Stormwater Management Report

Prepared For:

Proposed Washville Car Wash
1300 – 1310 Oaklawn Avenue
Cranston, RI 02920

Owner/Developer:
SITEology
3025 Highland Pkwy, Suite 850
Downers Grove, IL 60515

Prepared by:
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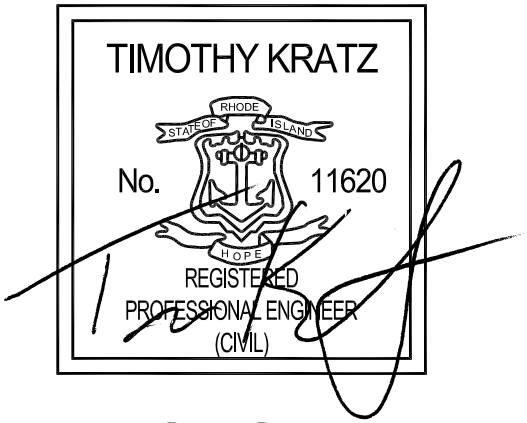
Tim Kratz, P.E.

Professional Certification: I hereby certify that these documents, applications, calculations, and drawings were prepared by me or under my direct supervision and approved by me, and that I am a duly licensed professional engineer in the State of Rhode Island.



Report Date:
Prepared: March 3, 2022
Revised: June 24, 2022
Revised: July 14, 2022

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Appendices

Purpose of Report

This stormwater management report and associated plan drawings were prepared in accordance with the stormwater management requirements of the Rhode Island Stormwater Design and Installation Standards Manual (The Manual). This report summarizes the predevelopment site conditions, post development site conditions, stormwater storage/conveyance, erosion control, and operation and maintenance procedures associated with the proposed re-development of the parcel of land located at 1300-1310 Oaklawn Avenue in the City of Cranston, Providence County, RI, 02920.

The site currently consists of a recently demolished building and associated parking lot which will be re-developed into a Washville branded car wash with associated vacuum stalls and pavement areas. The practices described in this report are designed to manage the effects of the redevelopment by decreasing stormwater runoff from the development, reducing soil erosion, minimizing pollutants in runoff, and protecting public safety through the proper design and operation of stormwater facilities, in order to comply with Section 3.2.6 "Minimum Standard 6: Redevelopment and Infill Projects" of the Rhode Island Stormwater Design and Installation Standards Manual (The Manual). This project qualifies as a Redevelopment under The Manual and will be designed to meet the requirements of Minimum Standards 2, 3 and 7-11 of The Manual

A location map is included in the *Appendix A* of this report.

Existing Conditions

The site is located at 1300-1310 Oaklawn Avenue in the City of Cranston, Providence County Rhode Island, 02920 with approximate coordinates of; Latitude 41.7335 North, Longitude 71.4769 West. The site is approximately 1.10 Acres in total size and is bounded by Bateman Avenue to the South, existing commercial and residential to the north, residential to the east, and Oaklawn Avenue to the west. In its current existing conditions, the site is fully developed with an existing one-story masonry commercial building (that served as a grocery store and has recently been demolished) and associated parking lot as noted in *Appendix B* "Existing Drainage Patterns".

As noted on *Appendix B* "Existing Drainage Patterns" The site can be broken down into a single watershed area consisting of 99.54% impervious surface and runoff currently drains undetained in a westerly direction towards Oaklawn Avenue. There do not appear to be any existing storm structures, storm pipe, retention/detention basins, infiltration basins or depressional storage areas on the parcel so the entirety of the site runoff is collected by the existing storm sewer structures along Oaklawn Avenue.

Site Soils

Site soil types were obtained from the NRCS website and verified by geotechnical borings performed by Whitestone Associates, Inc. (WAI) on December 15, 2021. Soil mapping generated from the NRCS website is provided in *Appendix C* and the WAI Geotechnical Report is provided in *Appendix D.* The mapping shows site

soils are comprised of urban land directly on the property with a Paxton-Urban land complex on the neighboring parcels. Urban land is classified as an area where at least 85% of the land is or was covered with asphalt, concrete or impervious building material. This classification is typically designated as a Type C soil site, unless the adjacent soils are of lower quality. Paxton-Urban land complex is also classified as a Type C soil. According to the soil boring logs however, below the reworked soil, topsoil and any fill currently present on site lays loose to medium dense silty sand with some medium sand and traces of fine gravel, this soil classifies as a Type A soil. In order to be conservative and apply the highest level of safety to the design, the more restrictive Type C soil will be used for all calculations.

The following runoff curve numbers were used for the land cover characteristics as noted:

Land Cover	Runoff Curve Number
Roofs	98
Paved Parking	98
Grass Cover, Fair – HSG A	79
Grass Cover, Good – HSG A	70

Rainfall Data

Rainfall design data is per NOAA Atlas 14, Volume 2, Version3. Location Cranston, Rhode Island: Lat: 41.1392, Long: -72.508. Refer to *Appendix E.*

Proposed Improvements

The proposed improvements will consist of a 4,201 gross square foot Car Wash building with a 110' long wash tunnel and associated vacuum parking lot, access drives, pay stations and pervious areas. Stormwater runoff will be collected by a proposed on-site storm sewer system and diverted to a proposed underground infiltration system where it will be detained and the higher frequency storms will be partially infiltrated into the ground along with a controlled release of the less frequent storms into the existing storm sewer system along Oaklawn Avenue, to meet the stormwater requirements.

As noted on *Appendix F* "Proposed Drainage Patterns" the proposed site improvements can be broken down into two separate watershed areas. A portion of the site at the access drive needs to be undetained while the larger overall watershed is captured by the proposed storm sewer and infiltration/detention system.

A comparison of Existing Conditions and Proposed Conditions reveals that under proposed conditions, the sites total impervious area will be reduced from 1.095 acres to 0.722 acres, a 33.91% reduction in impervious surfaces and an overall benefit to the overall watershed.

Hydrologic Analysis

The drainage analysis, including peak flows, for the existing development and proposed conditions was completed using Autodesk Hydraflow Hydrographs Extension Software (Hydraflow). Hydraflow uses TR-55 and TR-20 methodology as developed by the USDA Natural Resources Conservation Services. Runoff Curve Numbers (CN) and Times of Concentration were determined based on the soil types indicated previously, existing and proposed ground cover conditions.

Peak flows for the 1-, 2-, 10-, 25-, 50- and 100-year frequency storm events were determined by using a 24-hour type III storm, standard for the New England area. Existing and proposed hydrologic models are included in *Appendix G*.

Drainage Runoff Summaries:

Existing Conditions

Subarea	Area (ac)	1-year (cfs)	2-year (cfs)	5-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
EX1	1.10	2.766	3.400	4.241	5.081	6.338	7.594	9.058

Proposed Conditions

Subarea	Area (ac)	1-year (cfs)	2-year (cfs)	5-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
PUN1	0.04	0.084	0.108	0.140	0.172	0.219	0.266	0.320
PR1	1.06	2.052	2.688	3.538	4.386	5.649	6.903	8.357
Total	1.10	2.136	2.796	3.678	4.558	5.868	7.169	8.677

As noted on the above chart, the proposed improvements will result in a decrease of site runoff for every storm up to and including the 100-year event and provide a net benefit for the overall watershed.

Soil Erosion Control

Soil Erosion and sedimentation controls will be installed prior to the start of construction. Erosion and sedimentation control (E&S) details and narratives for construction activities are provided on the Site Plans. E&S details and procedures are in accordance with the Rhode Island Department of Environmental Management 'RIDEM" requirements. E&S will be maintained for the duration of the project until disturbed slopes have been fully stabilized.

Rhode Island Stormwater Design and Installation Standards Manual Minimum Standards

The proposed development is considered a redevelopment under Section 3.2.6 "Minimum Standard 6: Redevelopment and Infill Projects" of the Rhode Island Stormwater Design and Installation Standards Manual (The Manual) and has been designed to meet the requirements of Minimum Standards 2, 3 and 7-11 of The Manual

Minimum Standard 1: LID Site Planning and Design Strategies

As required in The Manual, Low Impact Development (LID) measures were considered with the proposed site redevelopment to enhance stormwater quality. The project has been designed to minimize impervious areas to the maximum extent possible. LID measures include:

- Proposed impervious surfaces have been minimized and new pervious areas have been maximized resulting in a 33.91% impervious area reduction from existing conditions.
- During construction, stormwater collection structures indicated on the site plans will be fitted with filter fabric inserts to remove sediments from the stormwater run-off prior to entering the receiving drainage systems.
- The proposed sand filter water quality system will be installed on the site to improve water quality from the parking areas and attenuate peak flows.

Minimum Standard 2: Groundwater Recharge

As noted on the soils report, there is bedrock beneath the existing fill materials. As such it is expected that infiltration methods would be ineffective on this site. As a result of this constraint, no groundwater recharge is possible on this site. It is requested that this criteria be waived for this development.

Minimum Standard 3: Water Quality

Per the RISDISM, the stormwater system is required to treat the impervious areas of the proposed development to provide stormwater runoff quality. Based on the calculations provided in *Appendix* H, as a redevelopment, the project has a required stormwater treatment area of 0.2 acres (8,712 sf). However, the proposed sand filter is designed to provide water quality treatment for the entire 0.732 acres of proposed impervious area. Per the state standard, a total of 2,657 cubic feet of water quality treatment is required. The proposed sand filter provides 2,890 cubic feet of total water quality treatment volume. Pretreatment will be provided by the proposed on-line Contech Cascade Separator Model #CS-4 which is an approved proprietary pre-treatment device as noted on the certification letter included in *Appendix I*.

There are no pollutant-specific requirements and/or pollutant removal efficiencies applicable to the site as the result of SAMP, TMDL or other watershed-specific requirements.

Minimum Standard 7: Pollution Prevention

A Soil Erosion and Sediment Control Plan (SESC) for this development can be found in the plans submitted under separate cover. The SESC contains information for construction pollution prevention.

Minimum Standard 8: Land Uses with High Potential Pollutant Loads (LUHPPI's)

This site is not considered LUHHPL.

Minimum Standard 9: Illicit Discharges

There are no proposed Illicit Discharges on site. The site will be serviced by public water and sewer.

Minimum Standard 10: Construction Activity Soil Erosion, Runoff and Sedimentation and Pollution Prevention Control Measure Requirements

A Soil Erosion and Sediment Control Plan (SESC) for this development can be found in the plans submitted under separate cover. The SESC contains information for construction pollution prevention.

Minimum Standard 11: Stormwater Management System Operation and Maintenance

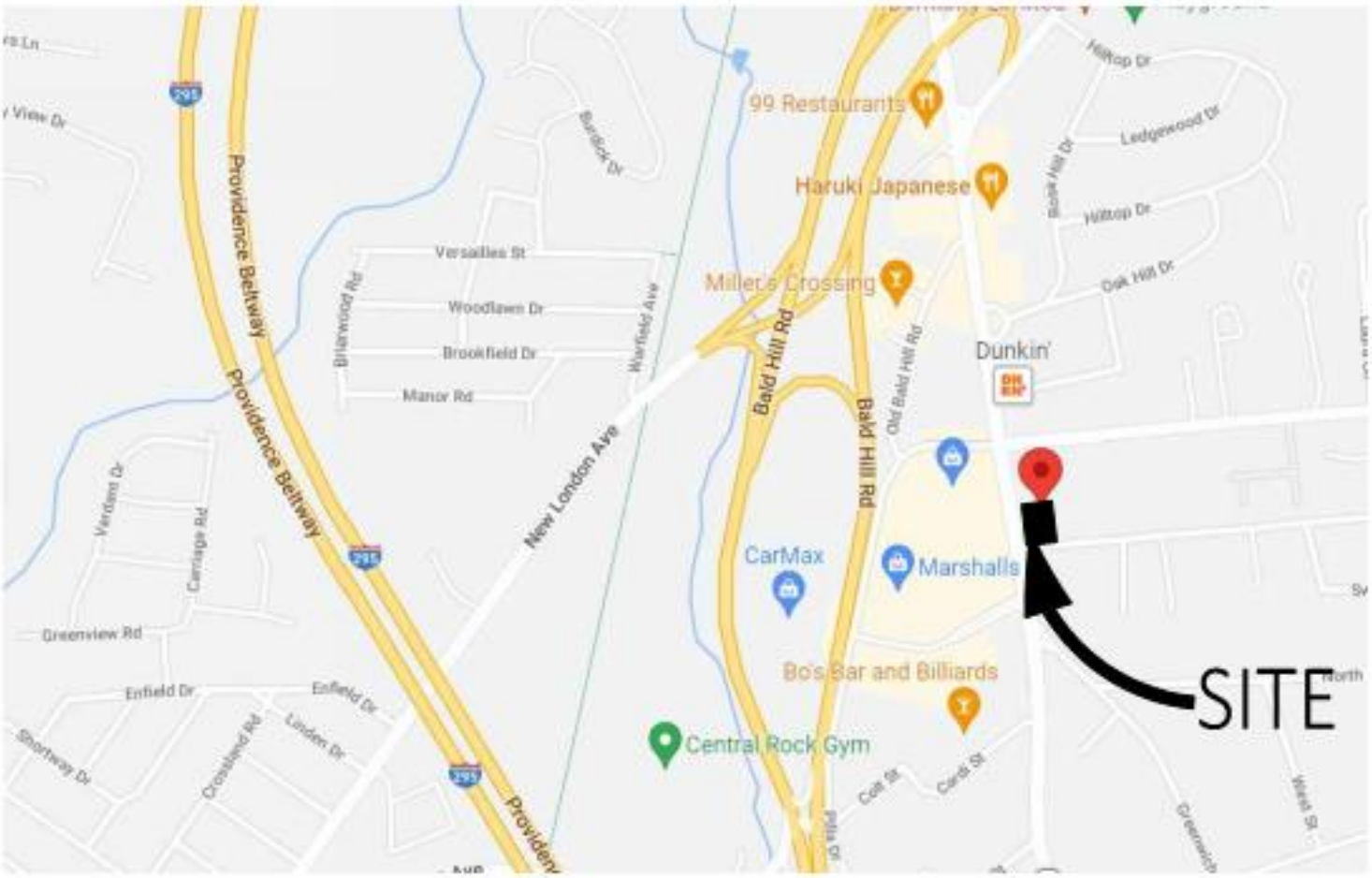
A Stormwater Management System Operation and Maintenance (SWMS O&M) plan will be developed for the development of the site and will be added to this document as soon as the proposed improvements and stormwater management items have been accepted by the authorities having jurisdiction over the proposed development. The owner shall be responsible for construction operation and maintenance of the site.

Conclusion

It is our professional opinion that with the incorporation of the above-mentioned stormwater management methodology, the proposed development plan for this site will be able to adequately manage the runoff across the site in accordance with the current requirements of The Manual and will present no detrimental impacts to the downstream wetlands or to adjacent properties and should be granted approval.

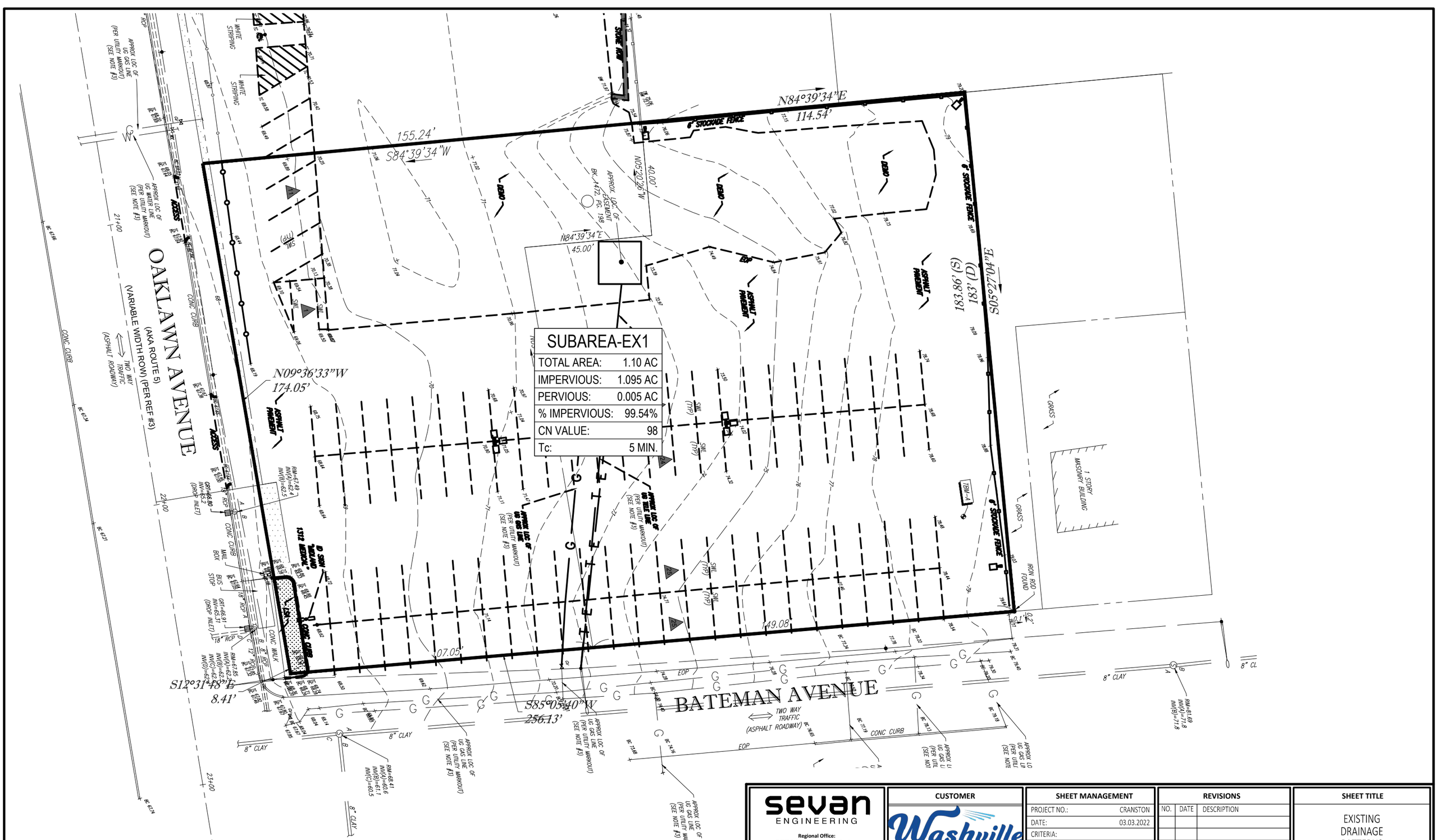
Appendix A

Location Map



Appendix B

Existing Drainage Patterns



N

0 30' 60'

EXISTING DRAINAGE PATTERNS

SCALE: 1" = 30'–0"

sevan ENGINEERING

Regional Office:
37704 Hills Tech Drive
Farmington Hills, MI 48331
734.367.4445 Telephone

Corporate Office:
3025 Highland Parkway, Suite 850
Downers Grove, IL 60515
info@sevansolutions.com www.sevansolutions.com

INTEGRITY | RESPECT | TEAMWORK | EXCELLENCE | CHARITY

CUSTOMER

Washville
Your Hometown Car Wash

PROJECT LOCATION

1300-1310 OAKLAWN AVE.
CRANSTON, RI 02920
(PROVIDENCE COUNTY)

SHEET MANAGEMENT

PROJECT NO.:	CRANSTON
DATE:	03.03.2022
CRITERIA:	
PROJECT MANAGER:	T. KRATZ

REVISIONS

NO.	DATE	DESCRIPTION

SHEET TITLE

EXISTING DRAINAGE PATTERNS

SHEET NUMBER

EDP

Appendix C

NRCS Soils Map and Classification

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

March 3, 2022

Preface

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

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

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

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

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

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

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How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

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

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

Soil Map

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

Custom Soil Resource Report
Soil Map

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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

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

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

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

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

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

Soil Survey Area: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 21, Sep 3, 2021

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

Date(s) aerial images were photographed: May 24, 2020—Jul 18, 2020

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

MAP LEGEND

MAP INFORMATION

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
PD	Paxton-Urban land complex, 3 to 15 percent slopes	0.1	6.6%
Ur	Urban land	1.1	93.4%
Totals for Area of Interest		**1.2**	**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.

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

PD—Paxton-Urban land complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2w67k
Elevation: 0 to 930 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: Not prime farmland

Map Unit Composition

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

Description of Paxton

Setting

Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Ap - 0 to 8 inches: fine sandy loam
Bw1 - 8 to 15 inches: fine sandy loam
Bw2 - 15 to 26 inches: fine sandy loam
Cd - 26 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 39 inches to densic material
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Description of Urban Land

Typical profile

M - 0 to 10 inches: cemented material

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Woodbridge

Percent of map unit: 9 percent
Landform: Ground moraines, hills, drumlins
Landform position (two-dimensional): Backslope, footslope, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Charlton

Percent of map unit: 6 percent
Landform: Hills
Landform position (two-dimensional): Shoulder, backslope, summit
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Udorthents

Percent of map unit: 4 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ridgebury

Percent of map unit: 1 percent
Landform: Drumlins, depressions, ground moraines, hills, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, head slope
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear
Hydric soil rating: Yes

Ur—Urban land

Map Unit Setting

National map unit symbol: 9lxk
Elevation: 0 to 810 feet
Mean annual precipitation: 44 to 50 inches
Mean annual air temperature: 48 to 50 degrees F
Frost-free period: 100 to 211 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Parent material: Human transported material

Minor Components

Udorthents

Percent of map unit: 5 percent
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Pittstown

Percent of map unit: 2 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Charlton

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Canton

Percent of map unit: 2 percent
Landform: Hills
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Sutton

Percent of map unit: 1 percent
Landform: Drainageways, depressions
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: No

Newport

Percent of map unit: 1 percent
Landform: Drumlins
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Sudbury

Percent of map unit: 1 percent
Landform: Terraces, outwash plains
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: No

Merrimac

Percent of map unit: 1 percent
Landform: Terraces, outwash plains, kames
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

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Appendix D

Geotechnical Report by Whitestone Associates, Inc.

WHITESTONE
An Employee-Owned Company

352 TURNPIKE ROAD
SUITE 320
SOUTHBOROUGH, MA 01772
508.485.0755
whitestoneassoc.com

REPORT OF GEOTECHNICAL INVESTIGATION

PROPOSED WASHVILLE CAR WASH
1310 OAKLAWN AVENUE
MAP 15, LOTS 25, 26, & 1481
CRANSTON, PROVIDENCE COUNTY, RHODE ISLAND

Prepared for:

SEVAN MULTI-SITE SOLUTIONS
3025 Highland Parkway
Suite 850
Downers Grove, Illinois 60515

Prepared by:

WHITESTONE ASSOCIATES, INC.
352 Turnpike Road
Suite 320
Southborough, Massachusetts 06067

Richard W.M. McLaren, P.E.
Senior Consultant

Ryan R. Roy, P.E.
Vice President

Whitestone Project No.: GM2118500.000
December 15, 2021

WHITESTONE
An Employee-Owned Company

352 TURNPIKE ROAD
SUITE 320
SOUTHBOROUGH, MA 01772
508.485.0755
whitestoneassoc.com

December 15, 2021

via email

SEVAN MULTI-SITE SOLUTIONS
3025 Highland Parkway
Suite 850
Downers Grove, Illinois 60515

Attention: Mr. Brady Carlucci
Project Manager

Regarding: REPORT OF GEOTECHNICAL INVESTIGATION
PROPOSED WASHVILLE CAR WASH
1310 OAKLAWN AVENUE
MAP 15, LOTS 25, 26, & 1481
CRANSTON, PROVIDENCE COUNTY, RHODE ISLAND
WHITESTONE PROJECT NO.: GM2118500.000

Dear Mr. Carlucci:

Whitestone Associates, Inc. (Whitestone) is pleased to submit the *Report of Geotechnical Investigation* for the above-referenced project. The report presents the results of Whitestone's subsurface exploration and includes design recommendations for the foundations, slab, pavements, and related earthwork associated with the proposed Washville car wash.

Whitestone appreciates the opportunity to be of service to Sevan Multi-Site Solutions. Should you have questions regarding the enclosed report, contact us at (508) 485-0755.

Sincerely,

WHITESTONE ASSOCIATES, INC.

Richard W.M. McLaren, P.E.
Senior Consultant

Ryan R. Roy, P.E.
Vice President

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Enclosures
Copy: Laurence W. Keller, P.E., Whitestone Associates, Inc.
Jeffrey T. Bauer, P.G., Whitestone Associates, Inc.

REPORT OF
GEOTECHNICAL INVESTIGATION
PROPOSED WASHVILLE CAR WASH
1310 Oaklawn Avenue
Map 15, Lots 25, 26, & 1481
Cranston, Providence County, Rhode Island

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REPORT OF
GEOTECHNICAL INVESTIGATION
PROPOSED WASHVILLE CAR WASH
1310 Oaklawn Avenue
Map 15, Lots 25, 26, & 1481
Cranston, Providence County, Rhode Island

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APPENDICES

SECTION 1.0
Summary of Findings

Whitestone has completed an exploration and evaluation of the subsurface conditions at the site of the proposed Washville car wash located at 1310 Oaklawn Avenue in the City of Cranston, Providence County, Rhode Island. Based on a September 27, 2021 (last revised) *Concept Site Plan Option 1* prepared by Sevan Engineering (Sevan) of Downers Grove, Illinois, the project consists of the demolition of the existing buildings (in progress) and the construction of a car wash with a footprint of 3,498-square feet within the southern portion of the site. The proposed building will be constructed close to existing site grade to match the adjacent roadway. No stormwater detention systems or new retaining walls are shown on the *Concept Site Plan Option 1*.

The geotechnical investigation included conducting a reconnaissance of the project site, advancing six soil borings, and collecting soil samples for laboratory testing and characterization. Site subsurface conditions consisted of asphaltic concrete overlying existing fill, which is generally underlain by a natural kame terrace deposit, in turn underlain by relatively shallow bedrock. Static groundwater was not encountered in the explorations during field activities. However, perched/trapped water is likely to be encountered above non-permeable strata, such as the bedrock surface, after rain events or during snow melt. Construction phase dewatering should be expected.

The results of the investigation indicate that the proposed structure may be supported on conventional spread footings designed to bear on the natural kame terrace deposit or structural fill placed over the kame terrace deposit or to bear on a layer of crushed stone placed over the bedrock. Existing fill was generally encountered to depths of 2.5 feet below ground surface (fbgs) to four fbgs, however, the existing fill extended to a depth of 7.5 fbgs in one boring. In addition, existing fill associated with on-going building demolition should be expected during construction. Slabs may be supported on the properly inspected and approved existing fill and/or structural fill placed over these materials. Weathered rock and bedrock were encountered at shallow depths below the ground surface that will present excavation difficulties, foundations, utilities, and similar excavations. Additionally, the site conditions support the use of typical pavement sections using standard Rhode Island Department of Transportation (RIDOT) specified materials.

The above summary is intended to provide an overview of the geotechnical findings and recommendations and is not fully developed. Greater detail is presented in the following sections. The entire report must be read for comprehensive understanding of the information contained herein.

SECTION 2.0
Introduction

2.1 AUTHORIZATION

Mr. Brady Carlucci, Project Manager at Sevan Multi-Site Solutions, issued authorization to Whitestone to conduct a geotechnical investigation on this site relevant to the construction of a proposed Washville car wash located at 1310 Oaklawn Avenue in the City of Cranston, Providence County, Rhode Island. The geotechnical investigation was conducted in general accordance with Whitestone's October 8, 2021 proposal.

2.2 PURPOSE

The purpose of this exploration and analysis was to:

- ascertain the various soil profile components at test locations;
- estimate the engineering characteristics of the proposed foundation bearing and subgrade materials;
- provide geotechnical criteria for use by the design engineers in preparing the foundation, slab, and pavement design;
- provide recommendations for required earthwork and subgrade preparation;
- record groundwater levels (if encountered) at the time of the investigation and discuss the potential impact on the proposed construction; and
- recommend additional investigation and/or analysis, if warranted.

2.3 SCOPE

The scope of the exploration and analysis included the subsurface exploration, field testing and sampling, laboratory testing, evaluation of the subsurface materials, and a geotechnical engineering analysis. This *Report of Geotechnical Investigation* is limited to addressing the site conditions related to the physical support of the proposed construction.

2.3.1 Field Exploration

Field exploration of the project site was conducted by means of six soil borings, identified as B-1 through B-6, advanced with a truck-mounted CME 55 drill rig equipped with hollow stem augers to termination depths that ranged from approximately 6.3 fbgs to 12.5 fbgs. Soil borings were backfilled with excavated

soils generated from the investigation and the surface patched with "cold patch" asphalt. The *Records of Subsurface Exploration* for the borings are included in Appendix A. Test locations are shown on the *Boring Location Plan* included as Figure 1.

Test locations were based on project information provided to Whitestone at the time of the investigation, including the September 28, 2021 (last revised) *Concept Site Plan Option 1* prepared by Sevan. The subsurface tests were conducted in the presence of a Whitestone field engineer, who conducted field tests, recorded visual classifications, and collected samples of the various strata encountered. Test locations were established in the field using normal taping procedures and estimated right angles. These locations are presumed to be accurate to the degree implied by the method used.

Soil borings and Standard Penetration Tests (SPTs) were conducted in general accordance with ASTM International (ASTM) designation D1586. The Standard Penetration Resistance value (N) can be used as an indicator of the consistency of fine-grained soils and the relative density of coarse-grained soils. The N-value for various soil types can be correlated with the engineering behavior of earthworks and foundations. Rock was cored using a NQ2-sized diamond bit. The rock core description, recovery, RQD, and other pertinent information were recorded on the boring log and are included in Appendix A on the *Records of Subsurface Exploration*. The RQD value reflects the quality and fracture spacing of the rock and is calculated by summing all unbroken samples that are four inches or longer divided by the total length of the run. The percentage of core recovery and RQD value provide an understanding of the physical and engineering properties of the rock.

Groundwater level observations, where encountered, were recorded during and immediately following the completion of the testing operations within the soil borings. Seasonal variations, temperature effects, and recent rainfall conditions may influence the levels of the groundwater, and the observed levels will depend on the permeability of the soils. Groundwater elevations derived from sources other than seasonally observed groundwater monitoring wells may not be representative of true groundwater levels.

2.3.2 Laboratory Testing

In addition to the field investigation, laboratory testing was conducted to determine additional, pertinent engineering characteristics of representative samples of on-site soils. The laboratory testing was conducted in general accordance with applicable ASTM standard test methods and included physical testing of the existing fill and kame terrace deposit.

