Stormwater Management Report
Palmer Pointe Neighborhood
Barrington, Rhode Island

East Bay Community Development Corporation
Bristol, Rhode Island

March 2016

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Project No. 20121033.A20

FUSS & O'NEILL

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Palmer Pointe Neighborhood

1 Introduction

East Bay Community Development Corporation proposes the redevelopment of Lots 72, 73, 246, 248, 249, and 263 of Tax Assessor's Plat 28, in the Town of Barrington, RI, referred to herein as "the site". The site totals approximately 8.7 acres, and is bound to the west by Sowams Road, to the north and south by residential properties, and to the east by the Palmer River.

The proposed development of the site includes the demolition of existing structures and improvements and the construction of a residential neighborhood consisting of twelve (12) low- and moderate- income, multi-family homes, a management office/maintenance garage, a new roadway, and associated paved parking areas and walkways. Site improvements will also include landscaping and coastal wetland buffer restoration, new utilities, and a stormwater management system.

This Stormwater Management Report includes the calculations and methodology used to design the proposed stormwater management system to comply with the current edition of the *Rhode Island Stormwater Design and Installations Standards Manual* (RISDISM). The National Resources Conservation Service (NRCS) TR-20 method was used to determine pre- and post-development peak runoff rates and volumes discharged to each point of analysis. Manning's equation was used for the design of stormwater conveyances.

2 Pre-Development Conditions

The property includes two single family homes sited on Sowams Road, with the balance comprised of a (former) commercial use, most recently operated by Sowams Nursery, which includes, a paved and gravel roadway, gravel storage area, greenhouses, several sheds, and vegetated areas, including predominantly undisturbed coastal wetlands.

The topography of the pre-development site is characterized by a high point approximately two hundred and fifty feet east of Sowams Road. The property slopes gradually toward the east and west, with steeper slopes existing in the eastern portions of the property defining the limits of onsite wetland.

2.1 Soil and Groundwater

According to the *Soil Survey of Rhode Island*, the western portion of the site is underlain by Merrimac-Urban land complex with 0 to 8 percent slopes (MU), which typically consists of well-drained soils, which have been disturbed by land development. Merrimac soils have a Hydrologic Soil Group of A, while Urban Land has a Hydrologic Soil Group (HSG) of D. For the purposes of the drainage analysis discussed herein, a Hydrologic Soil Group of C was assumed for these soils. The central area of the site is comprised of Merrimac fine sandy loam, 3 to 8 percent slopes (MmB), which typically consist of fine sandy loam underlain by stratified gravel to gravelly sand. These soils are somewhat excessively drained and have a Hydrologic Soil Group of A. The central-eastern portion of the site consists of Walpole Sandy Loam, with 0 to 3 percent slopes (Wa), which are defined by poorly drained soils belonging to Hydrologic Soil Group B/D. Hydrologic Soil Group C was used in the drainage analysis of Wa soils. The easternmost part of the site bordering the Palmer River is underlain by Sandyhook mucky fine sand with 0

to 2 percent slopes. These soils are frequently flooded and poorly drained, with a Hydrologic Soil Group of A/D. An HSG of C was assumed for these soils.

Test pits performed by Fuss & O'Neill were generally consistent with the typical soil profiles described by NRCS. Groundwater and mottling were not observed in the test pits, which were excavated to a typical depth of ten feet. See *Appendix G* for the Soil Evaluation Summary.

2.2 Flood Hazard Areas

Portions of the site lie within flood zone AE, a special flood hazard area inundated by the 1% annual chance flood with base flood elevation 13 feet (NGVD 1988). The remainder of the site lies within flood zone X, which includes areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths less than one foot or with drainage areas less than one square mile; areas protected by levees from the 1% annual chance flood. Flood zone information was obtained from Flood Insurance Rate Map 44001C0007H dated September 18, 2013, Last revised July 7, 2014.

2.3 Existing Watersheds

The site is comprised of two primary watershed areas established by current topographical features (refer to *Figure 3*).

- *Watershed 1,* which consists of the western portion of the site, is a total area of 1.88 acres. This watershed contains a paved driveway, gravel drive areas, compacted soil areas, a large greenhouse, a shed and some vegetated areas. This watershed slopes to the west and southwest. Stormwater sheds toward adjacent residential properties, and subsequently into the drainage system in Sowams Road. Discharges from the road are generally directed westward and ultimately discharge to the Barrington River, approximately one quarter mile west of the site.

- *Watershed 2* includes the remaining 7.07 acres of the site. This watershed consists primarily of gravel driveways, greenhouses, dirt/gravel staging areas, and limited (primarily understory) vegetation. The eastern portion of the watershed also includes densely vegetated coastal wetland areas. Runoff from *Watershed 2* flows discharges by overland and concentrated flows into the Palmer River.

Pre-development peak flow rates and volumes generated by each subwatershed for the 2-, 10-, 25-, and 100-year storm events are included in *Section 6* of this report. Supporting documentation and hydrologic calculations are included in *Appendix A*.

3 Post-Development Conditions

The Palmer Pointe Neighborhood development project includes permanent improvements within an approximately seven (7) acre area of the property. The primary components of the site improvements are twelve multi-family dwellings, an office and maintenance building, a new roadway, paved parking lots, walkways, and other site amenities, primarily sited in the western and central portions of the site. The

project also includes restoration work in the eastern portions of the lot, which are primarily incorporated with a 3.4 acre open space lot.

