Stormwater Management Report
Ferber Farm Laydown Area

#200-67639-18003
December 30, 2019

PRESENTED TO

PSE&G
4000 Hadley Road M/C 430
South Plainfield, NJ 07080

PRESENTED BY

Tetra Tech
5 Hanover Square
Suite 1003
New York, NY 10004
NJ Certificate No.
24GA28028700

P +1-646-576-4034
F +1-212-480-2836
tetratech.com

Prepared by:

Jake Oldenburger, PE, CFM, ENV SP December 30, 2019
Professional Engineer
License No. 24GE05297500
Certified Floodplain Manager
No. US-15-08538

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1.0 INTRODUCTION

This report has been prepared in support of the development for the Ferber Farm Laydown Area site to be used for laydown of construction materials during the construction of the Roseland Switch to Pleasant Valley Switch Upgrade Project in various counties throughout New Jersey. This report serves to support the approval and has been prepared in accordance with the following:

- NJDEP Stormwater Management Requirements (N.J.A.C. 7:8); and
- Township of Chatham Stormwater Control Ordinance (Section 30-64.3);
- Part 4. Stormwater Management of the Township of Harding Land Use and Development Code;
- Land Development Standards of Morris County, New Jersey;

A Stormwater Management Report is required to address the stormwater management requirements of the project because it creates over an acre of land disturbance triggering a major development.

2.0 EXISTING CONDITIONS

The Project consists of using the Ferber Farm site as a construction materials laydown area to assist in the replacement of 30-miles of high-tension electrical transmission infrastructure by Public Service Electric & Gas (PSE&G) as part of the Roseland Switch to Branchburg Switch Transmission Line Upgrade Project that spans through Essex, Morris, and Somerset County, New Jersey.

The Ferber Farm site consists of Lots 185 and 187 in Block 48.20 and Lots 174, 174.01 and 180 and 182 in Block 48.21 in the Township of Chatham and Lots 3 and 4 in Block 12.01 in the Township of Harding both located within Morris County New Jersey. The site is approximately 53.43 acres and bound by Meyersville Road to the west, the Green Village Volunteer Fire Department, residential properties, and Green Village Road to the north, and open space and residential properties to the east and south. A portion of the site is currently developed with an existing two-story barn, ancillary structures, and a paved access road. The remainder of the site is occupied by open space, the majority of which has been cultivated for agricultural use. Figures 1 through 3 show the Project Site USGS location map, the Aerial Map, and the Wetland Map for the Project.

2.1 EXISTING DRAINAGE CHARACTERISTICS

Under present conditions, stormwater runoff from the site generally drains via overland flow to on-site ponds and to the Loantaka Brook. There are three watersheds on the portion of the site being used for laydown areas. The grades slope from a ridge line located at the center of the site and traversing northwest to southeast across the site. See attached Figure 5– Existing Watershed Plan. The two southwestern watershed areas drain two separate ponds found on site near the existing asphalt access road that traverses the middle of the site providing access to Meyersville Road. The other watershed located in the northeastern portion of the site drains to the Loantaka Brook located in the eastern portion of the site. The Loantaka Brook is not a Category One waterbody but is a tributary of the Passaic River, which is a Category One waterbody. Therefore, a 300-foot riparian buffer has been assumed and will be confirmed by the NJDEP.

2.2 EXISTING SUBSURFACE CONDITIONS

According to the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey for Morris County, the soil in the project site consists of muck and silty and sandy loam type soils. The soil types across the site have hydrologic soil group types A, B, and D. See Figure 5 – NRSC Soils Map to see what soil types or located in what portions of the site.

3.0 PROPOSED DEVELOPMENT

The property will serve as a lay down area for construction material that will be used to construct the Roseland Switch to Branchburg Switch Transmission Line Upgrade Project that spans through Essex, Morris, and Somerset County, New Jersey. The portion of the site being used for the laydown of the construction materials is approximately 22 acres in size located in the northwest portion of the site west of the existing two-story barn and east/northeast of the existing pond. Approximately 6.68 acres of this 22 acre area will be covered with timber waffle mats. The laydown area will be compromised of timber waffle mats that are eight (8) feet by fourteen (14) feet. The timber waffle mats will be placed on existing undisturbed grade to create a level surface to laydown construction materials. The timber waffle mats will also be placed to create access roads throughout the site to facilitate the delivery of construction equipment to the site via flatbed trucks. One of the proposed access roads will connect to the existing asphalt access road that bisects the site from Meyersville Road in the Township of Harding. The other proposed access road will connect to the roadway at the intersection of Green Village Road and Meyersville Road in the Township of Chatham.

3.1 STORMWATER REQUIREMENTS AND DESIGN APPROACH

As stated previously, the proposed improvements will result in over an acre of disturbance and as such, the project is considered a major development. As a major development, the proposed design is subject to the following design requirements:

- Stormwater Quantity
- Stormwater Quality
- Nonstructural Stormwater Management Strategies
- Groundwater Recharge

The NJDEP stormwater quality requirements apply to a given project when the net increase in impervious area is greater than or equal to a quarter of an acre. The proposed temporary laydown area improvements that consist of the timber waffle matting are not considered an impervious surface. As such, the proposed temporary laydown improvements result in no change to the amount of impervious surface on site as compared to existing conditions and the project is not subject to any stormwater quality requirements. A hydrologic justification for considering the timber waffle matting as a pervious surface is described in more detail in the following section below.

3.2 TIMBER WAFFLE MATTING HYDROLOGY

The timber waffle mats are considered a pervious area due to the openings that allow rainfall to flow through the mating and not inhibit the rainfall from reaching the undisturbed existing land use below. PSE&G is proposing approximately 6.68 acres of timber waffle mats throughout an approximately 22 acre laydown area. The laydown area currently consists of open space lawn area in which timber waffle mats that are eight (8) feet wide by fourteen (14) feet long and comprised of eight (8) inch wide wood beams cross-hatched to form one-and-one-half-inch-

square openings will be placed over the undisturbed lawn area. It is estimated there is approximate 153 openings per mat, which total approximately 2.2 square feet of open area per mat. The timber waffle mat openings will function like the grate openings found in stormwater inlets allowing the passage of rainfall through to the existing underlying land-use/soil. The orifice equation below was utilized to calculate the flow rate through of the timber waffle mats similar to stormwater inlet grating:

- **Orifice Equation:** $Q = C_0 A_g \sqrt{2gd}$;
  - Where C_0 is the Orifice Coefficient = C_0 = 0.67
  - Where A_g is the area of opening; = 2.2;
  - Where g is gravity = g = 32.2;
  - Where d is head depth or rainfall depth atop the timber mats (assume a quarter inch) = d = 0.02;

Substituting these values into the orifice equation, a quarter inch of water depth over the laydown mating will flow through the timber waffle mat at a rate of approximately 1.7 cubic feet per second. For comparison purposes, the estimate duration of the laydown area is approximately 3 years, a 24-hour, 10-year storm event in the Township of Chatham, New Jersey has a precipitation depth of 5.22 inches (per NOAA Atlas 14 see attached). The volume of rainfall over one timber waffle mat (14' x 8') during that storm event would be approximately 48.7 cubic feet. Assuming a constant head of one-quarter inch and dividing this by the flow rate through the mat, the equivalent volume of rainfall from the 10-year, 24-hour storm event would flow through the matting in approximately 30 seconds.

Based on this analysis, with the assumption of a constant one-quarter inch rainfall depth atop the mat, it does not appear the matting would inhibit the rainfall from reaching the undisturbed native grass below. In addition, the timber matting would reduce the velocity of the runoff once it reaches the ground surface as it would be temporarily held in the openings, thereby allowing more time for the runoff to infiltrate. As such, the matting would not appear to be considered a change in land-use and impact stormwater runoff when compared to existing site conditions.

3.3 STORMWATER QUANTITY

As mentioned previously, the proposed improvements will result in over an acre of disturbance and as such, the project is considered a major development. Section 3.2 outlined that the proposed timber waffle matting will not impede the flow of runoff from reaching the existing land-use currently found on-site and should not be considered an impervious surface. Since the proposed timber waffle matting is not considered an impervious surface, the project is not subject to any groundwater recharge or water quality requirements.

The project is still required to address stormwater runoff quantity standards for a major development. N.J.A.C. 7:8-5.4(a)3 requires that one of the following criteria be met in order to address stormwater runoff quantity standards for a major development:

i. Demonstrate through hydrologic and hydraulic analysis that for stormwater leaving the site, post-construction runoff hydrographs for the 2-, 10-, and 100-year storm events do exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events

ii. Demonstrate through hydrologic and hydraulic analysis that there is no increase, as compared to the pre-construction condition, in the peak runoff rates of stormwater leaving the site for the 2-, 10-, and 100-year

storm events and that the increased volume or change in timing of stormwater runoff will not increase flood damage at or downstream of the site.

iii. Design stormwater management measures so that the post-construction peak runoff rates for the 2-, 10-, and 100-year storm events are 50, 75, and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be construction.

The peak flow rates for the 2-, 10-, and 100-year storm events must be determined for the site to evaluate compliance with one of the three runoff quantity criteria listed above. The United States Department of Agriculture (USDA) National Resource Conservation Service (NRSC) TR-55 Methodology of Urban Hydrology for Small Watersheds was utilized to determine the peak flows for these storm events. As previously described, the site is comprised of impervious and meadow (continuous grass, protected from grazing and generally mowed for hay) land-use with underlying A, B, and D type soils. In the area of the project improvements, the underlying soils are hydrologic soil group types B and D. Based on the underlying soil type and land-use cover, runoff curve numbers were chosen from the TR-55 manual to determine the runoff generated from the excess rainfall. As described in Section 2.1 there are three watersheds on-site located within the proposed project improvements that consist of installing timber waffle matting for construction laydown. For each watershed, a composite runoff curve number (CN) was calculated based on the land-use and underlying soil condition because of the disconnection of the impervious surfaces. The **Table 1** shows the composite runoff curve numbers were used to calculate the peak flow for each watershed.

Table 1 – Runoff Curve Numbers

Watershed	Total Area (Acres)	Impervious Area (Acres) CN = 98	Meadow Area HSG B (Acres) CN = 58	Meadow Area HSG D	Composite Runoff Curve Number
A-1	10.02	1.07	N/A	8.95	80
A-2	16.19	0.46	1.09	14.63	77
A-3	4.79	0.66	N/A	4.13	81

*CN values for each land-use used to obtained to composite CN value for the watersheds were obtained from Table 2-2 of the TR-55 manual.

In addition to the watershed areas and composite runoff curve numbers, precipitation depths for the 2-, 10-, and 100-year storm events are required to calculate the peak flow rates for the watersheds. Precipitation depths for a 24-hour storm duration for the 2-, 10-, and 100-year storm events in the project area were obtained from the NOAA Atlas 14 Precipitation Frequency Data Server (see Appendix A). This compiled information was input into Hydraflow Hydrographs Extension for AutoCAD which is a program that uses the TR-55 method to compute the peak runoff rates. The peak runoff rates for a 24-hour storm duration for the 2-, 10-, and 100-year storm events for each watershed are shown in **Table 2** on the following page.