Physical/Textural Analysis: Two representative samples of the site soils were subjected to laboratory testing that included moisture content determination (ASTM D2216) and washed gradation analyses (ASTM D422) in order to conduct supplementary engineering soil classifications and/or to assess possible re-use of the site soils as structural fill. The results of the laboratory testing are summarized in the following table:

LABORATORY TESTING SUMMARY					
Boring	**Sample Number**	**Depth (fbgs)**	**Moisture Content (%)**	**Passing No. 200 Sieve (%)**	**USCS Classification**
B-1	S-1	1.0 - 3.0	6.4	18.2	FILL (SM)
B-3	S-2	3.0 - 5.0	8.8	21.5	SM

The engineering classifications are useful when considered in conjunction with the additional site data to estimate properties of the soil types encountered and to predict soil behavior under construction and service loads. Laboratory test results are provided in Appendix B.

SECTION 3.0
Site Description

3.1 LOCATION AND DESCRIPTION

The subject site is located at 1310 Oaklawn Avenue in the City of Cranston, Providence County, Rhode Island, Latitude 41.7333 North, Longitude 71.4769 West. The approximately 2-acre property, which is identified further as Map 15, Lots 25, 26, and 1481, is developed with a former supermarket and a medical office building. The proposed car wash will occupy the southern approximately 1.2-acre portion of the property.

The irregularly shaped site is bounded to the west by Oaklawn Avenue, to the north by Mayfield Avenue, to the east by residences, and to the south by Bateman Avenue. Access to the site is from Oaklawn Avenue and Bateman Avenue. The site of the proposed construction is shown on the *Boring Location Plan* included as Figure 1.

3.2 EXISTING CONDITIONS

Existing Development: The subject site is developed with a former *Phred's* supermarket and a medical office building, both of which were being demolished during Whitestone's exploration.

Topography: Based on a review of the *USGS 7.5 Minute Series East Greenwich, Rhode Island, Quadrangle* (2021) and Whitestone's visual observations, the site slopes down to the west from approximately elevation 80 feet above National American Vertical Datum of 1988 (NAVD) to 70 feet above NAVD.

Utilities: The site is serviced by electrical, gas, and telecommunication utilities. The site is connected to municipal water and sewer. The utility information contained in this report is presented for general discussion only and is not intended for construction purposes.

Site Drainage: Surface run-off will generally flow over paved areas to catch basins, which are presumed to connect with the municipal storm sewer system.

3.3 SITE GEOLOGY

From a review of the *Geologic Map of the East Greenwich Quadrangle, Rhode Island - Surficial Geology (1955)*, the site is underlain by a kame terrace deposit. The mapped boundary with glacial till is at the eastern edge of the site. The *Bedrock Geologic Map of Rhode Island (1994)* indicates that the subject property is underlain by the Pennsylvanian-age Narragansett Bay Group - Rhode Island Formation, consisting of quartz arenite, litharenite, shale, and conglomerate with incidental anthracite, part of Esmond-Dedham Subterrane.

3.4 PROPOSED CONSTRUCTION

Based on the aforementioned Sevan *Concept Site Plan Option 1*, the project consists of demolition of the existing structures and the construction of a car wash with a footprint of 3,843 square feet within the southern portion of the site. The proposed building will be constructed close to existing site grade to match the adjacent roadways. No stormwater detention systems or new retaining walls are shown on the *Concept Site Plan Option 1*.

Whitestone anticipates the proposed building will be a single-story, masonry and metal-framed structure constructed with a ground-supported concrete slab and a crawl space for piping. Maximum wall and floor loads are expected to be on the order of:

- load bearing walls - two kips per linear foot; and
- slab - 150 pounds per square foot.

The scope of Whitestone's investigation and the professional advice contained in this report were generated based on the project details and loading noted herein. Revisions or additions to the design details enumerated in this report should be brought to the attention of Whitestone for additional evaluation as warranted.

SECTION 4.0
Subsurface Conditions

Details of the subsurface materials encountered are presented on the *Records of Subsurface Exploration* presented in Appendix A of this report. The subsurface soil conditions encountered in the test locations consisted of the following generalized strata in order of increasing depth.

4.1 SUBSURFACE SOIL CONDITIONS

Surface Cover Materials: The borings encountered two inches to three inches of asphaltic concrete at the ground surface with no apparent granular base.

Existing Fill: Beneath the surface cover materials, the borings encountered existing fill, consisting of brown to dark brown to gray, loose (occasionally very loose, medium dense or very dense), silty sand with gravel to sandy silt, asphalt and brick pieces. SPT N-values recorded within the existing fill were variable, ranging from three blows per foot (bpf) to 76 bpf. The existing fill extended to depths of 2.5 fbgs to 7.5 fbgs.

Kame Terrace Deposit: Beneath the existing fill, the borings, except B-1 and B-2, encountered a kame terrace deposit, consisting of brown, medium dense (occasionally loose or dense), silty sand to silty sand with gravel (USCS: SM). SPT N-values recorded within the kame terrace deposit were variable, ranging from six bpf to 49 bpf. Where encountered, the kame terrace deposit extended to depths of 5.5 fbgs to 12.5 fbgs.

Weathered Bedrock and Bedrock: Beneath the kame terrace deposit or existing fill, borings B-2, B-3, B-5, and B-6 encountered highly weathered bedrock at depths ranging from 2.5 fbgs to 8.8 fbgs, which has weathered to a soil-like consistency. Boring B-5 was terminated in the highly weathered bedrock at a depth of nine fbgs. The borings, except B-5, encountered auger refusal on more competent bedrock at depths ranging from four fbgs to 12.5 fbgs. The bedrock, which was cored in boring B-1 from four fbgs to nine fbgs, consisted of light gray, slightly weathered, medium grained, widely fractured, hard, quartz arenite bedrock. Rock core recovery was 92 percent. The RQD value was 78 percent, indicating "good" rock quality, however, the RQD value for the lower half of the core was 100 percent, indicating "very good" rock quality.

4.2 GROUNDWATER

Groundwater was not encountered in the borings during Whitestone's subsurface exploration activities. However, perched water should be expected above the weathered bedrock or more competent bedrock surface after rain events and during snow melt. Static and perched/trapped water conditions generally will fluctuate seasonally and following periods of precipitation.

SECTION 5.0
Conclusions and Recommendations

5.1 GENERAL

The results of the investigation indicate that the proposed structure may be supported on conventional spread footings designed to bear on the natural kame terrace deposit or structural fill placed over the kame terrace deposit or to bear on a layer of crushed stone placed over the bedrock. Existing fill was generally encountered to depths of 2.5 fbgs to four fbgs, however, the existing fill extended to a depth of 7.5 fbgs in one boring. In addition, existing fill associated with the buildings being demolished should be expected during construction. Deeper fill may also be encountered during construction between the widely spaced borings. Weathered rock and bedrock were encountered at shallow depths below the ground surface that will present excavation difficulties. The results also indicate that the site is suitable for a ground-supported slab bearing on the compacted, approved, and improved existing fill and/or structural fill. Additionally, the site conditions support the use of typical pavement sections using standard RIDOT specified materials.

5.2 SITE PREPARATION AND EARTHWORK

Surface Cover Stripping and Demolition: Prior to stripping operations, utilities should be identified and secured. The existing building foundations and pavements to be demolished and stripped should be removed from within and at least five feet beyond the limits of the proposed building and pavement areas. Given the size of the site and the configuration of the proposed and existing buildings, existing structural elements, such as foundation walls, and concrete foundations, walls or slabs encountered during excavations, should be removed entirely. Topsoil, organic subsoil, vegetation, trees, shrubs, and other organic matter should also be removed from within and at least five feet beyond the limits of the proposed building footprint and other site structures, as well as any other area that will require controlled structural fill placement. Tree/shrub removal should include the removal of stumps and root material. Root structures will require removal in excess of the few inches of topsoil typically encountered at the ground surface. The demolition contractor should be required to conduct earthwork in accordance with the recommendations in this report, including backfilling any excavation, etc. with structural fill. Fill or backfill placed within the proposed building area during demolition operations should be placed as structural fill in accordance with Section 5.2, 5.3, and 5.11 of this report.

Excavation Difficulties: The relatively shallow bedrock will likely present excavation difficulties at shallow depths below the ground surface during proposed site excavations. Weathered bedrock was encountered as shallow as 2.5 fbgs. Excavation difficulties will be affected by excavation size and depth. The speed and ease of excavation also will depend on the type of equipment used and the skill of the operator. Although excavation of some of the weathered bedrock close to the bedrock surface may be feasible with a large excavator. A “hoe-ram” or other mechanical device will be required to loosen up weathered and fractured rock to facilitate excavation.

Surface Preparation/Proofrolling: Prior to placing fill or base materials to raise or restore grades to the desired subgrade elevations, the existing exposed soils should be compacted to a firm surface with several passes in two perpendicular directions of a minimum 10-ton vibratory roller. The surface should then be proofrolled with a loaded tandem axle truck in the presence of the geotechnical engineer to help identify soft or loose pockets that may require removal and replacement or further investigation. Proofrolling should be conducted after a suitable period of dry and non-freezing weather to reduce the likelihood of degrading an otherwise stable subgrade. If construction is started during the winter months, Whitestone should be contacted for alternate surface preparation procedures. Fill or backfill should be placed and compacted in accordance with Section 5.3.

Bedrock Foundation Subgrade Preparation: If excavations extend below the bedrock surface, bedrock slopes should not be steeper than 4:1 (horizontal:vertical). Bedrock steeper than 4:1 (horizontal:vertical) should be stepped. Loose bedrock should be removed from the subgrade prior to placement of crushed stone. Bedrock fractures and joints should be tight. Bedrock joints, fractures, or fissures greater than 0.5-inch in width should be filled with lean concrete. Only minus ⅜-inch crushed stone should be placed directly over the bedrock. Structural fill (sand and gravel) should not be placed directly on the bedrock surface to reduce the likelihood of migration of fines into the bedrock.

Weather Performance Criteria: The site soils are moisture sensitive and will soften when exposed to water. Every effort should be made to maintain drainage of surface water runoff away from construction areas by grading and limiting the exposure of excavations and prepared subgrades to precipitation. Accordingly, excavation and fill placement procedures should be conducted during favorable weather conditions. Overexcavation of saturated soils and replacement with controlled structural fill per Section 5.3 of this report may be required prior to resuming work on disturbed subgrade soils.

Subgrade Protection and Maintenance: The site soils are moisture sensitive and will degrade if exposed to inclement weather, freeze-thaw cycles, or repeated construction traffic. However, if properly protected and maintained as recommended herein, the site soils will provide adequate support for the proposed pavement. The site contractors should employ appropriate means and methods to protect the subgrade including, but not limited to the following:

- sealing exposed subgrade soils on a daily basis with a smooth drum roller operated in static mode;
- regrading the site as needed to maintain positive drainage away from open earthwork construction areas and to prevent standing water;
- removing wet surficial soils and ruts immediately; and
- limiting exposure to construction traffic and precipitation especially following inclement weather and subgrade thawing.

5.3 STRUCTURAL FILL AND BACKFILL

Imported Fill Material: Imported material placed as structural fill or backfill to raise elevations or restore design grades should consist of clean, relatively well graded sand or gravel with a maximum particle size of three inches and up to 15 percent of material finer than a #200 sieve. Imported material to place directly over the bedrock should be clean, minus ⅜-inch crushed stone. Material brought to site should be free of silt, clay, organics, and deleterious material.

On-Site Material/Reuse: Whitestone anticipates that portions of the existing fill and kame terrace deposit will be suitable for selective reuse as structural fill/backfill material, provided that soil moisture contents are controlled within three percent of optimum moisture level, particles larger than three inches in diameter are either removed or crushed, and objectionable portions, such as debris and organics if encountered, are segregated. The site soils have a relatively high fines content. Prior to reuse, drying will likely be necessary and/or mixing with more granular materials. In addition, reuse should not be attempted during inclement weather or in damp conditions. Reuse of the site soils will be contingent on careful review in the field by the owner's geotechnical engineer by visual observation during construction as recommended herein.

Compaction and Placement Requirements: Fill and backfill should be placed in maximum 8-inch loose lifts and compacted using a vibratory drum roller during mass grading activities or a small hand-held vibratory compactor within excavations. Structural fill and backfill should be compacted to at least 95 percent of the maximum dry density within three percent of the optimum moisture content, as determined by ASTM D1557 (Modified Proctor).

Structural Fill Testing: A sample of the imported fill material or on-site material proposed for re-use as structural fill or backfill should be submitted to the owner's geotechnical engineer for analysis and approval at least one week prior to its use. The placement of fill and backfill should be monitored by a qualified engineering technician, so that the specified material and lift thicknesses are properly installed. A sufficient number of in-place density tests should be conducted to check that the specified compaction is achieved throughout the height of the fill or backfill.

5.4 GROUNDWATER CONTROL

Static groundwater was not encountered during this investigation. However, perched/trapped water will likely be encountered above non-permeable strata, such as the bedrock surface, during construction. As such, construction phase dewatering should be expected and will consist of removing surface water runoff, infiltrating (perched) water, or trapped water. Whitestone anticipates that construction phase dewatering would include installing temporary sump pits and pumps within trenches and excavations.

Proper grading and drainage should be incorporated into the site design and construction phase grading to discourage ponding of surface runoff. Every effort should be made to maintain drainage of surface run-off away from construction areas by grading. The contractor should limit exposure of excavations and prepared subgrades to rainfall. Overexcavation of wet soils and replacement with controlled structural fill per Section 5.3 of this report may be required prior to resuming work on disturbed subgrade soils.

5.5 FOUNDATIONS

Shallow Foundation Design Criteria: Whitestone recommends that the proposed structure be supported on conventional spread and continuous wall footings designed to bear on the natural kame terrace deposit, after thorough surface compaction, or structural fill placed on the kame terrace deposit, or to bear on a minimum 12-inch thick layer of ⅜-inch crushed stone placed on the bedrock, provided these materials are properly evaluated, placed, and compacted in accordance with Sections 5.2, 5.3, and 5.11 of this report. Existing fill was generally encountered to depths of 2.5 fbgs to four fbgs, however, the fill extended to a depth of 7.5 fbgs in one boring. In addition, existing fill associated with buildings demolition should be expected during construction. Deeper fill may also be encountered during construction between the widely spaced borings. Following in-trench compaction of foundation subgrades, foundations bearing within these materials may be designed to impart a maximum net allowable bearing pressure of 3,000 pounds per square foot.

Foundation subgrades should be compacted in the presence of the geotechnical engineer to densify loose upper soils and disturbed soils. Regardless of loading conditions, new foundations should be sized no less than minimum dimensions of 24 inches for continuous wall footings and 36 inches for isolated column footings.

Footings should be designed so that the maximum toe pressure due to the combined effect of vertical loads (including soil weight) and overturning moment does not exceed the recommended maximum allowable bearing pressure. In addition, positive contact pressure should be maintained throughout the base of the footings, such that no uplift or tension exists between the base of the footings and the supporting soil. Uplift loads should be resisted by the weight of the concrete footing and the weight of the soil above the footing. Side friction should be neglected when proportioning the footings, so that lateral resistance is provided by friction resistance at the base of the footings. A coefficient of friction against sliding of 0.4 is recommended for use in the design of the foundations bearing within the site soils or imported structural fill.

Foundation Inspection/Overexcavation Criteria: Whitestone recommends that the suitability of the bearing materials along new footing bottoms be reviewed by a Whitestone geotechnical engineer prior to placing concrete for the footings. Following review by the owner's geotechnical engineer, the exposed subgrade may be compacted. Special attention should be given to areas of the site underlain by any soft/loose conditions. In the event that isolated areas of unsuitable materials are encountered in footing excavations, overexcavation and replacement of the materials or deeper foundation embedment may be

necessary to provide a suitable footing subgrade. Overexcavation to be restored with structural fill will need to extend at least one foot laterally beyond footing edges for each vertical foot of overexcavation. Lateral overexcavation may be eliminated if grade is restored with lean concrete.

Settlement: Whitestone estimates post-construction settlements of building foundations will be on the order of less than one inch, if the recommendations outlined in this report are properly implemented. Differential settlements of building foundations should be less than ½ inch.

Frost Coverage: Footings subject to frost action should be placed at least 40 inches below adjacent exterior grades, in accordance with the *Rhode Island State Building Code* for Cranston east of Interstate 295, to provide protection from frost penetration. Interior footings not subject to frost action may be placed at a minimum depth of 18 inches below the slab subgrade, but should not be placed on existing fill.

5.6 SLABS

Following surficial compaction and proofrolling to densify any upper loose zones, Whitestone anticipates that inspected, approved, and improved existing fill and/or compacted structural fill will be suitable for support of proposed ground-supported concrete slabs provided these materials are properly compacted and proofrolled in accordance with Sections 5.2, 5.3, and 5.11 of this report during favorable weather conditions. Areas of overexcavation should be anticipated if the subgrades are exposed to precipitation. Areas of soil that are, or become, softened or disturbed as a result of wetting and/or repeated exposure to construction traffic should be removed and replaced with compacted structural fill. The properly prepared on-site soils are expected to yield a minimum subgrade modulus (k) of 150 psi/in.

A minimum 12-inch thick layer of RIDOT *304.02 Select Leveling & Filler Aggregate* (or approved equivalent) should be placed below slabs to provide a uniform granular base. If a slab has a moisture-sensitive covering and/or supports moisture-sensitive equipment, a moisture vapor barrier should be installed beneath the slab in accordance with flooring manufacturer's recommendations.

5.7 PAVEMENT DESIGN CRITERIA

General: Whitestone anticipates that the properly inspected, approved, and improved existing fill and/or compacted structural fill and/or backfill placed to raise or restore design elevations will be suitable for the support of the proposed pavements, provided these materials are properly evaluated, compacted, and proofrolled in accordance with Sections 5.2, 5.3, and 5.11 of this report during favorable weather conditions.

Design Criteria: A California Bearing Ratio value of 8.0 has been assigned to the properly prepared subgrade soils for pavement design purposes. This value was correlated with pertinent soil support values and assumed traffic loads to prepare flexible and rigid pavement designs per the AASHTO *Guide for the Design of Pavement Structures*.

Design traffic loads were assumed based on typical volumes for similar facilities and correlated with 18-kip equivalent single axle loads (ESAL) for a 20-year life. Estimated maximum pavement loads of 15,000 ESALs and 75,000 ESALs were used for the standard-duty and heavy-duty pavement areas, respectively. These values assume the pavements primarily will accommodate both automobile and limited heavier truck traffic, with the heavier truck traffic designated to the main drive lanes. Actual loading experienced is anticipated to be less than these values.

Pavement Sections: Pavement components should meet material specifications from RIDOT *Standard Specifications* specified below. The recommended flexible pavement sections are tabulated below:

FLEXIBLE PAVEMENT SECTION			
Layer	**Material**	**Standard-Duty Thickness (inches)**	**Heavy-Duty Thickness (inches)**
Asphalt Surface Course	RIDOT M.03.02 Class I-1; PG 64-28	1.5	1.5
Asphalt Binder Course	RIDOT M.03.02 Binder Course; PG 64-28	1.5	2.5
Granular Base	RIDOT 304.02 Select Leveling & Filler Aggregate	6.0	6.0
Granular Subbase	RIDOT M.01.02.1 Bank Run or Plant-Processed Sand and Gravel; M.01.09, Table I, Column Ia	6.0	6.0

A rigid concrete pavement should be used to provide suitable support at areas of high traffic or severe turns, such as ingress/egress locations and at the trash enclosure. The recommended rigid pavement is tabulated below:

RIGID PAVEMENT SECTION		
Layer	**Material**	**Thickness (inches)**
Surface	4,000 psi Air-Entrained Concrete	6.0
Granular Base	RIDOT 304.02 Select Leveling & Filler Aggregate	6.0
Granular Subbase	RIDOT M.01.02.1 Bank Run or Plant-Processed Sand and Gravel; M.01.09, Table I, Column Ia	6.0

[1] The outer edges of concrete pavements are susceptible to damage as trucks move from rigid pavement to adjacent flexible pavement. Therefore, the thickness at the outer two feet of the rigid concrete pavement should be 12 inches. The concrete should be reinforced with at least one layer of six-inch by six-inch W5.4/W5.4 welded wire fabric (ASTM A185).

Additional Design Considerations: The pavement section thickness designs presented in this report are based on the design parameters detailed herein and are contingent on proper construction, inspection, and maintenance. Additional pavement thickness may be required by local code. The designs are contingent on achieving the minimum soil support value in the field. To accomplish this requirement, subgrade soil and supporting fill or backfill must be placed, compacted, and evaluated in accordance with Sections 5.2, 5.3, and 5.11 of this report. Proper drainage should be provided for the pavement structure, including appropriate grading and surface water control.

The performance of the pavement also will depend on the quality of materials and workmanship. Whitestone recommends that RIDOT standards for materials, workmanship, and maintenance be applied to this site. Project specifications should include verifying that the installed asphaltic concrete material composition is within tolerance for the specified materials and that the percentage of air voids of the installed pavement is within specified ranges for the respective materials. Rigid concrete pavements should be suitably air-entrained, jointed, and reinforced in general accordance with ACI 330R-08 *Guide for the Design and Construction of Concrete Parking Lots*.

5.8 RETAINING WALLS/LATERAL EARTH PRESSURES

General: The following parameters may be used for design of any below-grade walls, retaining walls, and other structures reliant on granular materials to provide adequate drainage.

Lateral Earth Pressures: Retaining/below-grade walls should be capable of withstanding active and at-rest earth pressures. With an active earth pressure coefficient (K_a) of 0.33, a level backfill, and an assumed maximum backfill soil unit weight of 140 pounds per cubic foot (pcf), an equivalent fluid pressure of 46 psf per foot of wall height should be used in design of retaining/below-grade walls which are free to rotate.

Retaining/below-grade walls and wall corners that are restrained from lateral movement should be designed using at-rest earth pressures. A coefficient of at-rest earth pressure (K_o) of 0.5, for a level backfill, is recommended for retaining/below-grade walls designed to resist at-rest earth pressures, which assume no lateral movement. With an assumed maximum total unit weight of backfill of approximately 140 pcf, an equivalent fluid pressure of 70 pounds per square foot per foot of wall height should be used in design of restrained retaining/below-grade wall and wall corners. A coefficient of friction of 0.4 against sliding can be used for concrete on the existing site soils. Additional lateral earth pressures from a sloped backfill or any temporary or long-term surcharge loads also should be included in the design. Retaining wall design should include a global stability analysis.

Backfill Criteria: Whitestone recommends that granular soils be used to backfill behind retaining walls. The granular backfill materials should consist of clean, relatively well graded sand or gravel.

Whitestone recommends that backfill directly behind any walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within a zone of influence measured at a 45-degree angle from the base of the walls during backfilling to avoid developing excessive temporary or long-term lateral soil pressures.

Positive drainage should be provided at the base of the below-grade walls. Where wall drainage is not provided, the wall should be designed to withstand full hydrostatic pressure.

Whitestone should be notified if any other retaining structures or design considerations requiring lateral earth pressure estimations are proposed. Specific recommendations for temporary retaining structures are beyond Whitestone's scope of work.

5.9 SEISMIC AND LIQUEFACTION CONSIDERATIONS

The subsurface conditions are most consistent with a Site Class C, as defined by the *Rhode Island State Building Code*. The site soils are not susceptible to earthquake induced liquefaction.

5.10 EXCAVATIONS

The existing fill, kame terrace deposit, and highly weathered bedrock encountered during this investigation typically are, at a minimum, consistent with Type C Soil Conditions as defined by 29 CFR Part 1926 (OSHA) that require a maximum unbraced excavation angle of 1.5:1 (horizontal: vertical). Actual conditions encountered during construction should be evaluated by a competent person (as defined by OSHA), so that safe excavation methods and/or shoring and bracing requirements are implemented. Competent bedrock may be excavated at an angle of 1:6 (horizontal:vertical). A steeper temporary excavation angle in the bedrock may be feasible, if the exposed bedrock is reviewed by a professional engineer or geologist.

5.11 SUPPLEMENTAL POST INVESTIGATION SERVICES

Construction Phase Evaluation of Inaccessible Areas and Existing Fill: Portions of the proposed building footprint were inaccessible during Whitestone's subsurface investigation because of the presence of the existing buildings. Whitestone recommends further reviewing the condition of the site soils for floor slab and pavement support, and/or re-use as structural fill by means of supplemental test pit evaluation following removal of the buildings and either prior to or during the early stages of construction, as discussed further herein, to identify areas requiring removal and possible uncontrolled conditions or deleterious materials not disclosed by the soil borings conducted during this exploration.

Demolition and Construction Inspection and Monitoring: The owner's geotechnical engineer with specific knowledge of the site subsurface conditions and design intent should conduct inspection, testing, and consultation during demolition and construction as described in previous sections of this report. Monitoring and testing should also be conducted to confirm that the former building foundations are removed and properly backfilled, any other encountered underground structures are removed and properly backfilled, the existing surface cover materials are properly removed, and suitable materials, used for controlled fill, are properly placed and compacted over suitable subgrade soils. Proofrolling of all subgrades prior to foundation, slab and pavement support should be witnessed and documented by the owner's geotechnical engineer.

SECTION 6.0
General Comments

Supplemental recommendations may be required upon finalization of construction plans or if significant changes are made in the characteristics or location of the proposed structure. Soil bearing conditions should be checked at the appropriate time for consistency with those conditions encountered during Whitestone's geotechnical investigation.

The recommendations presented herein should be utilized by a qualified engineer in preparing the project plans and specifications. The engineer should consider these recommendations as minimum physical standards which may be superseded by local and regional building codes and structural considerations. These recommendations are prepared for the sole use of Sevan Multi-Site Solutions for the specific project detailed and should not be used by any third party. These recommendations are relevant to the design phase and should not be substituted for construction specifications.

The possibility exists that conditions between borings may differ from those at specific test locations, and conditions may not be as anticipated by the designers or contractors. In addition, the construction process may alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered.

Whitestone assumes that a qualified contractor will be employed to conduct the construction work, and that the contractor will be required to exercise care to ensure all excavations are conducted in accordance with applicable regulations and good practice. Particular attention should be paid to avoiding damaging or undermining adjacent properties and maintaining slope stability.

Whitestone recommends that the services of the geotechnical engineer be engaged to test and evaluate the soils in the footing excavations prior to concreting in order to determine that the soils will support the bearing capacities. Monitoring and testing also should be conducted to verify that suitable materials are used for controlled fills and that they are properly placed and compacted over suitable subgrade soils.

The exploration and analysis of the foundation conditions reported herein are considered sufficient in detail and scope to form a reasonable basis for the foundation design. The recommendations submitted for the proposed construction are based on the available soil information and the design details furnished by Sevan Multi-Site Solutions. Deviations from the noted subsurface conditions encountered during construction should be brought to the attention of the geotechnical engineer.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been promulgated after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics, and engineering geology. No other warranties, express or implied, are made.

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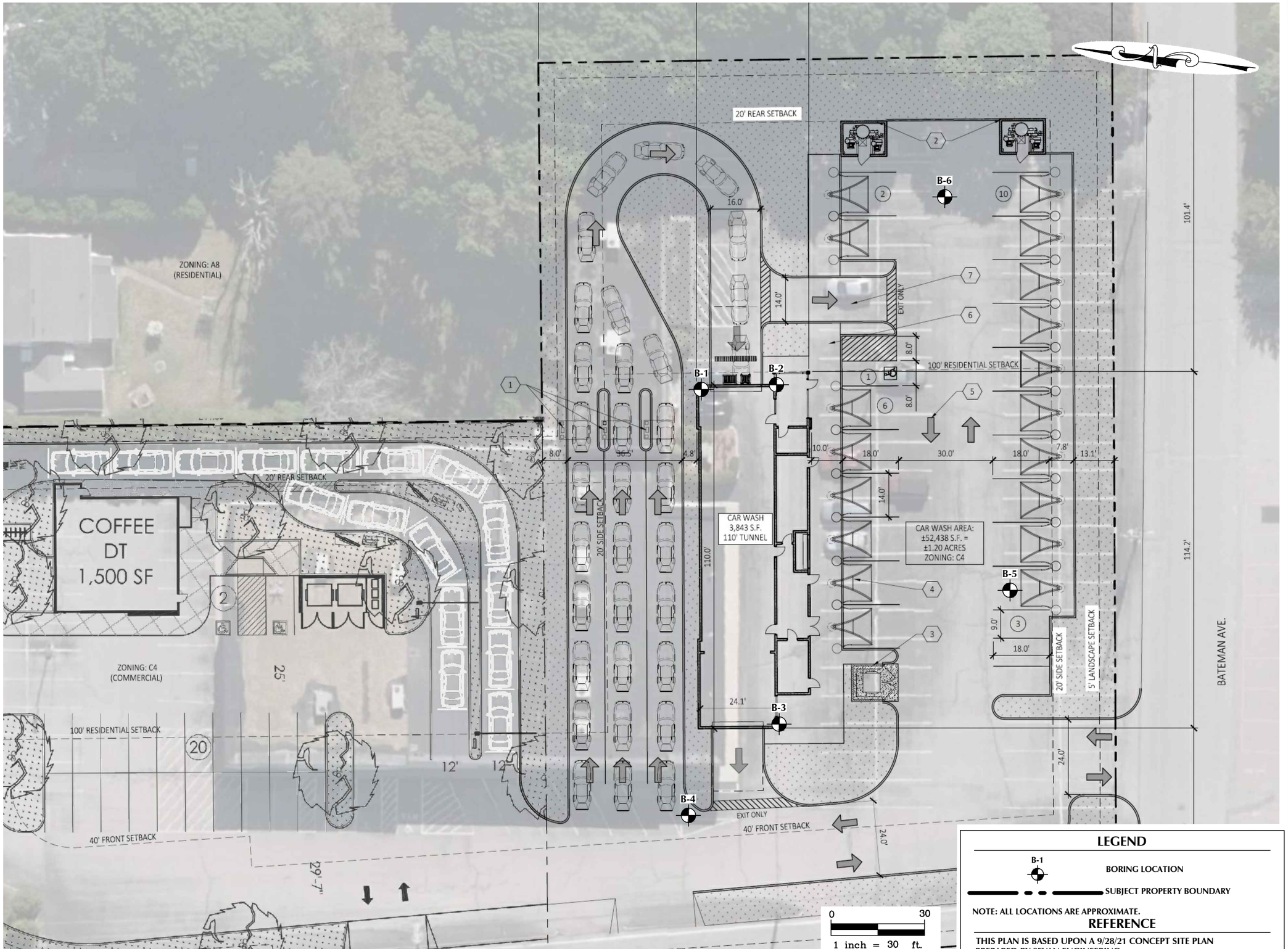
FIGURE 1
Boring Location Plan



LEGEND

B-1 — BORING LOCATION

SUBJECT PROPERTY BOUNDARY

NOTE: ALL LOCATIONS ARE APPROXIMATE.