3.1 Proposed Watersheds

The proposed project maintains the two existing watersheds which are described in the following paragraphs. Watershed 2 has been further broken down into smaller subwatershed areas to reflect differing hydrologic conditions and treatment systems. (For the Post-Development Watershed Map, see *Figure 4).*

- *Watershed 1*, under post-development conditions, is approximately 0.13 acres. Subwatershed 1 consists of the entrance to the proposed Red Maple Road from Sowams Rd., and is approximately seventy percent impervious pavement. Although significant reductions in impervious area are proposed in the developed conditions, runoff from this watershed is directed to (two) tree filters located to the north of Red Maple Road to provide runoff treatment. Larger event stormwater discharge is directed to Catch Basin 7 and to the existing Sowams Road drainage system.

- *Watershed 2* has a total area of approximately 8.8 acres and comprises the majority of the site. For the purpose of stormwater analysis, Watershed 2 has been divided into the following four drainage areas, which have been added to establish the cumulative discharge to the Palmer River.

    - *Subwatershed 2A* is approximately 2.6 acres and contains the significant majority the road network which incorporates an enclosed drainage network including catch basins with hooded outlets. The watershed also includes the two westernmost parking lots, limited rooftops, walkways, and maintained lawns. The subwatershed drainage system discharges runoff into a pretreatment forebay sited adjacent to the public road and then discharges to a bioretention basin to provide treatment. Overflows from the bioretention basin are discharged at grade outside of regulated buffer zones and flow by overland flow toward the Palmer River.

    - *Subwatershed 2B* is approximately 1.0 acre and is comprised of improvements on the southern portion of the proposed development. Runoff from the two southern parking lots, building rooftops, walkways, and landscaped areas are included in the subwatershed. A dry swale along the southern edge of the site collects, treats, and conveys stormwater east toward the River. Forebays pretreat runoff from the parking lots prior to discharging to the dry swale. The swale terminates at a large level area outside of regulated buffer zones.

    - *Subwatershed 2C* is approximately 1.0 acres and is comprised of the northern portion of the site improvements. Runoff from this watershed discharges to a dry swale sited along the northern site boundary which provides quality treatment. Similar to Subwatershed 2B, forebays provide pretreatment for the runoff generated by the two parking lots and the swale terminates at a large, level area outside of regulated buffer zones.

    - *Subwatershed 2D* includes the balance of the watershed area and is approximately 4.2 acres. The subwatershed consists almost entirely of vegetated (including significant existing

improved areas which are being restored) and also contains a small amount walkway. This subwatershed contains a managed buffer (meadow) area, a natural wetland buffer restoration area, as well as the existing wetlands. Runoff from this subwatershed drains to the east and into Palmer River.

Post-development peak flow rates and volumes generated by each subwatershed for the 2-, 10-, 25-, and 100-year storm events are included in *Section 6* of this report. Supporting documentation and hydrologic calculations are provided in *Appendix B*.

4 Proposed Stormwater Management System

The stormwater management system has been designed to mitigate the impacts of stormwater runoff generated by the proposed site. The drainage system has been designed to comply with Stormwater Management Standard and Performance Criteria of RISDISM using various low-impact development (LID) techniques and best management practices (BMP's). The proposed drainage system will consist of the following components:

- *Pretreatment Forebays.* Pretreatment of runoff from all paved areas is provided within forebays. Pretreatment for Subwatershed 2A is achieved with a single forebay located to the east of the proposed roadway, easily accessible by maintenance vehicles. The closed conduit drainage system discharges into this forebay with two flared end sections. The forebay is sized to store 25% of the water quality volume. Subwatersheds 2B and 2C each include pretreatment cells collecting runoff that discharges from the parking lots toward the dry swales. These forebays have been sized to store a minimum of 10% of the water quality volume for the subwatershed. For Watershed 1, the selected tree box units incorporate street grate with sump, again providing ease of access for maintenance. The sumps are sized to capture and store 25% if the water quality volume directed to the units.

- *Dry Swales.* The site's two proposed dry swales are designed to attenuate the water quality volume and convey excess stormwater from the project. The swales consist of a 30" bioretention soil filter depth, 4:1 side slopes, and longitudinal slopes averaging 1.5% toward the east. Check dams spaced 50-feet apart, retain the water quality volume and at an average depth of 4.5 inches.

- *Bioretention Basin*. A bioretention basin is incorporated to provide water quality treatment, and groundwater recharge. In accordance with RISDISM requirements, peak flow attenuation is not required, as stormwater discharges directly to tidal waters. The bioretention basin is designed in accordance with Section 5.5 of the RISDISM. The bioretention basin contains a 24" layer of bioretention soil media, which will filter stormwater runoff generated by Subwatershed 2A. Due to suitable groundwater separation, the basin will also allow infiltration and groundwater recharge. The embankment is designed to allow 9" of ponding within the bioretention basin. A 50-foot wide spillway in the embankment will discharge at grade outside of regulated buffers, directing overland flows toward the Palmer River.

- *Tree Filters.* Two tree filter systems (StormTree) are proposed to the north of Red Maple Road near its intersection with Sowams Road. These filters consist of a concrete frame and removable support grate, with a 24" engineered soil filter bed underlain by geotextile fabric and 12" of washed stone. During larger storm events, a PVC pipe discharges runoff to a catch basin, which connects to the existing Sowams Road closed conduit drainage system.