Table 2 – Watershed Peak Flow Rates

Watershed	Watershed Discharge Point	Peak Flow for the 2-Year Storm Event (cfs)	Peak Flow for the 10-Year Storm Event (cfs)	Peak Flow for the 100-Year Storm Event (cfs)
A-1	On-Site Retention Pond	16.95	32.74	64.63
A-2	Loantaka Brook	23.61	48.21	99.27
A-3	On-Site Retention Pond	8.49	16.11	31.38

As outlined in Section 3.2, the timber waffle matting is a temporary improvement that will be removed from the site at the completion of the Roseland Switch to Branchburg Switch Transmission Line Upgrade Project. Section 3.2 goes into detail to describe how the timber waffle matting does not impede rainfall from reaching the existing meadow-lawn land-use currently found on site and as such, does not result in any change to the land-use or hydrology of the site. As such, the peak flow rates calculated and shown in Table 2 are the peak flow rates on site for the 2-, 10-, and 100-year storm events for existing conditions as well as for when the timber waffle mats are in place to serve as a laydown area for construction materials. Therefore, the proposed temporary timber waffle matting improvements are in compliance with the stormwater quantity requirements criteria for a major develop as described in N.J.A.C. 7:8-5.4(a)3ii and N.J.A.C. 7:8-5.4(a)3iii.

3.4 NONSTRUCTURAL STORMWATER MANAGEMENT STRATEGIES

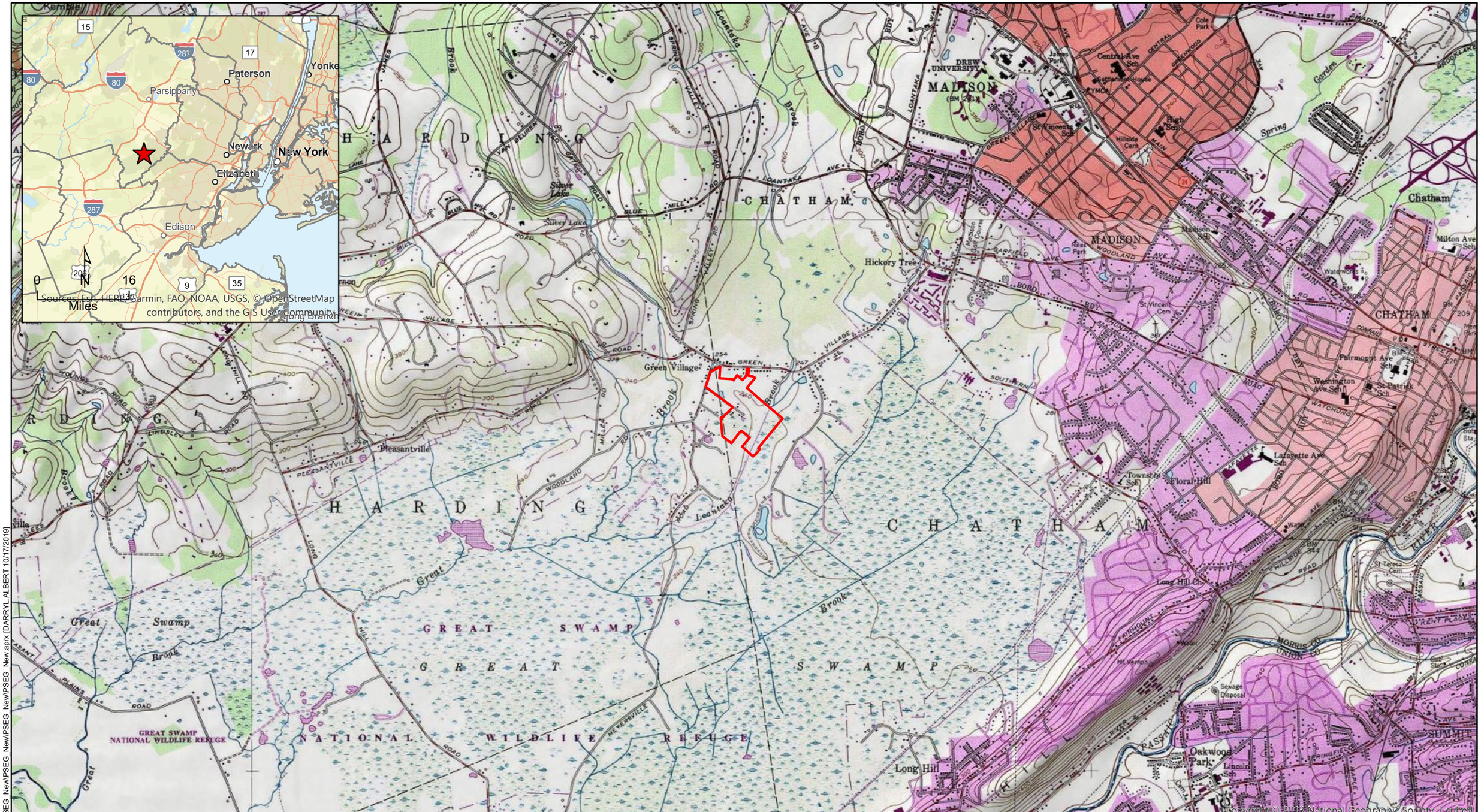
As mentioned previously, the proposed improvements will result in over an acre of disturbance and as such, the project is considered a major development. Section 3.2 and 3.3 outlined that there will be no change to the hydrology of the site from existing to proposed conditions and as a result, there will be no increase in stormwater runoff in proposed conditions as compared to existing conditions. Since there is no increase in stormwater runoff and water quality requirements are not applicable, no structural or nonstructural stormwater management strategies are required for the project site.

3.5 GROUNDWATER RECHARGE REQUIREMENTS

As mentioned previously, the proposed improvements will result in over an acre of disturbance and as such, the project is considered a major development. Section 3.2 and 3.3 outlined that there will be no change to the hydrology of the site from existing to proposed conditions and as a result, there will be no increase in stormwater runoff in proposed conditions as compared to existing conditions. Since there is no change to the hydrology on-site when comparing existing and proposed conditions, the site will also maintain 100 percent of the average annual pre-construction groundwater recharge volume for the site.

4.0 CONCLUSION

This report presents the stormwater management requirements for the development Ferber Farms site in the Township of Chatham and the Township of Harding, Morris County, New Jersey. The Ferber Farms site meets all the stormwater management requirements for a major development including stormwater quantity, quality, groundwater recharge, and nonstructural stormwater management strategies.



Source: USGS 7.5' Topo Quadrangles Bernardsville, Mendham, Chatham, Morristown NJ; PSE&G

N

0 0.5 Miles

LEGEND

Project Site

PSE&G ROSELAND - PLEASANT VALLEY PROJECT (RPV)
FERBER FARMS LAYDOWN AREA

USGS SITE LOCATION MAP

FIGURE 1

TETRA TECH

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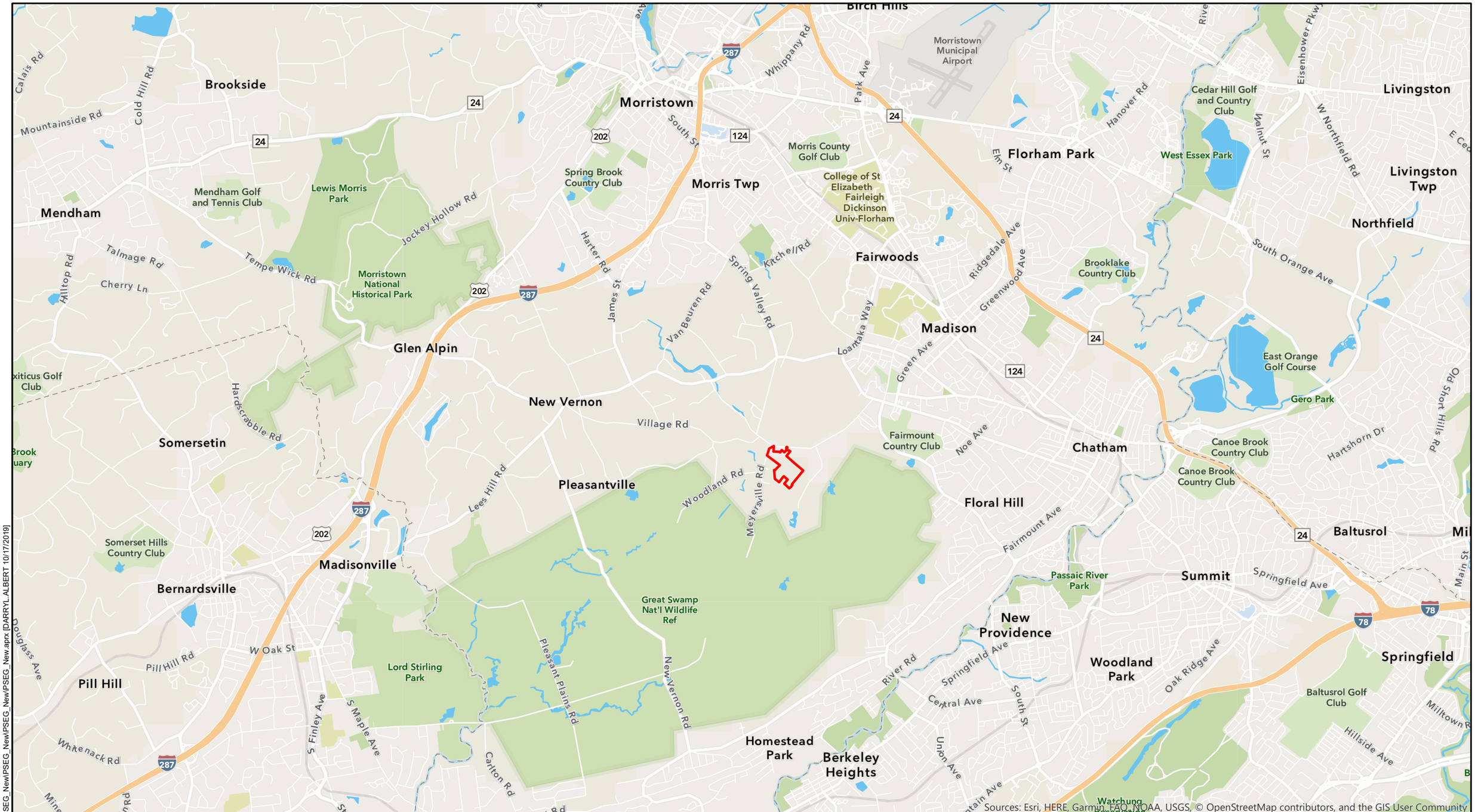