REFERENCE

THIS PLAN IS BASED UPON A 9/28/21 CONCEPT SITE PLAN PREPARED BY SEVAN ENGINEERING.

WHITESTONE
An Employee-Owned Company
16 OLD FORGE ROAD, SUITE A, ROCKY HILL, CT 06067
860.726.7889 WHITESTONEASSOC.COM

DRAWING TITLE: **BORING LOCATION PLAN**

CLIENT: **SEVAN MULTI-SITE SOLUTIONS**

PROJECT: SEVAN WASHVILLE
1310 OAKLAWN AVENUE
CRANSTON, PROVIDENCE COUNTY, RHODE ISLAND

PROJECT #: GM2118500.000	
DESIGNED BY: MR	PROJ. MGR.: RR
DATE: 12/14/21	FIGURE: 1
SCALE: 1" = 30'	

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APPENDIX A
Records of Subsurface Exploration

WHITESTONE

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-1

Page 1 of 1

Project:	Proposed Washville Car Wash	**WAI Project No.:**	GM2118500.000
Location:	1310 Oaklawn Avenue, Cranston, Providence County, Rhode Island	**Client:**	Sevan Multi-Site Solutions
Surface Elevation:	± NS feet Above NAVD88	**Date Started:**	12/3/2021
Termination Depth:	9.0 feet bgs	**Date Completed:**	12/3/2021
Proposed Location:	Building	**Logged By:**	RK
Drill / Test Method:	HSA / SPT	**Contractor:**	GS
		Equipment:	CME 55

Water Depth | Elevation (feet bgs) | (ft NAVD88)		Cave-In Depth | Elevation (feet bgs) | (ft NAVD88)	
During:	-- | --		
At Completion:	-- | --	**At Completion:**	-- | --
24 Hours:	-- | --	**24 Hours:**	-- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		2" Asphalt	
1 - 3	S-1		4 - 11 - 16 - 35	16	27		EXISTING FILL		Gray, Medium Dense, Silty Sand with Gravel (FILL)	
3 - 3.8	S-2		24 - 50/3"	6	-	4.0			As Above, Dense (FILL)	
4 - 9	C-1	NQ2	1.0 mins 0.5 mins 2.5 mins 3.0 mins 2.0 mins	55" 92%	RQD 78%	5.0	BEDROCK		Light Gray, Slightly Weathered, Medium Grained, Widely Fractured, Hard, Quartz Arenite Bedrock	
			Cumulative / Time	**Rec.**	**RQD**	10.0			Boring Log B-1 Terminated at Depth of 9.0 Feet Below Ground Surface.	
						15.0				
						20.0				
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-2

Page 1 of 1

Project:	Proposed Washville Car Wash	**WAI Project No.:**	GM2118500.000
Location:	1310 Oaklawn Avenue, Cranston, Providence County, Rhode Island	**Client:**	Sevan Multi-Site Solutions

				Water Depth | Elevation (feet bgs) | (ft NAVD88)	Cave-In Depth | Elevation (feet bgs) | (ft NAVD88)
Surface Elevation:	± NS feet Above NAVD88	**Date Started:**	12/3/2021		
Termination Depth:	6.3 feet bgs	**Date Completed:**	12/3/2021		
Proposed Location:	Building	**Logged By:**	RK	**During:** -- | --	
Drill / Test Method:	HSA / SPT	**Contractor:**	GS	**At Completion:** -- | --	**At Completion:** -- | --
		Equipment:	CME 55	**24 Hours:** -- | --	**24 Hours:** -- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		2" Asphalt	
1 - 2.8	S-1	X	7 - 39 - 37 - 50/4"	12	76	2.5	EXISTING FILL		Brown, Very Dense, Silty Sand with Gravel (FILL)	
3 - 4.2	S-2	X	23 - 42 - 50/2"	8	84		WEATHERED BEDROCK		Highly Weathered Bedrock	
						5.0				
5 - 6.1	S-3	X	10 - 22 - 50/1"	6	44				Highly Weathered Bedrock	
									Boring Log B-2 Terminated upon Auger Refusal at Depth of 6.3 fbgs.	
						10.0				
						15.0				
						20.0				
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-3

Page 1 of 1

Project:	Proposed Washville Car Wash	**WAI Project No.:**	GM2118500.000
Location:	1310 Oaklawn Avenue, Cranston, Providence County, Rhode Island	**Client:**	Sevan Multi-Site Solutions
Surface Elevation:	± NS feet Above NAVD88	**Date Started:**	12/3/2021
Termination Depth:	8.0 feet bgs	**Date Completed:**	12/3/2021
Proposed Location:	Building	**Logged By:**	RK
Drill / Test Method:	HSA / SPT	**Contractor:**	GS
		Equipment:	CME 55

Water Depth | Elevation (feet bgs) | (ft NAVD88)		Cave-In Depth | Elevation (feet bgs) | (ft NAVD88)	
During:	-- | --		
At Completion:	-- | --	**At Completion:**	-- | --
24 Hours:	-- | --	**24 Hours:**	-- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		2" Asphalt	
1 - 2.8	S-1	X	3 - 2 - 3 - 50/3"	14	5		EXISTING FILL		Dark Brown, Loose, Silty Sand with Gravel (FILL)	
						3.0				
3 - 5	S-2	X	1 - 2 - 4 - 6	16	6		KAME TERRACE DEPOSIT		Brown, Loose, Silty Sand (SM)	
						5.0				
5 - 7	S-3	X	3 - 8 - 13 - 24	18	21				As Above, Medium Dense (SM)	
						7.3				
7 - 7.3	S-4	X	50/4"	4	-		WEATHERED BEDROCK		Highly Weathered Bedrock	
									Boring Log B-3 Terminated upon Auger Refusal at Depth of 8.0 fbgs.	
						10.0				
						15.0				
						20.0				
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-4

Page 1 of 1

Project:	Proposed Washville Car Wash	**WAI Project No.:**	GM2118500.000
Location:	1310 Oaklawn Avenue, Cranston, Providence County, Rhode Island	**Client:**	Sevan Multi-Site Solutions

				Water Depth | Elevation (feet bgs) | (ft NAVD88)	Cave-In Depth | Elevation (feet bgs) | (ft NAVD88)
Surface Elevation:	± NS feet Above NAVD88	**Date Started:**	12/3/2021		
Termination Depth:	12.5 feet bgs	**Date Completed:**	12/3/2021		
Proposed Location:	Building	**Logged By:**	RK	**During:** -- | --	
Drill / Test Method:	HSA / SPT	**Contractor:**	GS	**At Completion:** -- | --	**At Completion:** -- | --
		Equipment:	CME 55	**24 Hours:** -- | --	**24 Hours:** -- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		2" Asphalt	
1 - 2.8	S-1		4 - 3 - 4 - 4	6	7		EXISTING FILL		Dark Brown, Loose, Silty Sand with Gravel (FILL)	
3 - 5	S-2		3 - 2 - 1 - 2	1	3	5.0			As Above, Very Loose, Asphalt and Brick Pieces (FILL)	
5 - 7	S-3		2 - 2 - 2 - 2	3	4				As Above, Very Loose to Loose, Brick Pieces (FILL)	
7 - 9	S-4		2 - 4 - 11 - 21	18	17	7.5			As Above (FILL)	
9 - 11	S-5		18 - 22 - 27 - 39	20	49	10.0	KAME TERRACE DEPOSIT		Brown, Loose, Silty Sand (SM)	
									As Above, Dense (SM)	
						15.0			Boring Log B-4 Terminated upon Auger Refusal at Depth of 12.5 fbgs.	
						20.0				
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-5

Page 1 of 1

Project:	Proposed Washville Car Wash	**WAI Project No.:**	GM2118500.000
Location:	1310 Oaklawn Avenue, Cranston, Providence County, Rhode Island	**Client:**	Sevan Multi-Site Solutions

				Water Depth | Elevation (feet bgs) | (ft NAVD88)	Cave-In Depth | Elevation (feet bgs) | (ft NAVD88)
Surface Elevation:	± NS feet Above NAVD88	**Date Started:**	12/3/2021		
Termination Depth:	9.0 feet bgs	**Date Completed:**	12/3/2021		
Proposed Location:	Vacuuming Area	**Logged By:**	RK	**During:** -- | --	
Drill / Test Method:	HSA / SPT	**Contractor:**	GS	**At Completion:** -- | --	**At Completion:** -- | --
		Equipment:	CME 55	**24 Hours:** -- | --	**24 Hours:** -- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		3" Asphalt	
1 - 2.8	S-1	X	4 - 2 - 2 - 2	14	4		EXISTING FILL		Dark Brown, Very Loose to Loose, Silty Sand with Gravel (FILL)	
3 - 5	S-2	X	4 - 4 - 9 - 12	12	13	4.0			As Above, Loose (FILL)	
5 - 7	S-3	X	4 - 11 - 9 - 13	6	20	5.0	KAME TERRACE DEPOSIT		Brown, Medium Dense, Silty Sand with Gravel (SM) As Above (SM)	
7 - 9	S-4	X	16 - 16 - 18 - 50	14	34	8.8			As Above, Dense (SM)	
							WEATHERED BEDROCK		Highly Weathered Bedrock	
						10.0			Boring Log B-5 Terminated at Depth of 9.0 Feet Below Ground Surface.	
						15.0				
						20.0				
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-6

Page 1 of 1

Project:	Proposed Washville Car Wash	**WAI Project No.:**	GM2118500.000
Location:	1310 Oaklawn Avenue, Cranston, Providence County, Rhode Island	**Client:**	Sevan Multi-Site Solutions
Surface Elevation:	± NS feet Above NAVD88	**Date Started:**	12/3/2021
Termination Depth:	8.3 feet bgs	**Date Completed:**	12/3/2021
Proposed Location:	Vacuuming Area	**Logged By:**	RK
Drill / Test Method:	HSA / SPT	**Contractor:**	GS
		Equipment:	CME 55

Water Depth | Elevation (feet bgs) | (ft NAVD88)		Cave-In Depth | Elevation (feet bgs) | (ft NAVD88)	
During:	-- | --		
At Completion:	-- | --	**At Completion:**	-- | --
24 Hours:	-- | --	**24 Hours:**	-- | --

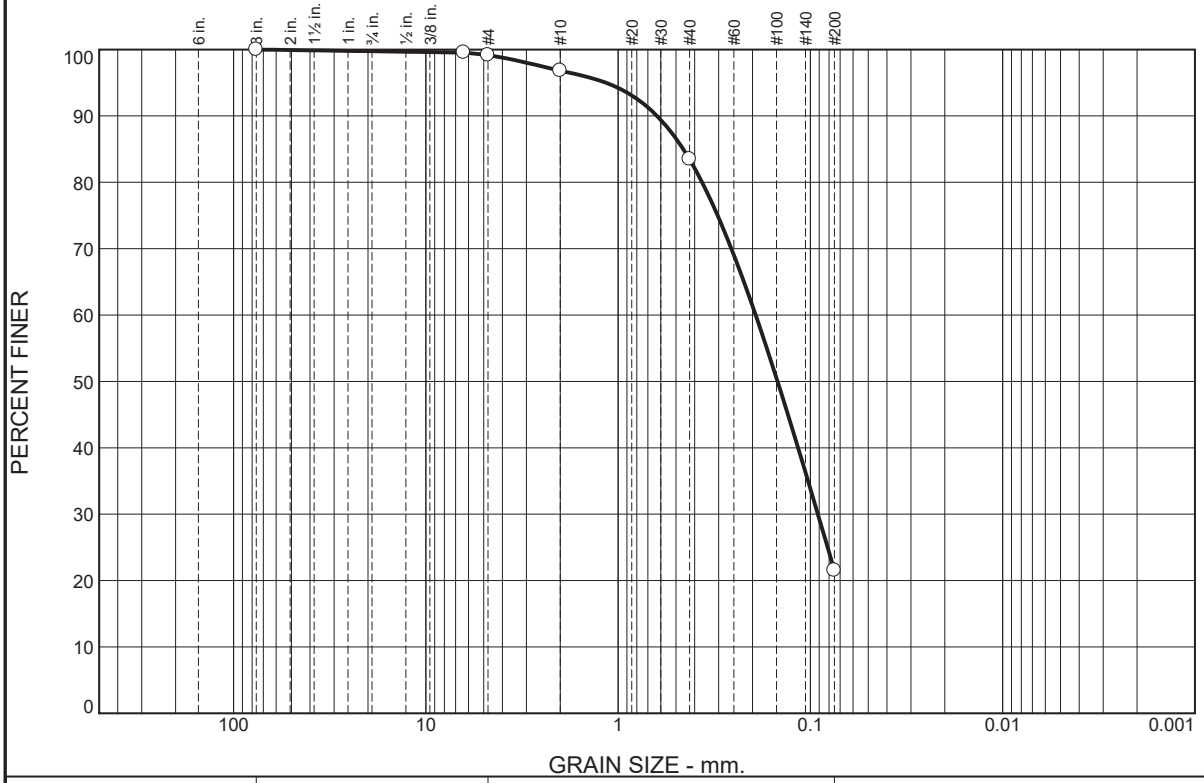
SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		3" Asphalt	
1 - 3	S-1	X	3 - 4 - 6 - 5	14	10	3.0	EXISTING FILL		Brown, Loose to Medium Dense, Sandy Silt (FILL)	
3 - 5	S-2	X	5 - 6 - 13 - 18	18	19	5.0	KAME TERRACE DEPOSIT		Brown, Medium Dense, Silty Sand (SM)	
						5.5			As Above (SM)	
5 - 7	S-3	X	4 - 18 - 21 - 25	20	39		WEATHERED BEDROCK		Highly Weathered Bedrock	
7 - 8.1	S-4	X	26 - 29 - 50/1"	10	58				Highly Weathered Bedrock	
						10.0			Boring Log B-6 Terminated upon Auger Refusal at Depth of 8.3 fbgs.	
						15.0				
						20.0				
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE

APPENDIX B
Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.3	0.6	2.3	13.3	62.0	21.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0	100.0	
1/4"	99.5		
#4	99.1		
#10	96.8		
#40	83.5		
#200	21.5	0.0 - 15.0	X

* Whitestone Structural Fill

Material Description

Silty Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.6275 D_{85}= 0.4584 D_{60}= 0.1925
D_{50}= 0.1481 D_{30}= 0.0914 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture Content = 8.8%
Gradation Unsuitable for Whitestone Structural Spec

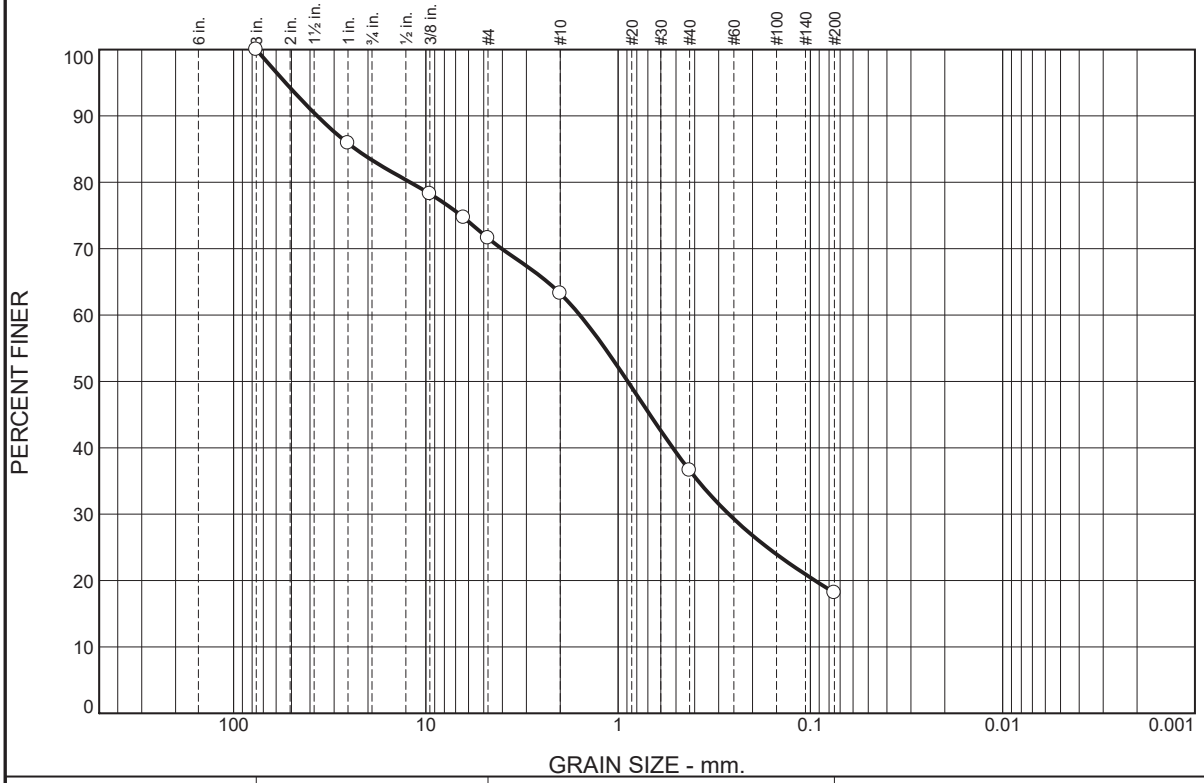
Location: Boring B-3
Sample Number: S-2 **Depth:** 3'-5' **Date:** 12/8/2021

WHITESTONE

Client: Sevan Multi-Site Solutions
Project: Proposed Washville Carwash
1310 Oaklawn Ave, Cranston, Providence County, RI
Project No: GM2118500.000 **Figure** S-2

Tested By: JM **Checked By:** RWM

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	16.7	11.7	8.3	26.7	18.4	18.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3"	100.0	100.0	
1"	85.9		
3/8"	78.3		
1/4"	74.7		
#4	71.6		
#10	63.3		
#40	36.6		
#200	18.2	0.0 - 15.0	X

* Whitestone Structural Fill

Material Description

Silty Sand with Gravel

Atterberg Limits

PL= NP LL= NP PI= NV

Coefficients

D_{90}= 36.7420 D_{85}= 23.1596 D_{60}= 1.5817
D_{50}= 0.8910 D_{30}= 0.2653 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Moisture Content = 6.4%
Gradation Unsuitable for Whitestone Structural Spec

Location: Boring B-1
Sample Number: S-1 **Depth:** 1'-3' **Date:** 12/8/2021

WHITESTONE

Client: Sevan Multi-Site Solutions
Project: Proposed Washville Carwash
1310 Oaklawn Ave, Cranston, Providence County, RI
Project No: GM2118500.000 **Figure** S-1

Tested By: JM **Checked By:** RWM

WHITESTONE

APPENDIX C
Supplemental Information (USCS, Terms & Symbols)

WHITESTONE
An Employee-Owned Company

352 TURNPIKE ROAD
SUITE 320
SOUTHBOROUGH, MA 01772
508.485.0755
whitestoneassoc.com

UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMITS LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMITS GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS FOR SAMPLES WITH 5% TO 12% FINES

GRADATION*

% FINER BY WEIGHT

TRACE..... 1% TO 10%
LITTLE..... 10% TO 20%
SOME..... 20% TO 35%
AND..... 35% TO 50%

COMPACTNESS*
Sand and/or Gravel

RELATIVE DENSITY

LOOSE. ..... 0% TO 40%
MEDIUM DENSE.... 40% TO 70%
DENSE..... 70% TO 90%
VERY DENSE..... 90% TO 100%

CONSISTENCY*
Clay and/or Silt

RANGE OF SHEARING STRENGTH IN POUNDS PER SQUARE FOOT

VERY SOFT..... LESS THAN 250
SOFT..... ..... 250 TO 500
MEDIUM..... 500 TO 1000
STIFF..... 1000 TO 2000
VERY STIFF..... 2000 TO 4000
HARD..... GREATER THAN 4000

** VALUES ARE FROM LABORATORY OR FIELD TEST DATA, WHERE APPLICABLE. WHEN NO TESTING WAS PERFORMED, VALUES ARE ESTIMATED.*

L:\Geotechnical Forms and References\Reports\USCSTRMSSYM MA.docx

WHITESTONE
An Employee-Owned Company

352 TURNPIKE ROAD
SUITE 320
SOUTHBOROUGH, MA 01772
508.485.0755
whitestoneassoc.com

GEOTECHNICAL TERMS AND SYMBOLS

SAMPLE IDENTIFICATION

The Unified Soil Classification System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

N: Standard Penetration Value: Blows per ft. of a 140 lb. hammer falling 30" on a 2" O.D. split-spoon.
Qu: Unconfined compressive strength, TSF.
Qp: Penetrometer value, unconfined compressive strength, TSF.
Mc: Moisture content, %.
LL: Liquid limit, %.
PI: Plasticity index, %.
δd: Natural dry density, PCF.
▼: Apparent groundwater level at time noted after completion of boring.

DRILLING AND SAMPLING SYMBOLS

NE: Not Encountered (Groundwater was not encountered).
SS: Split-Spoon - 1 ⅜" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
AU: Auger Sample.
OB: Diamond Bit.
CB: Carbide Bit
WS: Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

Term (Non-Cohesive Soils)	Standard Penetration Resistance
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	Over 50

Term (Cohesive Soils)	Qu (TSF)
Very Soft	0 - 0.25
Soft	0.25 - 0.50
Firm (Medium)	0.50 - 1.00
Stiff	1.00 - 2.00
Very Stiff	2.00 - 4.00
Hard	4.00+

PARTICLE SIZE

Boulders	8 in.+	Coarse Sand	5mm-0.6mm	Silt	0.074mm-0.005mm
Cobbles	8 in.-3 in.	Medium Sand	0.6mm-0.2mm	Clay	-0.005mm
Gravel	3 in.-5mm	Fine Sand	0.2mm-0.074mm		

Other Office Locations:

WARREN, NJ 908.668.7777 | CHALFONT, PA 215.712.2700 | ROCKY HILL, CT 860.726.7889 | WALL, NJ 732.592.2101 | PHILADELPHIA, PA 215.848.2323

Environmental & Geotechnical Engineers & Consultants

Appendix E

NOAA Local Rainfall Data

NOAA Atlas 14, Volume 10, Version 3
Location name: Cranston, Rhode Island, USA*
Latitude: 41.7335°, Longitude: -71.4769°
Elevation: 71.47 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**3.82** (3.07-4.74)	**4.67** (3.76-5.80)	**6.06** (4.85-7.56)	**7.21** (5.74-9.05)	**8.81** (6.74-11.5)	**10.00** (7.49-13.4)	**11.3** (8.17-15.6)	**12.7** (8.64-18.0)	**14.9** (9.68-21.7)	**16.7** (10.6-24.9)
10-min	**2.71** (2.17-3.35)	**3.31** (2.66-4.11)	**4.29** (3.43-5.35)	**5.11** (4.06-6.40)	**6.24** (4.78-8.17)	**7.08** (5.30-9.48)	**7.97** (5.78-11.1)	**9.02** (6.13-12.7)	**10.6** (6.86-15.4)	**11.9** (7.51-17.6)
15-min	**2.12** (1.70-2.63)	**2.60** (2.08-3.22)	**3.37** (2.69-4.20)	**4.01** (3.19-5.03)	**4.89** (3.75-6.41)	**5.55** (4.16-7.43)	**6.26** (4.54-8.70)	**7.08** (4.80-9.98)	**8.28** (5.38-12.1)	**9.30** (5.89-13.8)
30-min	**1.46** (1.17-1.81)	**1.79** (1.44-2.23)	**2.34** (1.87-2.91)	**2.79** (2.22-3.50)	**3.42** (2.62-4.48)	**3.88** (2.91-5.20)	**4.38** (3.18-6.09)	**4.95** (3.37-6.99)	**5.81** (3.78-8.47)	**6.53** (4.13-9.70)
60-min	**0.929** (0.747-1.15)	**1.15** (0.919-1.42)	**1.50** (1.20-1.87)	**1.79** (1.42-2.24)	**2.19** (1.68-2.87)	**2.49** (1.87-3.34)	**2.81** (2.04-3.91)	**3.19** (2.16-4.50)	**3.74** (2.43-5.46)	**4.20** (2.66-6.25)
2-hr	**0.608** (0.492-0.750)	**0.756** (0.612-0.934)	**0.998** (0.804-1.24)	**1.20** (0.959-1.49)	**1.48** (1.14-1.92)	**1.68** (1.27-2.23)	**1.90** (1.39-2.62)	**2.16** (1.47-3.02)	**2.54** (1.66-3.67)	**2.86** (1.82-4.20)
3-hr	**0.474** (0.385-0.582)	**0.589** (0.478-0.724)	**0.776** (0.627-0.957)	**0.932** (0.748-1.16)	**1.15** (0.887-1.48)	**1.31** (0.988-1.73)	**1.48** (1.08-2.02)	**1.67** (1.15-2.33)	**1.97** (1.29-2.83)	**2.21** (1.42-3.24)
6-hr	**0.310** (0.253-0.378)	**0.380** (0.310-0.464)	**0.494** (0.402-0.606)	**0.590** (0.476-0.725)	**0.720** (0.561-0.925)	**0.818** (0.623-1.07)	**0.922** (0.680-1.25)	**1.04** (0.720-1.44)	**1.22** (0.807-1.73)	**1.37** (0.881-1.98)
12-hr	**0.197** (0.162-0.238)	**0.237** (0.194-0.287)	**0.302** (0.247-0.367)	**0.356** (0.290-0.435)	**0.431** (0.338-0.548)	**0.486** (0.373-0.631)	**0.545** (0.404-0.732)	**0.613** (0.427-0.835)	**0.711** (0.474-0.999)	**0.792** (0.515-1.13)
24-hr	**0.118** (0.097-0.142)	**0.141** (0.116-0.170)	**0.179** (0.147-0.216)	**0.210** (0.172-0.255)	**0.253** (0.200-0.319)	**0.285** (0.220-0.367)	**0.320** (0.239-0.425)	**0.359** (0.252-0.484)	**0.415** (0.279-0.578)	**0.462** (0.303-0.654)
2-day	**0.066** (0.055-0.078)	**0.079** (0.066-0.095)	**0.101** (0.084-0.122)	**0.120** (0.099-0.144)	**0.145** (0.115-0.182)	**0.164** (0.128-0.209)	**0.184** (0.139-0.243)	**0.207** (0.147-0.277)	**0.242** (0.163-0.332)	**0.270** (0.178-0.378)
3-day	**0.047** (0.040-0.056)	**0.057** (0.048-0.068)	**0.073** (0.061-0.087)	**0.086** (0.071-0.103)	**0.104** (0.083-0.129)	**0.117** (0.091-0.149)	**0.131** (0.099-0.172)	**0.148** (0.105-0.196)	**0.172** (0.117-0.235)	**0.192** (0.127-0.267)
4-day	**0.038** (0.032-0.045)	**0.046** (0.038-0.054)	**0.058** (0.048-0.069)	**0.068** (0.056-0.081)	**0.082** (0.065-0.102)	**0.092** (0.072-0.117)	**0.103** (0.078-0.135)	**0.116** (0.082-0.153)	**0.134** (0.092-0.183)	**0.150** (0.099-0.207)
7-day	**0.026** (0.022-0.031)	**0.031** (0.026-0.036)	**0.038** (0.032-0.045)	**0.044** (0.037-0.052)	**0.053** (0.042-0.065)	**0.059** (0.046-0.074)	**0.066** (0.050-0.085)	**0.073** (0.052-0.096)	**0.084** (0.058-0.113)	**0.093** (0.062-0.127)
10-day	**0.021** (0.018-0.025)	**0.024** (0.021-0.029)	**0.030** (0.025-0.035)	**0.034** (0.029-0.041)	**0.040** (0.033-0.050)	**0.045** (0.036-0.056)	**0.050** (0.038-0.064)	**0.055** (0.040-0.072)	**0.063** (0.043-0.084)	**0.068** (0.046-0.093)
20-day	**0.015** (0.013-0.017)	**0.017** (0.014-0.019)	**0.020** (0.017-0.023)	**0.022** (0.019-0.026)	**0.025** (0.021-0.031)	**0.028** (0.022-0.034)	**0.031** (0.023-0.038)	**0.033** (0.024-0.043)	**0.036** (0.025-0.048)	**0.039** (0.026-0.052)
30-day	**0.012** (0.011-0.014)	**0.014** (0.012-0.016)	**0.016** (0.013-0.018)	**0.017** (0.015-0.020)	**0.020** (0.016-0.024)	**0.022** (0.017-0.026)	**0.023** (0.018-0.029)	**0.025** (0.018-0.032)	**0.027** (0.019-0.036)	**0.028** (0.019-0.038)
45-day	**0.010** (0.009-0.012)	**0.011** (0.010-0.013)	**0.013** (0.011-0.015)	**0.014** (0.012-0.016)	**0.016** (0.013-0.019)	**0.017** (0.013-0.020)	**0.018** (0.014-0.022)	**0.019** (0.014-0.025)	**0.021** (0.014-0.027)	**0.021** (0.014-0.028)
60-day	**0.009** (0.008-0.010)	**0.010** (0.008-0.011)	**0.011** (0.009-0.013)	**0.012** (0.010-0.014)	**0.013** (0.011-0.016)	**0.014** (0.011-0.017)	**0.015** (0.012-0.019)	**0.016** (0.012-0.020)	**0.017** (0.012-0.022)	**0.018** (0.012-0.023)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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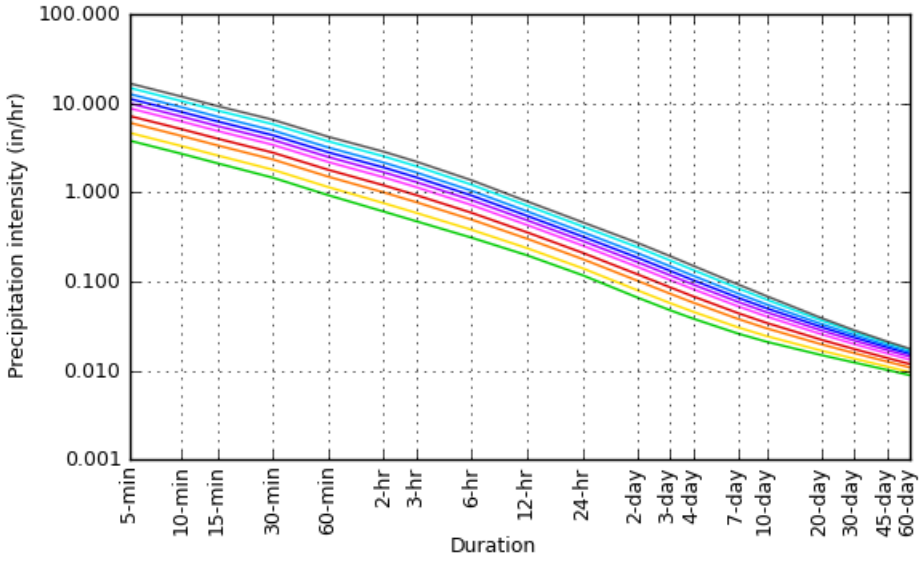
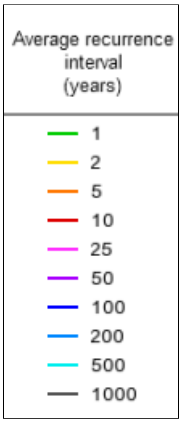
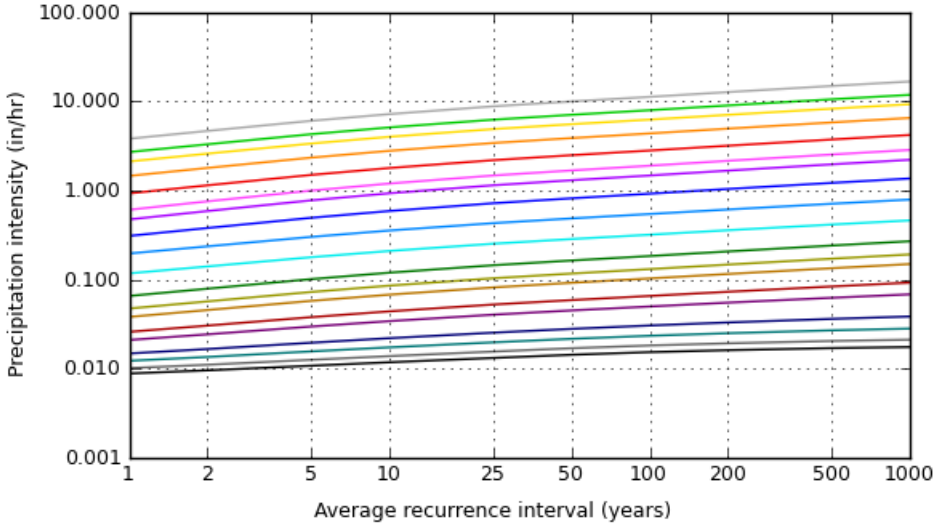
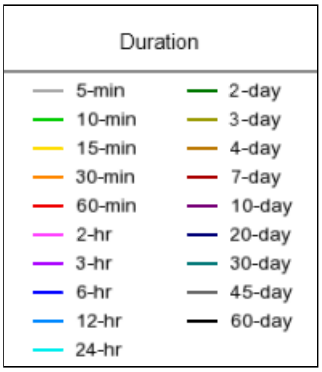
PF graphical