- *Closed-conduit system.* A closed-conduit drainage system consisting of high density polyethylene pipe, deep-sump catch basins, and pre-cast concrete drain manholes. All pipes within the closed-conduit drainage system have been designed to accommodate the 25-year flow rate as determined using the Rational Method (refer to Appendix C for pipe-sizing calculations). Each catch basin will have a minimum sump depth of three feet. Snouts will be installed at the outlets of each catch basin for water quality purposes.

Refer to *Appendix C* for best management practice (BMP) sizing calculations.

5 Minimum Stormwater Standards

The stormwater management system has been designed to comply with the applicable Minimum Standards in the RISDISM. The following paragraphs summarize the measures implemented to conform to the Standards.

- Standard 1: LID Site Planning and Design
  LID site planning and design strategies were utilized to the maximum extent practical in order to reduce the generation of water runoff volume for the project. The Stormwater Management Checklist, provided in *Appendix F*, provides a comprehensive list of LID strategies proposed for this project. Key LID strategies incorporated include:

  - Minimize site clearing and grading activities: The proposed limit of disturbance consists almost entirely of previously disturbed land and is designed to minimize cut and fill volumes while maintaining positive drainage.

  - Reduce and manage impacts associated with impervious cover: The impervious area was minimized to the extent reasonable for the intended use of the site. The impacts associated with the proposed impervious cover are managed using best management practices designed in accordance with the applicable RISDISM regulations.

- Standard 2: Groundwater Recharge
  The stormwater management system was designed to allow retention and infiltration of runoff generated by the site.

- Standard 3: Water Quality
  The proposed BMP's were designed to treat the required water quality volumes for each subwatershed, which were calculated in accordance with Section 3.3.3 of the RISDISM. The project is also subject to the provisions of Appendix H.3 of the RISDISM because Palmer River is a TMDL waterbody with Nitrogen impairment. The Simple Method was used to calculate the

site's net Nitrogen loading. The proposed BMP's were chosen based on their 55% median pollutant removal efficiency for total Nitrogen, resulting in a net decrease in net loading from the site to the Palmer River. Refer to *Appendix C* for water quality volume calculations and *Appendix D* for pollutant loading calculations.

- Standard 4: Conveyance and Natural Channel Protection
  This standard is waived for sites that discharge directly to a large waterway (4th order stream or larger).

- Standard 5: Overbank Flood Protection
  This standard is waived for sites that discharge directly to a large waterway (4th order stream or larger).

- Standard 6: Redevelopment and Infill Projects
  The site is not classified as a redevelopment or an infill project.

- Standard 7: Pollution Prevention
  The spill prevention and response procedure is included on the site drawings in accordance with Part II.B and C of the RIPDES Construction General Permit.

- Standard 8: Land Uses with Higher Potential Pollutant Loads
  This project does not include any stormwater land uses with a higher potential pollutant load (LUHPPL) in accordance with *Table 3-2* of the RISDISM.

- Standard 9: Illicit Discharges
  This project does not propose illicit discharges.

- Standard 10: Construction Erosion and Sedimentation Control
  Erosion and sediment control practices are also included on the site drawings. Measures include, but are not limited to: limiting exposure of soil surfaces, sediment barriers at the site perimeter and up-gradient of the proposed BMP's, a construction entrance, and catch basin inlet protection.

- Standard 11: Operation & Maintenance
  An Operation and Maintenance Plan has been prepared and is provided under separate cover.

6 Summary

The proposed project has been designed to fully mitigate the water quality impacts from the proposed site development. Under pre-development conditions, the site has no stormwater treatment system in place and poses risk of pollutant migration to bordering properties and to the Palmer River. The stormwater management system, consisting of catch basin sumps, two tree filters, five pretreatment forebays, two dry swales, and a bioretention basin, will treat the runoff from new impervious areas prior to infiltration and/or discharge, will reduce pollutant loads to the Palmer River, and comply with the requirements of the RIDSISM.

Runoff volumes and runoff peak flows from Subwatershed 1 to the Sowams Road drainage system will be reduced for the 2-, 10-, 25-, and 100-year storm events due to the significant reduction in the area of the watershed. Increases in peak flows to the east (Watershed 2) are anticipated for the 10-, 25-, and 100-year storm events, while peak volumes will be reduced for the 2-, 10-, and 25- year storms. The increases are attributable to the increased size of Watershed 2 which has been proposed to maximize runoff treatment on the property. The RISDISM does not require peak flow mitigation for the watershed because runoff is discharged from the property directly to the Palmer River.

The results of the analysis and calculations for the pre- and post-development conditions are summarized in the tables below.

