. It is comprised of a single parcel, identified on Tax Map 610, Block 123, Lot 47A. The site is currently developed with a multi-tenant building of approximately $97,200 \pm$ square feet and 562 parking spaces. The parcel is abutted by various restaurants with Dunkin' Donuts to the north and Texas Roadhouse to the southeast. Elevations on site range from a high elevation of 148 in the southeast corner of the parcel, to a low elevation of 109 in the northwest corner of the parcel.

Stormwater flows on site are captured within various series of deep sump catch basins, discharging through multiple outlet pipes along the southern and western property lines. Stormwater from the front portion of the building is collected by a series of catch basins in the parking lot and is directed to a 30" reinforced concrete pipe located in the northwestern property corner, discharging offsite. Stormwater at the rear of the existing building sheet flows with the pavement grade, flowing offsite along the southern property line; The collected roof water is also discharged along the southern property line through a 12" metal outlet pipe. Stormwater generated within the depressed loading area and the drive aisle located west of the existing building is routed through various catch basins which outlet to an existing 24" reinforced concrete pipe that discharges along the western property line. A review of the NRCS soil report for Essex County indicates that the soil on site is primarily "Urban Land". The primary soil type for the undeveloped portions of the site is "Canton" fine sandy loam which is classified as Hydrologic Soil Group Type "B" soil. Copies of the NRCS soils report and the Existing Watershed Plan, sheet EWS-1, are included with this summary.

Proposed Conditions

The project proposes to construct a 2,200 square foot Taco John's fast-food restaurant with a drive-through. The proposed site work will produce substantially less pavement area on the overall parcel, mitigating the rate of runoff and volume leaving the site. The existing drainage system is to remain

the same within the limit of disturbance, utilizing the existing drain manholes and catch basins within the project area and adding one proposed catch basin structure. A rain garden will also be introduced, providing treatment and infiltration for a portion of the runoff generated within the development. The project reduces the amount of parking on site, lessening the amount of impervious surface within the parcel while still maintaining an adequate number of parking spaces for all uses within the plaza.

Stormwater runoff was analyzed at the two study points described above, to ensure that the project does not result in an increase in the peak rate and volume of runoff. Runoff generated within the redeveloped area will be captured and routed through the existing drainage network or routed through the Rain Guardian – Foxhole curb inlet to the rain garden. Runoff from the roof area will be captured within roof scuppers and directed to an existing manhole, discharging to the existing drainage system on-site. Please see the table below for the existing and proposed runoff rates and volumes generated within the project site. Copies of the HydroCAD worksheets are attached to this summary.

STUDY POINT #1 (Flow to Existing Drainage Network)				
	2-Year	10-Year	25-Year	100-Year
Existing Flow (CFS)	2.79	4.61	6.02	8.93
Proposed Flow (CFS)	1.74	3.12	5.03	8.13
Change (CFS)	-1.05	-1.49	-0.99	-0.80
Existing Volume (CF)	9,035	15,311	20,352	30,922
Proposed Volume (CF)	5,643	10,866	15,450	25,431
Change (CF)	-3,392	-4,445	-4,902	-5,491

STUDY POINT #2 (Flow to 450 Broadway)				
	2-Year	10-Year	25-Year	100-Year
Existing Flow (CFS)	0.06	0.16	0.25	0.46
Proposed Flow (CFS)	0.02	0.09	0.16	0.31
Change (CFS)	-0.04	-0.07	-0.09	-0.15
Existing Volume (CF)	206	514	801	1,467
Proposed Volume (CF)	111	313	510	985
Change (CF)	-95	-201	-291	-482

Summary

As shown in the table above, the proposed project will have a positive impact on the surrounding stormwater system by reducing the peak rate and volume of runoff leaving the site for all design storm events.

Very truly yours,
ALLEN & MAJOR ASSOCIATES, INC.

A handwritten signature in blue ink, appearing to read "B. Jones".

Brian D. Jones, PE
Senior Project Manager

Attachments:

1. Extreme Precipitation Tables (Northeast Regional Climate Center)
2. NRCS Soil Report for Essex County
3. Existing HydroCAD worksheets
4. Proposed HydroCAD worksheets
5. Existing Watershed Plan, Sheet EWS-1
6. Proposed Watershed Plan, Sheet PWS-1

Extreme Precipitation Tables

Northeast Regional Climate Center

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

Metadata for Point																
Smoothing	Yes															
State																
Location																
Latitude	42.736 degrees North															
Longitude	71.196 degrees West															
Elevation	30 feet															
Date/Time	Thu Mar 16 2023 10:27:48 GMT-0400 (Eastern Daylight Time)															

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.27	0.42	0.52	0.68	0.85	1.07	1yr	0.73	1.01	1.24	1.58	2.01	2.57	2.78	1yr	2.27	2.67	3.12	3.79	4.42	1yr
2yr	0.33	0.51	0.64	0.84	1.06	1.33	2yr	0.91	1.22	1.54	1.94	2.45	3.09	3.41	2yr	2.73	3.28	3.80	4.51	5.14	2yr
5yr	0.39	0.61	0.77	1.03	1.32	1.68	5yr	1.14	1.53	1.95	2.47	3.11	3.92	4.36	5yr	3.47	4.20	4.82	5.72	6.47	5yr
10yr	0.44	0.69	0.88	1.19	1.55	2.00	10yr	1.34	1.81	2.34	2.96	3.74	4.71	5.26	10yr	4.17	5.06	5.78	6.84	7.71	10yr
25yr	0.52	0.83	1.06	1.46	1.94	2.52	25yr	1.67	2.27	2.96	3.77	4.77	5.99	6.74	25yr	5.30	6.48	7.34	8.68	9.72	25yr
50yr	0.59	0.94	1.21	1.70	2.29	3.02	50yr	1.98	2.69	3.56	4.54	5.74	7.20	8.13	50yr	6.37	7.82	8.80	10.39	11.58	50yr
100yr	0.67	1.09	1.41	1.99	2.71	3.59	100yr	2.34	3.20	4.25	5.44	6.89	8.65	9.81	100yr	7.65	9.43	10.56	12.45	13.81	100yr
200yr	0.77	1.25	1.62	2.33	3.22	4.29	200yr	2.78	3.80	5.09	6.54	8.28	10.39	11.85	200yr	9.19	11.39	12.67	14.93	16.48	200yr
500yr	0.92	1.51	1.98	2.87	4.03	5.43	500yr	3.48	4.77	6.46	8.33	10.56	13.26	15.21	500yr	11.73	14.62	16.12	18.98	20.82	500yr

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.37	0.45	0.60	0.74	0.88	1yr	0.64	0.86	1.11	1.37	1.66	2.36	2.57	1yr	2.09	2.47	2.80	3.37	4.03	1yr
2yr	0.32	0.49	0.61	0.82	1.01	1.21	2yr	0.87	1.18	1.38	1.82	2.32	2.99	3.31	2yr	2.64	3.18	3.69	4.38	5.00	2yr
5yr	0.37	0.57	0.71	0.97	1.23	1.45	5yr	1.06	1.41	1.63	2.12	2.70	3.68	4.03	5yr	3.26	3.88	4.50	5.31	6.04	5yr
10yr	0.41	0.63	0.78	1.09	1.41	1.65	10yr	1.21	1.61	1.86	2.39	3.03	4.27	4.64	10yr	3.78	4.46	5.20	6.14	6.95	10yr
25yr	0.47	0.72	0.89	1.27	1.68	1.95	25yr	1.45	1.90	2.20	2.79	3.53	5.21	5.59	25yr	4.61	5.37	6.33	7.45	8.31	25yr
50yr	0.52	0.79	0.99	1.42	1.91	2.22	50yr	1.65	2.17	2.49	3.14	3.97	6.04	6.43	50yr	5.34	6.18	7.35	8.62	9.49	50yr
100yr	0.59	0.89	1.11	1.60	2.20	2.52	100yr	1.90	2.46	2.82	3.54	4.46	6.63	7.40	100yr	5.87	7.11	8.56	9.99	10.85	100yr
200yr	0.65	0.99	1.25	1.81	2.52	2.86	200yr	2.18	2.79	3.19	3.98	5.03	7.62	8.53	200yr	6.74	8.20	9.96	11.55	12.37	200yr
500yr	0.77	1.14	1.47	2.13	3.03	3.38	500yr	2.61	3.31	3.76	4.66	5.89	9.10	10.29	500yr	8.05	9.90	12.20	14.01	14.71	500yr