PDS-based intensity-duration-frequency (IDF) curves
Latitude: 41.7335°, Longitude: -71.4769°









NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Thu Mar 3 17:53:54 2022

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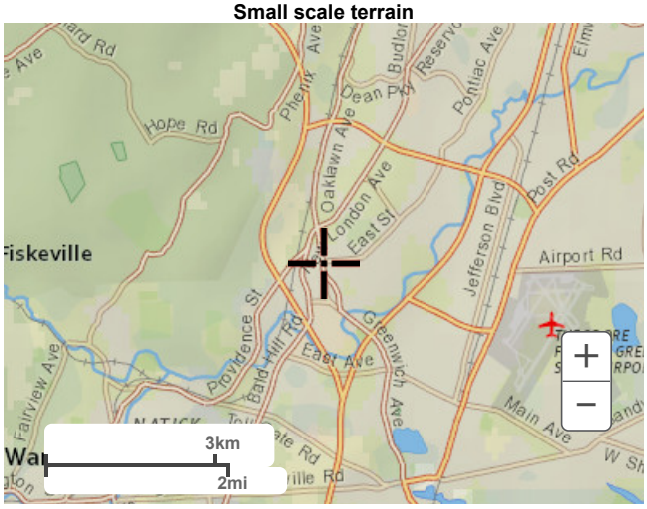
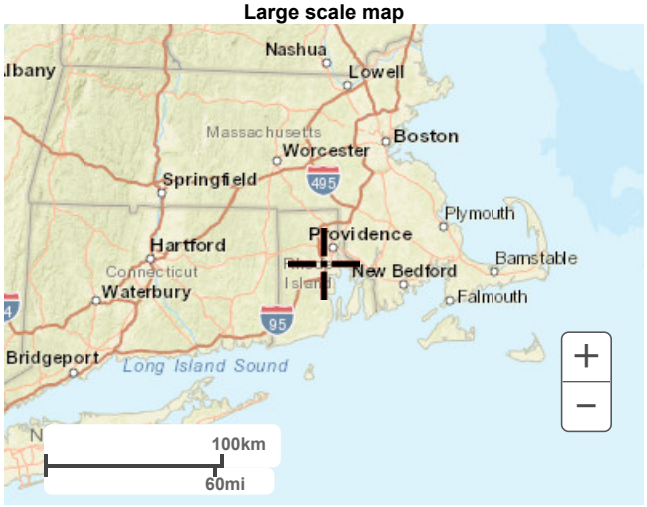
Maps & aerials

Small scale terrain

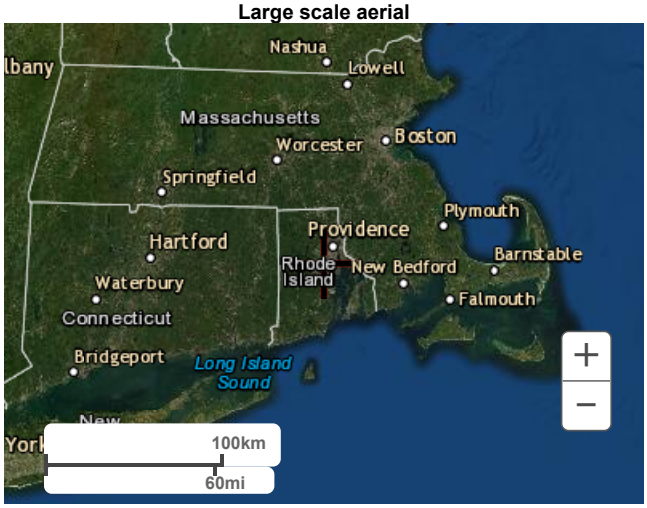


Large scale terrain

Large scale map



Large scale aerial



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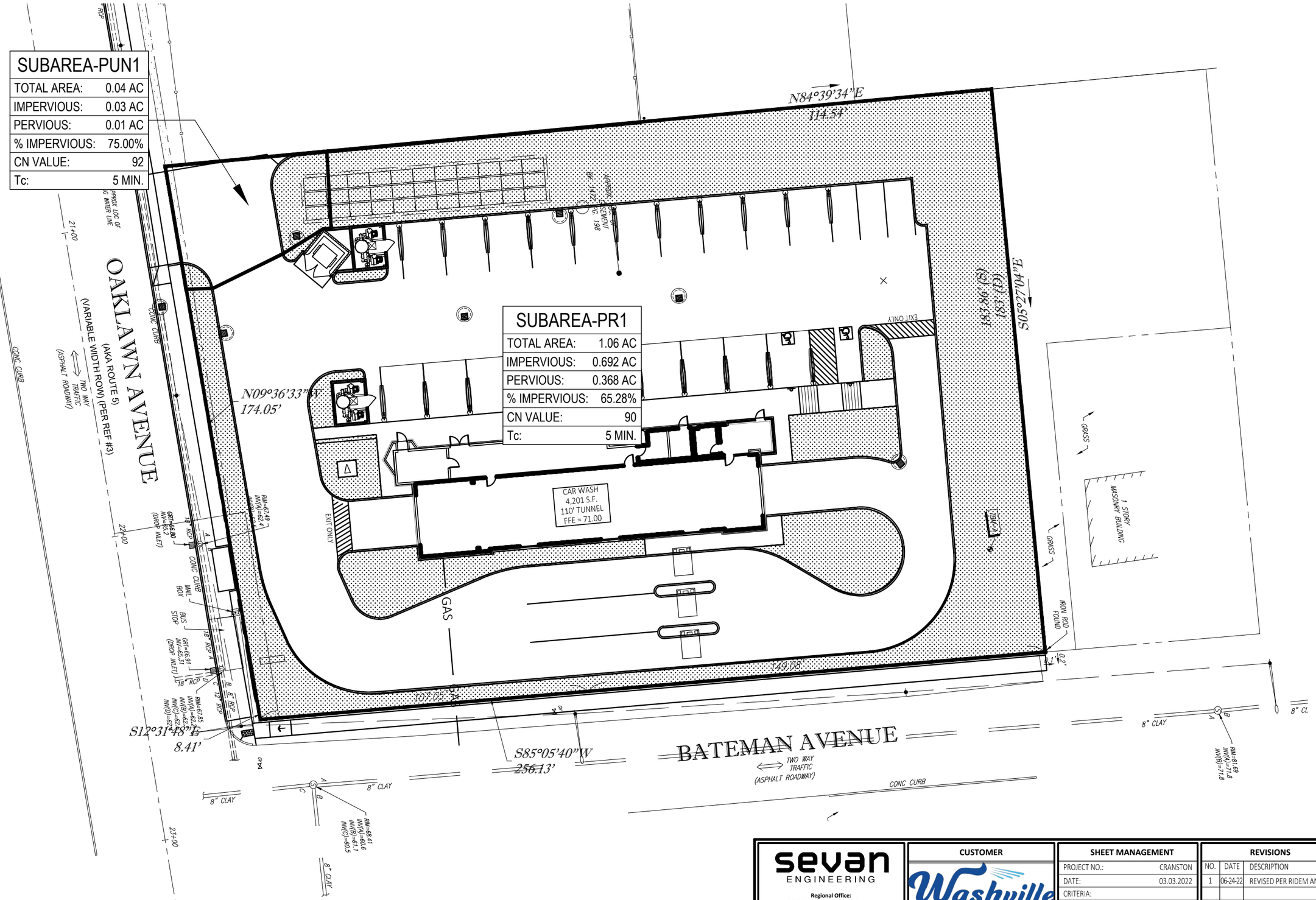
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Appendix F

Proposed Drainage Patterns



N

PROPOSED DRAINAGE PATTERNS

SCALE: 1" = 30'–0"

sevan ENGINEERING

Regional Office:
37704 Hills Tech Drive
Farmington Hills, MI 48331
734.367.4445 Telephone

Corporate Office:
3025 Highland Parkway, Suite 850
Downers Grove, IL 60515
info@sevansolutions.com www.sevansolutions.com

INTEGRITY | RESPECT | TEAMWORK | EXCELLENCE | CHARITY

CUSTOMER

Washville
Your Hometown Car Wash

PROJECT LOCATION

1300-1310 OAKLAWN AVE.
CRANSTON, RI 02920
(PROVIDENCE COUNTY)

SHEET MANAGEMENT

PROJECT NO.:	CRANSTON
DATE:	03.03.2022
CRITERIA:	
PROJECT MANAGER:	T. KRATZ

REVISIONS

NO.	DATE	DESCRIPTION
1	06-24-22	REVISED PER RIDEM AND RIDOT

SHEET TITLE

PROPOSED DRAINAGE PATTERNS

SHEET NUMBER

PDP

Appendix G

Hydraflow Hydrographs

Hydraflow Table of Contents

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022 Sunday, 06 / 26 / 2022

Watershed Model Schematic

Legend

Hyd.	Origin	Description
1	SCS Runoff	SUBAREA-EX1
2	SCS Runoff	SUBAREA-PUN1
3	SCS Runoff	SUBAREA-PR1
4	Reservoir	Sand Filter

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	2.766	3.400	-------	4.241	5.081	6.338	7.594	9.058	SUBAREA-EX1
2	SCS Runoff	------	0.084	0.108	-------	0.140	0.172	0.219	0.266	0.320	SUBAREA-PUN1
3	SCS Runoff	------	2.052	2.688	-------	3.538	4.386	5.649	6.903	8.357	SUBAREA-PR1
4	Reservoir	3	0.343	0.603	-------	2.558	5.715	6.271	7.051	8.362	Sand Filter

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	2.766	2	724	9,245	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.084	2	724	256	------	------	------	SUBAREA-PUN1
3	SCS Runoff	2.052	2	724	6,171	------	------	------	SUBAREA-PR1
4	Reservoir	0.343	2	752	6,171	3	66.88	1,877	Sand Filter

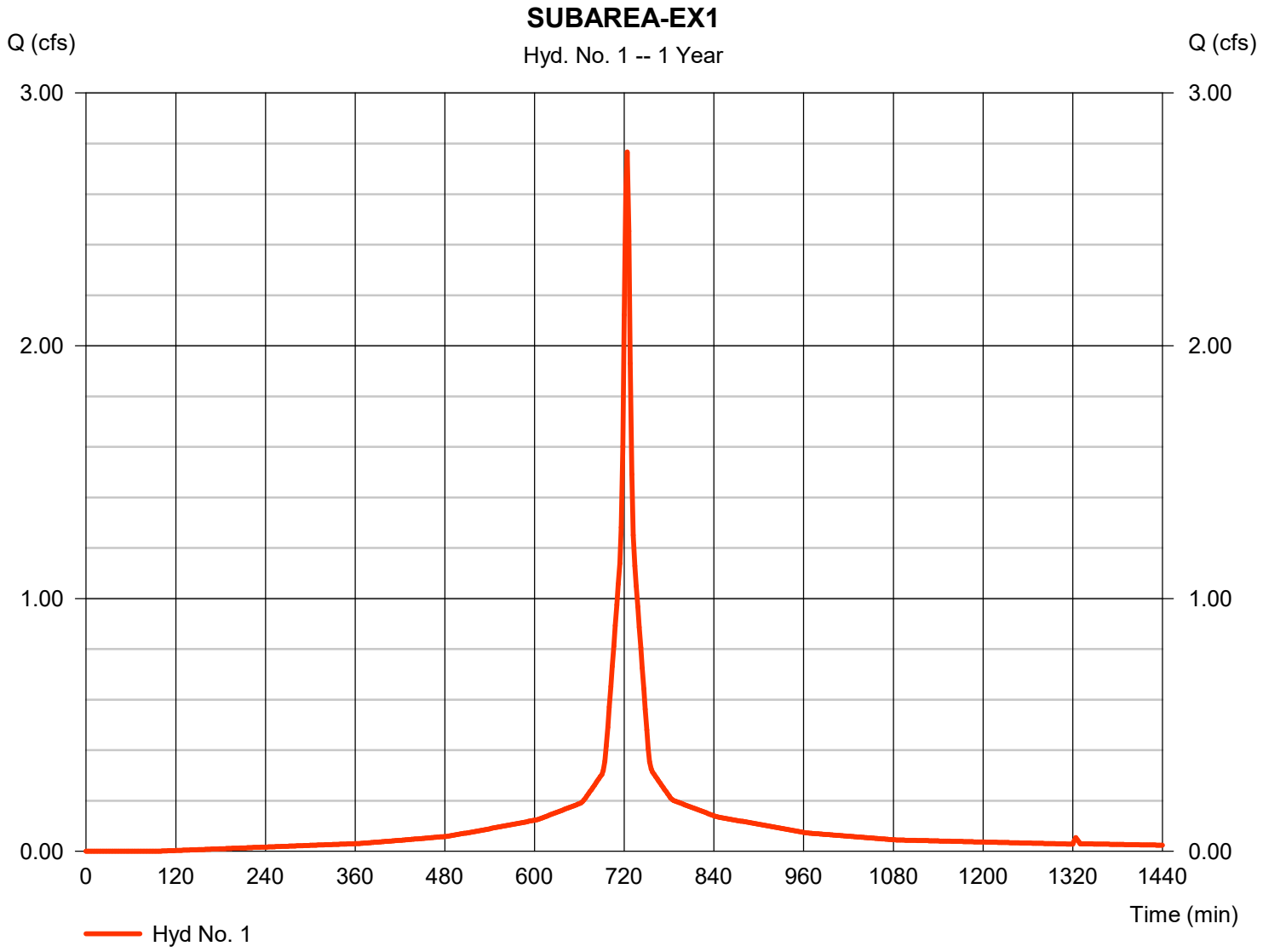
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.766 cfs
Storm frequency	=	1 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	9,245 cuft
Drainage area	=	1.100 ac	Curve number	=	98*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	2.70 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



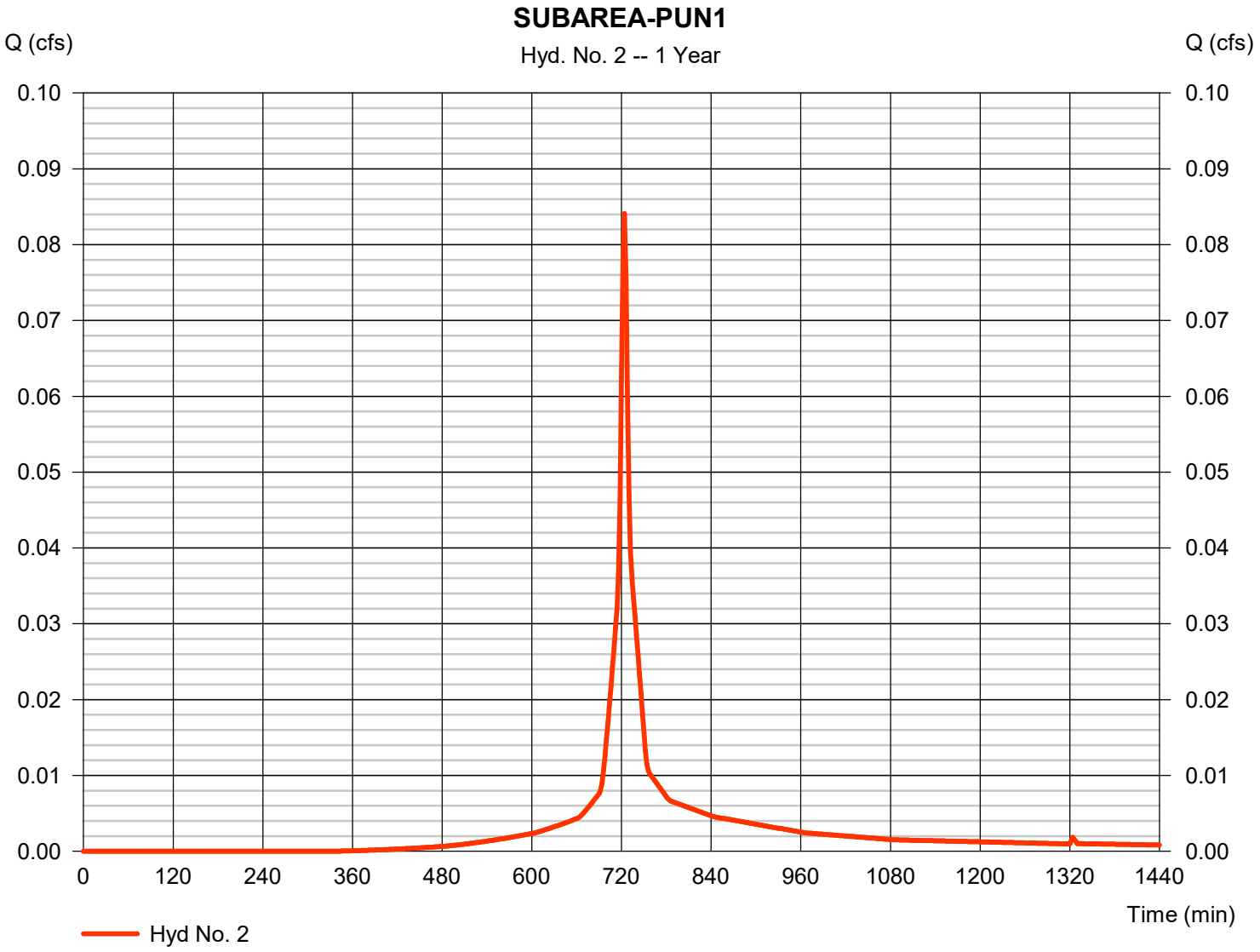
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.084 cfs
Storm frequency	=	1 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	256 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	2.70 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



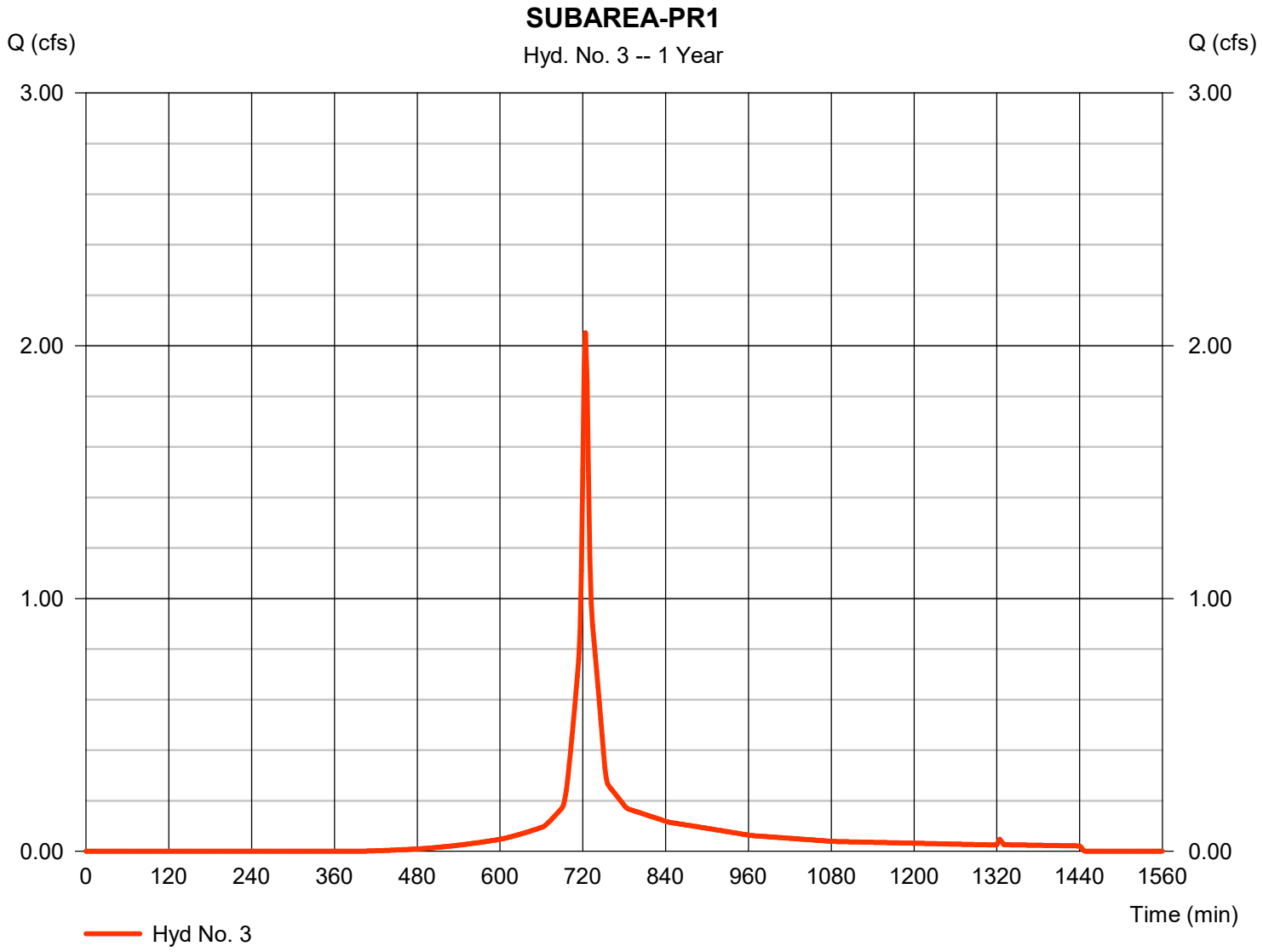
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.052 cfs
Storm frequency	=	1 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	6,171 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	2.70 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



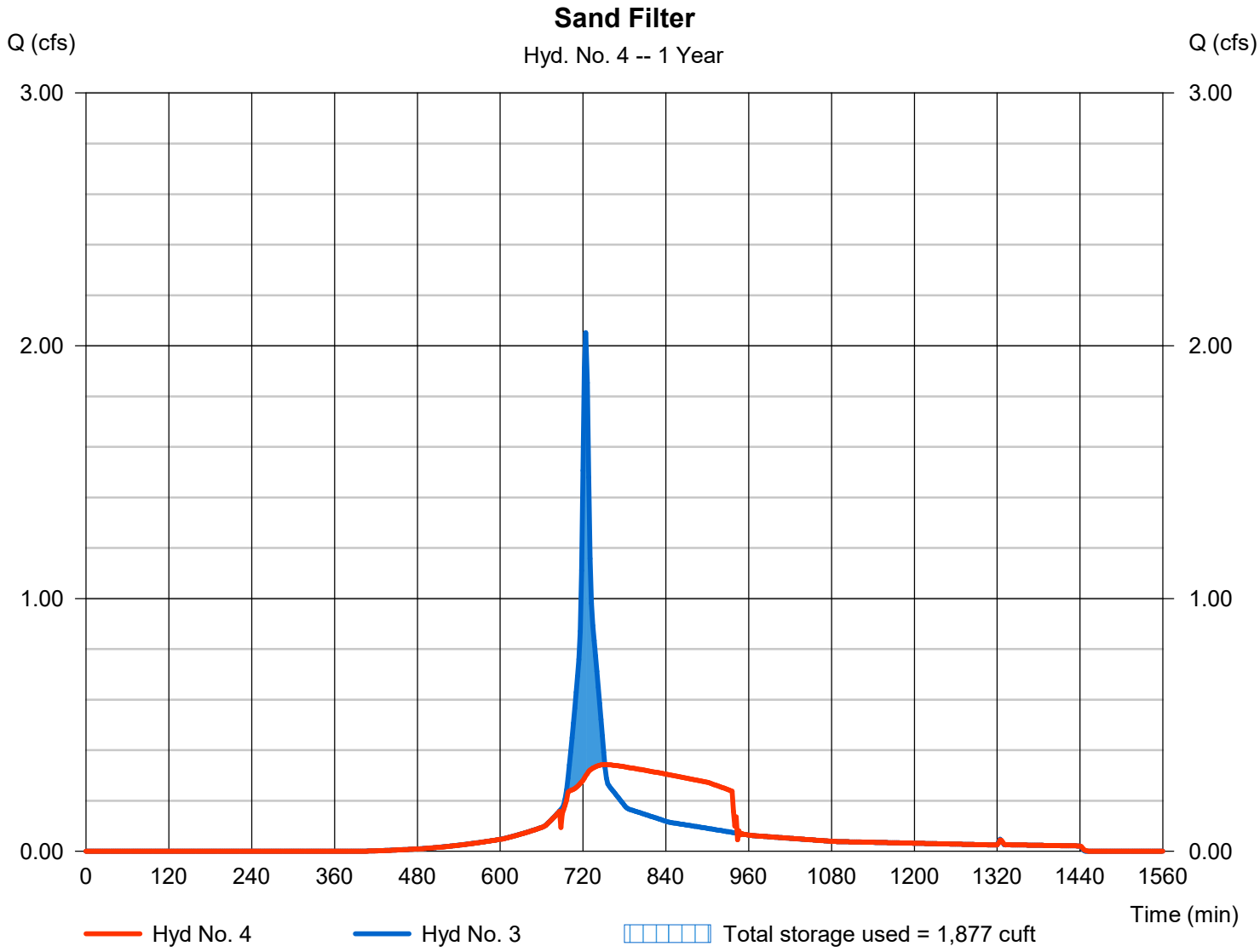
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	0.343 cfs
Storm frequency	=	1 yrs	Time to peak	=	752 min
Time interval	=	2 min	Hyd. volume	=	6,171 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	66.88 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	1,877 cuft

Storage Indication method used.