Table 1
Watershed 1: Pre- and Post-Development Runoff

24-Hour Storm Event	Pre-Conditions Peak Flow Rate (cfs)	Post-Conditions Peak Flow Rate (cfs)	Change in Flow Rate (cfs)	Pre-Conditions Volume (cf)	Post-Conditions Volume (cf)	Change in Volume (cf)
2-Year	3.59 cfs	0.28 cfs	-3.31 cfs	14,243 cf	881 cf	-13,362 cf
10-Year	6.05 cfs	0.45 cfs	-5.60 cfs	24,391 cf	1,454 cf	-22,937 cf
25-Year	8.05 cfs	0.58 cfs	-7.60 cfs	32,885 cf	1,892 cf	-30,993 cf
100-Year	11.69 cfs	0.84 cfs	-10.85 cfs	48,832 cf	2,814 cf	-46,018 cf

Table 2
Watershed 2: Pre- and Post-Development Runoff

24-Hr Storm Event	Pre-Conditions Peak Flow Rate (cfs)	Post-Conditions Peak Flow Rate (cfs)	Change in Flow Rate (cfs)	Pre-Conditions Volume (cf)	Post-Conditions Volume (cf)	Change in Volume (cf)
2-Year	4.22 cfs	3.10 cfs	-1.12 cfs	20,604 cf	14,373 cf	-6,231 cf
10-Year	10.10 cfs	12.26 cfs	2.16 cfs	45,592 cf	42,237 cf	-3,355 cf
25-Year	15.53 cfs	19.09 cfs	3.56 cfs	68,877 cf	67,625 cf	-1,252 cf
100-Year	26.24 cfs	34.73 cfs	8.49 cfs	115,791 cf	127,526 cf	11,735 cf

References

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.

Technical Notes

Technical Note 2.109
Re: Flow Capacity
Date: March 1, 1995

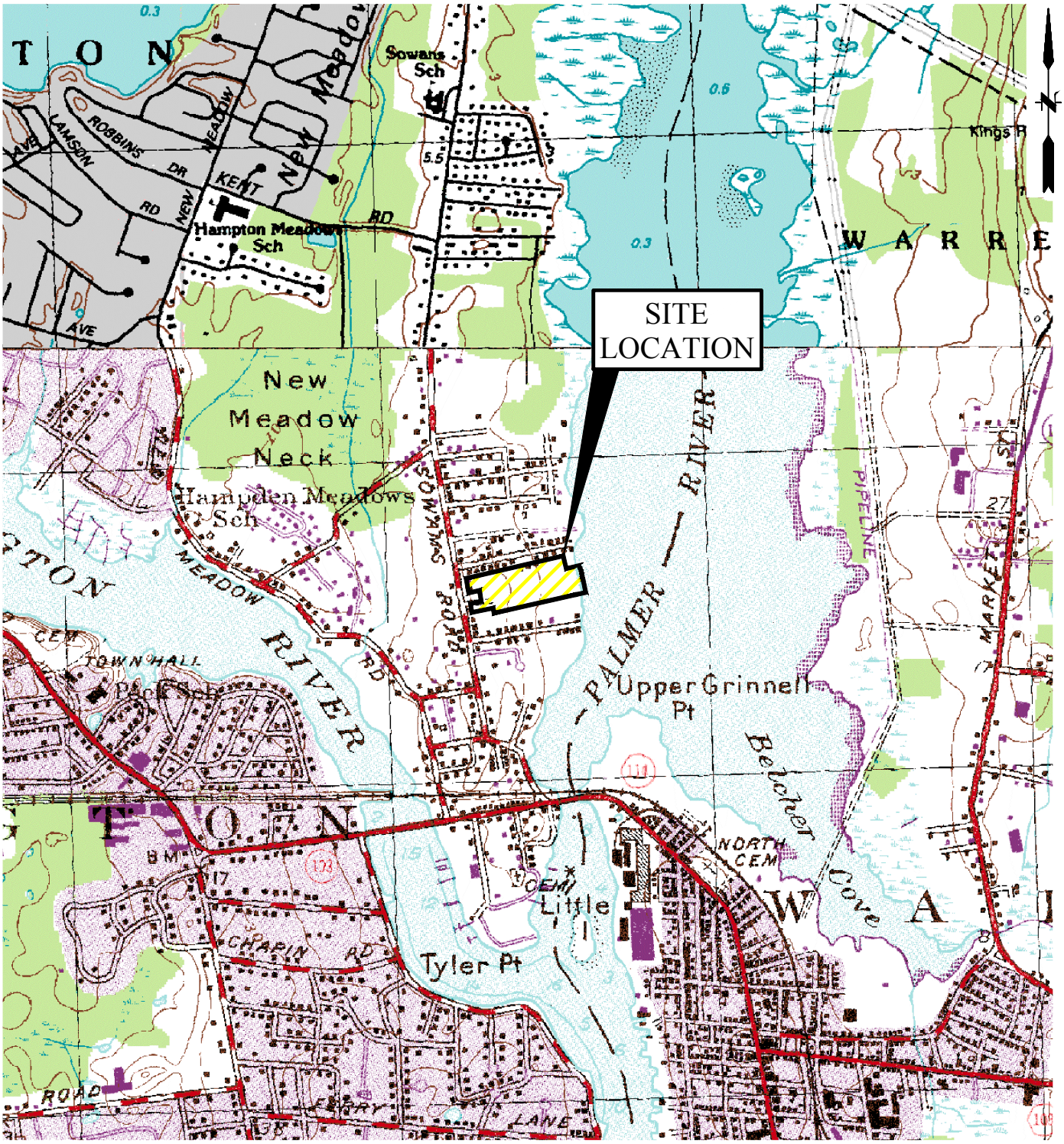
It is the intent of this Technical Note to provide current hydraulic performance data for use by the engineering community. A bibliography is included for the engineer's use if further information or guidance is needed.