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.30	0.46	0.57	0.76	0.94	1.10	1yr	0.81	1.07	1.25	1.66	2.12	2.77	2.95	1yr	2.45	2.84	3.37	4.06	4.79	1yr
2yr	0.34	0.53	0.65	0.89	1.09	1.30	2yr	0.94	1.27	1.49	1.95	2.49	3.20	3.56	2yr	2.83	3.42	3.93	4.66	5.33	2yr
5yr	0.43	0.66	0.82	1.12	1.42	1.68	5yr	1.23	1.64	1.93	2.49	3.16	4.18	4.70	5yr	3.70	4.52	5.16	6.13	6.91	5yr
10yr	0.52	0.79	0.98	1.37	1.77	2.05	10yr	1.53	2.00	2.35	3.01	3.80	5.15	5.83	10yr	4.56	5.61	6.34	7.53	8.46	10yr
25yr	0.66	1.01	1.26	1.79	2.36	2.68	25yr	2.04	2.62	3.08	3.86	4.83	6.81	7.77	25yr	6.02	7.47	8.34	9.93	11.11	25yr
50yr	0.80	1.21	1.51	2.17	2.92	3.28	50yr	2.52	3.21	3.77	4.68	5.80	8.41	9.68	50yr	7.44	9.31	10.25	12.24	13.65	50yr
100yr	0.97	1.47	1.84	2.65	3.64	4.02	100yr	3.14	3.93	4.63	5.66	6.98	10.87	12.06	100yr	9.62	11.60	12.61	15.10	16.80	100yr
200yr	1.17	1.77	2.24	3.24	4.52	4.94	200yr	3.90	4.83	5.68	6.86	8.38	13.54	15.03	200yr	11.98	14.45	15.50	18.60	20.70	200yr
500yr	1.52	2.26	2.91	4.23	6.01	6.48	500yr	5.19	6.34	7.47	8.83	10.70	18.13	20.14	500yr	16.04	19.36	20.36	24.54	27.31	500yr



United States
Department of
Agriculture



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 Essex County, Massachusetts, Northern Part



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

Preface	2
How Soil Surveys Are Made	5
Soil Map	8
Soil Map.....	9
Legend.....	10
Map Unit Legend.....	11
Map Unit Descriptions.....	11
Essex County, Massachusetts, Northern Part.....	13
256A—Deerfield loamy fine sand, 0 to 3 percent slopes.....	13
421C—Canton fine sandy loam, 8 to 15 percent slopes, very stony.....	14
602—Urban land.....	16
713A—Limerick and Rumney soils, 0 to 3 percent slopes, frequently flooded.....	17
717E—Rock outcrop-Charlton-Hollis complex, 15 to 35 percent slopes.....	19
Soil Information for All Uses	22
Soil Properties and Qualities.....	22
Soil Physical Properties.....	22
Saturated Hydraulic Conductivity (Ksat).....	22
Soil Qualities and Features.....	25
Hydrologic Soil Group.....	26
References	30

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

Custom Soil Resource Report

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

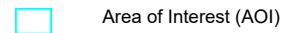
The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

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

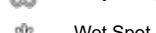
Spoil Area



Stony Spot



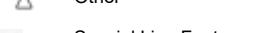
Very Stony Spot



Wet Spot

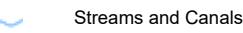


Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



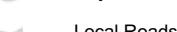
Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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: Essex County, Massachusetts, Northern Part

Survey Area Data: Version 18, Sep 9, 2022

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 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
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	0.3	2.4%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	1.6	10.9%
602	Urban land	9.9	68.9%
713A	Limerick and Rumney soils, 0 to 3 percent slopes, frequently flooded	0.1	0.4%
717E	Rock outcrop-Charlton-Hollis complex, 15 to 35 percent slopes	2.5	17.4%
Totals for Area of Interest		14.4	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.

Essex County, Massachusetts, Northern Part

256A—Deerfield loamy fine sand, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2xfg8

Elevation: 0 to 1,100 feet

Mean annual precipitation: 36 to 71 inches

Mean annual air temperature: 39 to 55 degrees F

Frost-free period: 145 to 240 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Deerfield and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Deerfield

Setting

Landform: Outwash terraces, outwash deltas, outwash plains, kame terraces

Landform position (three-dimensional): Tread

Down-slope shape: Concave, convex, linear

Across-slope shape: Convex, linear, concave

Parent material: Sandy outwash derived from granite, gneiss, and/or quartzite

Typical profile

Ap - 0 to 9 inches: loamy fine sand

Bw - 9 to 25 inches: loamy fine sand

BC - 25 to 33 inches: fine sand

Cg - 33 to 60 inches: sand

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Moderately well drained

Runoff class: Negligible

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: About 15 to 37 inches

Frequency of flooding: None

Frequency of ponding: None

Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)

Sodium adsorption ratio, maximum: 11.0

Available water supply, 0 to 60 inches: Moderate (about 6.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: A

Ecological site: F144AY027MA - Moist Sandy Outwash

Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 7 percent

Landform: Outwash terraces, kame terraces, outwash deltas, outwash plains

Landform position (three-dimensional): Tread

Down-slope shape: Concave, convex, linear

Across-slope shape: Convex, linear, concave

Hydric soil rating: No

Wareham

Percent of map unit: 5 percent

Landform: Drainageways, depressions

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

Sudbury

Percent of map unit: 2 percent

Landform: Outwash plains, kame terraces, outwash deltas, outwash terraces

Landform position (three-dimensional): Tread

Down-slope shape: Concave, convex, linear

Across-slope shape: Convex, linear, concave

Hydric soil rating: No

Ninigret

Percent of map unit: 1 percent

Landform: Kame terraces, outwash plains, outwash terraces

Landform position (three-dimensional): Tread

Down-slope shape: Convex, linear

Across-slope shape: Convex, concave

Hydric soil rating: No

421C—Canton fine sandy loam, 8 to 15 percent slopes, very stony

Map Unit Setting

National map unit symbol: 2w814

Elevation: 0 to 1,160 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 statewide importance

Map Unit Composition

Canton, very stony, and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Canton, Very Stony

Setting

Landform: Moraines, ridges, hills

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex, linear

Across-slope shape: Convex

Parent material: Coarse-loamy over sandy melt-out till derived from gneiss, granite, and/or schist

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material

A - 2 to 5 inches: fine sandy loam

Bw1 - 5 to 16 inches: fine sandy loam

Bw2 - 16 to 22 inches: gravelly fine sandy loam

2C - 22 to 67 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent

Surface area covered with cobbles, stones or boulders: 1.6 percent

Depth to restrictive feature: 19 to 39 inches to strongly contrasting textural stratification

Drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 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 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: B

Ecological site: F144AY034CT - Well Drained Till Uplands

Hydric soil rating: No

Minor Components

Montauk, very stony

Percent of map unit: 6 percent

Landform: Recessional moraines, ground moraines, hills, drumlins

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex, linear

Across-slope shape: Convex

Hydric soil rating: No

Scituate, very stony

Percent of map unit: 5 percent

Landform: Ground moraines, hills, drumlins

Landform position (two-dimensional): Backslope, footslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex, linear

Across-slope shape: Convex

Hydric soil rating: No

Chatfield, very stony

Percent of map unit: 3 percent

Landform: Hills, ridges

Landform position (two-dimensional): Summit, shoulder, backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Convex

Across-slope shape: Convex

Hydric soil rating: No

Swansea

Percent of map unit: 1 percent

Landform: Marshes, depressions, bogs, swamps, kettles

Down-slope shape: Concave

Across-slope shape: Concave

Hydric soil rating: Yes

602—Urban land

Map Unit Setting

National map unit symbol: vjx3

Frost-free period: 125 to 165 days

Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 80 percent

Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Excavated and filled land

Minor Components

Udorthents

Percent of map unit: 10 percent

Hydric soil rating: No

Hinckley

Percent of map unit: 2 percent

Hydric soil rating: No

Charlton

Percent of map unit: 2 percent

Hydric soil rating: No

Windsor

Percent of map unit: 2 percent
Hydric soil rating: No

Merrimac

Percent of map unit: 2 percent
Hydric soil rating: No

Paxton

Percent of map unit: 2 percent
Hydric soil rating: No

713A—Limerick and Rumney soils, 0 to 3 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 2zvfc
Elevation: 10 to 2,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Limerick and similar soils: 60 percent
Rumney and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Limerick