N

0 1
Miles

LEGEND

Source: PSE&G

Project Site

PSE&G ROSELAND - PLEASANT VALLEY PROJECT (RPV)
FERBER FARMS LAYDOWN AREA

VICINITY MAP

FIGURE 2

TETRA TECH

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N

0 500
Feet

Source: PSE&G

LEGEND

Project Site

PSE&G ROSELAND - PLEASANT VALLEY PROJECT (RPV)
FERBER FARMS LAYDOWN AREA

SITE LOCATION AERIAL MAP

FIGURE 3

TETRA TECH

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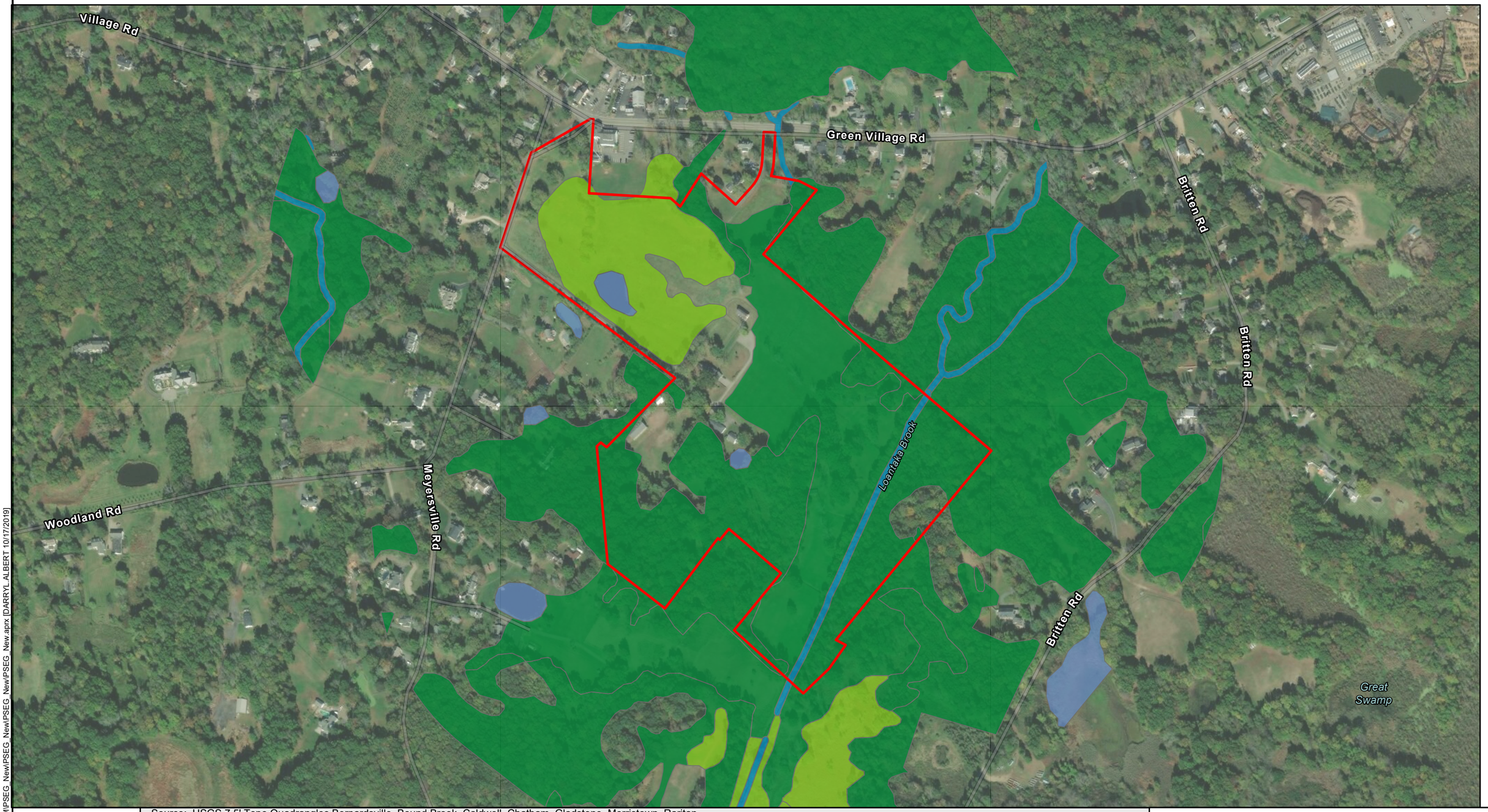

N

0 400
Feet

Source: USGS 7.5' Topo Quadrangles Bernardsville, Bound Brook, Caldwell, Chatham, Gladstone, Morristown, Raritan

LEGEND

Project Site

Wetland

Estuarine and Marine Deepwater

Estuarine and Marine Wetland

Freshwater Emergent Wetland

Freshwater Forested/Shrub Wetland

Freshwater Pond

Lake

Other

Riverine

PSE&G ROSELAND - PLEASANT VALLEY PROJECT (RPV)
FERBER FARMS LAYDOWN AREA

WETLAND MAP

TETRA TECH

FIGURE 4

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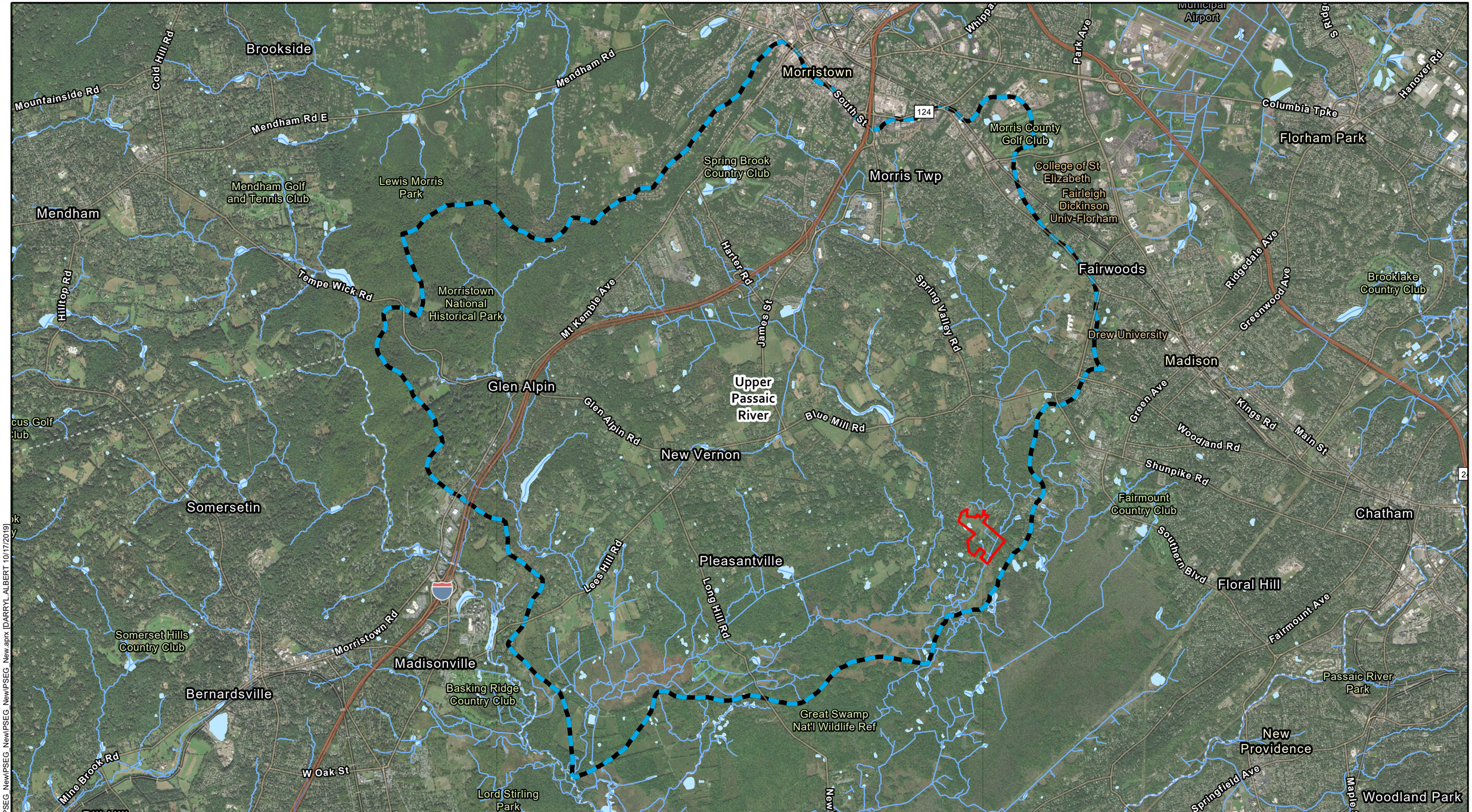

N

0 4,000
Feet

LEGEND

Project Site

NHD Watershed Boundary

NHD Flow Line

NHD Waterbody

NHD Area

Canal/Ditch

Stream/River

Source: NHD Data, New Jersey

PSE&G ROSELAND - PLEASANT VALLEY PROJECT (RPV)
FERBER FARMS LAYDOWN AREA

USGS HUC-12 WATER & SURFACE WATERS MAP

FIGURE 5

TETRA TECH

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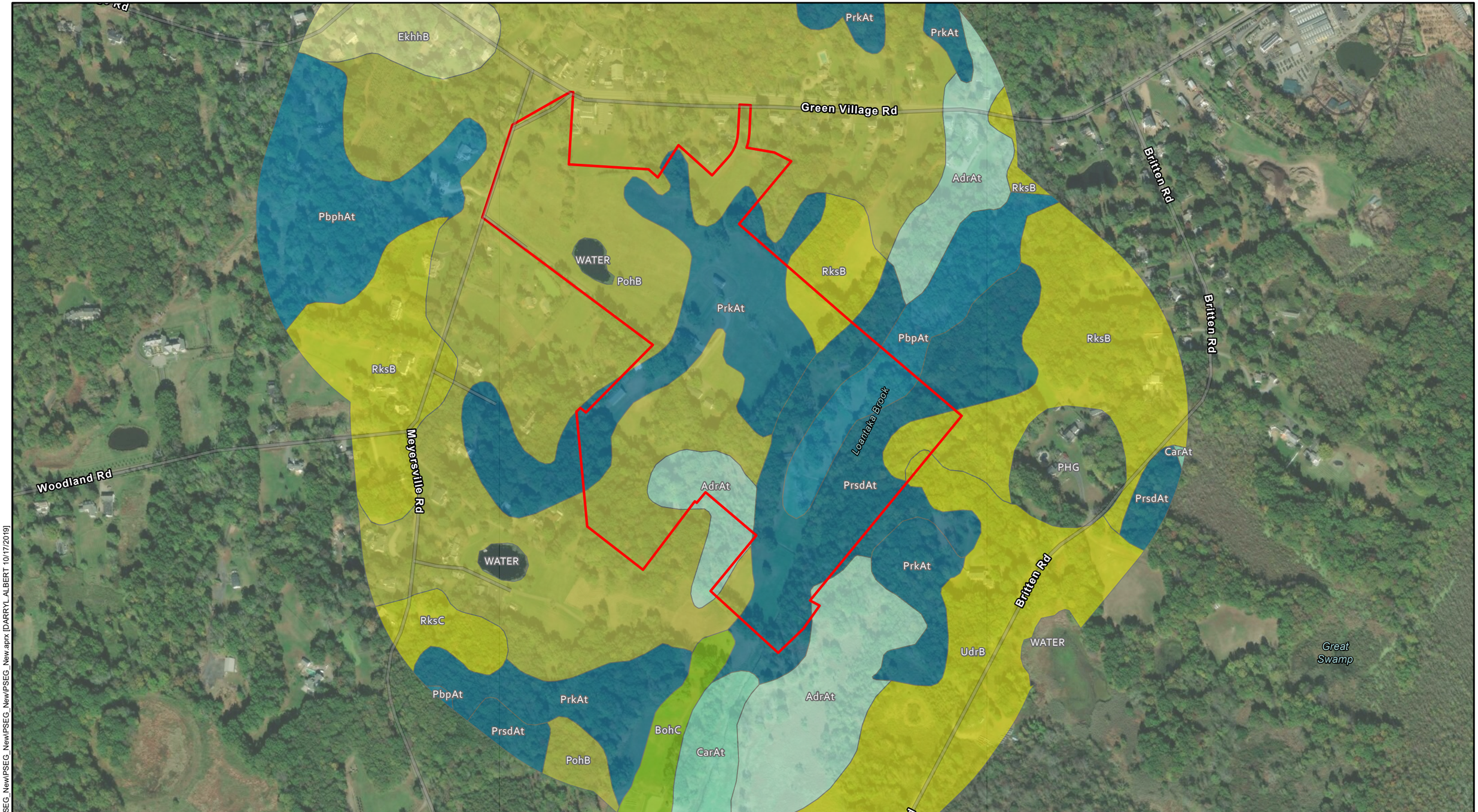