Pond No. 2 - SAND FILTER

Pond Data

UG Chambers -Invert elev. = 65.50 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 78.28 ft, No. Barrels = 3, Slope = 0.00%, Headers = Yes
Encasement -Invert elev. = 63.50 ft, Width = 15.75 ft, Height = 4.50 ft, Voids = 0.33%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	63.50	n/a	0	0
0.45	63.95	n/a	8	8
0.90	64.40	n/a	8	15
1.35	64.85	n/a	8	23
1.80	65.30	n/a	8	31
2.25	65.75	n/a	356	387
2.70	66.20	n/a	623	1,010
3.15	66.65	n/a	590	1,600
3.60	67.10	n/a	531	2,131
4.05	67.55	n/a	434	2,565
4.50	68.00	n/a	252	2,817

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 4.00	6.00	0.00	0.00
Span (in)	= 4.00	6.00	0.00	0.00
No. Barrels	= 1	3	0	0
Invert El. (ft)	= 63.50	67.50	0.00	0.00
Length (ft)	= 84.00	15.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 30.00	0.00	0.00	0.00
Crest El. (ft)	= 67.80	0.00	0.00	0.00
Weir Coeff.	= 2.60	3.33	3.33	3.33
Weir Type	= Broad	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	63.50	0.00	0.00	---	---	0.00	---	---	---	---	---	0.000
0.04	1	63.54	0.01 ic	0.00	---	---	0.00	---	---	---	---	---	0.005
0.09	2	63.59	0.02 ic	0.00	---	---	0.00	---	---	---	---	---	0.019
0.13	2	63.63	0.04 ic	0.00	---	---	0.00	---	---	---	---	---	0.042
0.18	3	63.68	0.07 ic	0.00	---	---	0.00	---	---	---	---	---	0.069
0.22	4	63.72	0.10 ic	0.00	---	---	0.00	---	---	---	---	---	0.101
0.27	5	63.77	0.13 ic	0.00	---	---	0.00	---	---	---	---	---	0.134
0.31	5	63.81	0.16 ic	0.00	---	---	0.00	---	---	---	---	---	0.163
0.36	6	63.86	0.03 oc	0.00	---	---	0.00	---	---	---	---	---	0.032
0.40	7	63.90	0.05 oc	0.00	---	---	0.00	---	---	---	---	---	0.053
0.45	8	63.95	0.07 oc	0.00	---	---	0.00	---	---	---	---	---	0.067
0.49	8	63.99	0.08 oc	0.00	---	---	0.00	---	---	---	---	---	0.079
0.54	9	64.04	0.09 oc	0.00	---	---	0.00	---	---	---	---	---	0.089
0.58	10	64.08	0.10 oc	0.00	---	---	0.00	---	---	---	---	---	0.098
0.63	11	64.13	0.11 oc	0.00	---	---	0.00	---	---	---	---	---	0.107
0.68	12	64.17	0.11 oc	0.00	---	---	0.00	---	---	---	---	---	0.115
0.72	12	64.22	0.12 oc	0.00	---	---	0.00	---	---	---	---	---	0.122
0.77	13	64.26	0.13 oc	0.00	---	---	0.00	---	---	---	---	---	0.129
0.81	14	64.31	0.14 oc	0.00	---	---	0.00	---	---	---	---	---	0.136
0.86	15	64.35	0.14 oc	0.00	---	---	0.00	---	---	---	---	---	0.142
0.90	15	64.40	0.15 oc	0.00	---	---	0.00	---	---	---	---	---	0.148
0.94	16	64.44	0.15 oc	0.00	---	---	0.00	---	---	---	---	---	0.154
0.99	17	64.49	0.16 oc	0.00	---	---	0.00	---	---	---	---	---	0.159
1.03	18	64.53	0.16 oc	0.00	---	---	0.00	---	---	---	---	---	0.164
1.08	18	64.58	0.17 oc	0.00	---	---	0.00	---	---	---	---	---	0.170
1.12	19	64.62	0.17 oc	0.00	---	---	0.00	---	---	---	---	---	0.175
1.17	20	64.67	0.18 oc	0.00	---	---	0.00	---	---	---	---	---	0.180
1.21	21	64.71	0.18 oc	0.00	---	---	0.00	---	---	---	---	---	0.184
1.26	22	64.76	0.19 oc	0.00	---	---	0.00	---	---	---	---	---	0.189
1.30	22	64.80	0.19 oc	0.00	---	---	0.00	---	---	---	---	---	0.194
1.35	23	64.85	0.20 oc	0.00	---	---	0.00	---	---	---	---	---	0.198
1.39	24	64.89	0.20 oc	0.00	---	---	0.00	---	---	---	---	---	0.202

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SAND FILTER

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.44	25	64.94	0.21 oc	0.00	---	---	0.00	---	---	---	---	---	0.207
1.48	25	64.98	0.21 oc	0.00	---	---	0.00	---	---	---	---	---	0.211
1.53	26	65.03	0.21 oc	0.00	---	---	0.00	---	---	---	---	---	0.215
1.57	27	65.07	0.22 oc	0.00	---	---	0.00	---	---	---	---	---	0.219
1.62	28	65.12	0.22 oc	0.00	---	---	0.00	---	---	---	---	---	0.223
1.66	29	65.16	0.23 oc	0.00	---	---	0.00	---	---	---	---	---	0.227
1.71	29	65.21	0.23 oc	0.00	---	---	0.00	---	---	---	---	---	0.230
1.75	30	65.25	0.23 oc	0.00	---	---	0.00	---	---	---	---	---	0.234
1.80	31	65.30	0.24 oc	0.00	---	---	0.00	---	---	---	---	---	0.238
1.85	66	65.35	0.24 oc	0.00	---	---	0.00	---	---	---	---	---	0.241
1.89	102	65.39	0.24 oc	0.00	---	---	0.00	---	---	---	---	---	0.245
1.93	138	65.43	0.25 oc	0.00	---	---	0.00	---	---	---	---	---	0.248
1.98	173	65.48	0.25 oc	0.00	---	---	0.00	---	---	---	---	---	0.252
2.02	209	65.52	0.26 oc	0.00	---	---	0.00	---	---	---	---	---	0.255
2.07	244	65.57	0.26 oc	0.00	---	---	0.00	---	---	---	---	---	0.259
2.12	280	65.61	0.26 oc	0.00	---	---	0.00	---	---	---	---	---	0.262
2.16	316	65.66	0.27 oc	0.00	---	---	0.00	---	---	---	---	---	0.265
2.21	351	65.70	0.27 oc	0.00	---	---	0.00	---	---	---	---	---	0.269
2.25	387	65.75	0.27 oc	0.00	---	---	0.00	---	---	---	---	---	0.272
2.30	449	65.79	0.27 oc	0.00	---	---	0.00	---	---	---	---	---	0.275
2.34	511	65.84	0.28 oc	0.00	---	---	0.00	---	---	---	---	---	0.278
2.39	574	65.88	0.28 oc	0.00	---	---	0.00	---	---	---	---	---	0.281
2.43	636	65.93	0.28 oc	0.00	---	---	0.00	---	---	---	---	---	0.284
2.48	698	65.97	0.29 oc	0.00	---	---	0.00	---	---	---	---	---	0.287
2.52	761	66.02	0.29 oc	0.00	---	---	0.00	---	---	---	---	---	0.290
2.57	823	66.06	0.29 oc	0.00	---	---	0.00	---	---	---	---	---	0.293
2.61	885	66.11	0.30 oc	0.00	---	---	0.00	---	---	---	---	---	0.296
2.66	948	66.15	0.30 oc	0.00	---	---	0.00	---	---	---	---	---	0.299
2.70	1,010	66.20	0.30 oc	0.00	---	---	0.00	---	---	---	---	---	0.302
2.75	1,069	66.24	0.30 oc	0.00	---	---	0.00	---	---	---	---	---	0.305
2.79	1,128	66.29	0.31 oc	0.00	---	---	0.00	---	---	---	---	---	0.308
2.84	1,187	66.33	0.31 oc	0.00	---	---	0.00	---	---	---	---	---	0.311
2.88	1,246	66.38	0.31 oc	0.00	---	---	0.00	---	---	---	---	---	0.313
2.93	1,305	66.42	0.32 oc	0.00	---	---	0.00	---	---	---	---	---	0.316
2.97	1,364	66.47	0.32 oc	0.00	---	---	0.00	---	---	---	---	---	0.319
3.02	1,423	66.51	0.32 oc	0.00	---	---	0.00	---	---	---	---	---	0.322
3.06	1,482	66.56	0.32 oc	0.00	---	---	0.00	---	---	---	---	---	0.324
3.11	1,541	66.60	0.33 oc	0.00	---	---	0.00	---	---	---	---	---	0.327
3.15	1,600	66.65	0.33 oc	0.00	---	---	0.00	---	---	---	---	---	0.330
3.20	1,653	66.69	0.33 oc	0.00	---	---	0.00	---	---	---	---	---	0.332
3.24	1,706	66.74	0.33 oc	0.00	---	---	0.00	---	---	---	---	---	0.335
3.29	1,759	66.78	0.34 oc	0.00	---	---	0.00	---	---	---	---	---	0.337
3.33	1,812	66.83	0.34 oc	0.00	---	---	0.00	---	---	---	---	---	0.340
3.38	1,865	66.87	0.34 oc	0.00	---	---	0.00	---	---	---	---	---	0.342
3.42	1,918	66.92	0.34 oc	0.00	---	---	0.00	---	---	---	---	---	0.345
3.47	1,971	66.96	0.35 oc	0.00	---	---	0.00	---	---	---	---	---	0.347
3.51	2,024	67.01	0.35 oc	0.00	---	---	0.00	---	---	---	---	---	0.350
3.56	2,078	67.05	0.35 oc	0.00	---	---	0.00	---	---	---	---	---	0.352
3.60	2,131	67.10	0.35 oc	0.00	---	---	0.00	---	---	---	---	---	0.355
3.65	2,174	67.14	0.36 oc	0.00	---	---	0.00	---	---	---	---	---	0.357
3.69	2,217	67.19	0.36 oc	0.00	---	---	0.00	---	---	---	---	---	0.360
3.74	2,261	67.23	0.36 oc	0.00	---	---	0.00	---	---	---	---	---	0.362
3.78	2,304	67.28	0.36 oc	0.00	---	---	0.00	---	---	---	---	---	0.365
3.83	2,348	67.32	0.37 oc	0.00	---	---	0.00	---	---	---	---	---	0.367
3.87	2,391	67.37	0.37 oc	0.00	---	---	0.00	---	---	---	---	---	0.369
3.92	2,434	67.41	0.37 oc	0.00	---	---	0.00	---	---	---	---	---	0.372
3.96	2,478	67.46	0.37 oc	0.00	---	---	0.00	---	---	---	---	---	0.374
4.01	2,521	67.50	0.38 oc	0.00 ic	---	---	0.00	---	---	---	---	---	0.376
4.05	2,565	67.55	0.38 oc	0.02 ic	---	---	0.00	---	---	---	---	---	0.402
4.10	2,590	67.60	0.38 oc	0.08 ic	---	---	0.00	---	---	---	---	---	0.463
4.14	2,615	67.64	0.38 oc	0.17 ic	---	---	0.00	---	---	---	---	---	0.555
4.19	2,640	67.68	0.39 oc	0.29 ic	---	---	0.00	---	---	---	---	---	0.676
4.23	2,665	67.73	0.39 oc	0.43 ic	---	---	0.00	---	---	---	---	---	0.820
4.28	2,691	67.77	0.39 oc	0.59 ic	---	---	0.00	---	---	---	---	---	0.983
4.32	2,716	67.82	0.39 oc	0.77 ic	---	---	0.22	---	---	---	---	---	1.380
4.37	2,741	67.86	0.39 oc	0.95 ic	---	---	1.29	---	---	---	---	---	2.635
4.41	2,766	67.91	0.40 oc	1.13 ic	---	---	2.85	---	---	---	---	---	4.369
4.46	2,791	67.95	0.40 oc	1.29 ic	---	---	4.76	---	---	---	---	---	6.450
4.50	2,817	68.00	0.40 oc	1.42 ic	---	---	6.98	---	---	---	---	---	8.795

...End

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	3.400	2	724	11,482	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.108	2	724	333	------	------	------	SUBAREA-PUN1
3	SCS Runoff	2.688	2	724	8,158	------	------	------	SUBAREA-PR1
4	Reservoir	0.603	2	748	8,157	3	67.66	2,625	Sand Filter

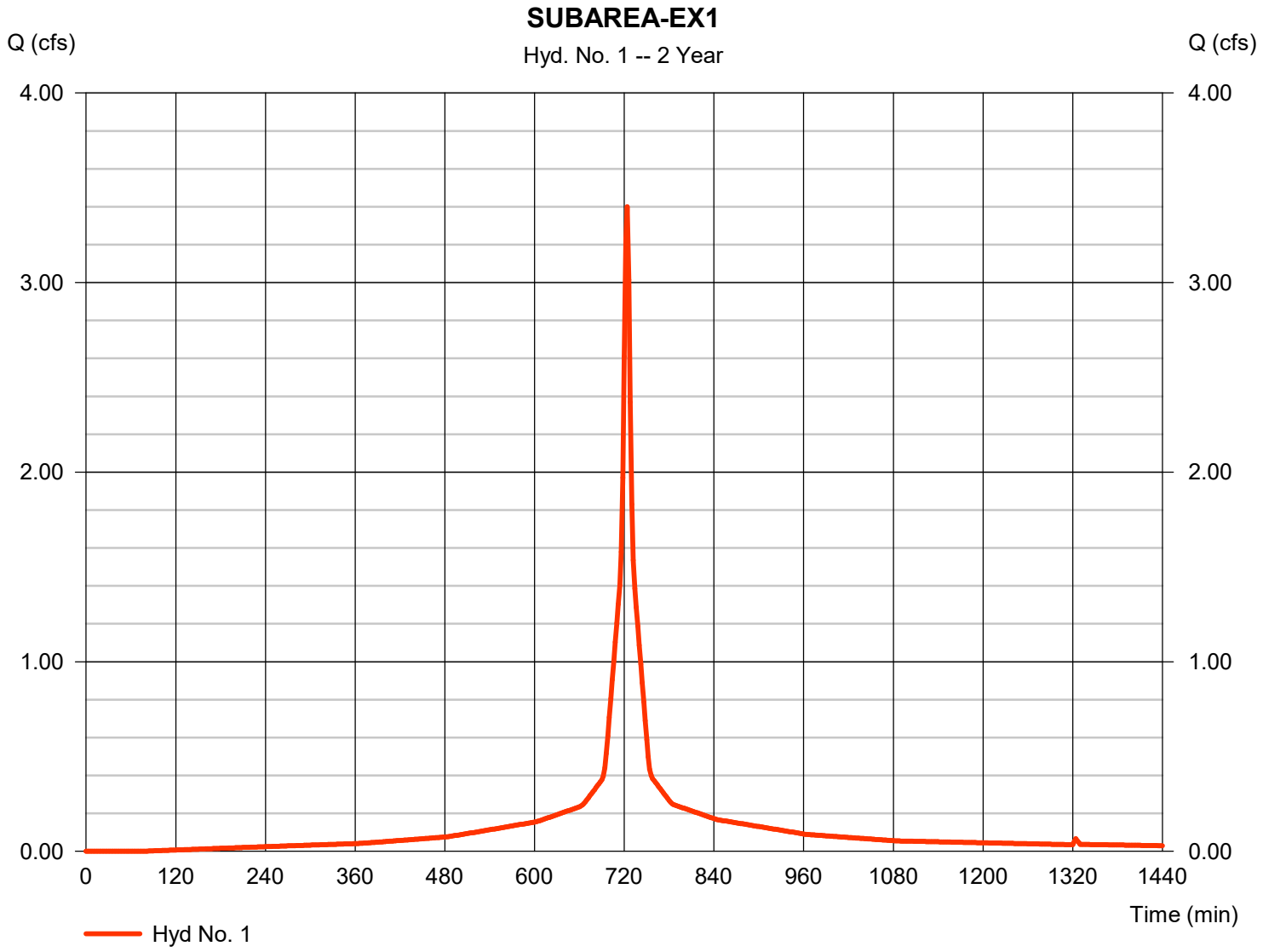
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.400 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	11,482 cuft
Drainage area	=	1.100 ac	Curve number	=	98*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



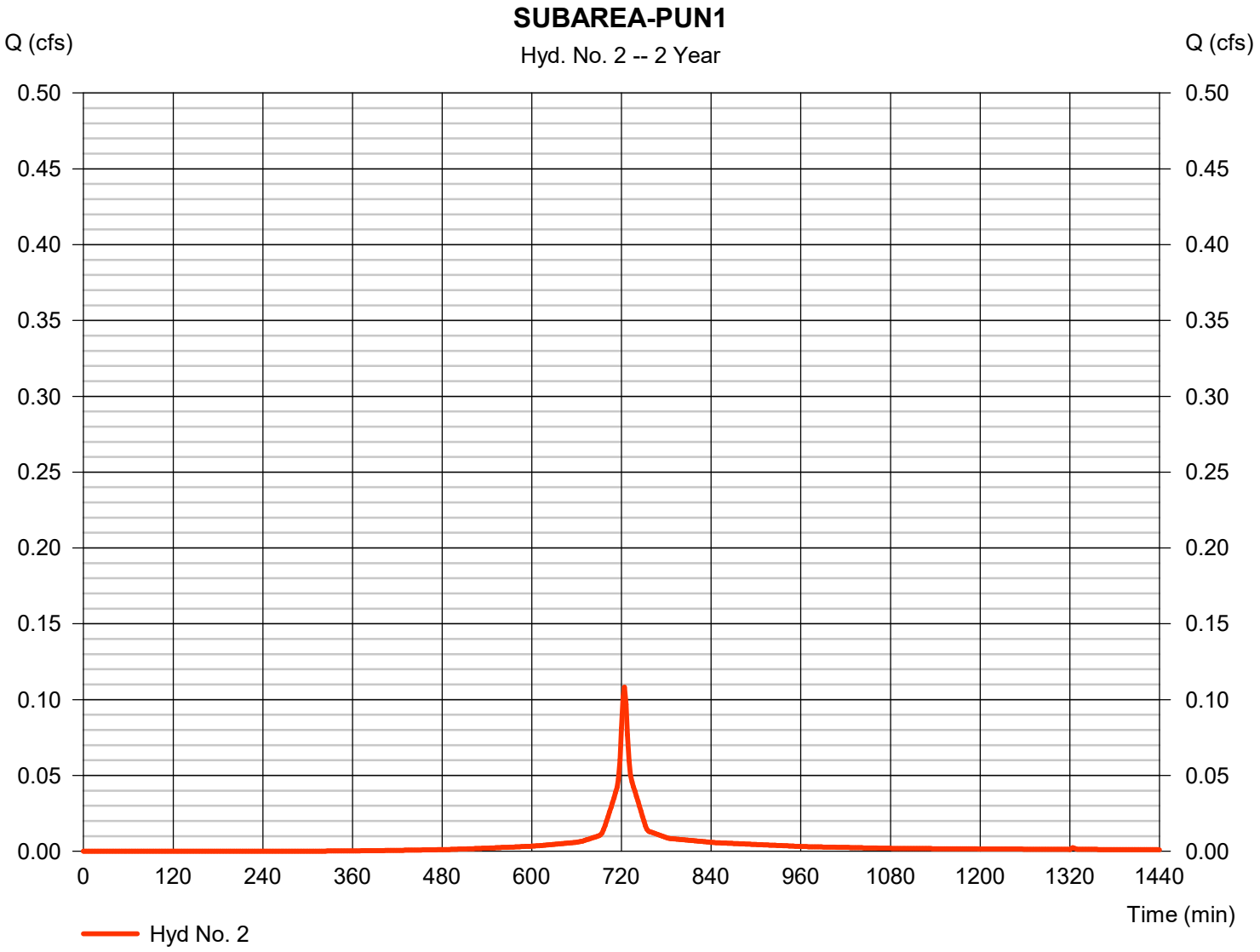
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.108 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	333 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



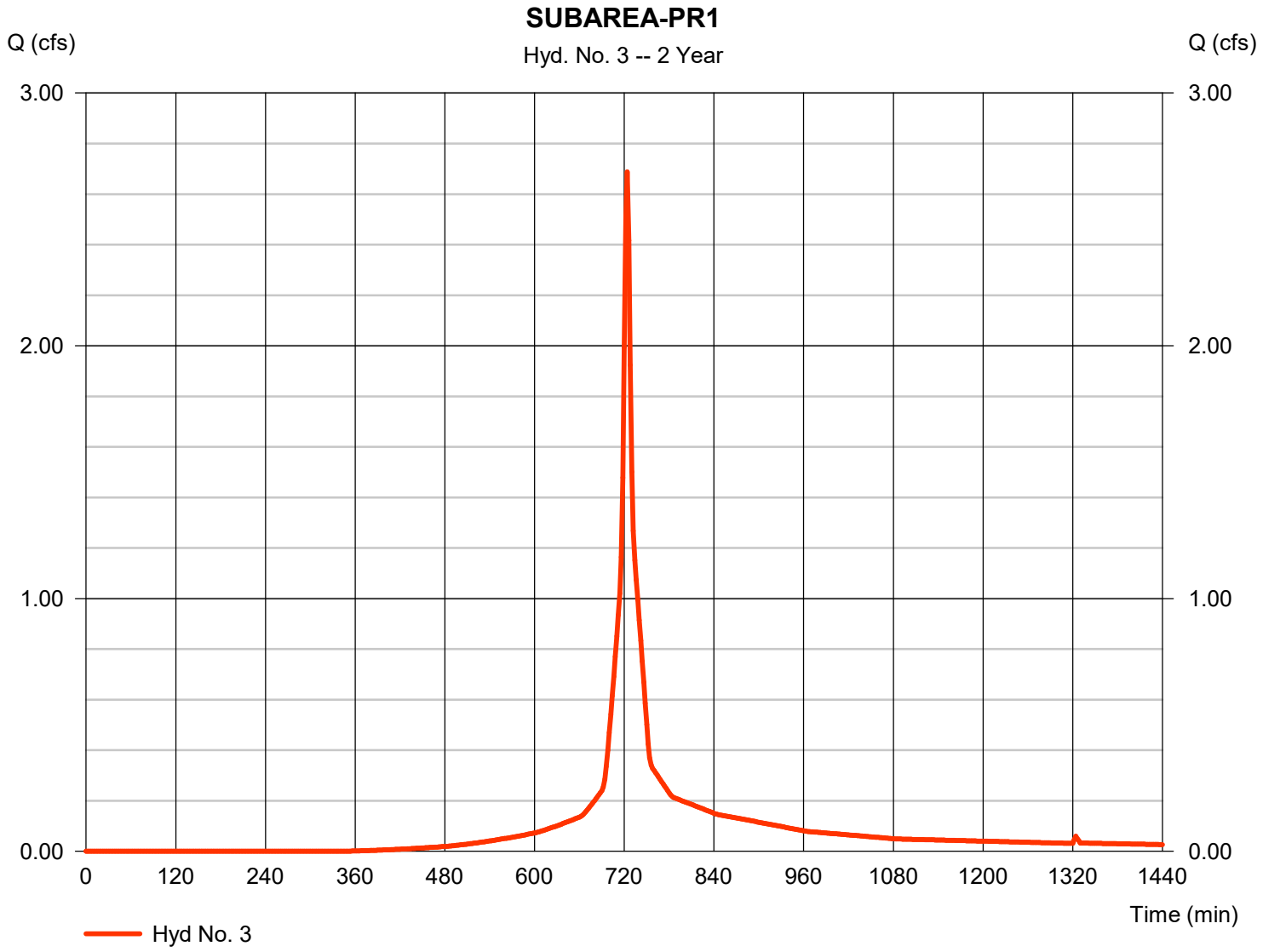
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.688 cfs
Storm frequency	=	2 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	8,158 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	3.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



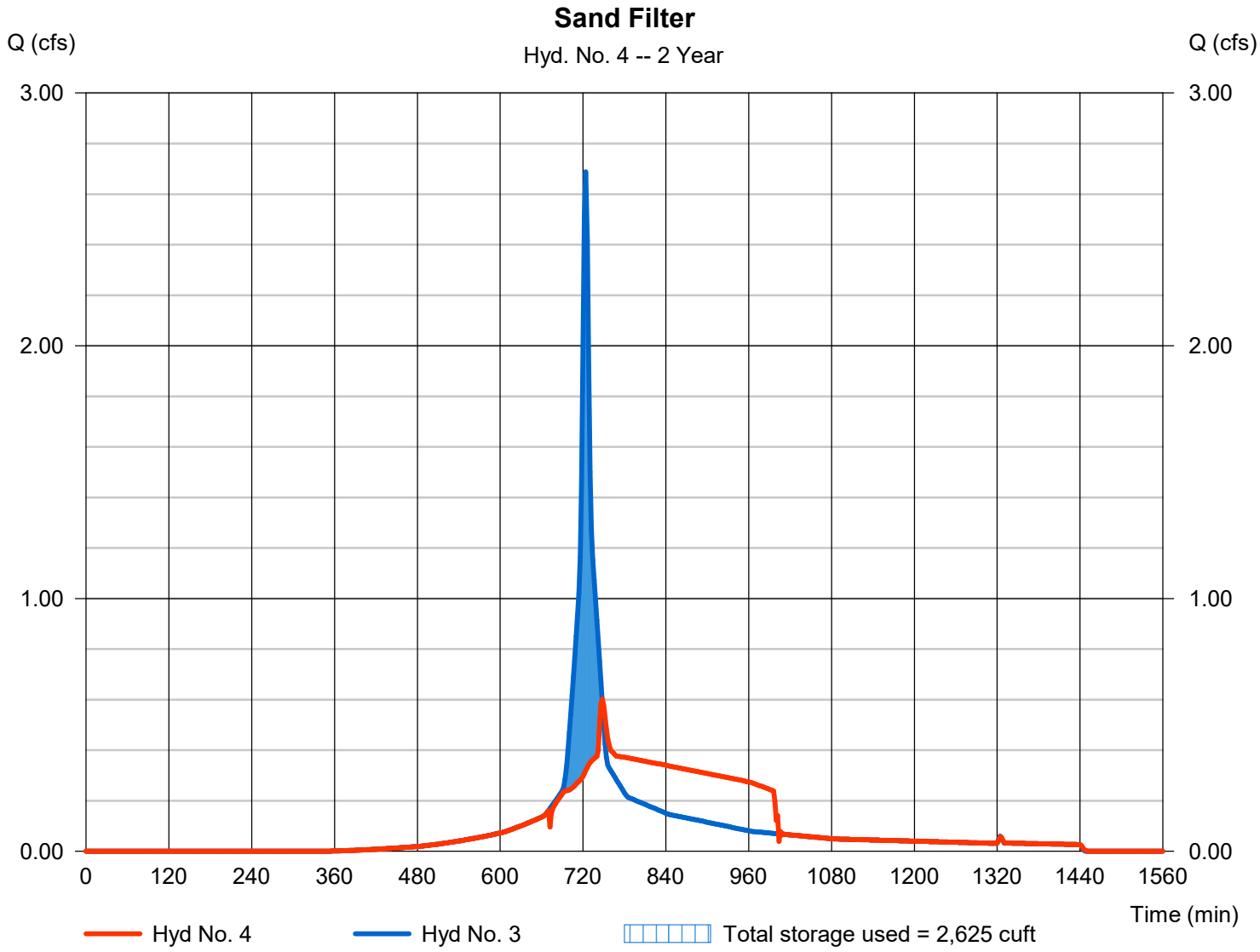
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	0.603 cfs
Storm frequency	=	2 yrs	Time to peak	=	748 min
Time interval	=	2 min	Hyd. volume	=	8,157 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	67.66 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	2,625 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	4.241	2	724	14,468	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.140	2	724	438	------	------	------	SUBAREA-PUN1
3	SCS Runoff	3.538	2	724	10,873	------	------	------	SUBAREA-PR1
4	Reservoir	2.558	2	730	10,873	3	67.86	2,740	Sand Filter

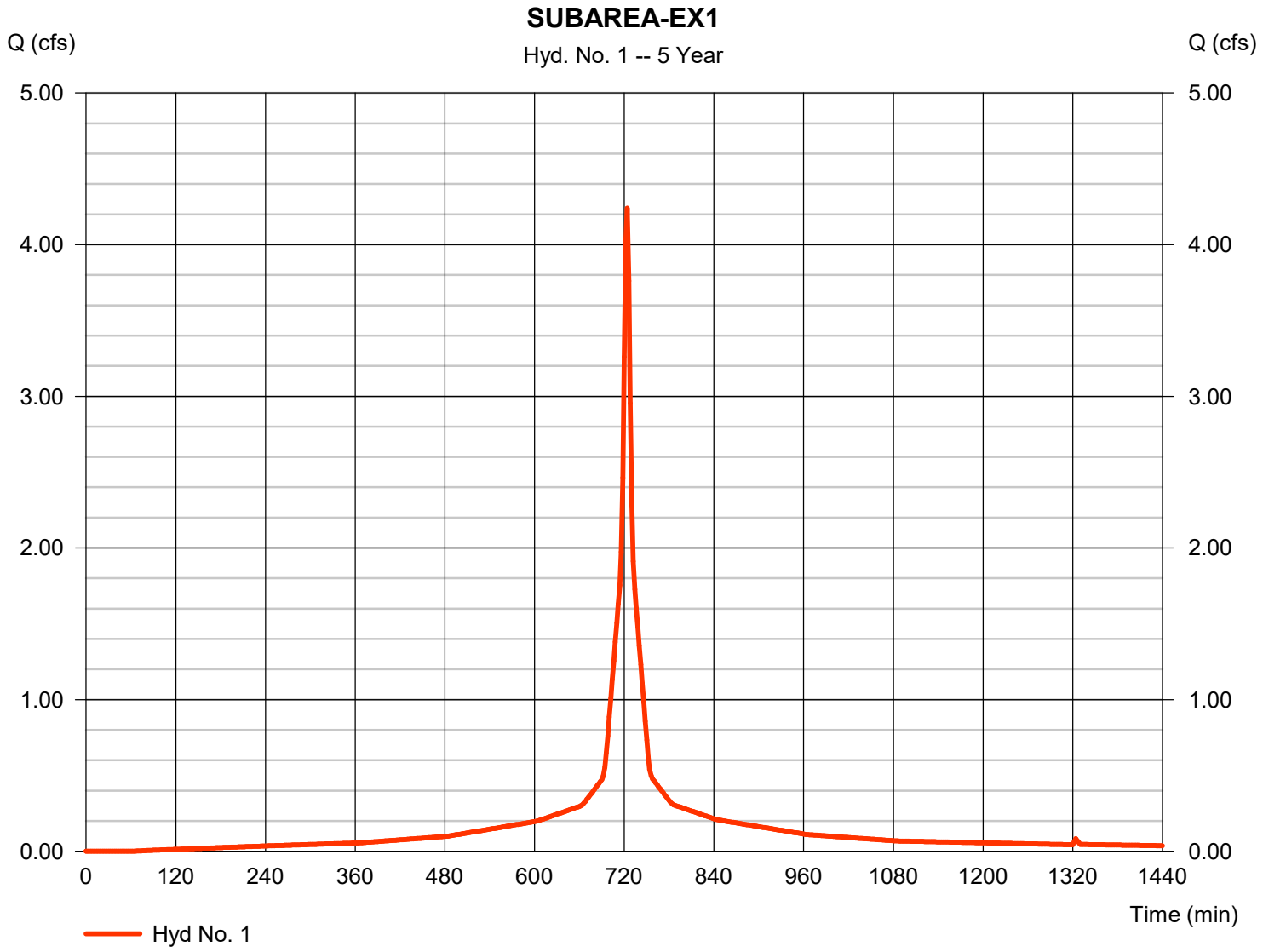
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.241 cfs
Storm frequency	=	5 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	14,468 cuft
Drainage area	=	1.100 ac	Curve number	=	98*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