Setting

Landform: Alluvial flats
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Coarse-silty alluvium derived from mica schist over friable sandy alluvium derived from mica schist

Typical profile

H1 - 0 to 13 inches: silt loam
H2 - 13 to 25 inches: silt loam
H3 - 25 to 60 inches: very fine sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)

Depth to water table: About 6 to 10 inches

Frequency of flooding: Frequent

Frequency of ponding: None

Available water supply, 0 to 60 inches: Very high (about 13.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w

Hydrologic Soil Group: B/D

Ecological site: F144AY015NY - Wet Silty Low Floodplain

Hydric soil rating: Yes

Description of Rumney

Setting

Landform: Alluvial flats

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Dip

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Coarse-loamy alluvium over sandy alluvium

Typical profile

O - 0 to 2 inches: muck

H2 - 2 to 7 inches: fine sandy loam

H3 - 7 to 31 inches: fine sandy loam

H4 - 31 to 60 inches: stratified gravelly sand to loamy sand to coarse sand

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)

Depth to water table: About 0 to 18 inches

Frequency of flooding: NoneFrequent

Frequency of ponding: None

Available water supply, 0 to 60 inches: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3w

Hydrologic Soil Group: A/D

Ecological site: F144AY014CT - Wet Sandy Low Floodplain

Hydric soil rating: Yes

Minor Components

Winooski

Percent of map unit: 10 percent

Hydric soil rating: No

Saco variant

Percent of map unit: 5 percent

Landform: Alluvial flats

Hydric soil rating: Yes

717E—Rock outcrop-Charlton-Hollis complex, 15 to 35 percent slopes

Map Unit Setting

National map unit symbol: vjrb
Elevation: 0 to 260 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 125 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 40 percent
Charlton and similar soils: 30 percent
Hollis and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Setting

Parent material: Granite and gneiss

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: Unranked

Description of Charlton

Setting

Landform: Ridges, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable coarse-loamy eolian deposits over friable coarse-loamy basal till derived from granite and gneiss

Typical profile

H1 - 0 to 4 inches: fine sandy loam
H2 - 4 to 28 inches: gravelly fine sandy loam
H3 - 28 to 60 inches: gravelly fine sandy loam

Properties and qualities

Slope: 15 to 25 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6s

Hydrologic Soil Group: A

Ecological site: F144AY034CT - Well Drained Till Uplands

Hydric soil rating: No

Description of Hollis

Setting

Landform: Ridges, hills

Landform position (two-dimensional): Backslope

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Convex

Parent material: Shallow, friable loamy eolian deposits over granite and gneiss

Typical profile

O - 0 to 1 inches: muck

H2 - 1 to 6 inches: fine sandy loam

H3 - 6 to 17 inches: gravelly fine sandy loam

H4 - 17 to 20 inches: unweathered bedrock

Properties and qualities

Slope: 15 to 25 percent

Depth to restrictive feature: 10 to 60 inches to lithic bedrock

Drainage class: Somewhat excessively drained

Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e

Hydrologic Soil Group: D

Ecological site: F144AY033MA - Shallow Dry Till Uplands

Hydric soil rating: No

Minor Components

Sutton

Percent of map unit: 5 percent

Hydric soil rating: No

Chatfield

Percent of map unit: 5 percent

Custom Soil Resource Report

Hydric soil rating: No

Leicester

Percent of map unit: 5 percent

Landform: Depressions

Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

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

Soil Physical Properties

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

Saturated Hydraulic Conductivity (Ksat)

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

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

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

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



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Background



Aerial Photography

Soils

Soil Rating Polygons

-  <= 9.1700
-  > 9.1700 and <= 52.0359
-  > 52.0359 and <= 100.0000
-  Not rated or not available

Soil Rating Lines

-  <= 9.1700
-  > 9.1700 and <= 52.0359
-  > 52.0359 and <= 100.0000
-  Not rated or not available

Soil Rating Points

-  <= 9.1700
-  > 9.1700 and <= 52.0359
-  > 52.0359 and <= 100.0000
-  Not rated or not available

Water Features

-  Streams and Canals

Transportation

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

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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: Essex County, Massachusetts, Northern Part
 Survey Area Data: Version 18, Sep 9, 2022

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 imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Saturated Hydraulic Conductivity (Ksat)

Map unit symbol	Map unit name	Rating (micrometers per second)	Acres in AOI	Percent of AOI
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	100.0000	0.3	2.4%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	52.0359	1.6	10.9%
602	Urban land		9.9	68.9%
713A	Limerick and Rumney soils, 0 to 3 percent slopes, frequently flooded	9.1700	0.1	0.4%
717E	Rock outcrop-Charlton-Hollis complex, 15 to 35 percent slopes		2.5	17.4%
Totals for Area of Interest			14.4	100.0%

Rating Options—Saturated Hydraulic Conductivity (Ksat)

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

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

Top Depth: 1

Bottom Depth: 100

Units of Measure: Inches

Soil Qualities and Features

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

Hydrologic Soil Group

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

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

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

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

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

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

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

Custom Soil Resource Report Map—Hydrologic Soil Group



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

-  A
-  A/D
-  B
-  B/D

C

C/D

D

Not rated or not available

Water Features

 Streams and Canals

Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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: Essex County, Massachusetts, Northern Part

Survey Area Data: Version 18, Sep 9, 2022

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 imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
256A	Deerfield loamy fine sand, 0 to 3 percent slopes	A	0.3	2.4%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	B	1.6	10.9%
602	Urban land		9.9	68.9%
713A	Limerick and Rumney soils, 0 to 3 percent slopes, frequently flooded	B/D	0.1	0.4%
717E	Rock outcrop-Charlton-Hollis complex, 15 to 35 percent slopes		2.5	17.4%
Totals for Area of Interest			14.4	100.0%

Rating Options—Hydrologic Soil Group*Aggregation Method: Dominant Condition**Component Percent Cutoff: None Specified**Tie-break Rule: Higher*

References

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

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

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

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

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

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

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

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

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

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

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

Custom Soil Resource Report

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf



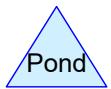
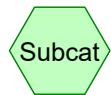
EXISTING DRAINAGE
NETWORK

Subcat E-1



450 BROADWAY

Subcat E-2



Routing Diagram for 3115-01A - Existing HydroCAD
Prepared by Allen & Major Associates, Inc., Printed 3/29/2023
HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

3115-01A - Existing HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Printed 3/29/2023

Page 2

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type III 24-hr		Default	24.00	1	3.09	2
2	10-year	Type III 24-hr		Default	24.00	1	4.71	2
3	100-year	Type III 24-hr		Default	24.00	1	8.65	2

3115-01A - Existing HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Printed 3/29/2023

Page 3

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
11,275	61	>75% Grass cover, Good, HSG B (E-1, E-2)
40,671	98	Paved parking, HSG B (E-1, E-2)

Summary for Subcatchment E-1: Subcat E-1

Runoff = 2.79 cfs @ 12.09 hrs, Volume= 9,035 cf, Depth= 2.25"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description
8,320	61	>75% Grass cover, Good, HSG B
39,949	98	Paved parking, HSG B
48,269	92	Weighted Average
8,320		17.24% Pervious Area
39,949		82.76% Impervious Area

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

Summary for Subcatchment E-2: Subcat E-2

Runoff = 0.06 cfs @ 12.11 hrs, Volume= 206 cf, Depth= 0.67"
 Routed to Link SP2 : 450 BROADWAY

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description
2,955	61	>75% Grass cover, Good, HSG B
722	98	Paved parking, HSG B
3,678	68	Weighted Average
2,955		80.36% Pervious Area
722		19.64% Impervious Area