Source: USDA NRCS Soil Survey New Jersey, PSE&G

N

0 400
Feet

LEGEND

Project Site
Project Site

Soils
Hydro Group A/D
PohB

Hydro Group B
EkhhB
RksB
RksC
UdrB

Hydro Group B/D
AdrAt
CarAt

Hydro Group C
BohC

Hydro Group D
PbpAt
PbphAt
PrkAt
PrsdAt

PSE&G ROSELAND - PLEASANT VALLEY PROJECT (RPV)
FERBER FARMS LAYDOWN AREA

NRCS SOIL MAP

TETRA TECH

FIGURE 6

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LEGEND:

- WATERSHED BOUNDARY
- PROPERTY LINE
- EXISING IMPERVIOUS AREA
- MEADOW AREA (HSG B)
- PROPOSED LIMITS OF TIMBER WAFFLE MAT LAYDOWN AREA

NOTE: AREAS WITH NO PATTERN SHOWN IS MEADOW LAND-USE UNDERLAIN WITH HYDROLOGIC SOIL GROUP TYPE D SOILS

TABLE 1 - RUNOFF COEFFICIENTS

Watershed	Total Area (Acres)	Impervious Area (Acres) CN = 98	Meadow Area HSG B (Acres) CN = 58	Meadow Area HSG D	Composite Runoff Curve Number
A-1	10.02	1.07	N/A	8.95	80
A-2	16.19	0.46	1.09	14.63	77
A-3	4.79	0.66	N/A	4.13	81

TABLE 2 - PEAK FLOW RATES

Watershed	Watershed Discharge Point	Peak Flow for the 2-Year Storm Event (cfs)	Peak Flow for the 10-Year Storm Event (cfs)	Peak Flow for the 100-Year Storm Event (cfs)
A-1	On-Site Retention Pond	16.95	32.74	64.63
A-2	Loantaka Brook	23.61	48.21	99.27
A-3	On-Site Retention Pond	8.49	16.11	31.38

0 50' 100' 200'

ZONE	REV	DESCRIPTION	DATE	APPROVED

REVISIONS

PSEG
ASSET MANAGEMENT
ELECTRIC TRANSMISSION ENGINEERING

SUBJECT: ROSELAND – PLEASANT VALLEY PROJECT (RPV) FERBER FARMS LAYDOWN AREA

SCALE: 1" = 100' | CHECKED | APPROVED/TITLE
DATE: 10/18/2019 | DRAWN BY | DISCIPLINE: CIVIL
LOCATION: CHATHAM/HARDING NJ | SIZE: ARCH D | DWG NO. | FIGURE 7 - WATERSHED MAP | REV | SHEET OF

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APPENDIX A

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.
2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.
3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2b Runoff curve numbers for cultivated agricultural lands [1]

Cover description			Curve numbers for hydrologic soil group			
Cover type	Treatment [2]	Hydrologic condition [3]	A	B	C	D
Fallow	Bare soil	—	77	86	91	94
	Crop residue cover (CR)	Poor	76	85	90	93
		Good	74	83	88	90
Row crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR + CR	Poor	71	80	87	90
		Good	64	75	82	85
	Contoured (C)	Poor	70	79	84	88
		Good	65	75	82	86
	C + CR	Poor	69	78	83	87
		Good	64	74	81	85
	Contoured & terraced (C&T)	Poor	66	74	80	82
		Good	62	71	78	81
	C&T+ CR	Poor	65	73	79	81
		Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88
		Good	63	75	83	87
	SR + CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C + CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T+ CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89
		Good	58	72	81	85
	C	Poor	64	75	83	85
		Good	55	69	78	83
	C&T	Poor	63	73	80	83
		Good	51	67	76	80

[1] Average runoff condition, and I_a=0.2S
[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.
[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

Table 2-2c Runoff curve numbers for other agricultural lands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition	A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. [2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. [3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 [4]	48	65	73
Woods—grass combination (orchard or tree farm). [5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. [6]	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 [4]	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

1 Average runoff condition, and $I_a = 0.2S$.
2 *Poor:* <50%) ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: > 75% ground cover and lightly or only occasionally grazed.
3 *Poor:* <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use CN = 30 for runoff computations.
5 CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.
6 *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Table 2-2d Runoff curve numbers for arid and semiarid rangelands [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type	Hydrologic condition [2]	A [3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

1 Average runoff condition, and I_a, = 0.2S. For range in humid regions, use table 2-2c.
2 Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: > 70% ground cover.
3 Curve numbers for group A have been developed only for desert shrub.

APPENDIX B

NOAA Atlas 14, Volume 2, Version 3
Location name: Green Village, New Jersey, USA*
Latitude: 40.7391°, Longitude: -74.4554°
Elevation: 257.03 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

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)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.337 (0.308-0.371)	0.402 (0.367-0.442)	0.475 (0.432-0.521)	0.527 (0.479-0.579)	0.591 (0.535-0.648)	0.635 (0.573-0.697)	0.679 (0.610-0.744)	0.718 (0.641-0.787)	0.769 (0.681-0.845)	0.804 (0.707-0.885)
10-min	0.537 (0.491-0.591)	0.641 (0.585-0.705)	0.758 (0.691-0.833)	0.840 (0.764-0.923)	0.939 (0.851-1.03)	1.01 (0.910-1.11)	1.08 (0.965-1.18)	1.13 (1.01-1.24)	1.21 (1.07-1.33)	1.26 (1.11-1.38)
15-min	0.670 (0.613-0.738)	0.805 (0.735-0.885)	0.958 (0.873-1.05)	1.06 (0.966-1.17)	1.19 (1.08-1.30)	1.28 (1.15-1.40)	1.36 (1.22-1.49)	1.43 (1.28-1.57)	1.52 (1.35-1.67)	1.58 (1.39-1.74)
30-min	0.917 (0.838-1.01)	1.11 (1.01-1.22)	1.36 (1.24-1.49)	1.54 (1.40-1.69)	1.76 (1.59-1.93)	1.92 (1.73-2.10)	2.07 (1.86-2.27)	2.22 (1.98-2.43)	2.41 (2.13-2.65)	2.55 (2.24-2.80)
60-min	1.14 (1.04-1.26)	1.39 (1.27-1.53)	1.74 (1.58-1.91)	2.00 (1.82-2.19)	2.34 (2.12-2.56)	2.59 (2.34-2.84)	2.85 (2.56-3.13)	3.11 (2.77-3.41)	3.45 (3.05-3.79)	3.71 (3.26-4.08)
2-hr	1.40 (1.27-1.54)	1.70 (1.55-1.88)	2.16 (1.96-2.38)	2.51 (2.27-2.77)	3.00 (2.70-3.31)	3.40 (3.04-3.74)	3.81 (3.39-4.19)	4.24 (3.74-4.67)	4.84 (4.22-5.34)	5.32 (4.60-5.87)
3-hr	1.57 (1.43-1.74)	1.91 (1.74-2.11)	2.42 (2.20-2.68)	2.82 (2.56-3.12)	3.37 (3.04-3.72)	3.82 (3.42-4.21)	4.28 (3.81-4.72)	4.76 (4.21-5.25)	5.43 (4.74-5.99)	5.97 (5.16-6.59)
6-hr	2.02 (1.84-2.23)	2.45 (2.24-2.71)	3.10 (2.82-3.42)	3.63 (3.29-3.99)	4.39 (3.94-4.81)	5.03 (4.48-5.50)	5.70 (5.04-6.23)	6.43 (5.63-7.02)	7.47 (6.45-8.17)	8.34 (7.11-9.12)
12-hr	2.52 (2.30-2.79)	3.07 (2.80-3.39)	3.91 (3.55-4.31)	4.61 (4.18-5.07)	5.65 (5.07-6.19)	6.55 (5.82-7.15)	7.52 (6.61-8.20)	8.59 (7.46-9.38)	10.2 (8.68-11.1)	11.6 (9.69-12.6)
24-hr	2.86 (2.65-3.11)	3.46 (3.20-3.77)	4.41 (4.08-4.80)	5.22 (4.81-5.68)	6.43 (5.89-6.98)	7.48 (6.80-8.10)	8.63 (7.77-9.35)	9.90 (8.82-10.8)	11.8 (10.4-12.9)	13.4 (11.6-14.7)
2-day	3.38 (3.12-3.68)	4.08 (3.77-4.45)	5.19 (4.79-5.66)	6.12 (5.62-6.66)	7.46 (6.82-8.12)	8.60 (7.81-9.35)	9.83 (8.86-10.7)	11.2 (9.97-12.2)	13.1 (11.6-14.4)	14.8 (12.8-16.3)
3-day	3.55 (3.28-3.86)	4.29 (3.97-4.67)	5.44 (5.02-5.91)	6.38 (5.88-6.93)	7.75 (7.10-8.41)	8.90 (8.10-9.65)	10.1 (9.15-11.0)	11.5 (10.3-12.5)	13.4 (11.8-14.7)	15.0 (13.1-16.5)
4-day	3.72 (3.45-4.04)	4.50 (4.17-4.88)	5.68 (5.25-6.16)	6.65 (6.13-7.21)	8.04 (7.38-8.70)	9.19 (8.39-9.96)	10.4 (9.44-11.3)	11.8 (10.6-12.8)	13.7 (12.1-14.9)	15.3 (13.4-16.7)
7-day	4.40 (4.09-4.77)	5.28 (4.91-5.72)	6.55 (6.08-7.09)	7.60 (7.03-8.22)	9.10 (8.37-9.85)	10.3 (9.46-11.2)	11.7 (10.6-12.6)	13.1 (11.8-14.2)	15.1 (13.4-16.5)	16.8 (14.7-18.3)
10-day	5.06 (4.72-5.45)	6.05 (5.64-6.51)	7.39 (6.88-7.95)	8.49 (7.88-9.13)	10.0 (9.27-10.8)	11.3 (10.4-12.2)	12.6 (11.5-13.6)	14.0 (12.7-15.1)	16.0 (14.3-17.3)	17.6 (15.6-19.1)
20-day	6.84 (6.42-7.30)	8.11 (7.61-8.66)	9.67 (9.08-10.3)	10.9 (10.2-11.6)	12.6 (11.7-13.4)	13.9 (12.9-14.8)	15.2 (14.1-16.2)	16.5 (15.2-17.7)	18.3 (16.7-19.7)	19.6 (17.8-21.2)
30-day	8.51 (8.05-9.01)	10.0 (9.50-10.6)	11.7 (11.1-12.4)	13.0 (12.3-13.8)	14.7 (13.9-15.6)	16.0 (15.0-16.9)	17.2 (16.1-18.3)	18.5 (17.2-19.6)	20.0 (18.6-21.4)	21.2 (19.5-22.7)
45-day	10.8 (10.3-11.4)	12.7 (12.1-13.4)	14.6 (13.9-15.4)	16.1 (15.3-17.0)	18.0 (17.0-19.0)	19.4 (18.3-20.4)	20.7 (19.5-21.9)	22.0 (20.6-23.3)	23.6 (22.0-25.0)	24.8 (23.0-26.3)
60-day	13.0 (12.3-13.6)	15.2 (14.5-16.0)	17.4 (16.5-18.3)	19.0 (18.0-20.0)	21.0 (19.9-22.1)	22.4 (21.3-23.7)	23.8 (22.5-25.1)	25.1 (23.7-26.5)	26.6 (25.0-28.2)	27.7 (26.0-29.4)