Manning's "n" values are offered for design purposes based on the best available data assembled from a variety of sources as indicated. Table 1 presents the Manning's "n" values recommended by the A.D.S. engineering staff for use in design.

Table 1
Manning's "n" Value For Design
(Storm & Sanitary Sewer and Culverts)

Pipe Type	"n"
A.D.S. Corrugated Polyethylene Pipe	
3" - 6" Diameter	0.015
8" Diameter	0.016
10" Diameter	0.017
12" - 15" Diameter	0.018
18" - 36" Diameter	0.020
A.D.S. N-12	0.012 ← VALUE USED FOR HDPE
Concrete Pipe	0.013 ← VALUE USED FOR RCP
Corrugated Metal Pipe (2 2/3" x 1/2" corrugation)	
Annular	
Plain	0.024
Paved Invert	0.020
Fully Paved (smooth lined)	0.013
Helical	
Plain 15" Diameter	0.013
Plain 18" Diameter	0.015
Plain 24" Diameter	0.018
Plain 36" Diameter	0.021
Spiral-Rib	0.012
Plastic Pipe (SDR, S&D, Etc.)	0.011
Vitrified Clay	0.013

Figures



MAP REFERENCE:

THIS MAP WAS PREPARED FROM THE RHODE ISLAND GEOGRAPHIC INFORMATION SYSTEM (RIGIS WEBSITE). SCANNED 7.5 MINUTE USGS TOPOGRAPHIC MAPS: PROVIDENCE QUADRANGLE, RHODE ISLAND–MASSACHUSETTS DATED 1987 AND BRISTOL QUADRANGLE, RHODE ISLAND–MASSACHUSETTS DATED 1955, PHOTOREVISED 1970 AND 1975.

SCALE:
HORZ.: 1" = 1500'
VERT.:
DATUM:
HORZ.:
VERT.:
0 750 1500
GRAPHIC SCALE

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317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

EAST BAY COMMUNITY DEVELOPMENT CORPORATION

SITE LOCATION MAP

PALMER POINTE NEIGHBORHOOD

BARRINGTON RHODE ISLAND

PROJ. No.: 20121033.A20
DATE: MARCH 2016

FIGURE 1

File Path: J:\DWG\P2012\1033\A20\Civil\Plan\20121033A20_LOC01_USGS.dwg Layout: FIGURE 1 Plotted: Mon, February 22, 2016 - 4:07 PM User: cviera
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
LAYER STATE:
MS VIEW:

File Path: J:\DWG\P20121033\A20\Civil\HydraFlow\20121033A20_PRE01.dwg Layout: FIG-2 Plotted: Thu, February 25, 2016 - 7:01 PM User: cvitera
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
LAYER STATE:
MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.				

SEAL

SEAL

EAST BAY COMMUNITY DEVELOPMENT CORPORATION

FJS Associates, Ltd.

SCALE:
HORZ.: 1" = 40'
VERT.:
DATUM:
HORZ.:
VERT.: NGVD 1925
40 20 0 40
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