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

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 48,269 sf, 82.76% Impervious, Inflow Depth = 2.25" for 2-year event

Inflow = 2.79 cfs @ 12.09 hrs, Volume= 9,035 cf

Primary = 2.79 cfs @ 12.09 hrs, Volume= 9,035 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link SP2: 450 BROADWAY

Inflow Area = 3,678 sf, 19.64% Impervious, Inflow Depth = 0.67" for 2-year event

Inflow = 0.06 cfs @ 12.11 hrs, Volume= 206 cf

Primary = 0.06 cfs @ 12.11 hrs, Volume= 206 cf, Atten= 0%, Lag= 0.0 min

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

3115-01A - Existing HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 10-year Rainfall=4.71"

Printed 3/29/2023

Page 6

Summary for Subcatchment E-1: Subcat E-1

Runoff = 4.61 cfs @ 12.09 hrs, Volume= 15,311 cf, Depth= 3.81"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

Area (sf)	CN	Description
8,320	61	>75% Grass cover, Good, HSG B
39,949	98	Paved parking, HSG B
48,269	92	Weighted Average
8,320		17.24% Pervious Area
39,949		82.76% Impervious Area

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

Summary for Subcatchment E-2: Subcat E-2

Runoff = 0.16 cfs @ 12.10 hrs, Volume= 514 cf, Depth= 1.68"
 Routed to Link SP2 : 450 BROADWAY

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

Area (sf)	CN	Description
2,955	61	>75% Grass cover, Good, HSG B
722	98	Paved parking, HSG B
3,678	68	Weighted Average
2,955		80.36% Pervious Area
722		19.64% Impervious Area

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

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 48,269 sf, 82.76% Impervious, Inflow Depth = 3.81" for 10-year event

Inflow = 4.61 cfs @ 12.09 hrs, Volume= 15,311 cf

Primary = 4.61 cfs @ 12.09 hrs, Volume= 15,311 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link SP2: 450 BROADWAY

Inflow Area = 3,678 sf, 19.64% Impervious, Inflow Depth = 1.68" for 10-year event

Inflow = 0.16 cfs @ 12.10 hrs, Volume= 514 cf

Primary = 0.16 cfs @ 12.10 hrs, Volume= 514 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Subcatchment E-1: Subcat E-1

Runoff = 8.93 cfs @ 12.09 hrs, Volume= 30,922 cf, Depth= 7.69"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description
8,320	61	>75% Grass cover, Good, HSG B
39,949	98	Paved parking, HSG B
48,269	92	Weighted Average
8,320		17.24% Pervious Area
39,949		82.76% Impervious Area

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

Summary for Subcatchment E-2: Subcat E-2

Runoff = 0.46 cfs @ 12.09 hrs, Volume= 1,467 cf, Depth= 4.79"
 Routed to Link SP2 : 450 BROADWAY

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description
2,955	61	>75% Grass cover, Good, HSG B
722	98	Paved parking, HSG B
3,678	68	Weighted Average
2,955		80.36% Pervious Area
722		19.64% Impervious Area

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

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 48,269 sf, 82.76% Impervious, Inflow Depth = 7.69" for 100-year event

Inflow = 8.93 cfs @ 12.09 hrs, Volume= 30,922 cf

Primary = 8.93 cfs @ 12.09 hrs, Volume= 30,922 cf, Atten= 0%, Lag= 0.0 min

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

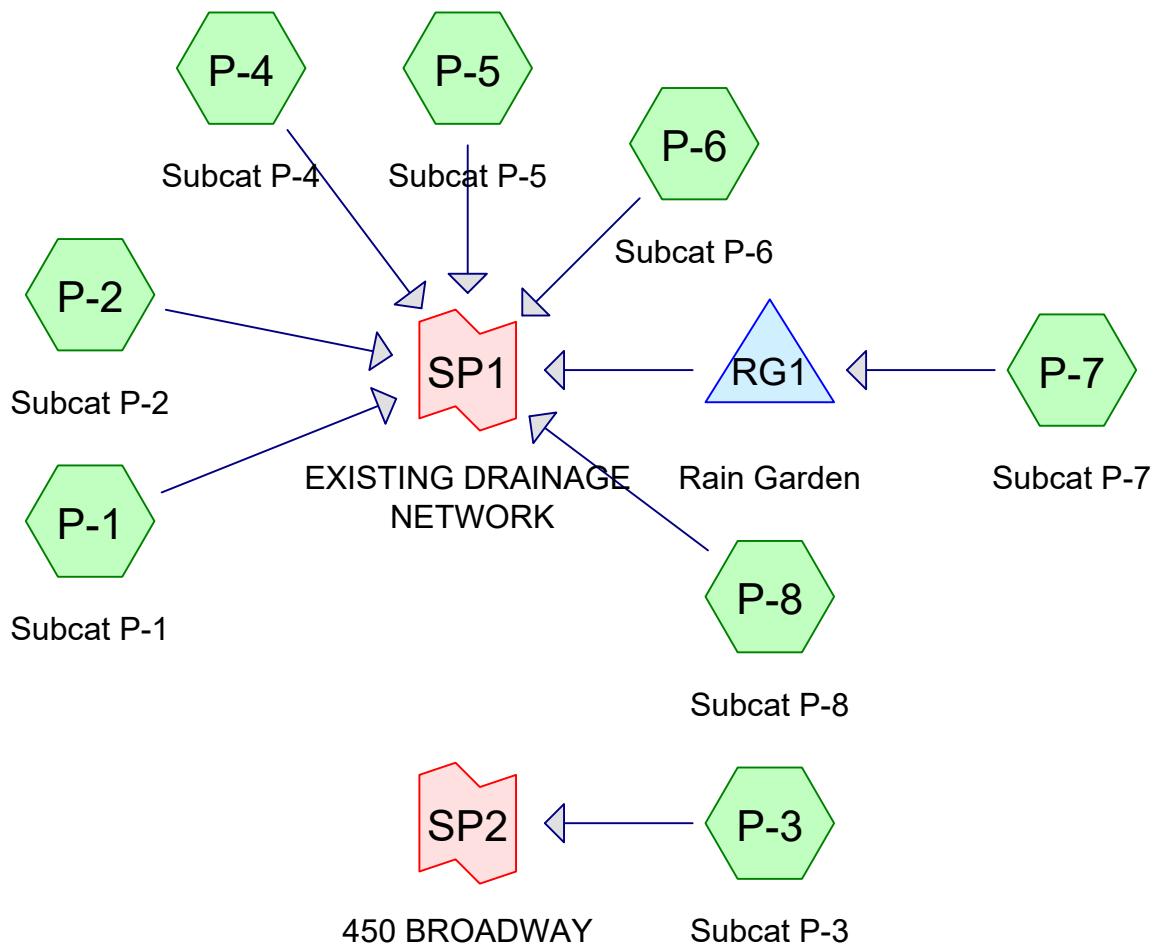
Summary for Link SP2: 450 BROADWAY

Inflow Area = 3,678 sf, 19.64% Impervious, Inflow Depth = 4.79" for 100-year event

Inflow = 0.46 cfs @ 12.09 hrs, Volume= 1,467 cf

Primary = 0.46 cfs @ 12.09 hrs, Volume= 1,467 cf, Atten= 0%, Lag= 0.0 min

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



3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Printed 3/30/2023

Page 2

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year	Type III 24-hr		Default	24.00	1	3.09	2
2	10-year	Type III 24-hr		Default	24.00	1	4.71	2
3	25-year	Type III 24-hr		Default	24.00	1	5.99	2
4	100-year	Type III 24-hr		Default	24.00	1	8.65	2

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Printed 3/30/2023

Page 3

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
21,257	61	>75% Grass cover, Good, HSG B (P-2, P-3, P-4, P-5, P-6, P-7, P-8)
28,457	98	Paved parking, HSG B (P-2, P-3, P-4, P-5, P-6, P-7, P-8)
2,232	98	Roofs, HSG B (P-1)

Summary for Subcatchment P-1: Subcat P-1

Runoff = 0.15 cfs @ 12.09 hrs, Volume= 532 cf, Depth= 2.86"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description							
2,232	98	Roofs, HSG B							
2,232		100.00% Impervious Area							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
6.0									