[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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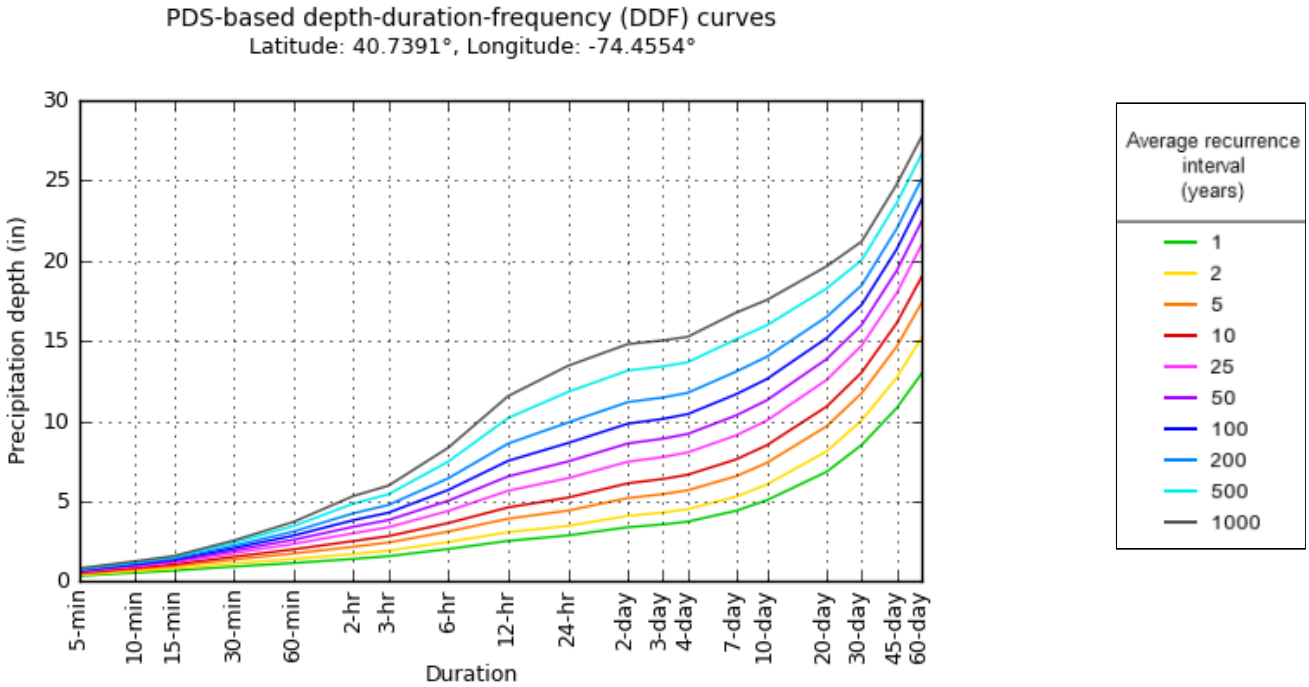
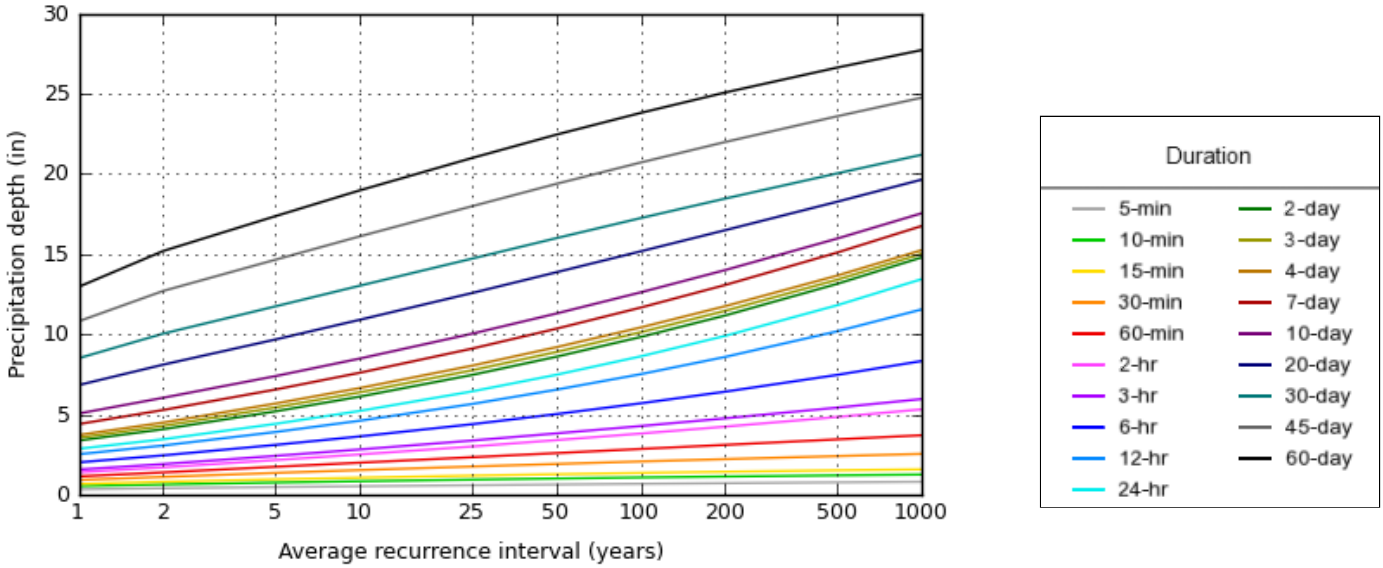
PF graphical





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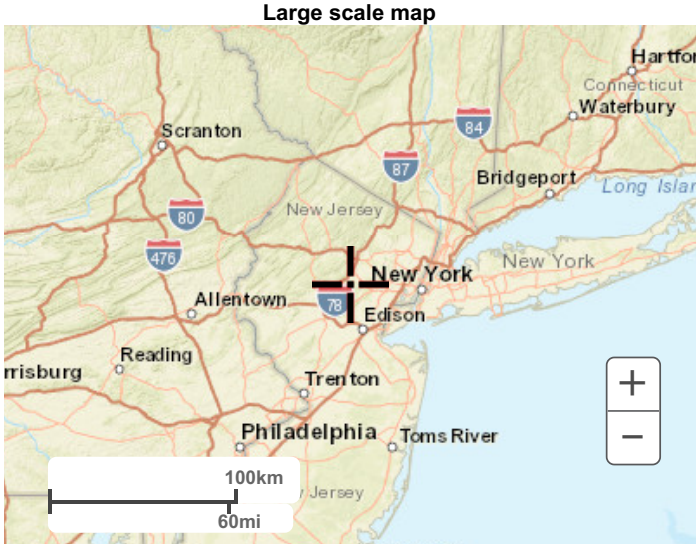
Maps & aerials

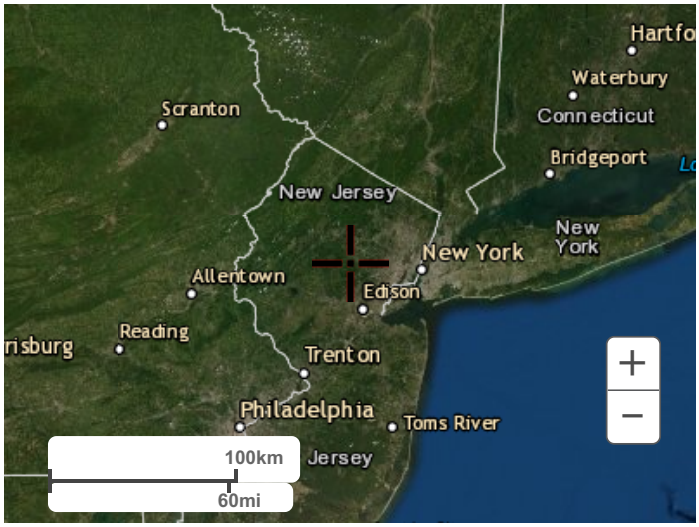
Small scale terrain

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

Disclaimer

APPENDIX C

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

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	------	-------	16.95	-------	-------	32.74	-------	-------	64.63	WSHD A-1
3	SCS Runoff	------	-------	23.61	-------	-------	48.21	-------	-------	99.27	WSHD A-2
5	SCS Runoff	------	-------	8.488	-------	-------	16.11	-------	-------	31.38	WSHD A-3

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

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	16.95	1	727	58,367	------	------	------	WSHD A-1
3	SCS Runoff	23.61	1	727	82,328	------	------	------	WSHD A-2
5	SCS Runoff	8.488	1	727	29,146	------	------	------	WSHD A-3

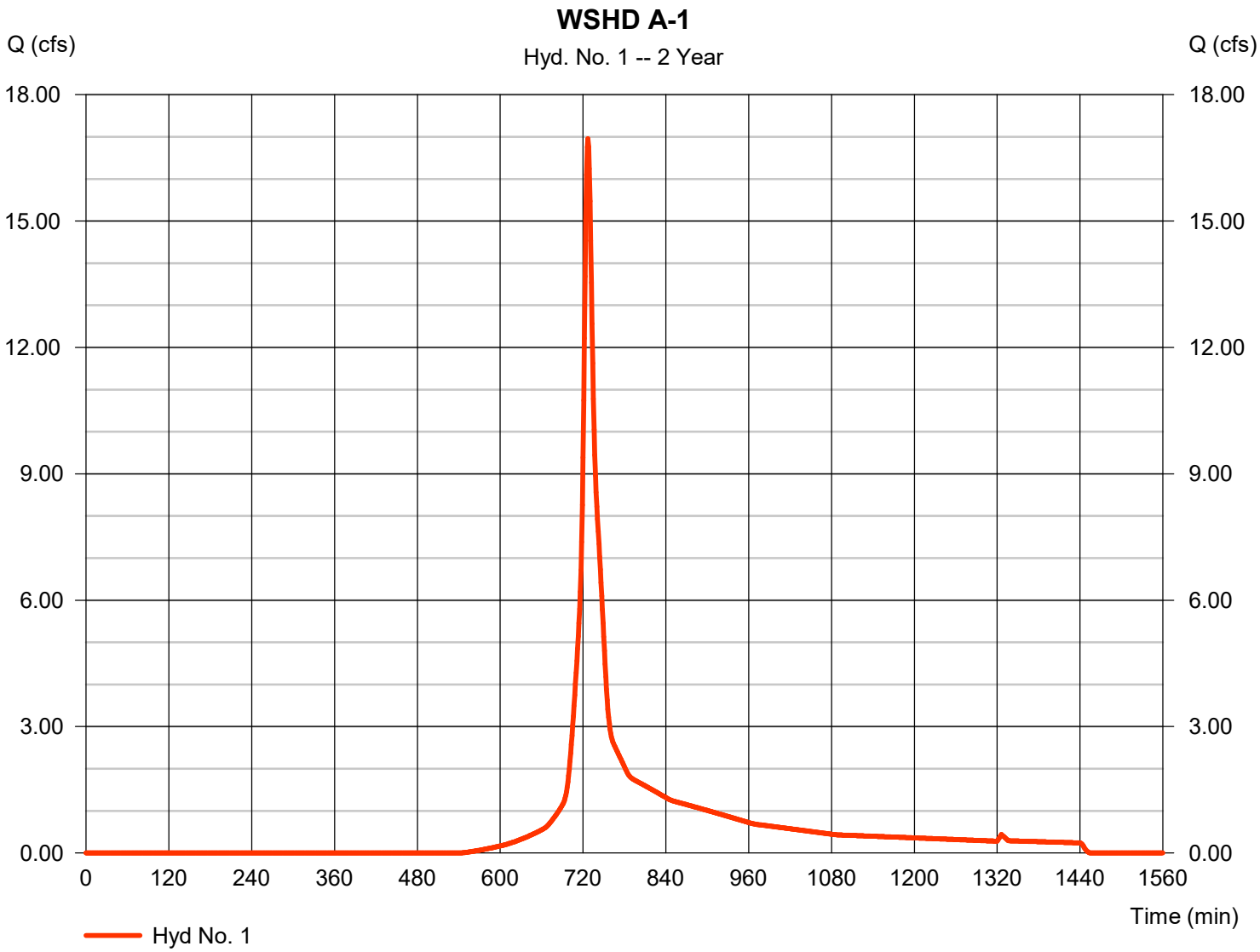
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 1