EAST BAY COMMUNITY DEVELOPMENT CORPORATION

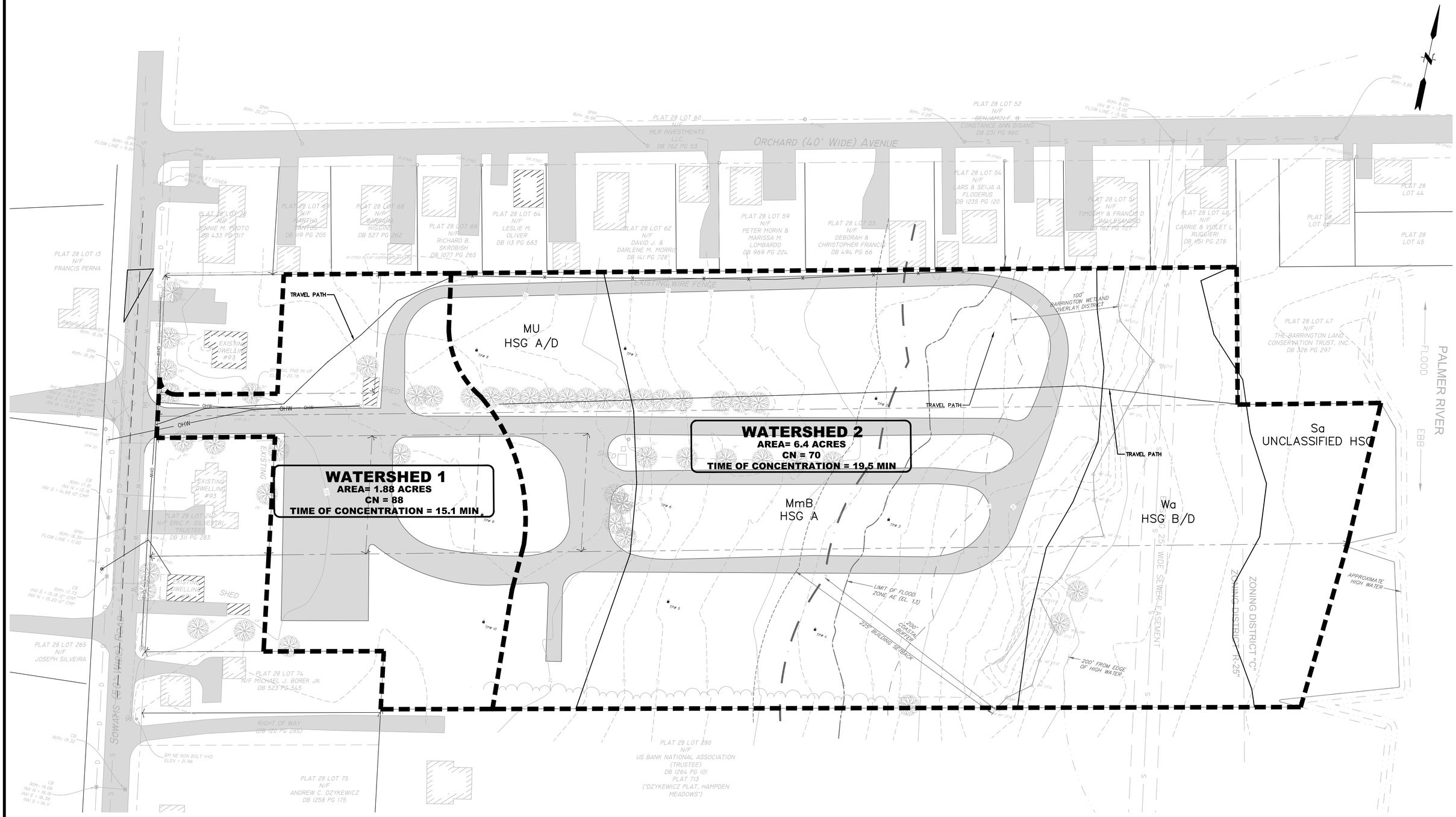
COMPREHENSIVE PERMIT EXISTING CONDITIONS MAP

PALMER POINTE NEIGHBORHOOD

BARRINGTON RHODE ISLAND

PROJ. No.: 20121033.A20
DATE: FEBRUARY 2016

FIG. 2



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Plotter: DWG TO PDF.PC3 CTB File: FO.STB
LAYER STATE:
MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.				

SEAL

SEAL

EAST BAY COMMUNITY DEVELOPMENT CORPORATION

FJS Associates, Ltd.

SCALE:
HORZ.: 1" = 40'
VERT.:
DATUM:
HORZ.:
VERT.: NGVD 1925
40 20 0 40
GRAPHIC SCALE

FUSS & O'NEILL
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PROVIDENCE, RI 02908
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EAST BAY COMMUNITY DEVELOPMENT CORPORATION
COMPREHENSIVE PERMIT
PRE-DEVELOPMENT WATERSHED MAP
PALMER POINTE NEIGHBORHOOD
BARRINGTON RHODE ISLAND

PROJ. No.: 20121033.A20
DATE: FEBRUARY 2016

FIG. 3

SUBWATERSHED 2C
AREA= 0.98 ACRES
CN = 71
TIME OF CONCENTRATION = 5.0 MIN

WATERSHED 1
AREA= 0.13 ACRES
CN = 91
TIME OF CONCENTRATION = 5.0 MIN

SUBWATERSHED 2A
AREA= 2.63 ACRES
CN = 77
TIME OF CONCENTRATION = 5.0 MIN

SUBWATERSHED 2B
AREA= 1.02ACRES
CN = 74
TIME OF CONCENTRATION = 5.0 MIN

SUBWATERSHED 2D
AREA= 4.18 ACRES
CN = 51
TIME OF CONCENTRATION = 13.4 MIN

ORCHARD AVENUE
SOWAMS ROAD
RED MAPLE ROAD
PALMER RIVER
FLOOD EBB
100' BARRINGTON WETLAND OVERLAY DISTRICT
TRAVEL PATH
MU HSG A/D
MmB HSG A
Sa UNCLASSIFIED HSG
Wa HSG B/D
EXISTING DWELLING #91
EXISTING DWELLING #93
SHED
CB-1
CB-2
CB-3
CB-4
CB-5
CB-6
DMH-1
DMH-2
DMH-3
DMH-4
DMH-5
FE-1
FE-2
BM NE BON BOLT HYD ELEV = 21.96
APPROXIMATE HIGH WATER
200' FROM EDGE OF HIGH WATER
ZONING DISTRICT "R-25"
75' WIDE SEWER EASEMENT
ZONING SETBACK

File Path: J:\DWG\P20121033A20\Civil\HydraFlow\20121033A20_POST01.dwg Layout: FIG-4 Plotted: Mon, February 29, 2016 - 3:13 PM User: cvitera
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
LAYER STATE:
MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.				

SEAL

SEAL

EAST BAY COMMUNITY DEVELOPMENT CORPORATION

FJS Associates, Ltd.