Summary for Subcatchment P-2: Subcat P-2

Runoff = 0.40 cfs @ 12.09 hrs, Volume= 1,272 cf, Depth= 1.45"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description							
4,527	61	>75% Grass cover, Good, HSG B							
6,001	98	Paved parking, HSG B							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
6.0									

Summary for Subcatchment P-3: Subcat P-3

Runoff = 0.02 cfs @ 12.12 hrs, Volume= 111 cf, Depth= 0.47"
 Routed to Link SP2 : 450 BROADWAY

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description							
2,698	61	>75% Grass cover, Good, HSG B							
125	98	Paved parking, HSG B							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
2,823	63	Weighted Average							
2,698		95.56% Pervious Area							
125		4.44% Impervious Area							

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 2-year Rainfall=3.09"

Printed 3/30/2023

Page 5

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

Summary for Subcatchment P-4: Subcat P-4

Runoff = 0.30 cfs @ 12.09 hrs, Volume= 1,001 cf, Depth= 2.54"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description
446	61	>75% Grass cover, Good, HSG B
4,287	98	Paved parking, HSG B
4,733	95	Weighted Average
446		9.43% Pervious Area
4,287		90.57% Impervious Area

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

Summary for Subcatchment P-5: Subcat P-5

Runoff = 0.35 cfs @ 12.09 hrs, Volume= 1,113 cf, Depth= 1.98"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description
1,610	61	>75% Grass cover, Good, HSG B
5,133	98	Paved parking, HSG B
6,743	89	Weighted Average
1,610		23.87% Pervious Area
5,133		76.13% Impervious Area

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

Summary for Subcatchment P-6: Subcat P-6

Runoff = 0.47 cfs @ 12.09 hrs, Volume= 1,496 cf, Depth= 1.74"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 2-year Rainfall=3.09"

Printed 3/30/2023

Page 6

Area (sf)	CN	Description
3,449	61	>75% Grass cover, Good, HSG B
6,871	98	Paved parking, HSG B
10,320	86	Weighted Average
3,449		33.42% Pervious Area
6,871		66.58% Impervious Area

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

Summary for Subcatchment P-7: Subcat P-7

Runoff = 0.34 cfs @ 12.10 hrs, Volume= 1,092 cf, Depth= 1.19"
 Routed to Pond RG1 : Rain Garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description
5,837	61	>75% Grass cover, Good, HSG B
5,146	98	Paved parking, HSG B
10,983	78	Weighted Average
5,837		53.15% Pervious Area
5,146		46.85% Impervious Area

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

Summary for Subcatchment P-8: Subcat P-8

Runoff = 0.06 cfs @ 12.11 hrs, Volume= 228 cf, Depth= 0.76"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-year Rainfall=3.09"

Area (sf)	CN	Description
2,691	61	>75% Grass cover, Good, HSG B
893	98	Paved parking, HSG B
3,584	70	Weighted Average
2,691		75.08% Pervious Area
893		24.92% Impervious Area

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

Summary for Pond RG1: Rain Garden

Exfiltration rate used is derived from the Rawls rate for fine sandy loam being 1.02 in/hr.

Inflow Area = 10,983 sf, 46.85% Impervious, Inflow Depth = 1.19" for 2-year event
 Inflow = 0.34 cfs @ 12.10 hrs, Volume= 1,092 cf
 Outflow = 0.02 cfs @ 14.12 hrs, Volume= 1,092 cf, Atten= 93%, Lag= 121.5 min
 Discarded = 0.02 cfs @ 14.12 hrs, Volume= 1,092 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 134.65' @ 14.12 hrs Surf.Area= 933 sf Storage= 495 cf
 Flood Elev= 135.00' Surf.Area= 1,139 sf Storage= 859 cf

Plug-Flow detention time= 230.4 min calculated for 1,091 cf (100% of inflow)
 Center-of-Mass det. time= 230.2 min (1,081.4 - 851.1)

Volume	Invert	Avail.Storage	Storage Description		
#1	134.00'	859 cf	Surface Storage (Irregular) Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
134.00	606	99.0	0	0	606
135.00	1,139	148.0	859	859	1,577

Device	Routing	Invert	Outlet Devices
#0	Primary	135.00'	Automatic Storage Overflow (Discharged without head)
#1	Discarded	134.00'	1.020 in/hr Exfiltration over Surface area
			Conductivity to Groundwater Elevation = 130.00' Phase-In= 0.01'
#2	Device 3	134.80'	24.0" Horiz. Orifice/Grate C= 0.600
			Limited to weir flow at low heads
#3	Primary	128.64'	8.0" Round Culvert L= 69.0' Ke= 0.500
			Inlet / Outlet Invert= 128.64' / 127.26' S= 0.0200 '/' Cc= 0.900
			n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.02 cfs @ 14.12 hrs HW=134.65' (Free Discharge)
 ↗ 1=Exfiltration (Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=134.00' (Free Discharge)
 ↗ 3=Culvert (Passes 0.00 cfs of 3.02 cfs potential flow)
 ↗ 2=Orifice/Grate (Controls 0.00 cfs)

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 49,123 sf, 62.22% Impervious, Inflow Depth = 1.38" for 2-year event
 Inflow = 1.74 cfs @ 12.09 hrs, Volume= 5,643 cf
 Primary = 1.74 cfs @ 12.09 hrs, Volume= 5,643 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link SP2: 450 BROADWAY

Inflow Area = 2,823 sf, 4.44% Impervious, Inflow Depth = 0.47" for 2-year event

Inflow = 0.02 cfs @ 12.12 hrs, Volume= 111 cf

Primary = 0.02 cfs @ 12.12 hrs, Volume= 111 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Subcatchment P-1: Subcat P-1

Runoff = 0.23 cfs @ 12.09 hrs, Volume= 832 cf, Depth= 4.47"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

Area (sf)	CN	Description				
2,232	98	Roofs, HSG B				
2,232		100.00% Impervious Area				
Tc	Length	Slope	Velocity	Capacity	Description	
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.	
6.0						

Summary for Subcatchment P-2: Subcat P-2

Runoff = 0.78 cfs @ 12.09 hrs, Volume= 2,475 cf, Depth= 2.82"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

Area (sf)	CN	Description				
4,527	61	>75% Grass cover, Good, HSG B				
6,001	98	Paved parking, HSG B				
Tc	Length	Slope	Velocity	Capacity	Description	
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.	
6.0						

Summary for Subcatchment P-3: Subcat P-3

Runoff = 0.09 cfs @ 12.10 hrs, Volume= 313 cf, Depth= 1.33"
 Routed to Link SP2 : 450 BROADWAY

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

Area (sf)	CN	Description				
2,698	61	>75% Grass cover, Good, HSG B				
125	98	Paved parking, HSG B				
Tc	Length	Slope	Velocity	Capacity	Description	
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.	
2,823	63	Weighted Average				
2,698		95.56% Pervious Area				
125		4.44% Impervious Area				

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 10-year Rainfall=4.71"

Printed 3/30/2023

Page 10

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

Summary for Subcatchment P-4: Subcat P-4

Runoff = 0.47 cfs @ 12.09 hrs, Volume= 1,630 cf, Depth= 4.13"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

Area (sf)	CN	Description
446	61	>75% Grass cover, Good, HSG B
4,287	98	Paved parking, HSG B
4,733	95	Weighted Average
446		9.43% Pervious Area
4,287		90.57% Impervious Area

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

Summary for Subcatchment P-5: Subcat P-5

Runoff = 0.60 cfs @ 12.09 hrs, Volume= 1,964 cf, Depth= 3.49"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

Area (sf)	CN	Description
1,610	61	>75% Grass cover, Good, HSG B
5,133	98	Paved parking, HSG B
6,743	89	Weighted Average
1,610		23.87% Pervious Area
5,133		76.13% Impervious Area

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

Summary for Subcatchment P-6: Subcat P-6

Runoff = 0.86 cfs @ 12.09 hrs, Volume= 2,750 cf, Depth= 3.20"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 10-year Rainfall=4.71"

Printed 3/30/2023

Page 11

Area (sf)	CN	Description
3,449	61	>75% Grass cover, Good, HSG B
6,871	98	Paved parking, HSG B
10,320	86	Weighted Average
3,449		33.42% Pervious Area
6,871		66.58% Impervious Area

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

Summary for Subcatchment P-7: Subcat P-7

Runoff = 0.71 cfs @ 12.09 hrs, Volume= 2,258 cf, Depth= 2.47"
 Routed to Pond RG1 : Rain Garden

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

Area (sf)	CN	Description
5,837	61	>75% Grass cover, Good, HSG B
5,146	98	Paved parking, HSG B
10,983	78	Weighted Average
5,837		53.15% Pervious Area
5,146		46.85% Impervious Area

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

Summary for Subcatchment P-8: Subcat P-8

Runoff = 0.17 cfs @ 12.10 hrs, Volume= 545 cf, Depth= 1.82"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

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

Area (sf)	CN	Description
2,691	61	>75% Grass cover, Good, HSG B
893	98	Paved parking, HSG B
3,584	70	Weighted Average
2,691		75.08% Pervious Area
893		24.92% Impervious Area

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

Summary for Pond RG1: Rain Garden

Exfiltration rate used is derived from the Rawls rate for fine sandy loam being 1.02 in/hr.