WSHD A-1

Hydrograph type	= SCS Runoff	Peak discharge	= 16.95 cfs
Storm frequency	= 2 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 58,367 cuft
Drainage area	= 10.020 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.46 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



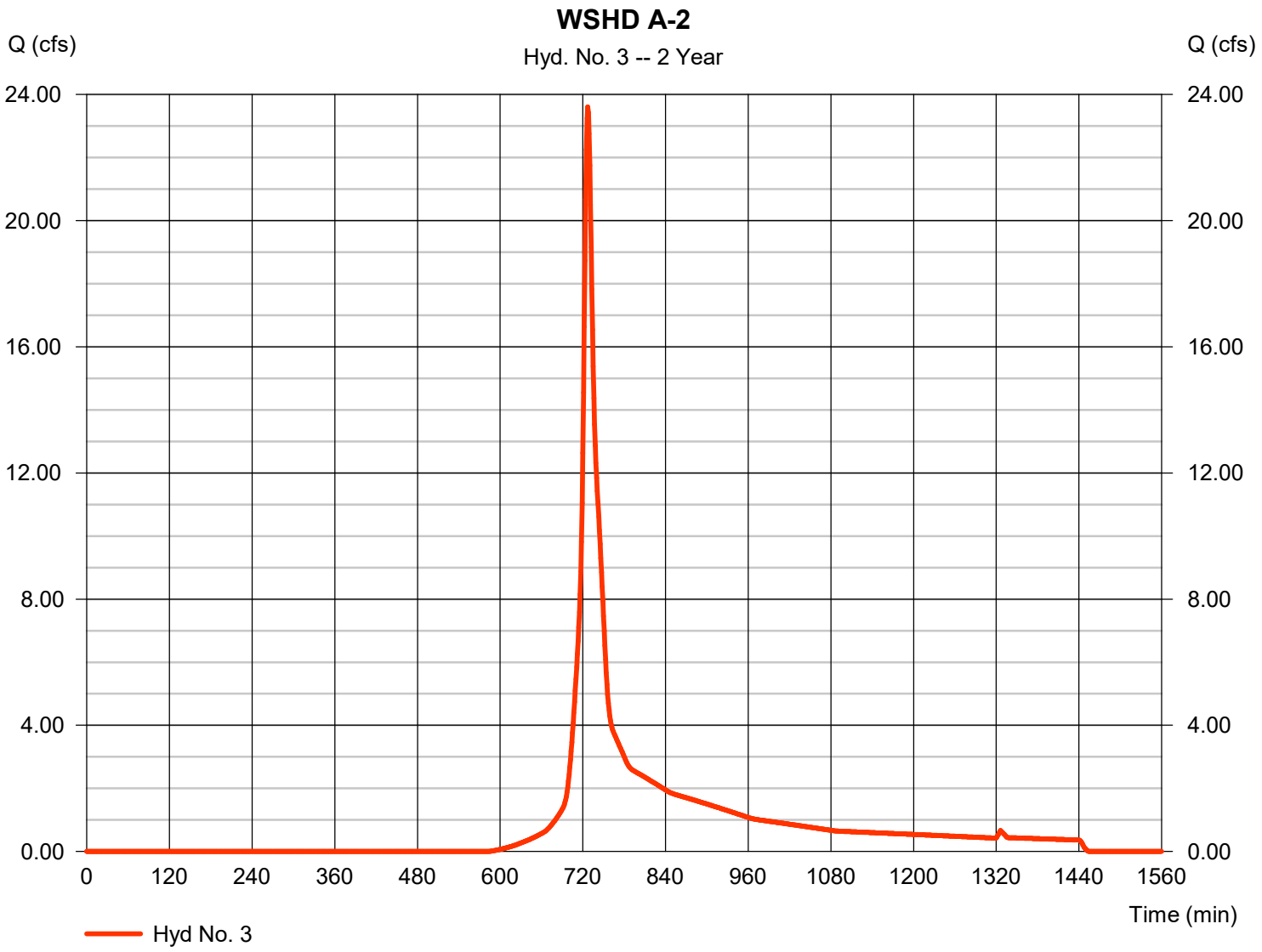
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 3

WSHD A-2

Hydrograph type	= SCS Runoff	Peak discharge	= 23.61 cfs
Storm frequency	= 2 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 82,328 cuft
Drainage area	= 16.190 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.46 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



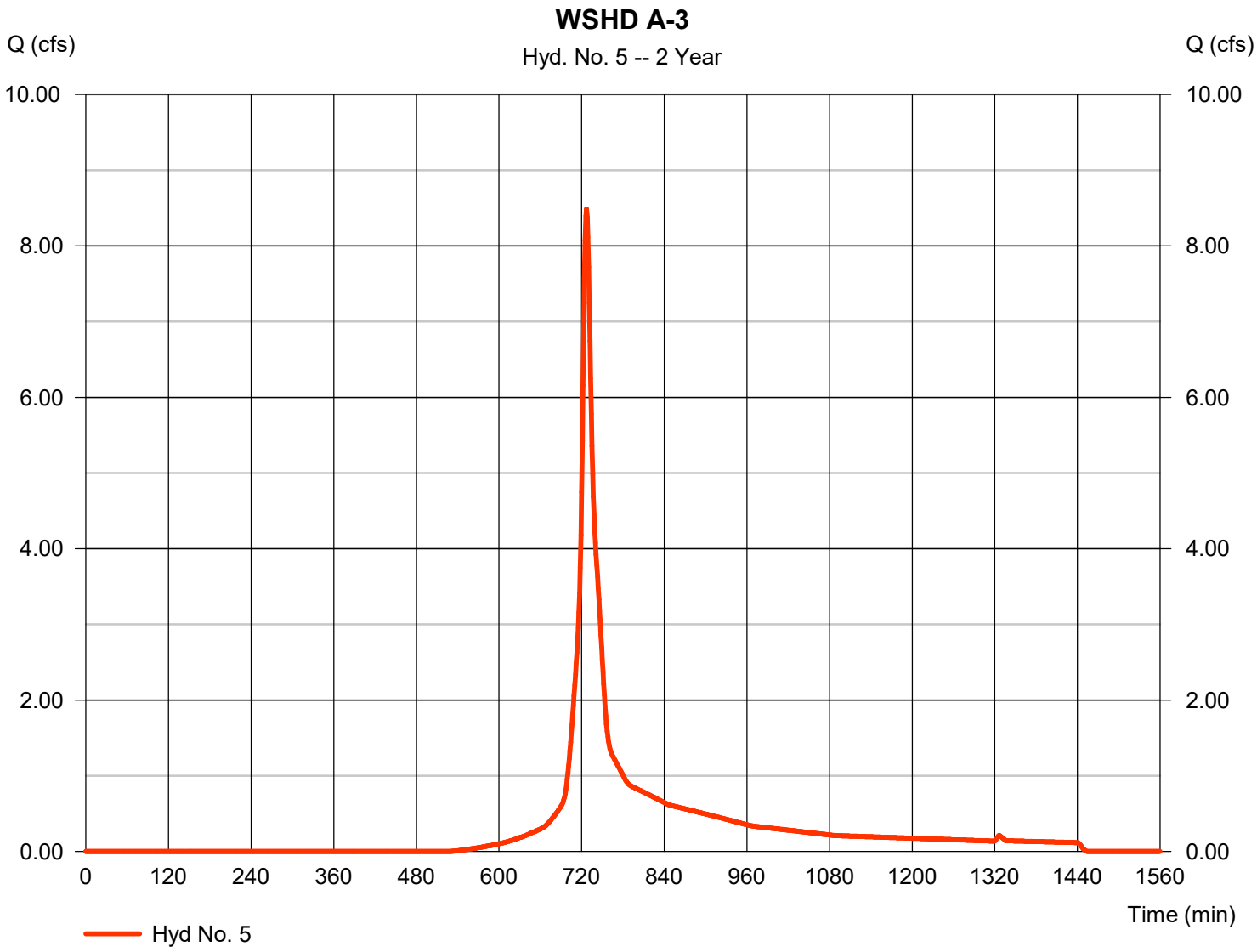
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 5

WSHD A-3

Hydrograph type	= SCS Runoff	Peak discharge	= 8.488 cfs
Storm frequency	= 2 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 29,146 cuft
Drainage area	= 4.790 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 3.46 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

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	32.74	1	727	112,233	------	------	------	WSHD A-1
3	SCS Runoff	48.21	1	727	165,030	------	------	------	WSHD A-2
5	SCS Runoff	16.11	1	727	55,302	------	------	------	WSHD A-3