SCALE:
HORZ.: 1" = 40'
VERT.:
DATUM:
HORZ.:
VERT.: NGVD 1925
40 20 0 40
GRAPHIC SCALE

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EAST BAY COMMUNITY DEVELOPMENT CORPORATION
COMPREHENSIVE PERMIT
POST-DEVELOPMENT WATERSHED MAP
PALMER POINTE NEIGHBORHOOD
BARRINGTON RHODE ISLAND

PROJ. No.: 20121033.A20
DATE: FEBRUARY 2016

FIG. 4

Appendix A

TR-20 Analysis Pre-Development Conditions (2-, 10-, 25-, 100-Year Design Storms)

Hydraflow Table of Contents

PRE.gpw

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Wednesday, 02 / 24 / 2016

Watershed Model Schematic

Legend

Hyd.	Origin	Description
1	SCS Runoff	Subwatershed 1
2	SCS Runoff	Subwatershed 2

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	------	-------	3.594	-------	-------	6.051	8.045	-------	11.69	Subwatershed 1
2	SCS Runoff	------	-------	4.224	-------	-------	10.10	15.53	-------	26.24	Subwatershed 2

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	3.594	1	730	14,243	------	------	------	Subwatershed 1
2	SCS Runoff	4.224	1	736	20,604	------	------	------	Subwatershed 2

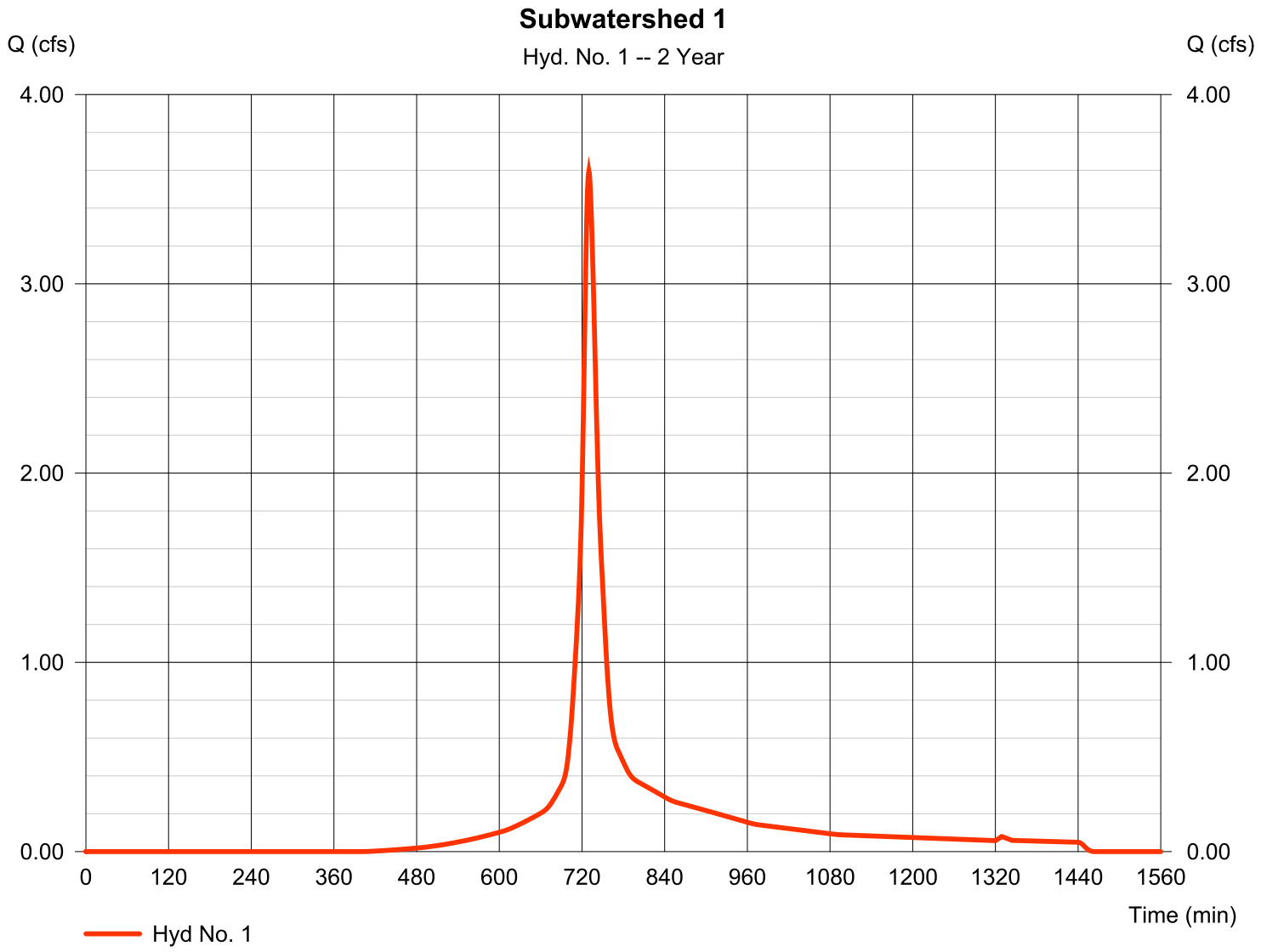
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 3.594 cfs
Storm frequency	= 2 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 14,243 cuft
Drainage area	= 1.880 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.10 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.170 x 98) + (0.570 x 89) + (0.480 x 87) + (0.660 x 86)] / 1.880



TR55 Tc Worksheet

Hyd. No. 1

Subwatershed 1

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.30		0.00		0.00		
Land slope (%)	= 2.25		0.00		0.00		
Travel Time (min)	**= 13.41**	**+**	**0.00**	**+**	**0.00**	**=**	**13.41**
Shallow Concentrated Flow							
Flow length (ft)	= 180.00		0.00		0.00		
Watercourse slope (%)	= 1.25		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=1.80		0.00		0.00		
Travel Time (min)	**= 1.66**	**+**	**0.00**	**+**	**0.00**	**=**	**1.66**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 15.10 min