Inflow Area = 10,983 sf, 46.85% Impervious, Inflow Depth = 2.47" for 10-year event
 Inflow = 0.71 cfs @ 12.09 hrs, Volume= 2,258 cf
 Outflow = 0.38 cfs @ 12.26 hrs, Volume= 2,258 cf, Atten= 46%, Lag= 10.2 min
 Discarded = 0.03 cfs @ 12.26 hrs, Volume= 1,588 cf
 Primary = 0.36 cfs @ 12.26 hrs, Volume= 670 cf

Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 134.87' @ 12.26 hrs Surf.Area= 1,058 sf Storage= 712 cf
 Flood Elev= 135.00' Surf.Area= 1,139 sf Storage= 859 cf

Plug-Flow detention time= 200.6 min calculated for 2,255 cf (100% of inflow)
 Center-of-Mass det. time= 200.7 min (1,030.5 - 829.8)

Volume	Invert	Avail.Storage	Storage Description		
#1	134.00'	859 cf	Surface Storage (Irregular) Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
134.00	606	99.0	0	0	606
135.00	1,139	148.0	859	859	1,577

Device	Routing	Invert	Outlet Devices
#0	Primary	135.00'	Automatic Storage Overflow (Discharged without head)
#1	Discarded	134.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 130.00' Phase-In= 0.01'
#2	Device 3	134.80'	24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Primary	128.64'	8.0" Round Culvert L= 69.0' Ke= 0.500 Inlet / Outlet Invert= 128.64' / 127.26' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.03 cfs @ 12.26 hrs HW=134.87' (Free Discharge)
 ↑ 1=Exfiltration (Controls 0.03 cfs)

Primary OutFlow Max=0.34 cfs @ 12.26 hrs HW=134.87' (Free Discharge)
 ↑ 3=Culvert (Passes 0.34 cfs of 3.23 cfs potential flow)
 ↑ 2=Orifice/Grate (Weir Controls 0.34 cfs @ 0.84 fps)

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 49,123 sf, 62.22% Impervious, Inflow Depth = 2.65" for 10-year event
 Inflow = 3.12 cfs @ 12.09 hrs, Volume= 10,866 cf
 Primary = 3.12 cfs @ 12.09 hrs, Volume= 10,866 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link SP2: 450 BROADWAY

Inflow Area = 2,823 sf, 4.44% Impervious, Inflow Depth = 1.33" for 10-year event

Inflow = 0.09 cfs @ 12.10 hrs, Volume= 313 cf

Primary = 0.09 cfs @ 12.10 hrs, Volume= 313 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Subcatchment P-1: Subcat P-1

Runoff = 0.29 cfs @ 12.09 hrs, Volume= 1,070 cf, Depth= 5.75"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description							
2,232	98	Roofs, HSG B							
2,232		100.00% Impervious Area							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
6.0									

Summary for Subcatchment P-2: Subcat P-2

Runoff = 1.09 cfs @ 12.09 hrs, Volume= 3,490 cf, Depth= 3.98"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description							
4,527	61	>75% Grass cover, Good, HSG B							
6,001	98	Paved parking, HSG B							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
6.0									

Summary for Subcatchment P-3: Subcat P-3

Runoff = 0.16 cfs @ 12.10 hrs, Volume= 510 cf, Depth= 2.17"
 Routed to Link SP2 : 450 BROADWAY

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description							
2,698	61	>75% Grass cover, Good, HSG B							
125	98	Paved parking, HSG B							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
2,823	63	Weighted Average							
2,698		95.56% Pervious Area							
125		4.44% Impervious Area							

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 25-year Rainfall=5.99"

Printed 3/30/2023

Page 15

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

Summary for Subcatchment P-4: Subcat P-4

Runoff = 0.61 cfs @ 12.09 hrs, Volume= 2,131 cf, Depth= 5.40"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description
446	61	>75% Grass cover, Good, HSG B
4,287	98	Paved parking, HSG B
4,733	95	Weighted Average
446		9.43% Pervious Area
4,287		90.57% Impervious Area

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

Summary for Subcatchment P-5: Subcat P-5

Runoff = 0.80 cfs @ 12.09 hrs, Volume= 2,656 cf, Depth= 4.73"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description
1,610	61	>75% Grass cover, Good, HSG B
5,133	98	Paved parking, HSG B
6,743	89	Weighted Average
1,610		23.87% Pervious Area
5,133		76.13% Impervious Area

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

Summary for Subcatchment P-6: Subcat P-6

Runoff = 1.17 cfs @ 12.09 hrs, Volume= 3,784 cf, Depth= 4.40"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 25-year Rainfall=5.99"

Printed 3/30/2023

Page 16

Area (sf)	CN	Description
3,449	61	>75% Grass cover, Good, HSG B
6,871	98	Paved parking, HSG B
10,320	86	Weighted Average
3,449		33.42% Pervious Area
6,871		66.58% Impervious Area

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

Summary for Subcatchment P-7: Subcat P-7

Runoff = 1.03 cfs @ 12.09 hrs, Volume= 3,268 cf, Depth= 3.57"
 Routed to Pond RG1 : Rain Garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description
5,837	61	>75% Grass cover, Good, HSG B
5,146	98	Paved parking, HSG B
10,983	78	Weighted Average
5,837		53.15% Pervious Area
5,146		46.85% Impervious Area

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

Summary for Subcatchment P-8: Subcat P-8

Runoff = 0.26 cfs @ 12.09 hrs, Volume= 835 cf, Depth= 2.80"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 25-year Rainfall=5.99"

Area (sf)	CN	Description
2,691	61	>75% Grass cover, Good, HSG B
893	98	Paved parking, HSG B
3,584	70	Weighted Average
2,691		75.08% Pervious Area
893		24.92% Impervious Area

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

Summary for Pond RG1: Rain Garden

Exfiltration rate used is derived from the Rawls rate for fine sandy loam being 1.02 in/hr.