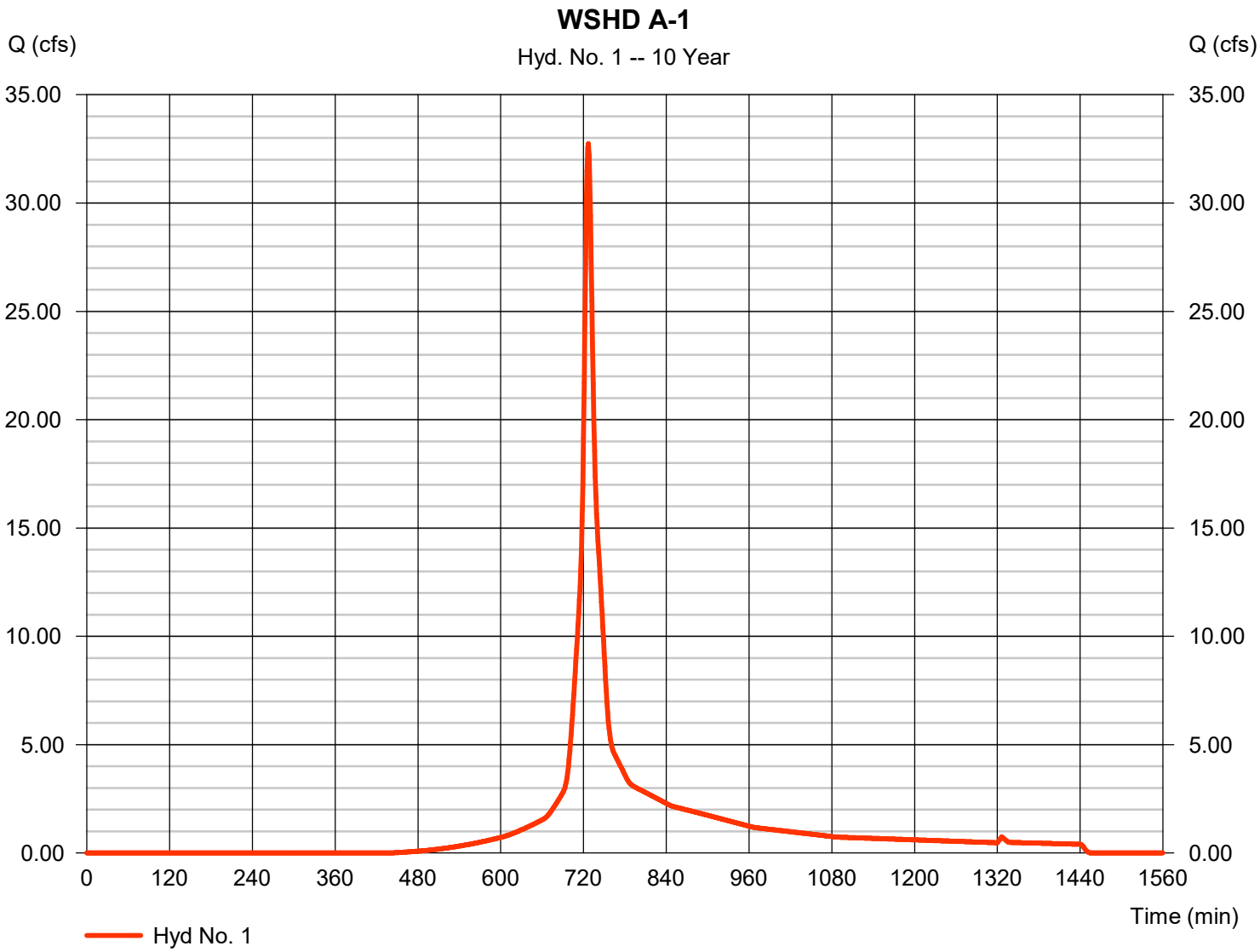
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 1

WSHD A-1

Hydrograph type	= SCS Runoff	Peak discharge	= 32.74 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 112,233 cuft
Drainage area	= 10.020 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.22 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



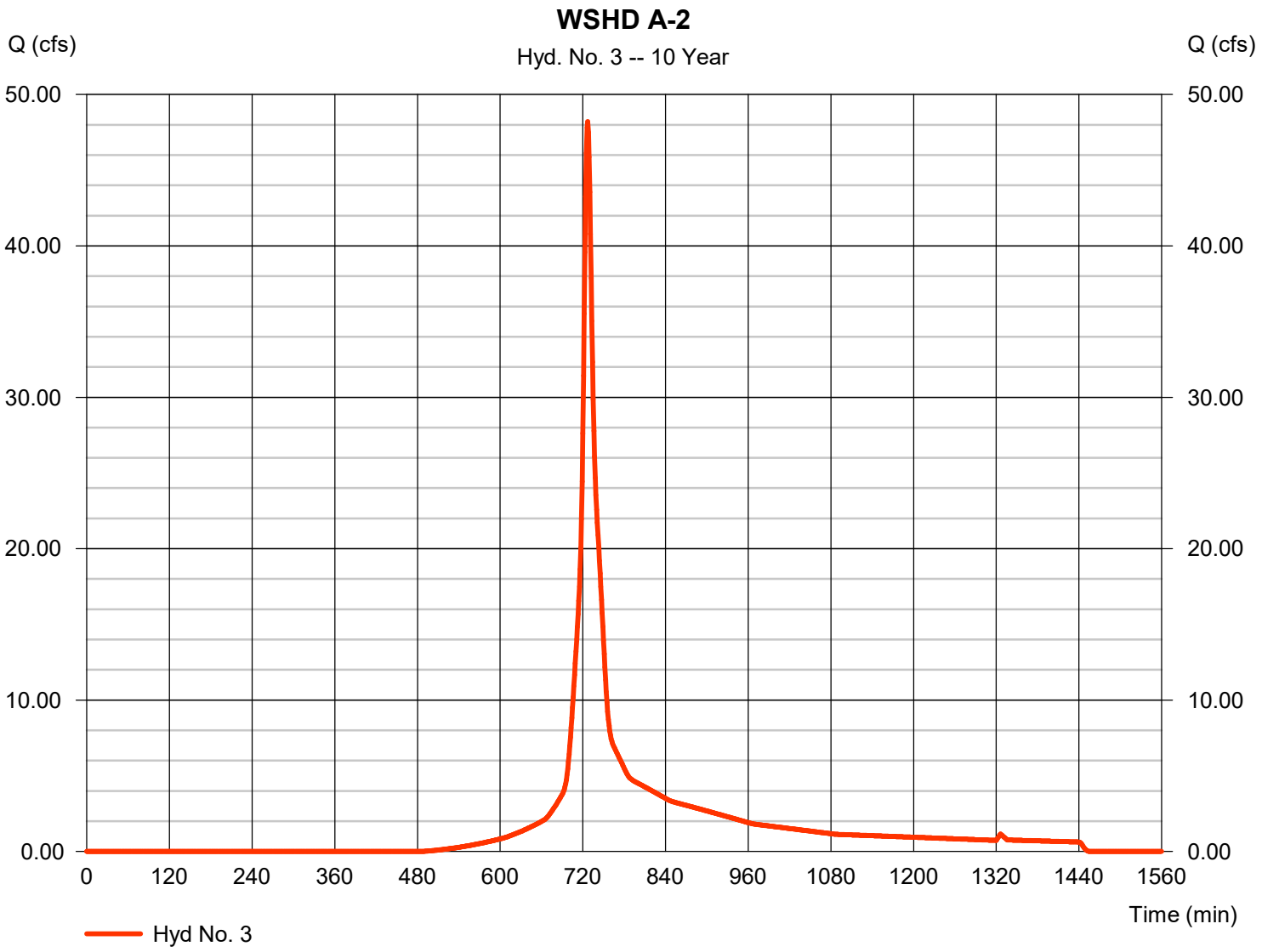
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 3

WSHD A-2

Hydrograph type	= SCS Runoff	Peak discharge	= 48.21 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 165,030 cuft
Drainage area	= 16.190 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.22 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



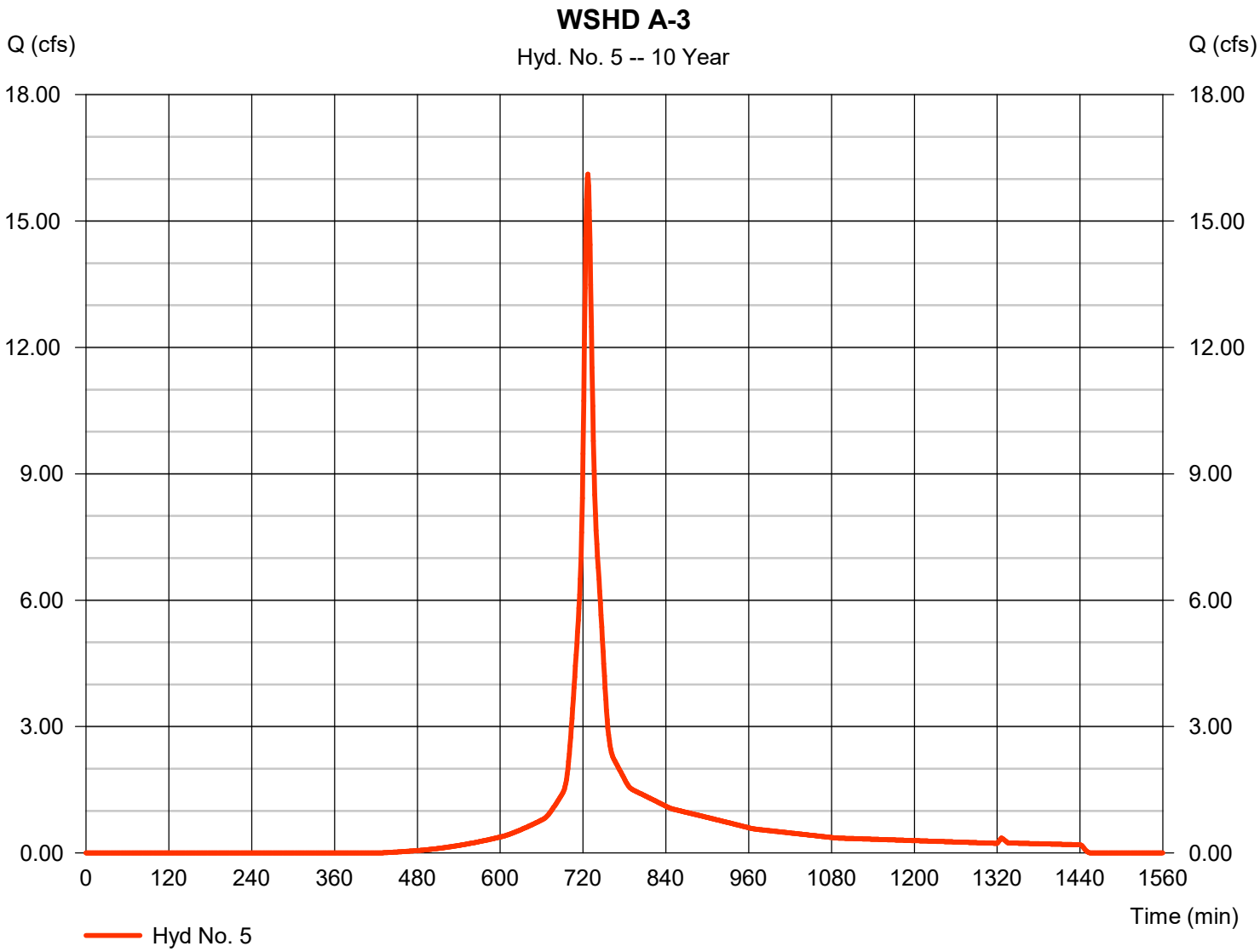
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 5

WSHD A-3

Hydrograph type	= SCS Runoff	Peak discharge	= 16.11 cfs
Storm frequency	= 10 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 55,302 cuft
Drainage area	= 4.790 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 5.22 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

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	64.63	1	727	226,164	------	------	------	WSHD A-1
3	SCS Runoff	99.27	1	727	344,112	------	------	------	WSHD A-2
5	SCS Runoff	31.38	1	727	110,219	------	------	------	WSHD A-3