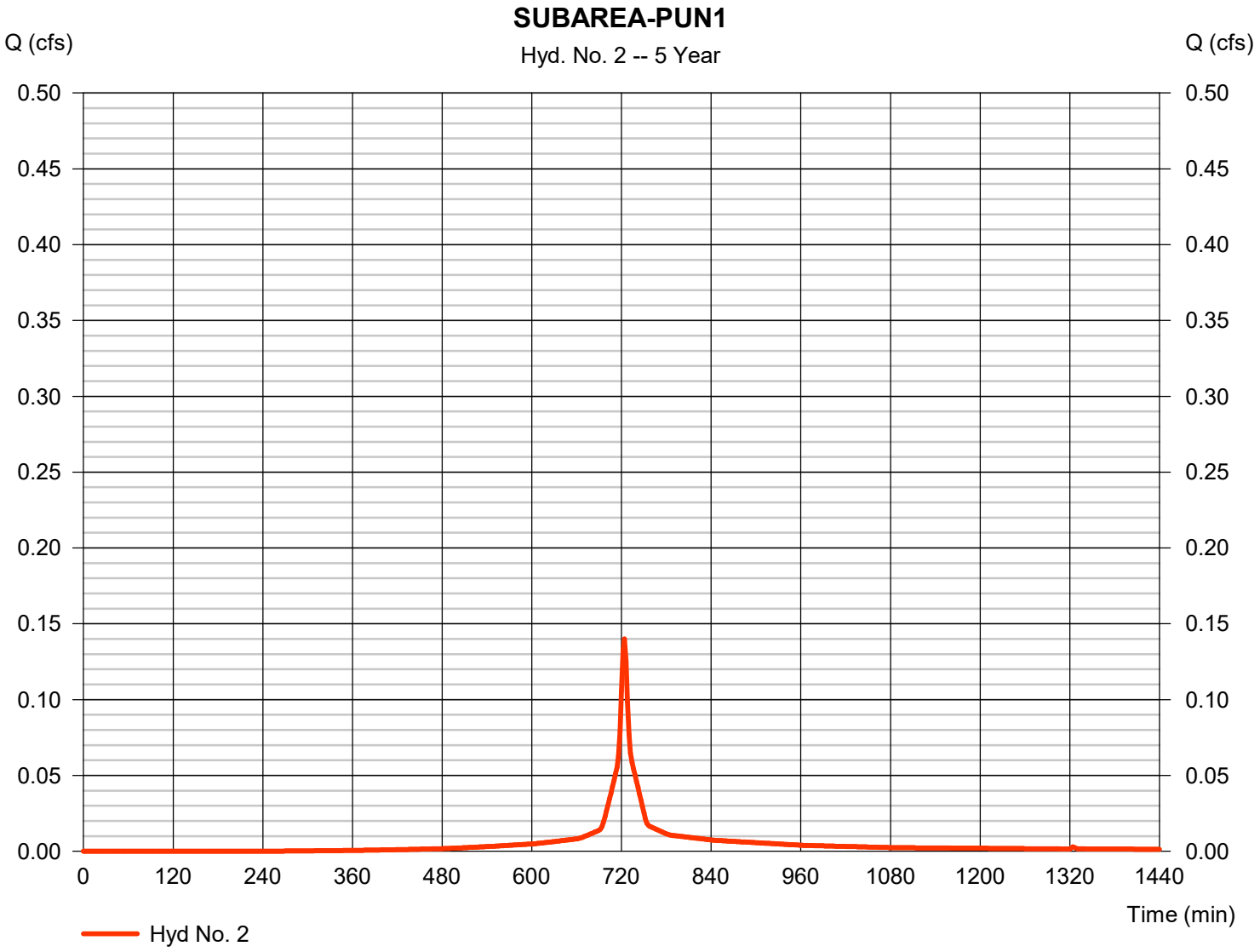
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.140 cfs
Storm frequency	=	5 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	438 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



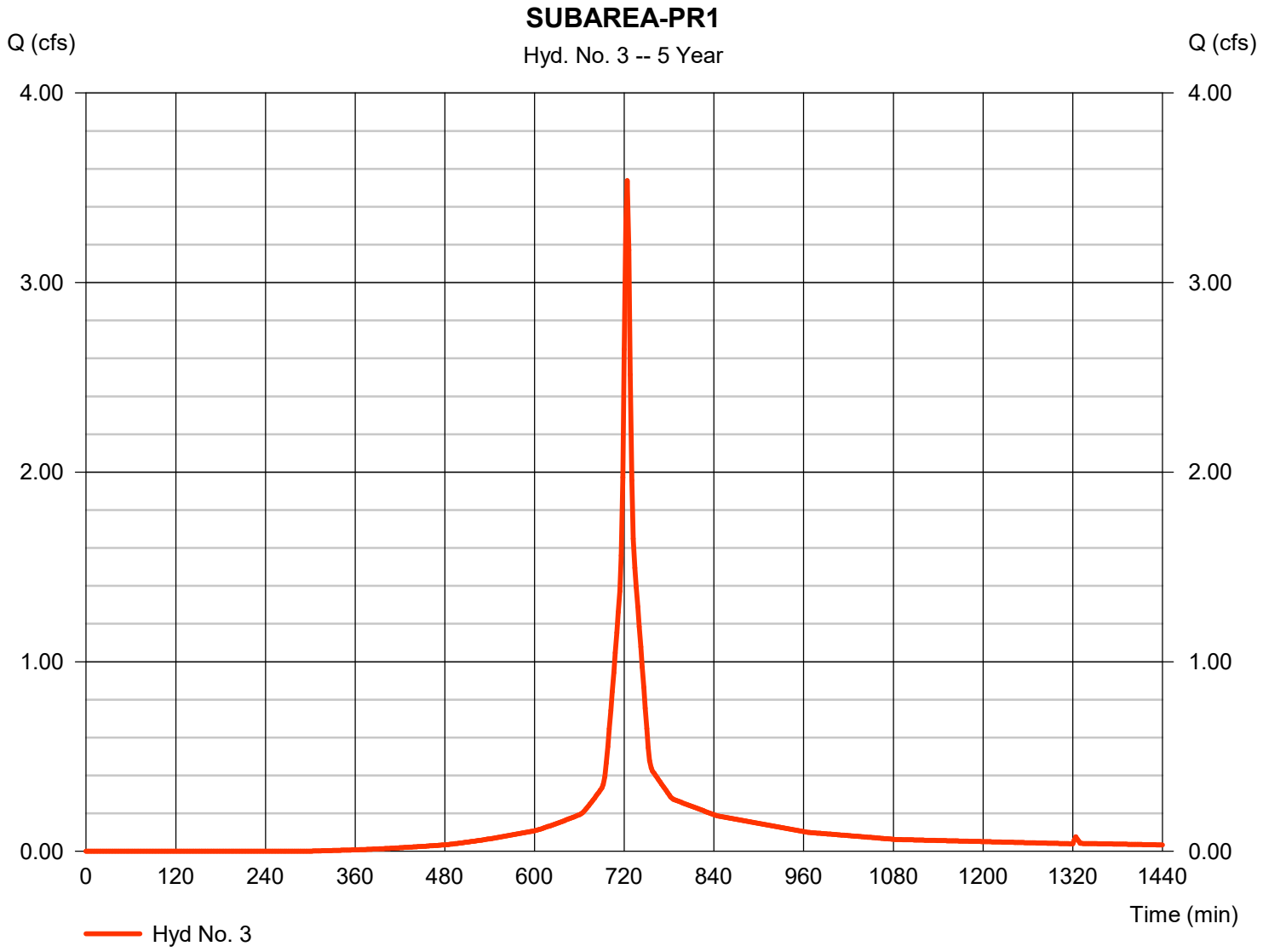
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.538 cfs
Storm frequency	=	5 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	10,873 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



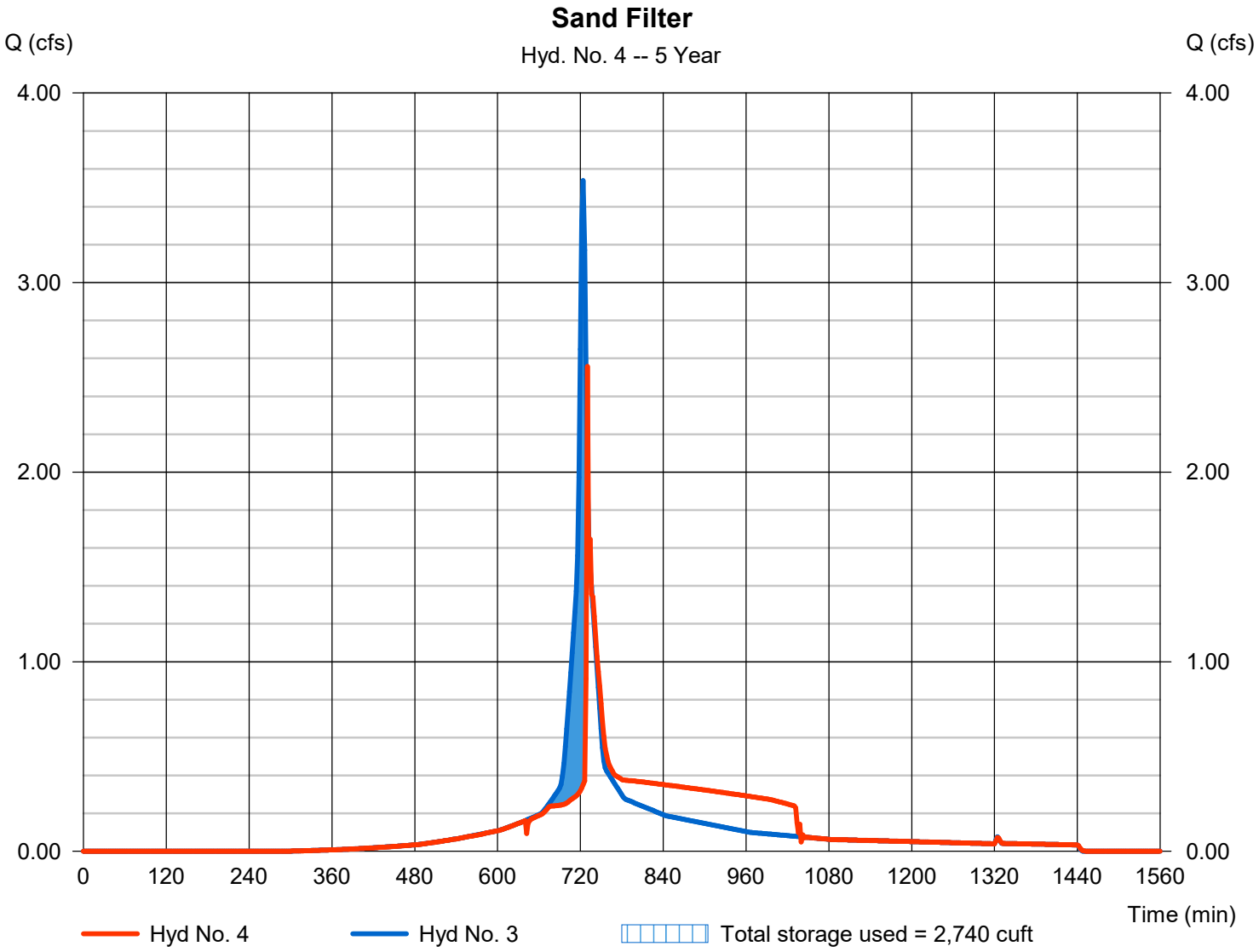
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	2.558 cfs
Storm frequency	=	5 yrs	Time to peak	=	730 min
Time interval	=	2 min	Hyd. volume	=	10,873 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	67.86 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	2,740 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	5.081	2	724	17,457	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.172	2	724	543	------	------	------	SUBAREA-PUN1
3	SCS Runoff	4.386	2	724	13,635	------	------	------	SUBAREA-PR1
4	Reservoir	5.715	2	726	13,635	3	67.94	2,783	Sand Filter

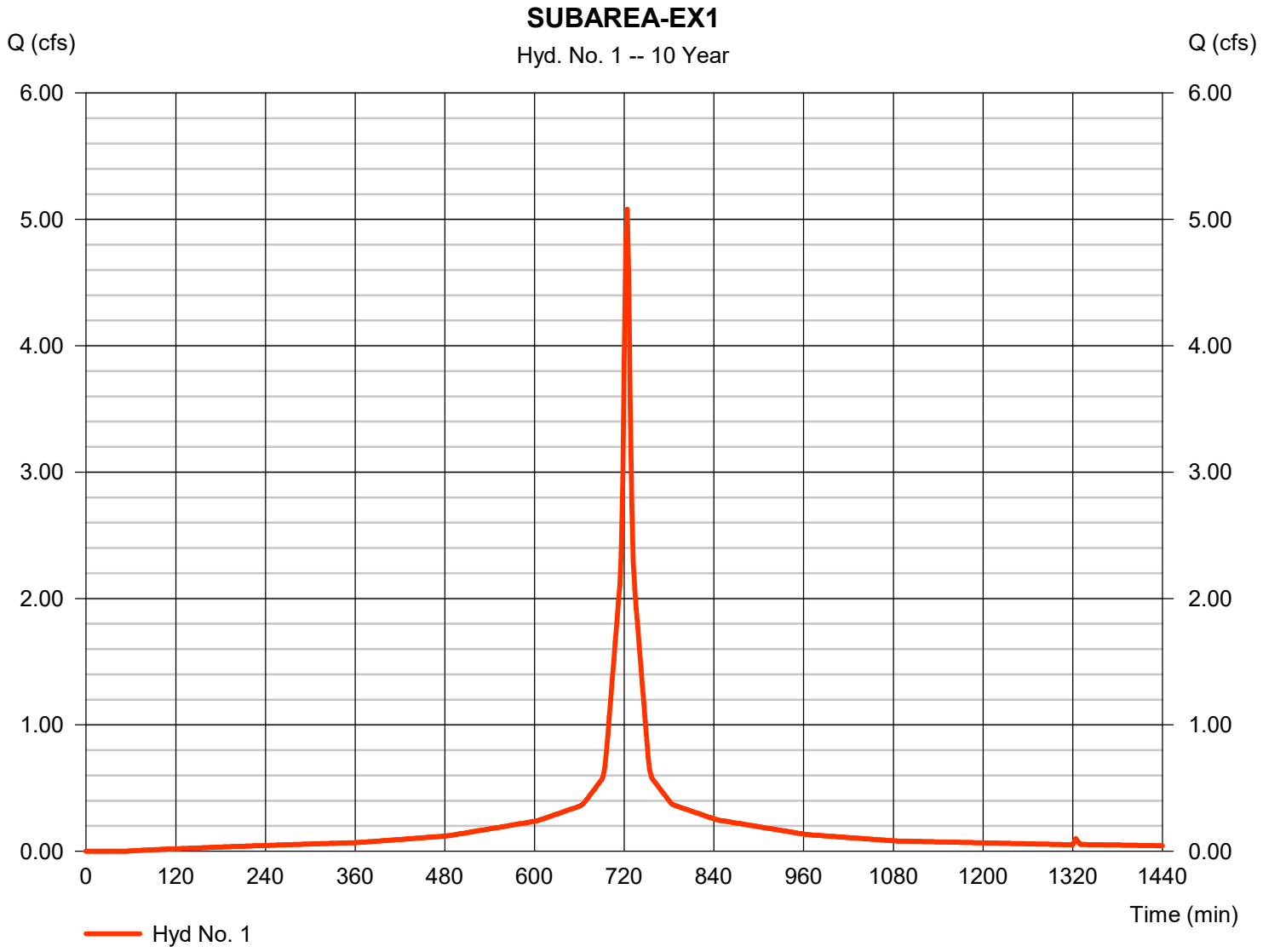
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	= SCS Runoff	Peak discharge	= 5.081 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 2 min	Hyd. volume	= 17,457 cuft
Drainage area	= 1.100 ac	Curve number	= 98*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.90 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



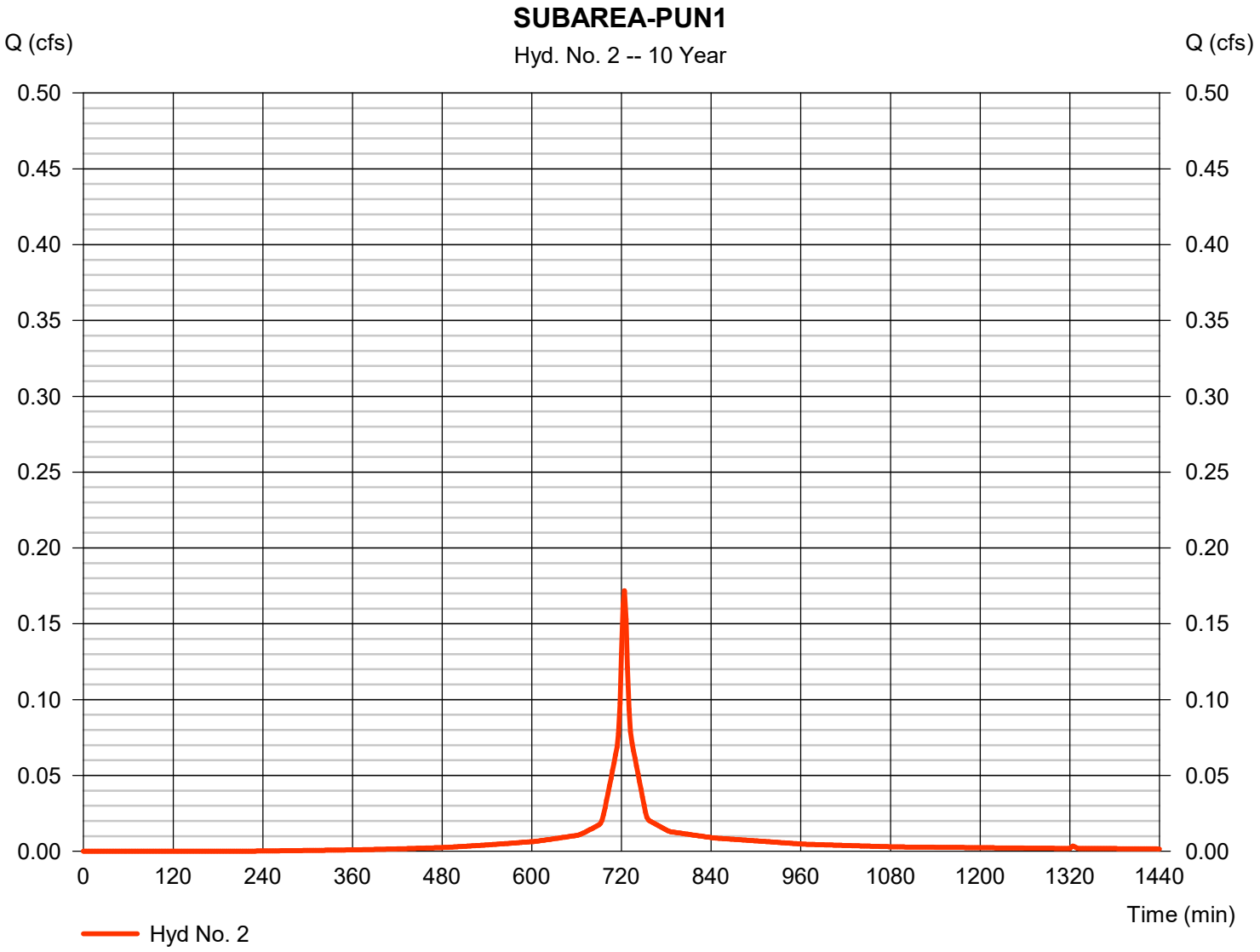
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.172 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	543 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.90 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



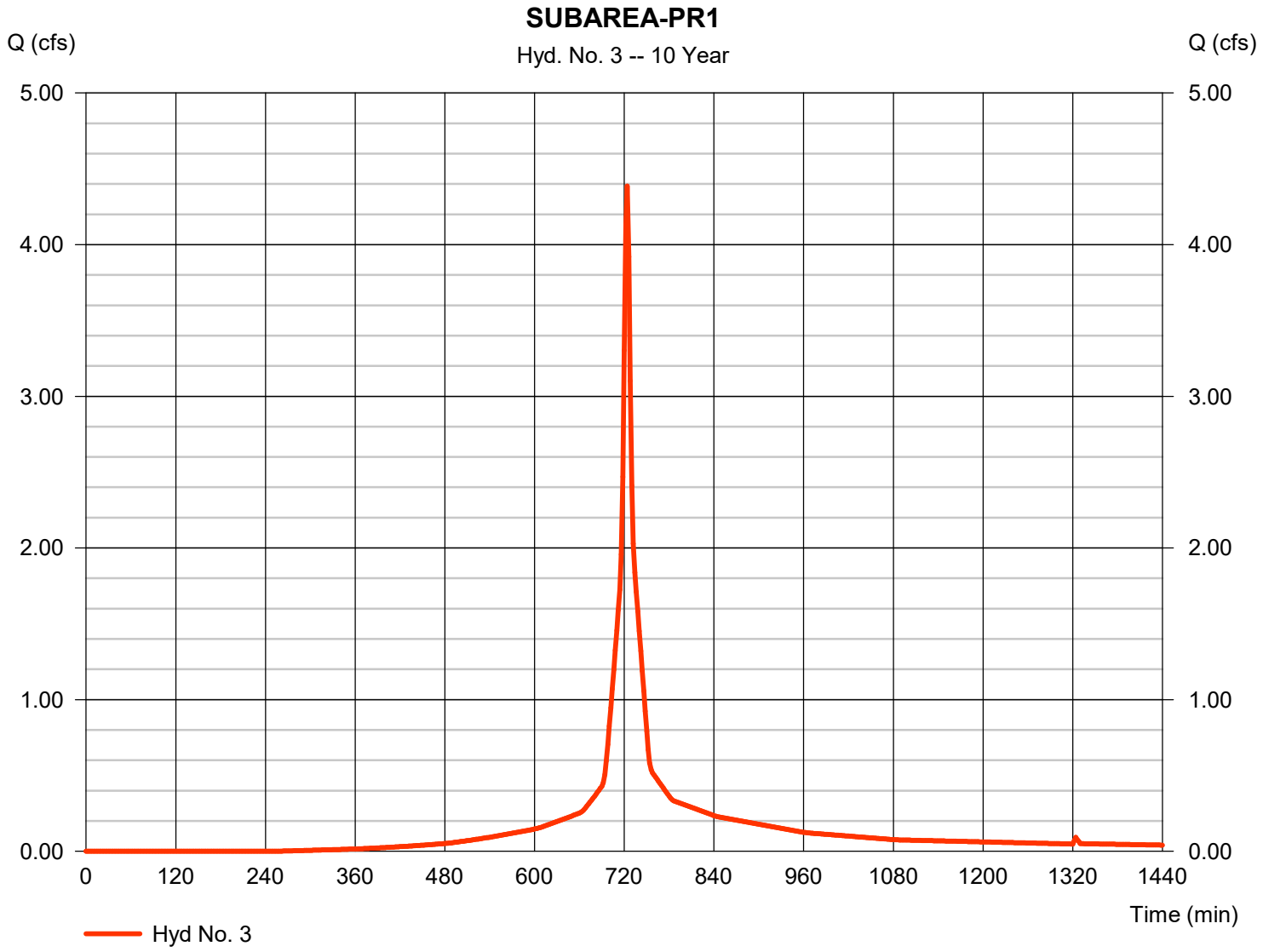
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.386 cfs
Storm frequency	=	10 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	13,635 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	4.90 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



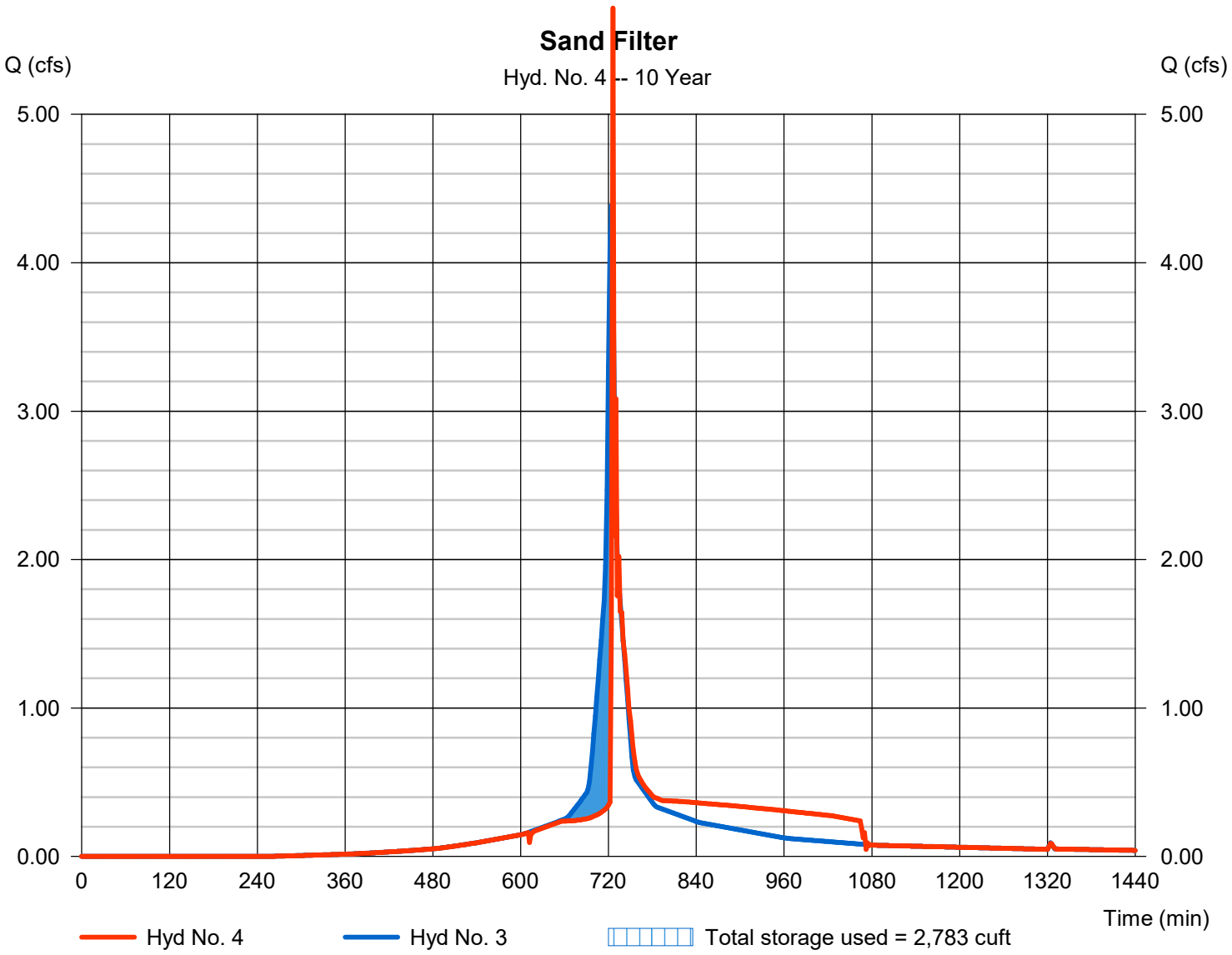
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	5.715 cfs
Storm frequency	=	10 yrs	Time to peak	=	726 min
Time interval	=	2 min	Hyd. volume	=	13,635 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	67.94 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	2,783 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	6.338	2	724	21,943	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.219	2	724	703	------	------	------	SUBAREA-PUN1
3	SCS Runoff	5.649	2	724	17,832	------	------	------	SUBAREA-PR1
4	Reservoir	6.271	2	722	17,832	3	67.95	2,789	Sand Filter

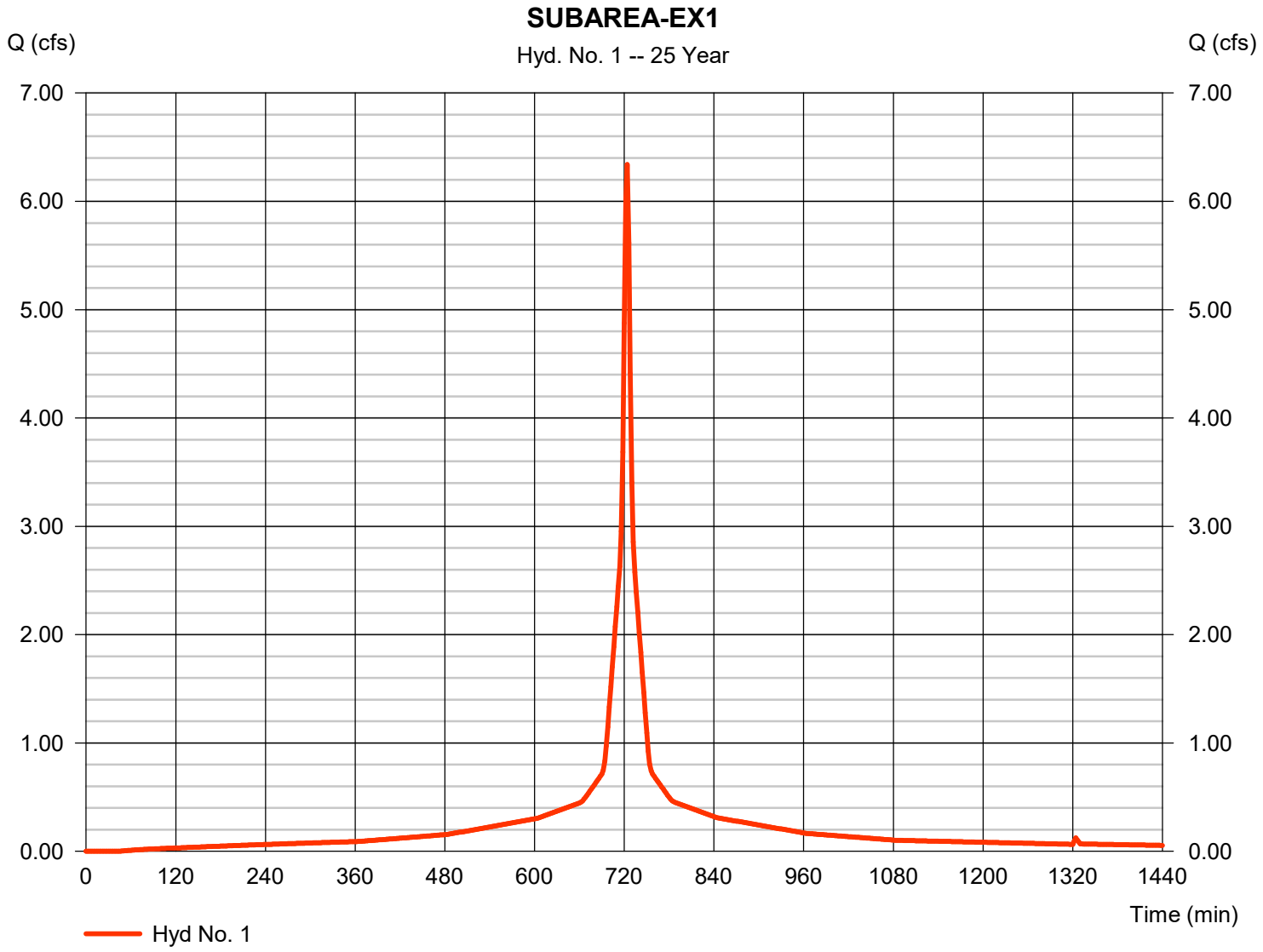
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.338 cfs
Storm frequency	=	25 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	21,943 cuft
Drainage area	=	1.100 ac	Curve number	=	98*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	6.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