Inflow Area = 10,983 sf, 46.85% Impervious, Inflow Depth = 3.57" for 25-year event
 Inflow = 1.03 cfs @ 12.09 hrs, Volume= 3,268 cf
 Outflow = 0.93 cfs @ 12.14 hrs, Volume= 3,268 cf, Atten= 10%, Lag= 2.9 min
 Discarded = 0.03 cfs @ 12.14 hrs, Volume= 1,783 cf
 Primary = 0.90 cfs @ 12.14 hrs, Volume= 1,485 cf

Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 134.92' @ 12.14 hrs Surf.Area= 1,093 sf Storage= 774 cf
 Flood Elev= 135.00' Surf.Area= 1,139 sf Storage= 859 cf

Plug-Flow detention time= 159.4 min calculated for 3,263 cf (100% of inflow)
 Center-of-Mass det. time= 159.7 min (979.0 - 819.2)

Volume	Invert	Avail.Storage	Storage Description		
#1	134.00'	859 cf	Surface Storage (Irregular) Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
134.00	606	99.0	0	0	606
135.00	1,139	148.0	859	859	1,577

Device	Routing	Invert	Outlet Devices
#0	Primary	135.00'	Automatic Storage Overflow (Discharged without head)
#1	Discarded	134.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 130.00' Phase-In= 0.01'
#2	Device 3	134.80'	24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Primary	128.64'	8.0" Round Culvert L= 69.0' Ke= 0.500 Inlet / Outlet Invert= 128.64' / 127.26' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.03 cfs @ 12.14 hrs HW=134.92' (Free Discharge)
 ↑ 1=Exfiltration (Controls 0.03 cfs)

Primary OutFlow Max=0.88 cfs @ 12.14 hrs HW=134.92' (Free Discharge)
 ↑ 3=Culvert (Passes 0.88 cfs of 3.24 cfs potential flow)
 ↑ 2=Orifice/Grate (Weir Controls 0.88 cfs @ 1.14 fps)

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 49,123 sf, 62.22% Impervious, Inflow Depth = 3.77" for 25-year event
 Inflow = 5.03 cfs @ 12.10 hrs, Volume= 15,450 cf
 Primary = 5.03 cfs @ 12.10 hrs, Volume= 15,450 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link SP2: 450 BROADWAY

Inflow Area = 2,823 sf, 4.44% Impervious, Inflow Depth = 2.17" for 25-year event

Inflow = 0.16 cfs @ 12.10 hrs, Volume= 510 cf

Primary = 0.16 cfs @ 12.10 hrs, Volume= 510 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Subcatchment P-1: Subcat P-1

Runoff = 0.43 cfs @ 12.09 hrs, Volume= 1,564 cf, Depth= 8.41"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description							
2,232	98	Roofs, HSG B							
2,232		100.00% Impervious Area							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
6.0									

Summary for Subcatchment P-2: Subcat P-2

Runoff = 1.75 cfs @ 12.09 hrs, Volume= 5,684 cf, Depth= 6.48"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description							
4,527	61	>75% Grass cover, Good, HSG B							
6,001	98	Paved parking, HSG B							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
6.0									

Summary for Subcatchment P-3: Subcat P-3

Runoff = 0.31 cfs @ 12.09 hrs, Volume= 985 cf, Depth= 4.19"
 Routed to Link SP2 : 450 BROADWAY

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description							
2,698	61	>75% Grass cover, Good, HSG B							
125	98	Paved parking, HSG B							
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	Direct Entry, TR-55 min.				
2,823	63	Weighted Average							
2,698		95.56% Pervious Area							
125		4.44% Impervious Area							

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 100-year Rainfall=8.65"

Printed 3/30/2023

Page 20

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

Summary for Subcatchment P-4: Subcat P-4

Runoff = 0.89 cfs @ 12.09 hrs, Volume= 3,175 cf, Depth= 8.05"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description
446	61	>75% Grass cover, Good, HSG B
4,287	98	Paved parking, HSG B
4,733	95	Weighted Average
446		9.43% Pervious Area
4,287		90.57% Impervious Area

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

Summary for Subcatchment P-5: Subcat P-5

Runoff = 1.22 cfs @ 12.09 hrs, Volume= 4,116 cf, Depth= 7.33"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description
1,610	61	>75% Grass cover, Good, HSG B
5,133	98	Paved parking, HSG B
6,743	89	Weighted Average
1,610		23.87% Pervious Area
5,133		76.13% Impervious Area

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

Summary for Subcatchment P-6: Subcat P-6

Runoff = 1.80 cfs @ 12.09 hrs, Volume= 5,988 cf, Depth= 6.96"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

3115-01A - Proposed HydroCAD

Prepared by Allen & Major Associates, Inc

HydroCAD® 10.20-2g s/n 02881 © 2022 HydroCAD Software Solutions LLC

Type III 24-hr 100-year Rainfall=8.65"

Printed 3/30/2023

Page 21

Area (sf)	CN	Description
3,449	61	>75% Grass cover, Good, HSG B
6,871	98	Paved parking, HSG B
10,320	86	Weighted Average
3,449		33.42% Pervious Area
6,871		66.58% Impervious Area

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

Summary for Subcatchment P-7: Subcat P-7

Runoff = 1.71 cfs @ 12.09 hrs, Volume= 5,487 cf, Depth= 5.99"
 Routed to Pond RG1 : Rain Garden

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description
5,837	61	>75% Grass cover, Good, HSG B
5,146	98	Paved parking, HSG B
10,983	78	Weighted Average
5,837		53.15% Pervious Area
5,146		46.85% Impervious Area

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

Summary for Subcatchment P-8: Subcat P-8

Runoff = 0.47 cfs @ 12.09 hrs, Volume= 1,501 cf, Depth= 5.03"
 Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Type III 24-hr 100-year Rainfall=8.65"

Area (sf)	CN	Description
2,691	61	>75% Grass cover, Good, HSG B
893	98	Paved parking, HSG B
3,584	70	Weighted Average
2,691		75.08% Pervious Area
893		24.92% Impervious Area

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

Summary for Pond RG1: Rain Garden

Exfiltration rate used is derived from the Rawls rate for fine sandy loam being 1.02 in/hr.

Inflow Area = 10,983 sf, 46.85% Impervious, Inflow Depth = 5.99" for 100-year event
 Inflow = 1.71 cfs @ 12.09 hrs, Volume= 5,487 cf
 Outflow = 1.65 cfs @ 12.11 hrs, Volume= 5,487 cf, Atten= 4%, Lag= 1.4 min
 Discarded = 0.03 cfs @ 12.11 hrs, Volume= 2,085 cf
 Primary = 1.62 cfs @ 12.11 hrs, Volume= 3,402 cf

Routed to Link SP1 : EXISTING DRAINAGE NETWORK

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
 Peak Elev= 134.98' @ 12.11 hrs Surf.Area= 1,129 sf Storage= 840 cf
 Flood Elev= 135.00' Surf.Area= 1,139 sf Storage= 859 cf

Plug-Flow detention time= 115.5 min calculated for 5,479 cf (100% of inflow)
 Center-of-Mass det. time= 116.0 min (920.5 - 804.5)

Volume	Invert	Avail.Storage	Storage Description		
#1	134.00'	859 cf	Surface Storage (Irregular) Listed below (Recalc)		
Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
134.00	606	99.0	0	0	606
135.00	1,139	148.0	859	859	1,577

Device	Routing	Invert	Outlet Devices
#0	Primary	135.00'	Automatic Storage Overflow (Discharged without head)
#1	Discarded	134.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 130.00' Phase-In= 0.01'
#2	Device 3	134.80'	24.0" Horiz. Orifice/Grate C= 0.600 Limited to weir flow at low heads
#3	Primary	128.64'	8.0" Round Culvert L= 69.0' Ke= 0.500 Inlet / Outlet Invert= 128.64' / 127.26' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf

Discarded OutFlow Max=0.03 cfs @ 12.11 hrs HW=134.98' (Free Discharge)
 ↗ 1=Exfiltration (Controls 0.03 cfs)

Primary OutFlow Max=1.57 cfs @ 12.11 hrs HW=134.98' (Free Discharge)
 ↗ 3=Culvert (Passes 1.57 cfs of 3.26 cfs potential flow)
 ↗ 2=Orifice/Grate (Weir Controls 1.57 cfs @ 1.39 fps)

Summary for Link SP1: EXISTING DRAINAGE NETWORK

Inflow Area = 49,123 sf, 62.22% Impervious, Inflow Depth = 6.21" for 100-year event
 Inflow = 8.13 cfs @ 12.09 hrs, Volume= 25,431 cf
 Primary = 8.13 cfs @ 12.09 hrs, Volume= 25,431 cf, Atten= 0%, Lag= 0.0 min