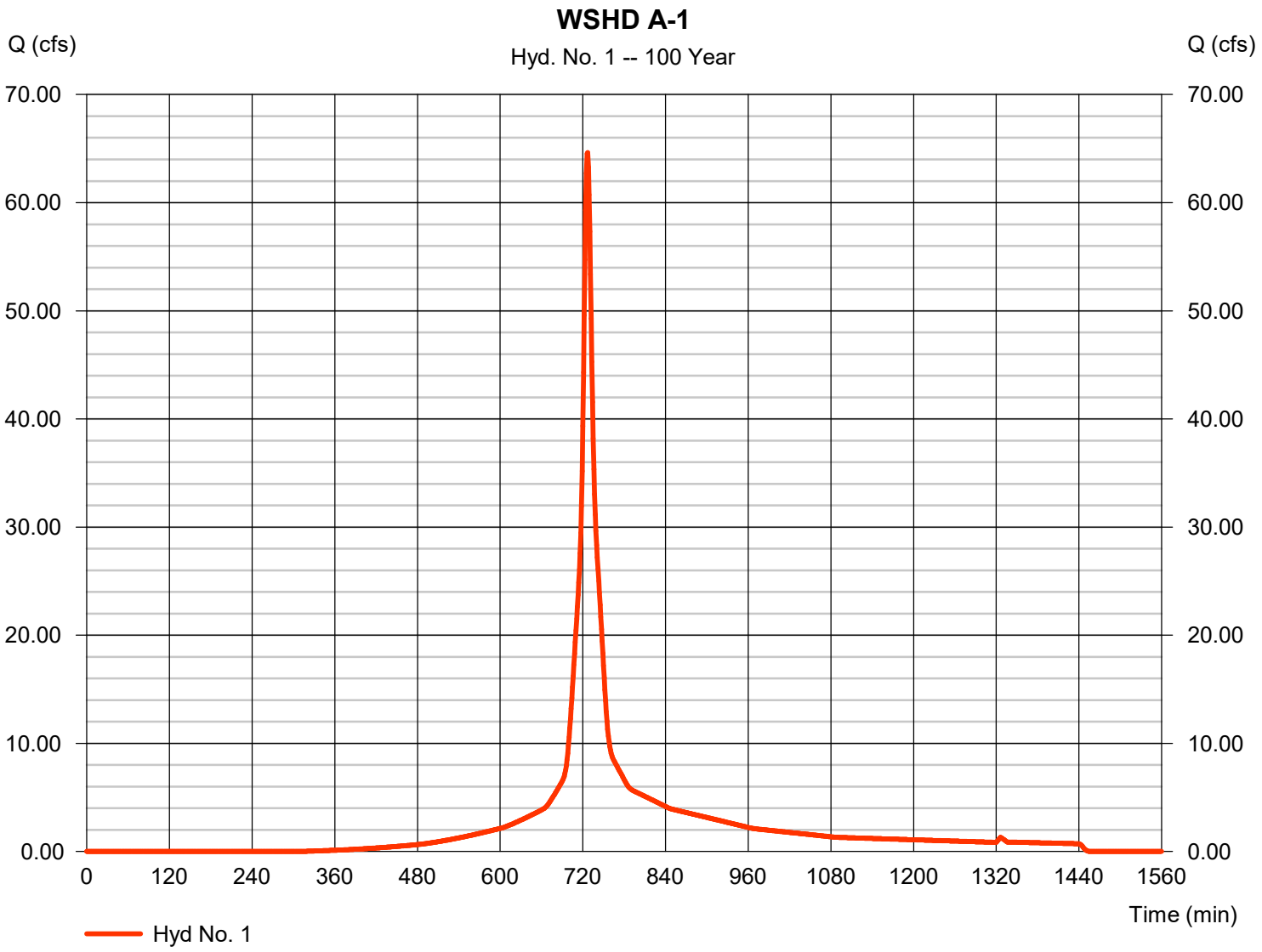
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 1

WSHD A-1

Hydrograph type	= SCS Runoff	Peak discharge	= 64.63 cfs
Storm frequency	= 100 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 226,164 cuft
Drainage area	= 10.020 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.63 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



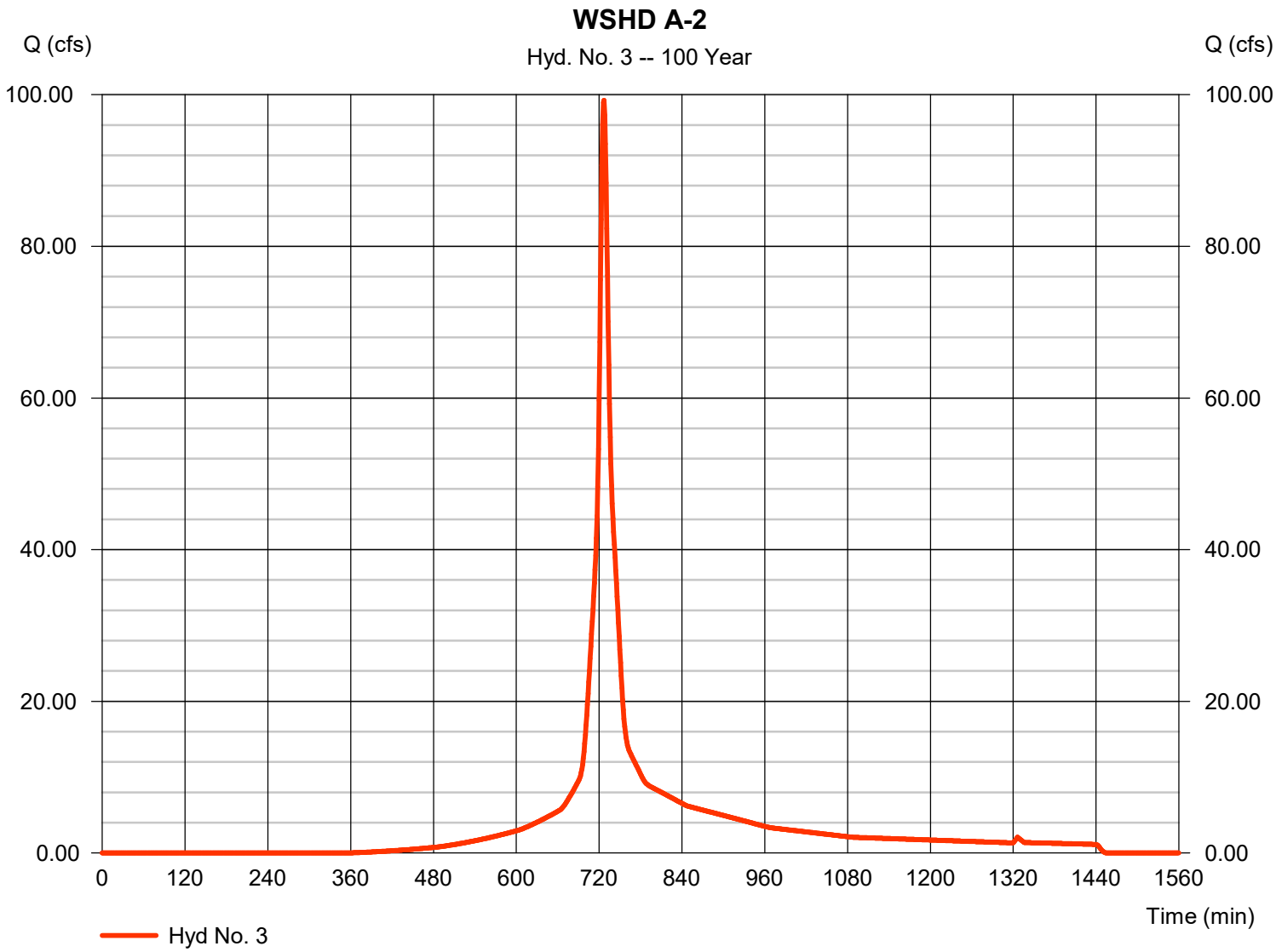
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 3

WSHD A-2

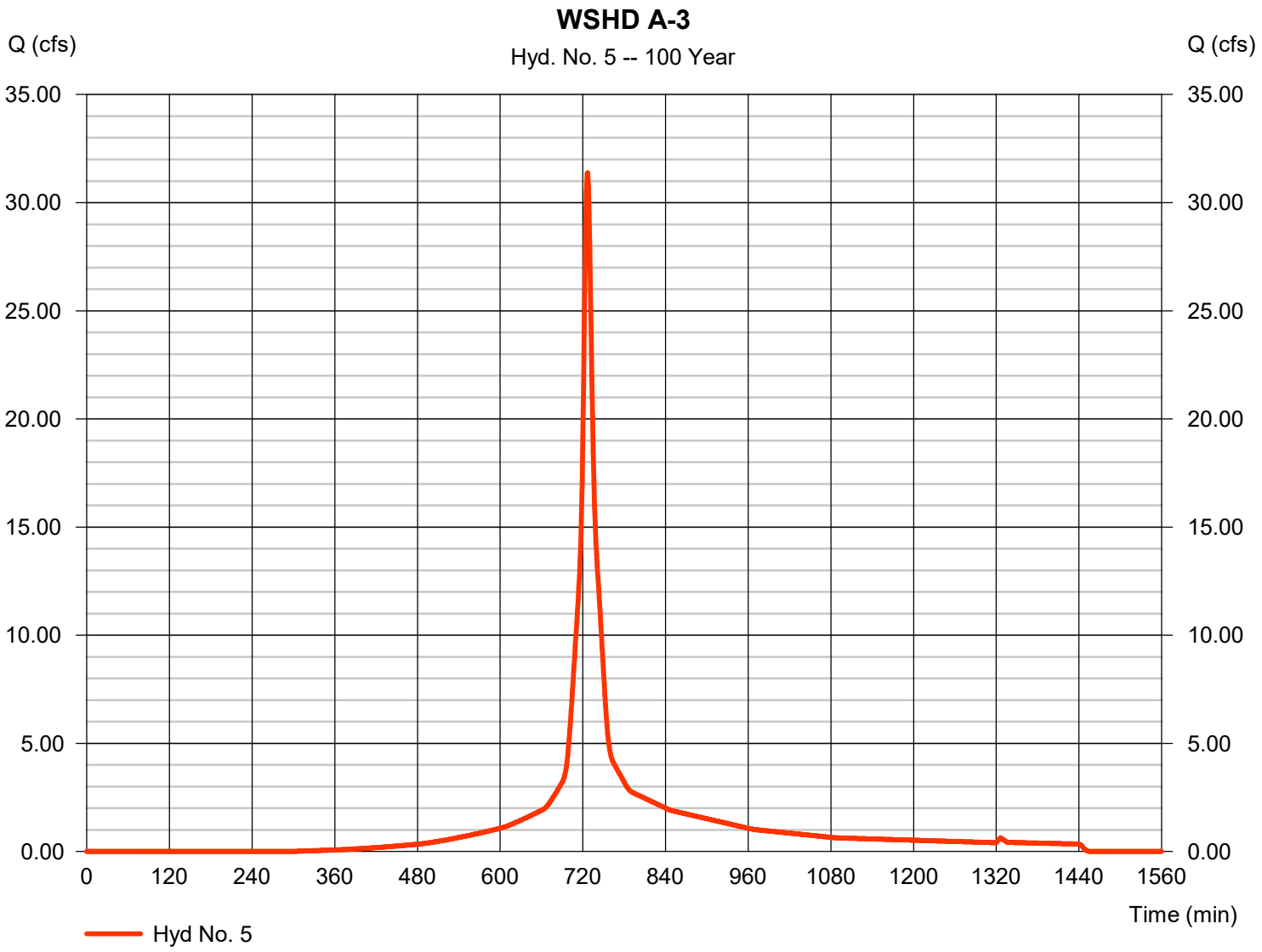
Hydrograph type	= SCS Runoff	Peak discharge	= 99.27 cfs
Storm frequency	= 100 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 344,112 cuft
Drainage area	= 16.190 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.63 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12 Friday, 10 / 4 / 2019

Hyd. No. 5

WSHD A-3

Hydrograph type	= SCS Runoff	Peak discharge	= 31.38 cfs
Storm frequency	= 100 yrs	Time to peak	= 727 min
Time interval	= 1 min	Hyd. volume	= 110,219 cuft
Drainage area	= 4.790 ac	Curve number	= 81
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.63 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484