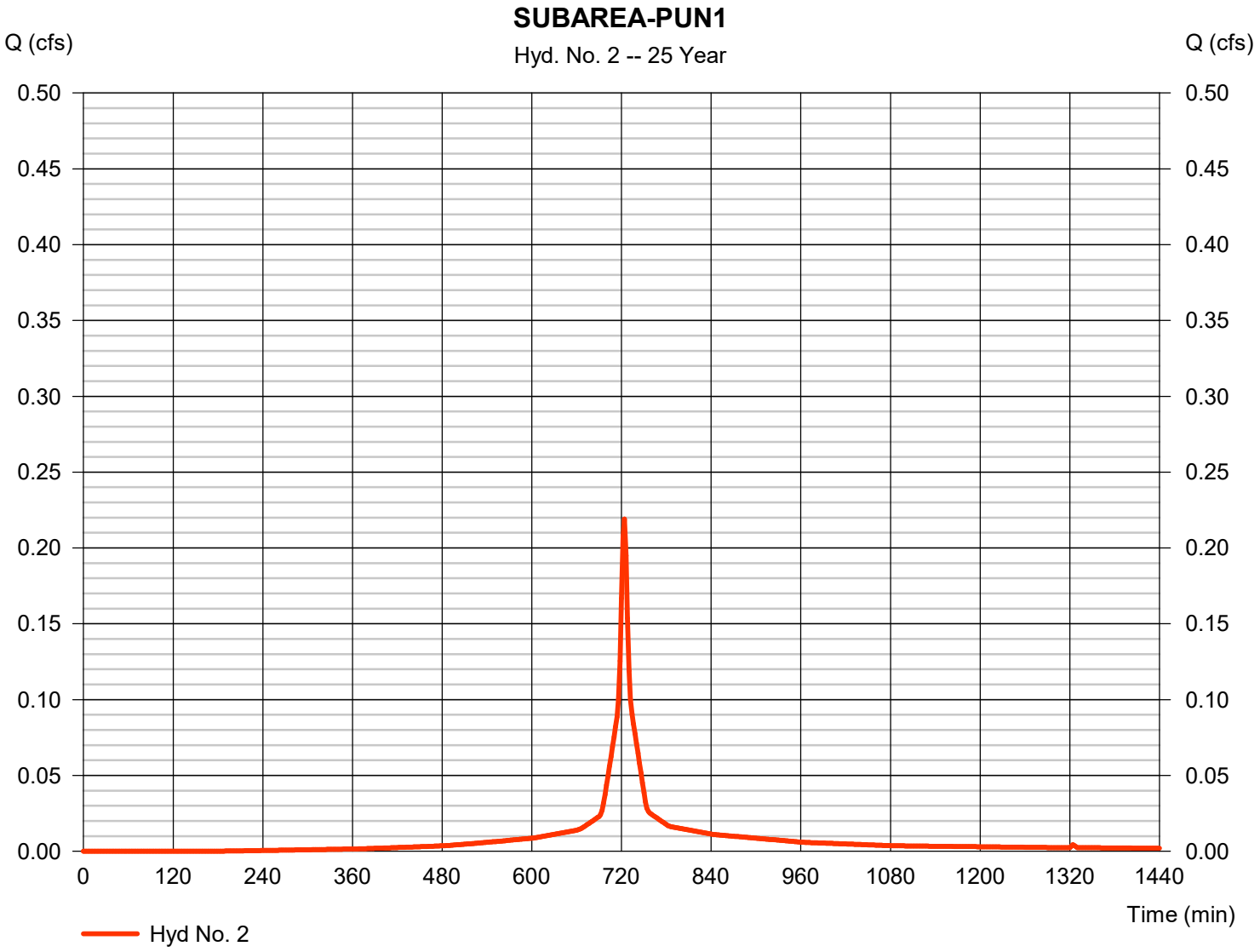
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.219 cfs
Storm frequency	=	25 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	703 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	6.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



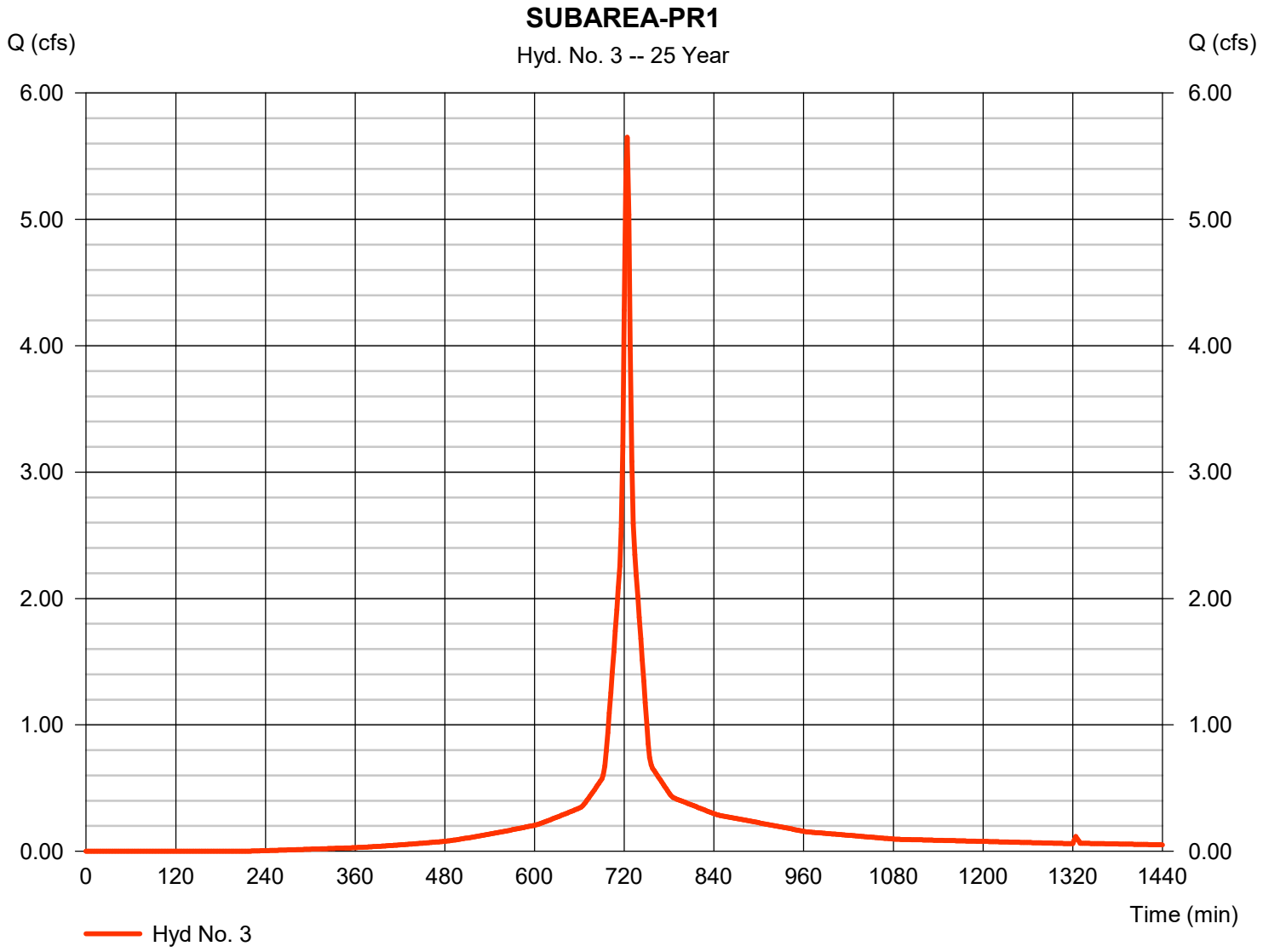
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	5.649 cfs
Storm frequency	=	25 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	17,832 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	6.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



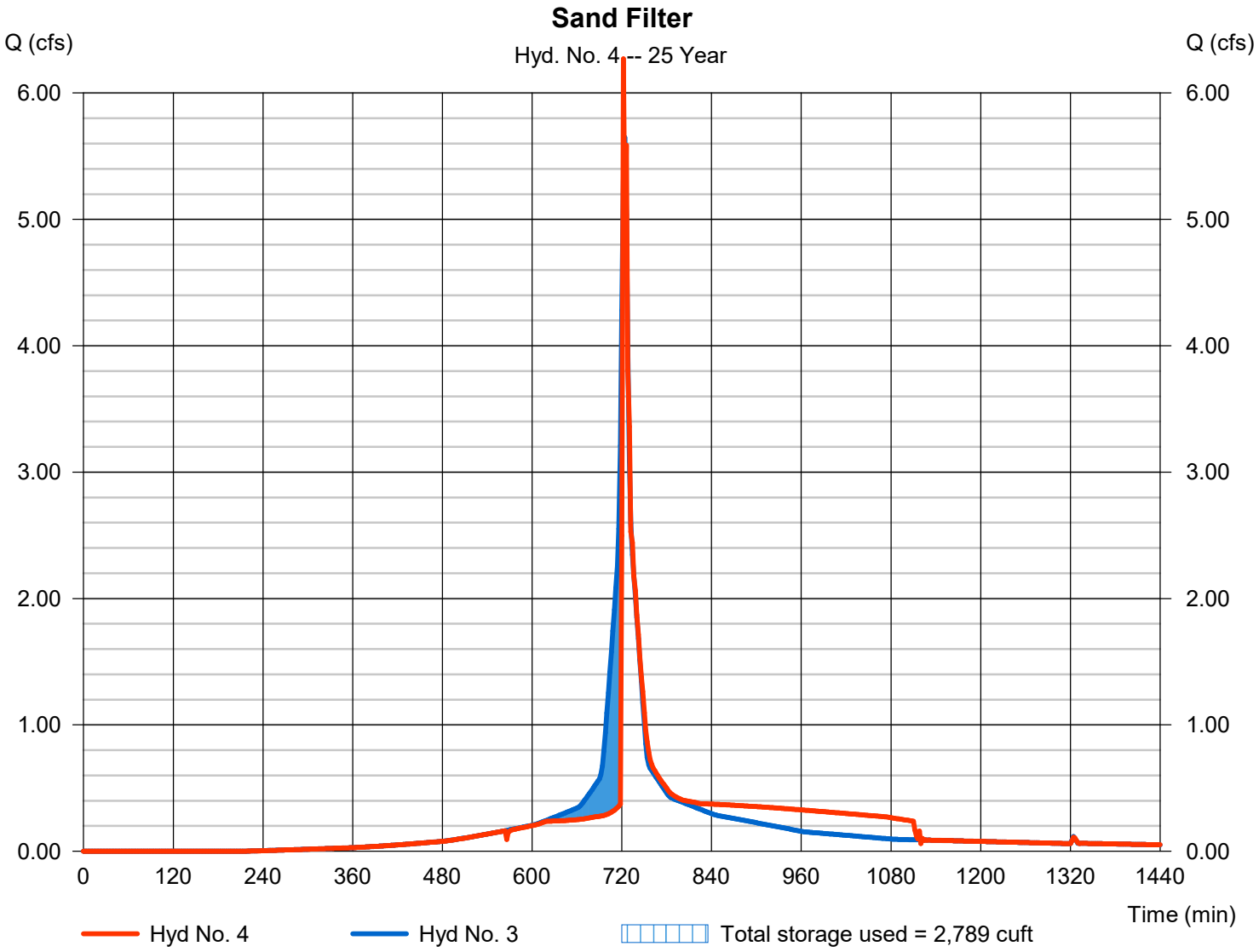
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	6.271 cfs
Storm frequency	=	25 yrs	Time to peak	=	722 min
Time interval	=	2 min	Hyd. volume	=	17,832 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	67.95 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	2,789 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	7.594	2	724	26,431	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.266	2	724	865	------	------	------	SUBAREA-PUN1
3	SCS Runoff	6.903	2	724	22,067	------	------	------	SUBAREA-PR1
4	Reservoir	7.051	2	724	22,067	3	67.97	2,798	Sand Filter

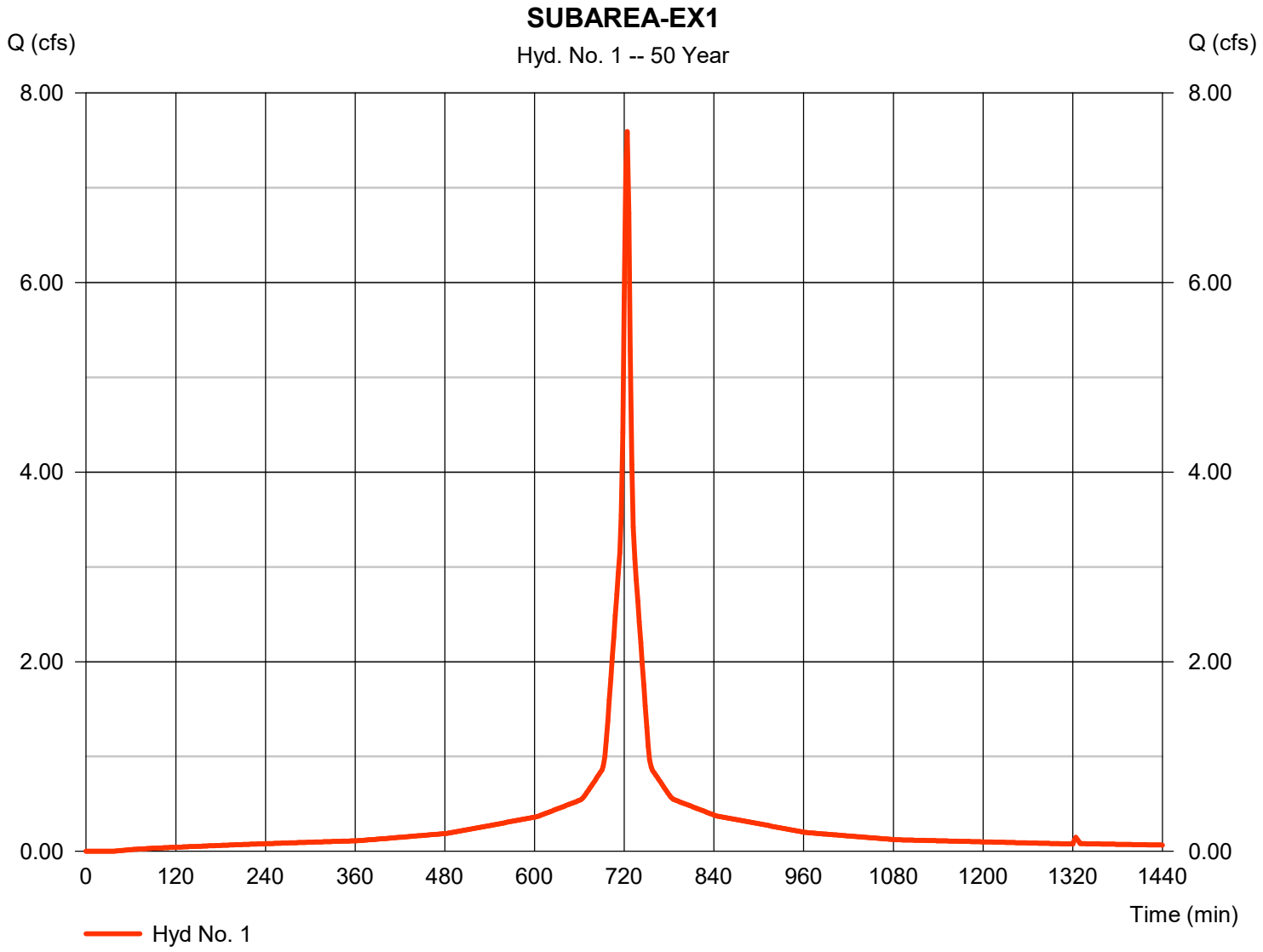
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.594 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	26,431 cuft
Drainage area	=	1.100 ac	Curve number	=	98*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



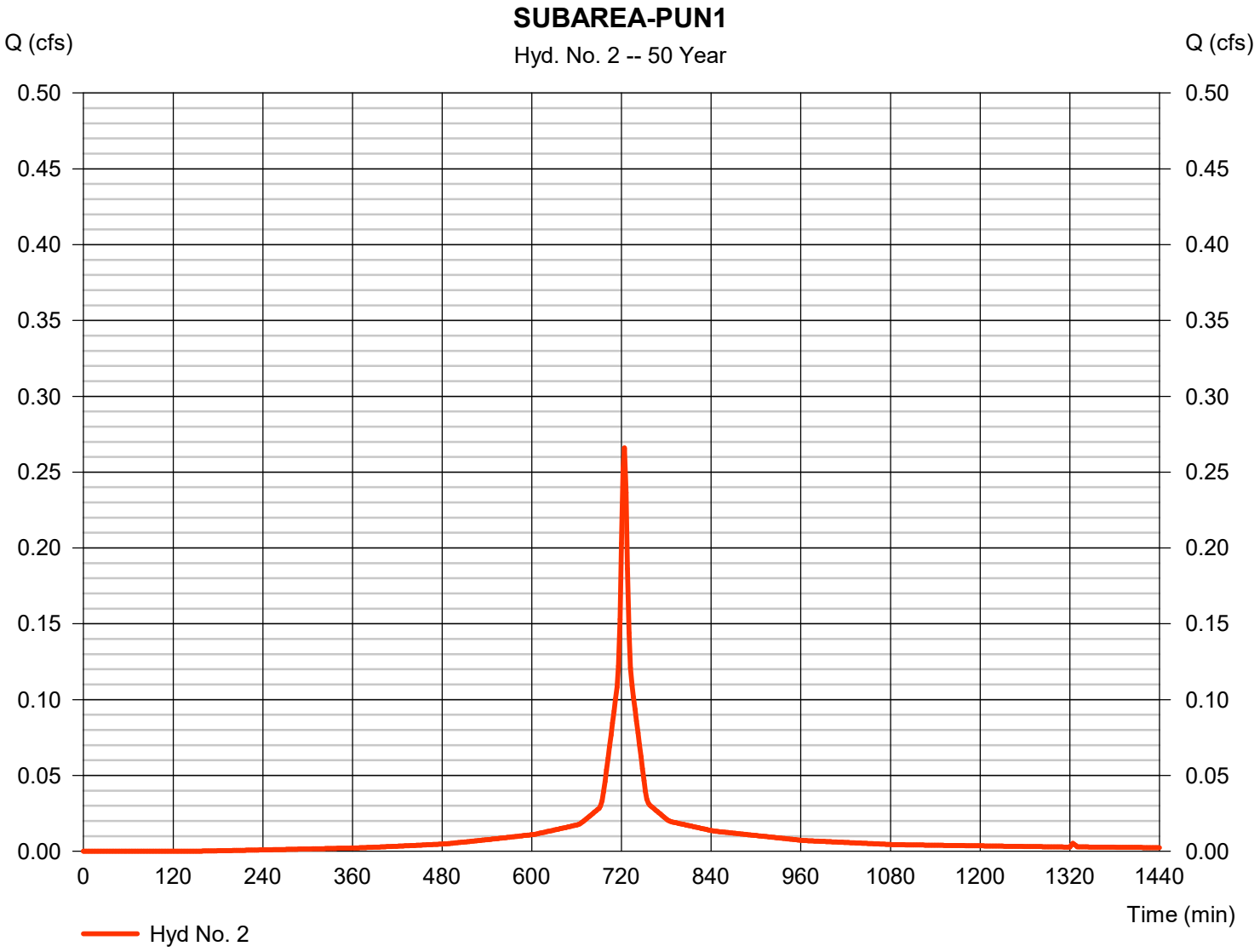
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.266 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	865 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



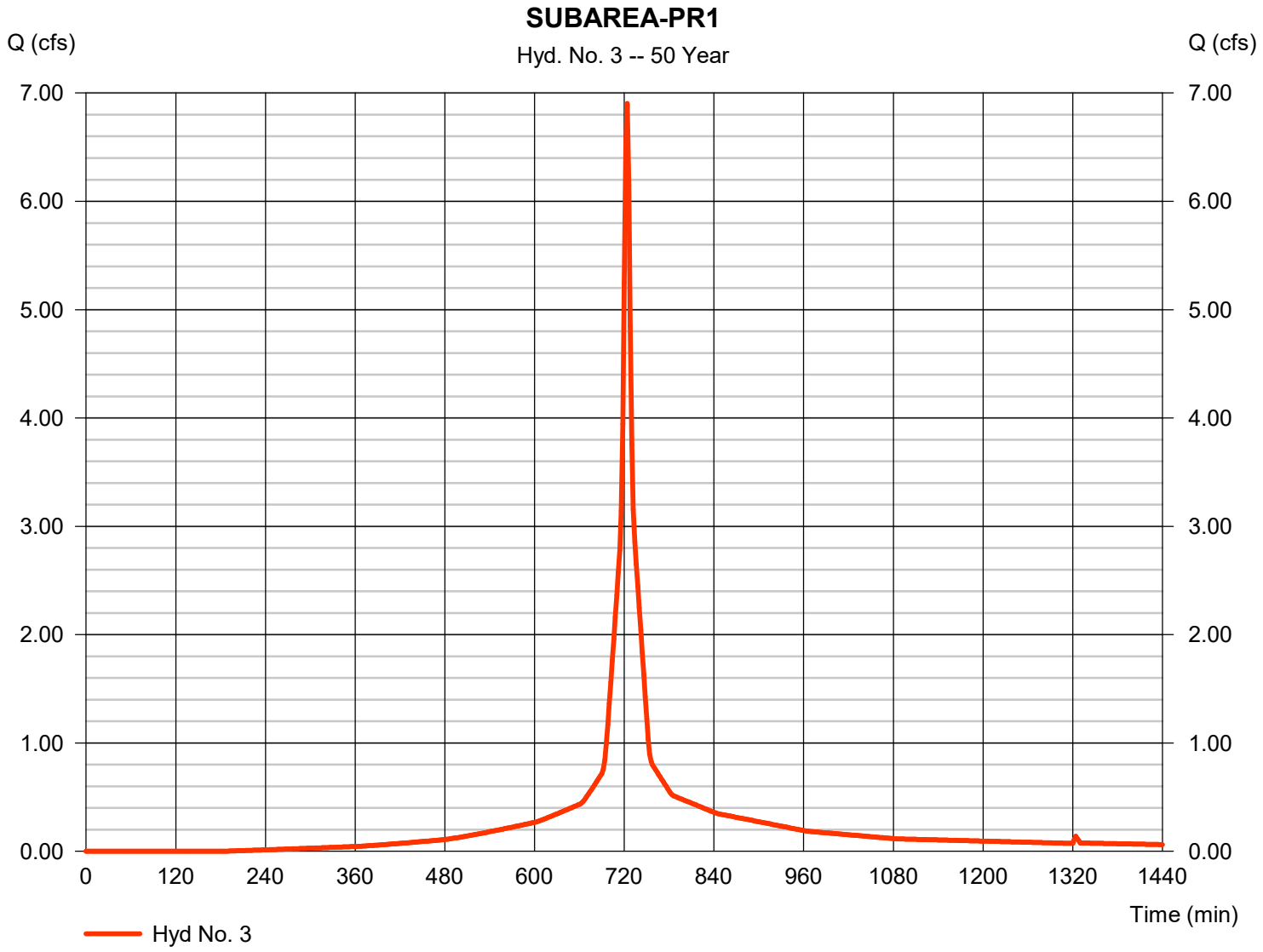
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.903 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	22,067 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	7.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



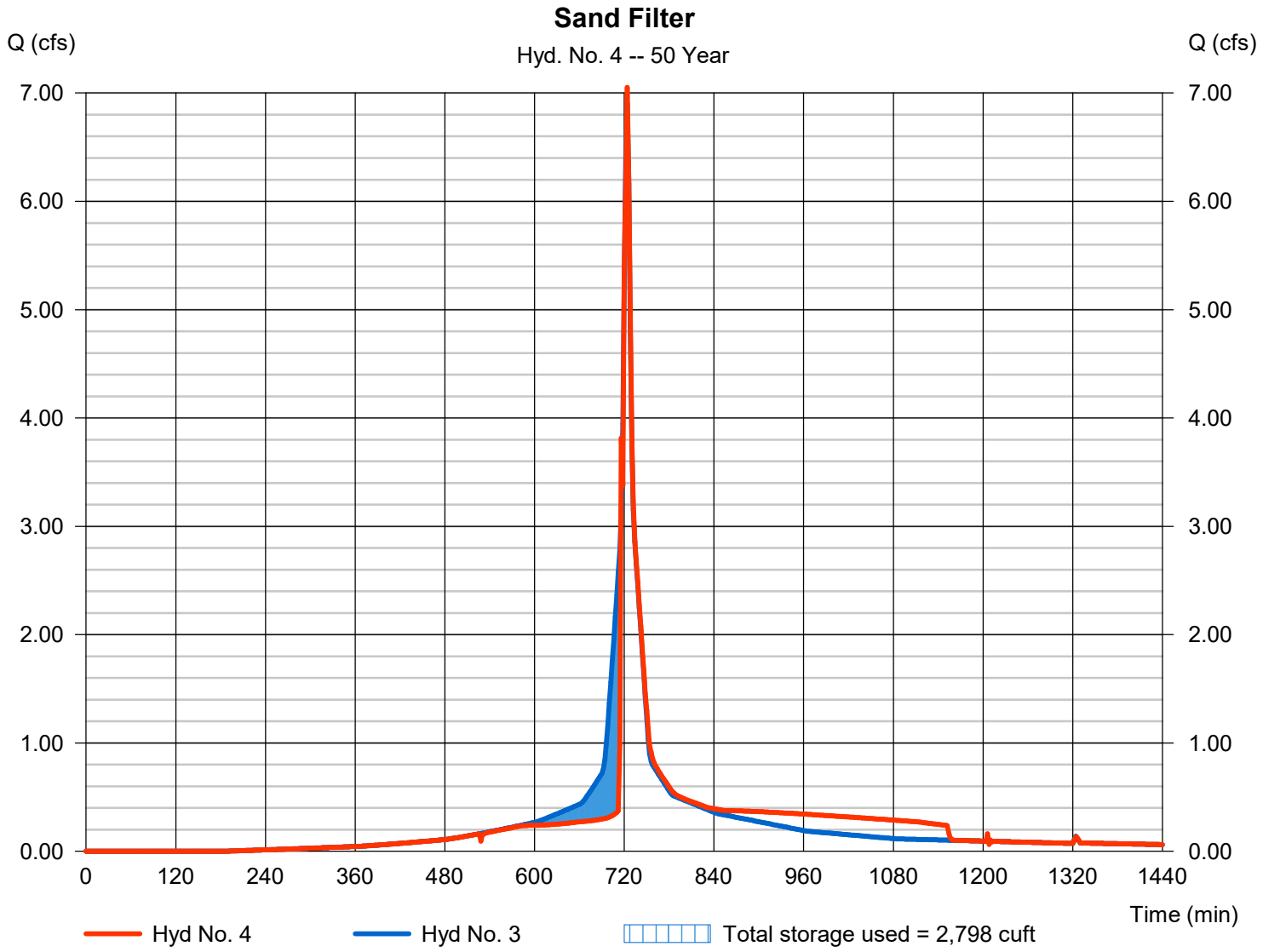
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	7.051 cfs
Storm frequency	=	50 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	22,067 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	67.97 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	2,798 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2022

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.058	2	724	31,669	------	------	------	SUBAREA-EX1
2	SCS Runoff	0.320	2	724	1,053	------	------	------	SUBAREA-PUN1
3	SCS Runoff	8.357	2	724	27,038	------	------	------	SUBAREA-PR1
4	Reservoir	8.362	2	724	27,038	3	67.99	2,812	Sand Filter

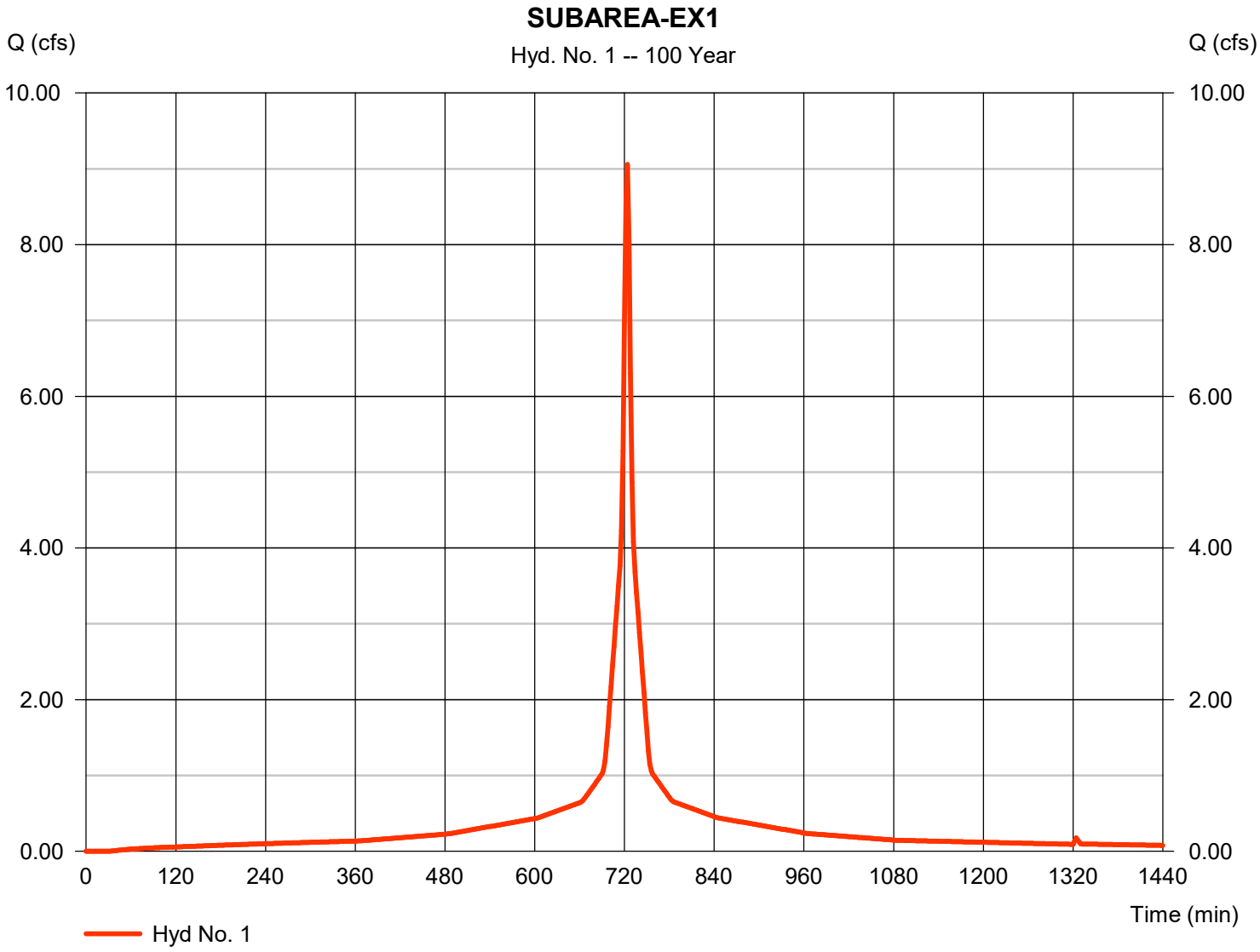
Hydrograph Report

Hyd. No. 1

SUBAREA-EX1

Hydrograph type	=	SCS Runoff	Peak discharge	=	9.058 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	31,669 cuft
Drainage area	=	1.100 ac	Curve number	=	98*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	8.70 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.095 x 98) + (0.005 x 74)] / 1.100