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

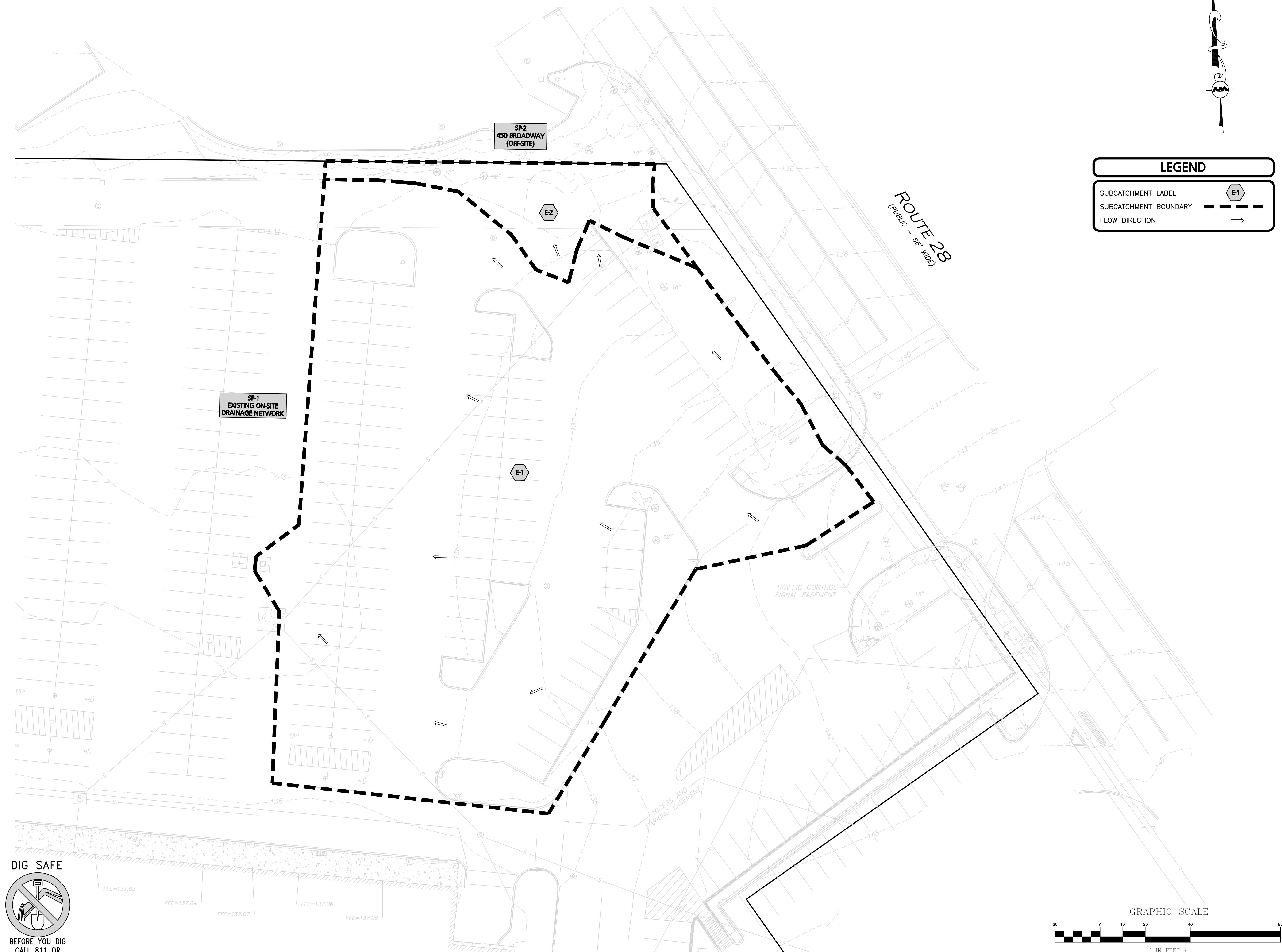
Summary for Link SP2: 450 BROADWAY

Inflow Area = 2,823 sf, 4.44% Impervious, Inflow Depth = 4.19" for 100-year event

Inflow = 0.31 cfs @ 12.09 hrs, Volume= 985 cf

Primary = 0.31 cfs @ 12.09 hrs, Volume= 985 cf, Atten= 0%, Lag= 0.0 min

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



PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

REV DATE DESCRIPTION
APPLICANT/OWNER:
SHRI SWAMINE LLC
PO BOX 2022
DANVERS, MA 01923

PROJECT:
TACO JOHN'S
436 BROADWAY
THE VILLAGE MALL
METHUEN, MA

PROJECT NO. 3115-01A DATE: 03/31/2023

SCALE: 1" = 20' DWG. NAME: C-3115-01A

DESIGNED BY: JRG CHECKED BY: BDJ

PREPARED BY:
ALLEN & MAJOR ASSOCIATES, INC.
civil engineering • land surveying
environmental consulting • landscape architecture
www.allenmajor.com
100 COMMERCE WAY, SUITE 5
WOBURN MA 01801
TEL: (781) 935-6889
FAX: (781) 935-2896

WOBURN, MA • LAKELVILLE, MA • MANCHESTER, NH
THIS DRAWING HAS BEEN PREPARED IN DIGITAL FORMAT.
CLIENT/CLIENT'S REPRESENTATIVE OR CONSULTANTS MAY BE
PROVIDED COPIES OF DRAWINGS AND SPECIFICATIONS FOR HIS/HER
INFORMATION AND/OR SPECIFIC USE ON THIS PROJECT. DUE TO THE
POTENTIAL THAT THE PROVIDED INFORMATION MAY BE MODIFIED
UNINTENTIONALLY OR OTHERWISE, ALLEN & MAJOR ASSOCIATES, INC.
MAY REMOVE ALL INDICATION OF THE DOCUMENTS'
AUTHORSHIP ON THE DIGITAL MEDIA. PRINTED REPRESENTATIONS OR
PORTABLE DOCUMENT FORMAT OF THE DRAWINGS AND
SPECIFICATIONS ISSUED SHALL BE THE ONLY RECORD COPIES OF
ALLEN & MAJOR ASSOCIATES, INC.'S WORK PRODUCT.

DRAWING TITLE: EXISTING WATERSHED PLAN EWS-1
SHEET No.
Copyright ©2023 Allen & Major Associates, Inc.
All Rights Reserved



BEFORE YOU DIG
CALL 811 OR
1-888-DIG-SAFE
1-888-344-7233

LEGEND

SUBCATCHMENT LABEL	P-1
SUBCATCHMENT BOUNDARY	—
FLOW DIRECTION	→

PROFESSIONAL ENGINEER FOR
ALLEN & MAJOR ASSOCIATES, INC.

REV DATE DESCRIPTION
APPLICANT/OWNER:
SHRI SWAMINE LLC
PO BOX 2022
DANVERS, MA 01923

PROJECT:
TACO JOHN'S
436 BROADWAY
THE VILLAGE MALL
METHUEN, MA

PROJECT NO. 3115-01A DATE: 03/31/2023
SCALE: 1" = 20' DWG. NAME: C-3115-01A
DESIGNED BY: JRG CHECKED BY: BDJ

PREPARED BY:
ALLEN & MAJOR ASSOCIATES, INC.
civil engineering • land surveying
environmental consulting • landscape architecture
www.allenmajors.com
100 COMMERCE WAY, SUITE 5
WOBURN MA 01801
TEL: (781) 935-6889
FAX: (781) 935-2896

WOBURN, MA • LAKELVILLE, MA • MANCHESTER, NH
THIS DRAWING HAS BEEN PREPARED IN DIGITAL FORMAT.
CLIENT/CLIENT'S REPRESENTATIVE OR CONSULTANTS MAY BE
PROVIDED COPIES OF DRAWINGS AND SPECIFICATIONS FOR HIS/HER
INFORMATION AND/OR SPECIFIC USE ON THIS PROJECT. DUE TO THE
POTENTIAL THAT THE PROVIDED INFORMATION MAY BE MODIFIED
UNINTENTIONALLY OR OTHERWISE, ALLEN & MAJOR ASSOCIATES,
INC. MAY REMOVE ALL INDICATION OF THE DOCUMENTS'
AUTHORSHIP ON THE DIGITAL MEDIA. PRINTED REPRESENTATIONS OR
PORTABLE DOCUMENT FORMAT OF THE DRAWINGS AND
SPECIFICATIONS ISSUED SHALL BE THE ONLY RECORD COPIES OF
ALLEN & MAJOR ASSOCIATES, INC.'S WORK PRODUCT.

DRAWING TITLE: PROPOSED WATERSHED PLAN PWS-1
SHEET No.
Copyright ©2023 Allen & Major Associates, Inc.
All Rights Reserved