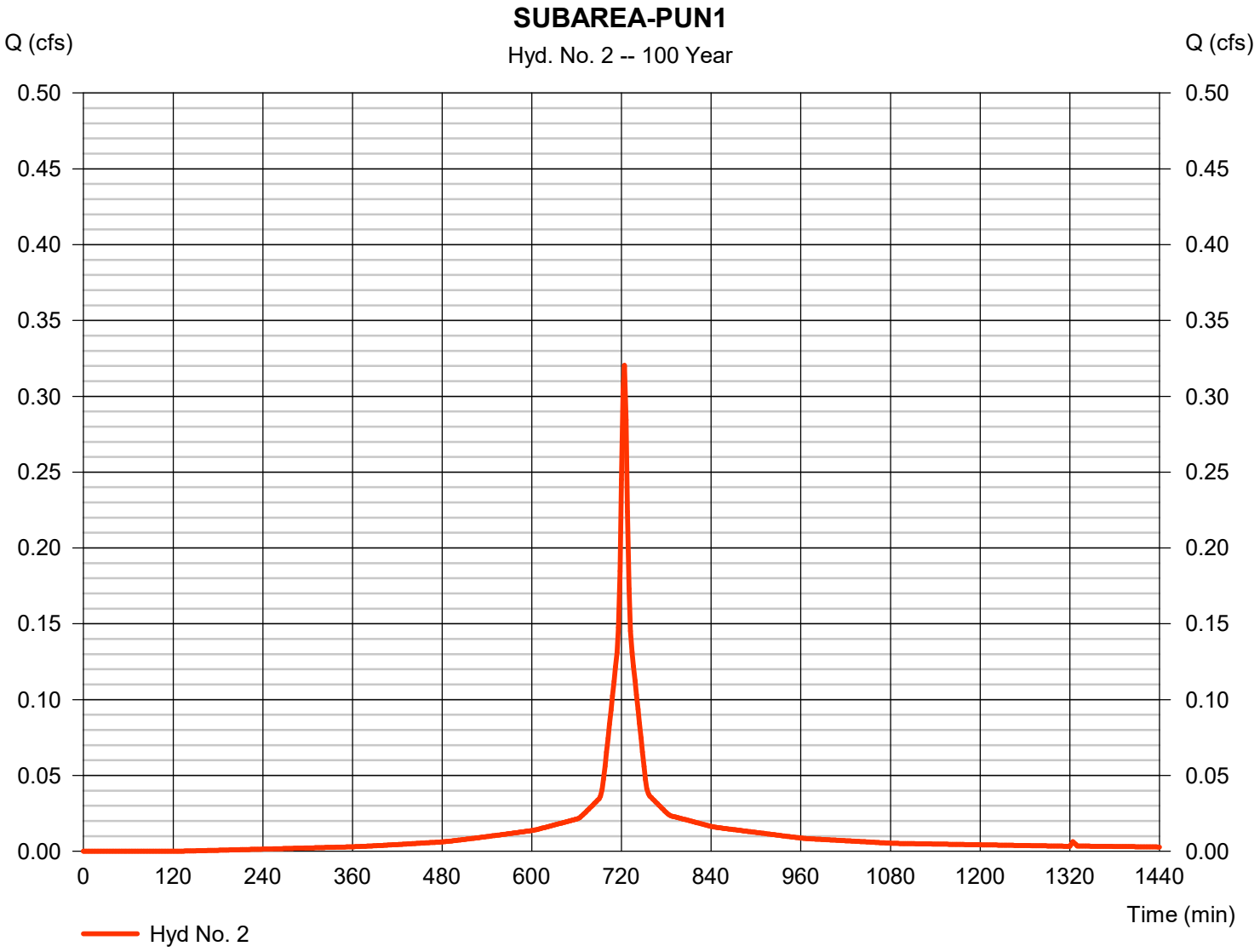
Hydrograph Report

Hyd. No. 2

SUBAREA-PUN1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.320 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	1,053 cuft
Drainage area	=	0.040 ac	Curve number	=	92*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	8.70 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.030 x 98) + (0.010 x 74)] / 0.040



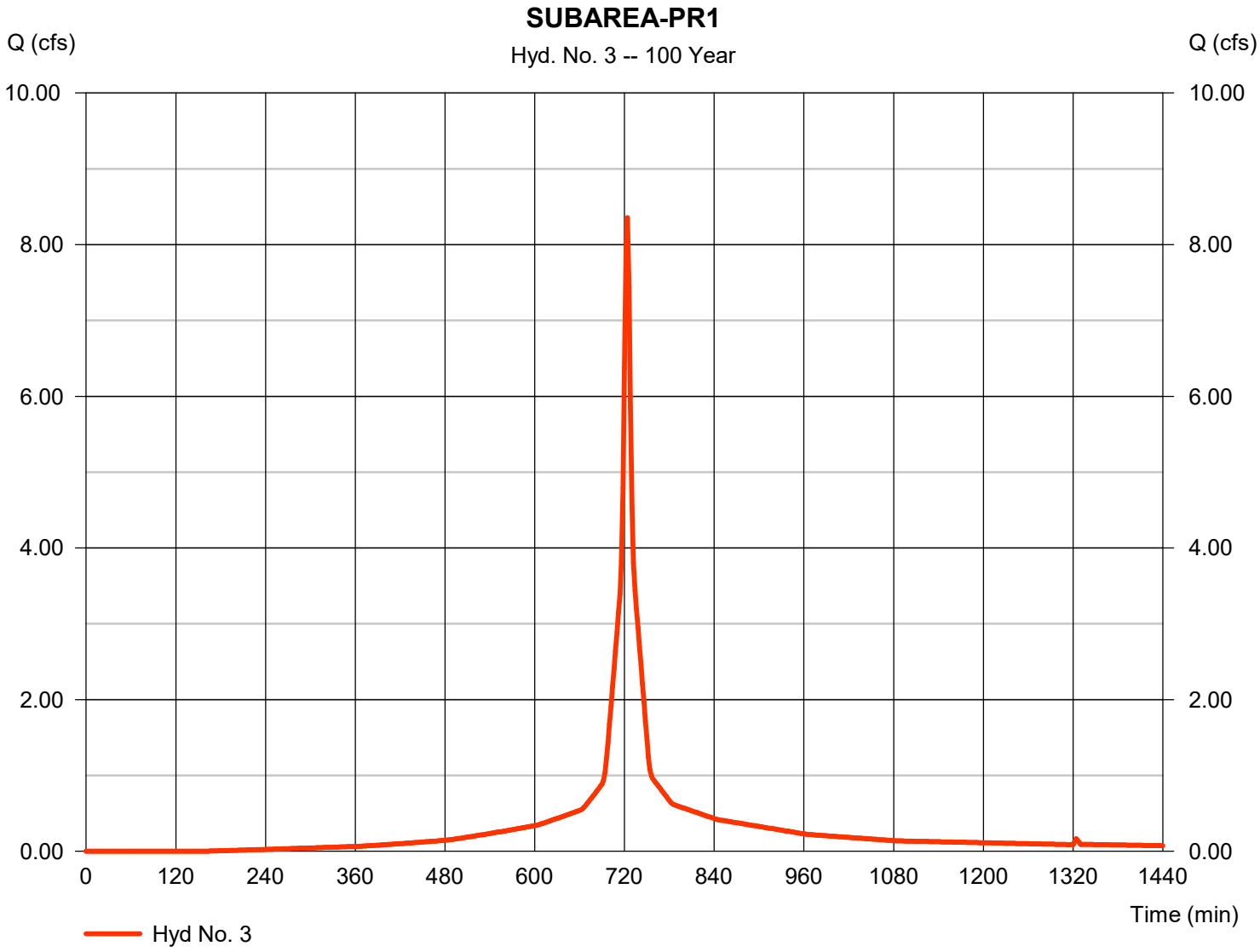
Hydrograph Report

Hyd. No. 3

SUBAREA-PR1

Hydrograph type	=	SCS Runoff	Peak discharge	=	8.357 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	27,038 cuft
Drainage area	=	1.060 ac	Curve number	=	90*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	8.70 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.692 x 98) + (0.368 x 74)] / 1.060



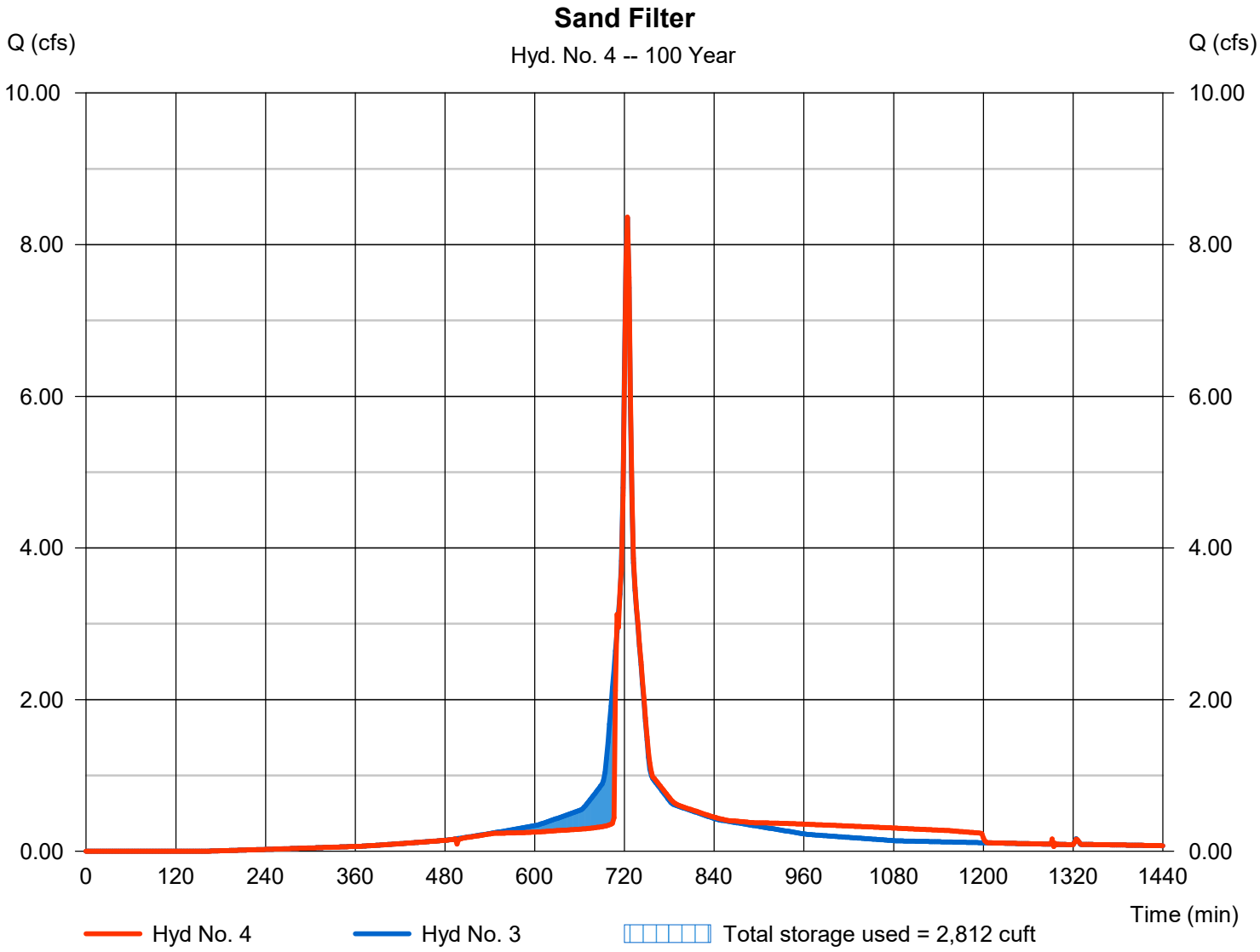
Hydrograph Report

Hyd. No. 4

Sand Filter

Hydrograph type	=	Reservoir	Peak discharge	=	8.362 cfs
Storm frequency	=	100 yrs	Time to peak	=	724 min
Time interval	=	2 min	Hyd. volume	=	27,038 cuft
Inflow hyd. No.	=	3 - SUBAREA-PR1	Max. Elevation	=	67.99 ft
Reservoir name	=	SAND FILTER	Max. Storage	=	2,812 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	17.6390	3.7000	0.7084	--------
2	20.0242	3.3000	0.6888	--------
3	21.4697	3.2000	0.6820	--------
5	27.0974	3.6000	0.6969	--------
10	32.1558	3.6000	0.6956	--------
25	40.4350	3.8000	0.7016	--------
50	44.9849	3.7000	0.6967	--------
100	50.8695	3.7000	0.6971	--------

File name: Cranston.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	3.81	2.76	2.22	1.87	1.64	1.46	1.32	1.21	1.12	1.05	0.99	0.93
2	4.66	3.37	2.70	2.29	2.00	1.79	1.63	1.49	1.39	1.29	1.22	1.15
3	5.11	3.70	2.97	2.52	2.20	1.97	1.79	1.65	1.53	1.43	1.34	1.27
5	6.05	4.40	3.53	2.99	2.62	2.34	2.12	1.95	1.81	1.69	1.59	1.50
10	7.20	5.23	4.21	3.57	3.12	2.79	2.53	2.33	2.16	2.02	1.89	1.79
25	8.79	6.41	5.16	4.37	3.83	3.42	3.10	2.85	2.64	2.47	2.32	2.19
50	9.97	7.26	5.85	4.96	4.34	3.88	3.52	3.24	3.00	2.80	2.64	2.49
100	11.26	8.20	6.60	5.60	4.90	4.38	3.98	3.65	3.39	3.17	2.97	2.81

Tc = time in minutes. Values may exceed 60.

Precip. file name: Y:\Shared\Clients\Jiffy Lube\Projects\OH\Northfield\02_Civil\Engineering\Storm\Northfield.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.70	3.30	0.00	4.10	4.90	6.10	7.30	8.70
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Appendix H

Water Quality Volume Calculations

Version: 4/2015

Project Name: WASHVILLE - CRANSTON
Date: 6-24-22

Water Quality Volume Calculation WorkSheet

This worksheet is designed to assist the project engineer with a determination of the required water quality treatment area. The worksheet leads the designer through redevelopment applicability first and then receiving water requirements. This tool is intended to compliment to the Redevelopment Criteria Guidance and the Water Quality Guidance and assist both the designer and the permit application reviewer towards consistent results. Enter information into only the YELLOW Boxes.

Redevelopment Criteria Guidance
Water Quality Goals "Stormwater Compensation Method"

Step 1 - Determine which office in OWR you are applying to: Application Guidance

Step 2 - Site Information		value/calculation	units
Total Site Area (total area of project parcels)	TS	1.10	acres
Total Jurisdictional Wetlands and/or floodplain within the above TSA	JW1	0.00	acres
Existing impervious also within the Jurisdictonal Wetlands	-JW2	0.00	acres
Conservation Land within the TSA		0.00	acres
Site Size = (TSA)-(JW1-JW2)-CL	**SS=**	**1.10**	acres

Step 3 - Redevelopment Applicability			
Total Impervious Area (pre-construction)	TIA=	1.10	acres
% Impervious (if ≥40% - redevelopment standard 3.2.6 applies)		**1.00**	

REPEAT IF NECESSARY Steps 4, 5 and 6 for EACH Waterbody ID (RIVER-ID as found in the GIS Map Server)

Step 4 - Receiving waterbody information

Waterbody ID or RIVER ID from GIS Map Server	
Waterbody Name from GIS Map Server	
Name the sub-watersheds (design-points) contributing to this Waterbody ID	
Is this Waterbody Impaired/TMDL for any Phosphorus, Metals or Bacteria?	NO
Is this Waterbody Impaired for Nitrogen?	NO

Step 5 - Pre-Post Construction Conditions to the Waterbody

Total Pre-Construction Impervious Surface to this Waterbody ID	1.10	acres
Total Disturbed Existing Impervious (DI)	1.10	acres
Total Post-Construction Impervious to this Waterbody ID	0.73	acres
Net Increased Impervious (NII)	-0.37	acres

Step 6 - Infiltration and BMP information - Note: Increasing infiltration will likely decrease stormwater treatment area for Metals, Bacteria and Phosporus

I am proposing to infiltrate this percentage WQv to this WBID	0%	%
I am proposing this number of BMP's	2	#

RESULTS - Select the Larger Number of the 2 numbers provided

Applicable Condition	**Min Water Quality Treatment Area**	**Min Treatment w/o WQ consideration**
No Impairement or TMDL - New Development		
No Impairment or TMDL - Redevelopment	0.18	0.18
Only Phosphorus, Metals or Bacteria Impairment - New Development		
Only Phosphorus, Metals or Bacteria Impairment - Redevelopment		
Nitrogen Impairment - New Development		
Nitrogen Impairment - Redevelopment		
REQUIRED STORMWATER TREATMENT AREA	**0.2** acres	

* Enter the name of the STP (both type and label) which has been designed to treat this particular Rev or Rea.

sevan ENGINEERING

Project: Washville, Cranston
Date: 06.24.2022
Revision: 07.14.2022
Revision Date: -

RHODE ISLAND STORMWATER DESIGN AND INSTALLATION STANDARDS MANUAL

WATER QUALITY CALCULATIONS

TOTAL REQUIRED WATER QUALITY FOR THE SITE

90% Rainfall Event Number	P=	1.2	in
Rainfall Intensity	I=	1.0	in
Impervious Area to be Treated	Ai=	0.732	Ac
Water Quality Volume Required	Wqv=	2657	c.f.

WATER QUALITY PEAK FLOW CALCULATION

90% Rainfall Event Number	P=	1.2	in
Area	A=	1.1	Ac
Water Quality Volume	Wqv=	2657	c.f.
Runoff Volume	Q=	0.67	in
Curve Number	CN=	93.98	
Ia = (200/CN) - 2	Ia=	0.13	in
R = Ia/P	R=	0.11	
qu	qu=	500	
Qp = qu*A*WQv	P=	0.58	cfs

Appendix I

RIDEM Contech Cascade Separator Certification Letter

Rhode Island Department of Environmental Management

Office of Water Resources – Stormwater Technology Review Committee

235 Promenade St. Providence, RI 02908 Ph: 401-222-4700

Alternative Stormwater Technology Certification

Vendor Contact:
Mr. Derek M. Berg
Director of Stormwater Management - East
Contech Engineered Solutions, LLC
71 US Route 1, Suite F
Derek.berg@contechllc.com
www.conteches.com
Ph: 207-885-6174

Technology Name:
Cascade Separator®

Approval Type:
Pretreatment/Retrofits

Certification Dates:
Issued: October 12, 2021
Expires: October 12, 2026

CERTIFICATION:

The Rhode Island Stormwater Technology Review Committee which consists of members from the Department of Environmental Management (DEM), Department of Transportation (DOT) and the Coastal Resources Management Council (CRMC) have reviewed the **Cascade Separator®** application for certification of its Technology Approval and accepted use for Stormwater Treatment in the State of Rhode Island.

In accordance with Stormwater Rule 250-RICR-150-10-8.9B, **Contech Engineered Solutions, LLC** has petitioned the permitting agencies to certify the **Cascade Separator®** as an acceptable structural stormwater control described in Stormwater Rule 250-RICR-150-10-8.31. They have submitted monitoring results and supporting information developed in accordance with the provisions of the Technology Assessment Protocol (TAP) for Innovative and Emerging Technologies as described in in Stormwater Rule 250-RICR-150-10 Sections 8.39 and 8.40.

The **Cascade Separator®** is granted reciprocity in Rhode Island as a proprietary stormwater treatment technology, given that it has been issued an MTD (manufactured treatment device) Lab Certification from the New Jersey Department of Environmental Protection (NJDEP) effective October 1, 2019 as a result of the *NJCAT Technology Verification – Cascade Separator®* study from April 2019, performed by Contech's laboratory in Portland, Oregon, with independent third-party observation provided by Dr. Scott Wells and Dr. Chris Berger from Portland State University. The study was conducted in accordance with the NJDEP "Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" from January 2013. This NJDEP MTD Lab Certification recognizes the **Cascade Separator®** as a stormwater treatment technology which provides 50% removal of total suspended solids when operating at the maximum treatment flow rate for each device specified in the attached *Table 1: RIDEM Approved Cascade Separator Sizing Table for 50% TSS Removal.* The State of New Jersey is a member of the Technology Acceptance Reciprocity Partnership (TARP), which allows for reciprocity consideration in Rhode Island.

The **Cascade Separator®** is a pre-treatment or retrofit device that captures both TSS and free oil (TPH) from stormwater runoff as described in Stormwater Rule 250-RICR-150-10-8.31. It is a vertically oriented cylindrical structure manufactured from pre-cast reinforced concrete and fiber reinforced plastic, designed to remove trash, hydrocarbons, and sediment from stormwater. This product was developed by **Contech Engineered Solutions, LLC**. The **Cascade Separator®** is approved for online and off-line use.

The manufacturer has demonstrated that this product meets the minimum water quality standards for pretreatment as described in Stormwater Rule 250-RICR-150-10-8.31. The **Cascade Separator®** is approved for **50%** removal of total suspended solids (TSS) when designed using flow rates specified in the attached *Table 1: RIDEM Approved Sizing for Cascade Separator®*. The **Cascade Separator®** is NOT recognized for removal of

Pathogens, Total Phosphorus or Nitrogen. This device may be used as an **Oil and Grit Separator** for use on **LUHPPL sites** in accordance with Stormwater Rule 250-RICR-150-10-8.14 provided that the design, installation, and maintenance are conducted in accordance with the following terms and conditions:

I. GENERAL CERTIFICATION REQUIREMENTS

1. The system must be designed and installed to adhere to the manufacturer's specifications titled "Cascade Separator General Specification" which can be found on at: https://www.conteches.com/technical-guides/search?filter=QL31JT8LA0

2. The **Cascade Separator®** is **certified as a pretreatment** device in accordance with Stormwater Rule 250-RICR-150-10-8.31, provided the device treats the flow of the first inch of runoff from the capture area, unless waived by the state permitting agency.

3. The CS-8 or greater models meet (**LUHPPL**) minimum requirements for sites that are classified as **LUHPPLs or MSGPs** that are required to have an oil water separator. These models meet the minimum 500 gallon hydrocarbon storage capacity required for pretreatment. Models that do not typically meet the minimum 500 gallon hydrocarbon storage capacity requirement may be modified to do so by adding additional hydrocarbon storage capacity; however modified units must receive engineering approval by the manufacturer and are subject to review by the state permitting agency on a case-by-case basis for approval.

4. The applicant must provide the RI specific manufacturers design sheet for Departmental review or provide the manufacturer's review approval. All units that capture greater than one acre of impervious cover must be reviewed by the manufacturer.

5. This device is **certified as a retrofit device** in accordance with Stormwater Rule 250-RICR-150-10-8.6A. Retrofits are allowed flexibility with regards to the eleven minimum standards described in Sections 8.6 through 8.17 of Stormwater Rule 250-RICR-150-10, but in general they are considered effective if they capture at least 50% of the catchment and meet the target water quality treatment of at least the first 0.5 inches of the water quality volume.

6. The approved devices shall be located such that they are accessible for maintenance and/or emergency removal of oil or chemical spills.

7. The device cannot be used in series with another Hydrodynamic separator to achieve enhanced removal rates for TSS.

II. MAINTENANCE REQUIREMENTS

1. The device must be maintained in accordance with the manufacturer's specifications provided in the **Cascade Separator®** Inspection and Maintenance Guide.

2. The device must be maintained in accordance with the requirements for proprietary pre-treatment devices, as stated in Stormwater Rule 250-RICR-150-10-8.31-C, which requires that the device be inspected a minimum of 2 times per year. Additionally, the device must be cleaned out when either pollutant removal capacity is reduced by 50% or more, or when 50% or more of the pollutant storage capacity is filled or displaced.

3. All material removed from the unit must be properly disposed of and is the responsibility of the owner.

4. The applicant must provide evidence of a maintenance contract which extends for a minimum of two years. The contracted maintenance provider must receive training by **Contech Engineered Solutions, LLC** on how to properly maintain **Cascade Separator®** devices. This requirement excludes maintenance providers recognized by the RIDEM to be qualified in maintenance of **Cascade Separator®** devices.

5. The applicant must include a copy of the **Cascade Separator®** Inspection and Maintenance Guide in their project specific long term operation and maintenance plan.

III. REPORTING REQUIREMENTS

1. Upon request from the owner of any Cascade Separator system installed in the State of Rhode Island, the vendor shall provide the owner with a recommended maintenance schedule after the first year of operation. If a recommended maintenance schedule is requested by the owner after the first year of the device's operation, then the owner is responsible for notifying the vendor of any additional pollutant loads on sites where contributing drainage areas may be subject to further development.

2. The Vendor shall provide a listing to the RIDEM Office of Water Resources of all systems installed within the State of Rhode Island on an annual basis.

3. The Vendor shall provide an annual listing to the RIDEM Office of Water Resources of all Rhode Island maintenance providers that they trained in **Cascade Separator®** maintenance.

4. The Vendor shall immediately notify the RIDEM Office of Water Resources if and when any changes are made to the model name or number of any **Cascade Separator®** device for all models applicable to this certification.

5. The Vendor shall immediately notify the RIDEM Office of Water Resources if and when any revisions are made to the design, installation operation and maintenance manuals for all models applicable to this certification. Revisions deemed by the RIDEM to be substantial, may require re-application to the Alternative Stormwater Technology Program.

6. The Vendor shall notify the RIDEM at least thirty (30) days following any proposed transfer of ownership of the Component technology. Notification shall include the name and address of the new owner and a written agreement between the existing and new owner specifying a date for transfer of ownership, responsibility, and liability for the Component. All provisions of this Certification shall be applicable to any new owners.

IV. RIGHTS OF THE RIDEM AND CRMC

1. The RIDEM may suspend, modify, or revoke this approval for cause, including but not limited to non-compliance with any of the conditions or provisions of this approval, mis-representation, or failure to fully disclose all relevant data, or receipt of new information indicating that the use of the **Cascade Separator®** system is contrary to the public interest, public health, or the environment.

2. This approval does not represent an endorsement of the **Cascade Separator®** system by the RIDEM, RIDOT or CRMC. This letter of approval may be reproduced only in its entirety.

3. The **Cascade Separator®** General Specification and **Cascade Separator®** Inspection and Maintenance Guide referenced herein are approved upon the date of approval of this Certification.

4. The RIDEM reserves the right to suspend or revoke this Certification if updated design, installation, and O&M manuals are not provided to the RIDEM within thirty (30) days of RIDEM request or one hundred and eighty (180) days prior to the expiration date of this Certification. All revisions must be reviewed and approved by the RIDEM prior to re-certification.

Eric A. Beck, P.E. Date
Administrator of Groundwater and Wetlands Protection
RIDEM

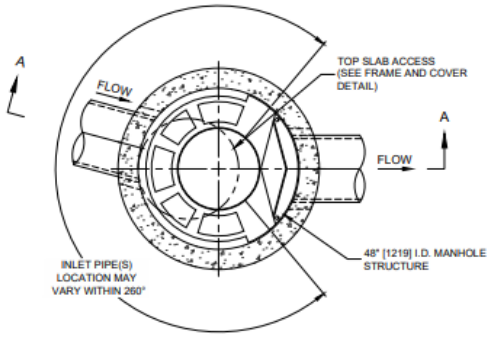
ATTACHMENTS

Table 1: RIDEM Approved Cascade Separator Sizing Table for 50% TSS Removal

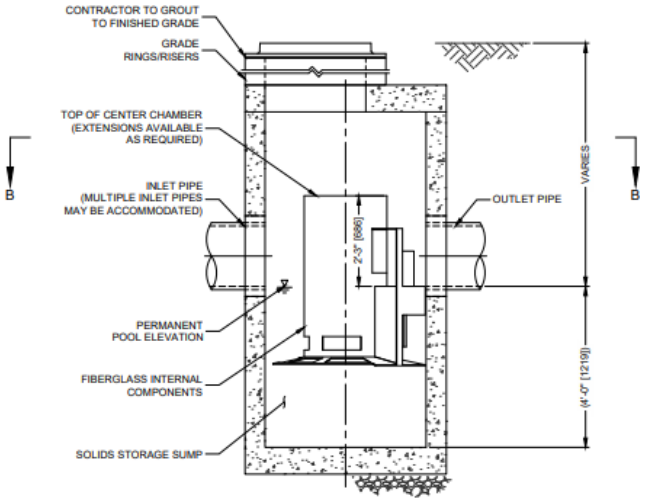
Model #	Water Quality Flow Rate (cfs)	Approximate Impervious Treatment Area (acres)
CS-3	1.02	0.93
CS-4	1.80	1.68
CS-5	2.81	2.63
CS-6	4.05	3.78
CS-8	7.20	6.73
CS-10	11.3	10.56
CS-12	16.2	15.14

Table 2: Standard Hydrocarbon & Sediment Storage Capacity of Cascade Separator® Devices

Model #	Structure Inside Diameter (ft)	Oil Spill Volume (gal)	Sediment Storage Volume (ft^3)
CS-4	4	141	18.9
CS-5	5	269.3	29.4
CS-6	6	475.9	42.4
CS-8	8	1128	75.3
CS-10	10	2203.2	117.7
CS-12	12	3807.1	169.6



PLAN VIEW B-B
NOT TO SCALE



ELEVATION A-A
NOT TO SCALE

CASCADE separator™

CASCADE SEPARATOR DESIGN NOTES

THE STANDARD CS-4 CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES

FRAME AND COVER
(DIAMETER VARIES)
NOT TO SCALE

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (cfs [L/s])			
PEAK FLOW RATE (cfs [L/s])			
RETURN PERIOD OF PEAK FLOW (yrs)			
RIM ELEVATION			
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			
NOTES / SPECIAL REQUIREMENTS:			

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
3. CASCADE SEPARATOR WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
4. CASCADE SEPARATOR STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 2' [610], AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.
5. CASCADE SEPARATOR STRUCTURE SHALL BE PRECAST CONCRETE CONFORMING TO ASTM C478 AND AASHTO LOAD FACTOR DESIGN METHOD.
6. ALTERNATE UNITS ARE SHOWN IN MILLIMETERS [mm].

INSTALLATION NOTES
A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CASCADE SEPARATOR MANHOLE STRUCTURE.
C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET AND OUTLET PIPE(S). MATCH PIPE INVERTS WITH ELEVATIONS SHOWN. ALL PIPE CENTERLINES TO MATCH PIPE OPENING CENTERLINES.
E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH Engineered Solutions LLC
www.contechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CS-4
CASCADE SEPARATOR
STANDARD DETAIL

I:\COMMON\CAD\TREATMENT\21 CASCADE\40 STANDARD DRAWINGS\DWG\CS-4-DTL.DWG 1/22/2019 9:34 AM