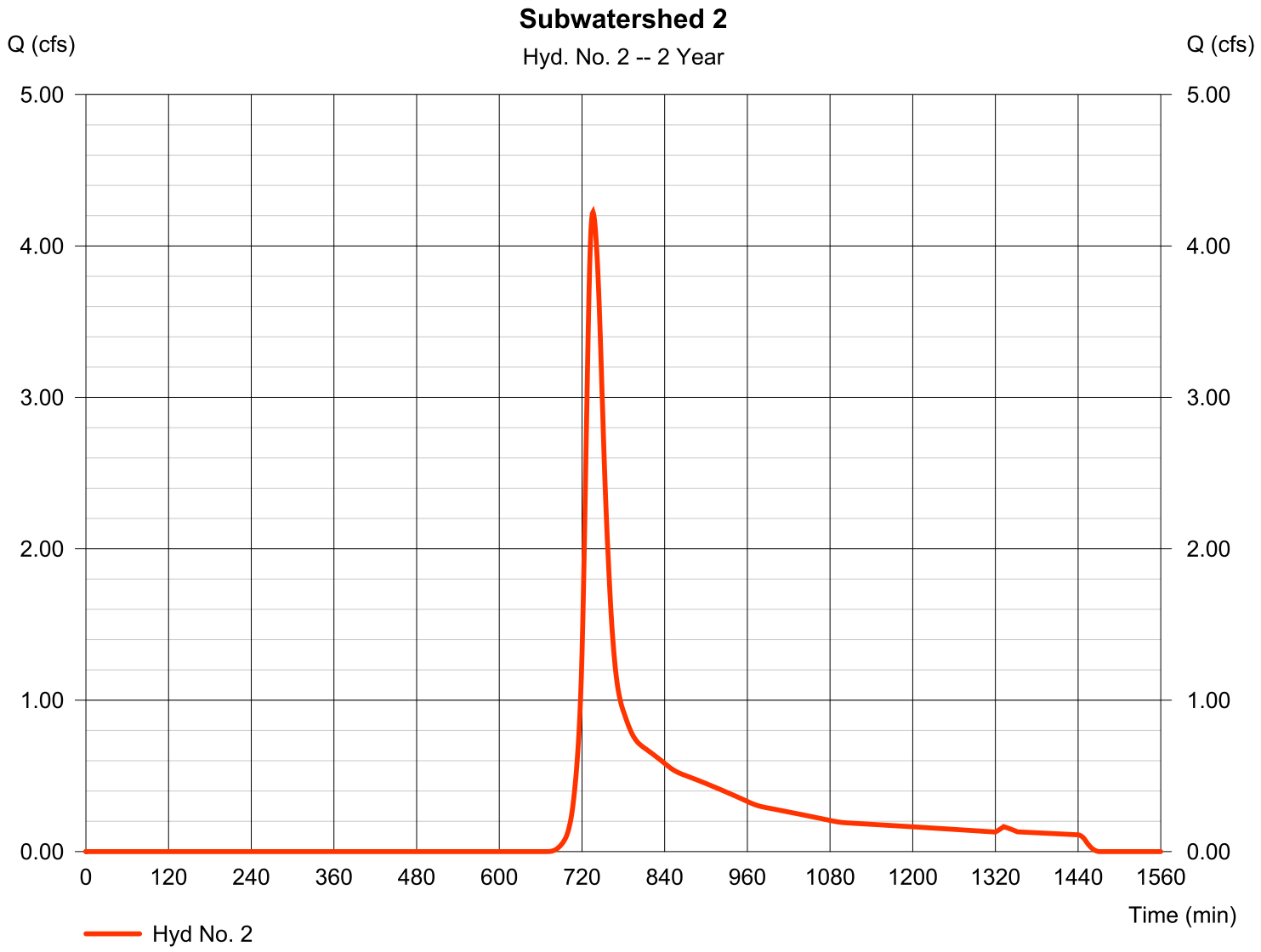
Hydrograph Report

Hyd. No. 2

Subwatershed 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.224 cfs
Storm frequency	=	2 yrs	Time to peak	=	736 min
Time interval	=	1 min	Hyd. volume	=	20,604 cuft
Drainage area	=	6.400 ac	Curve number	=	70*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.50 min
Total precip.	=	3.30 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.730 x 98) + (0.300 x 89) + (1.200 x 76) + (0.960 x 87) + (1.310 x 36) + (1.900 x 68)] / 6.400



TR55 Tc Worksheet

Hyd. No. 2

Subwatershed 2

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.400		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.30		0.00		0.00		
Land slope (%)	= 2.75		0.00		0.00		
Travel Time (min)	**= 18.62**	**+**	**0.00**	**+**	**0.00**	**=**	**18.62**
Shallow Concentrated Flow							
Flow length (ft)	= 160.00		0.00		0.00		
Watercourse slope (%)	= 3.25		0.00		0.00		
Surface description	= Unpaved		Paved		Paved		
Average velocity (ft/s)	=2.91		0.00		0.00		
Travel Time (min)	**= 0.92**	**+**	**0.00**	**+**	**0.00**	**=**	**0.92**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.240		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 19.50 min

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	6.051	1	730	24,391	------	------	------	Subwatershed 1
2	SCS Runoff	10.10	1	734	45,592	------	------	------	Subwatershed 2

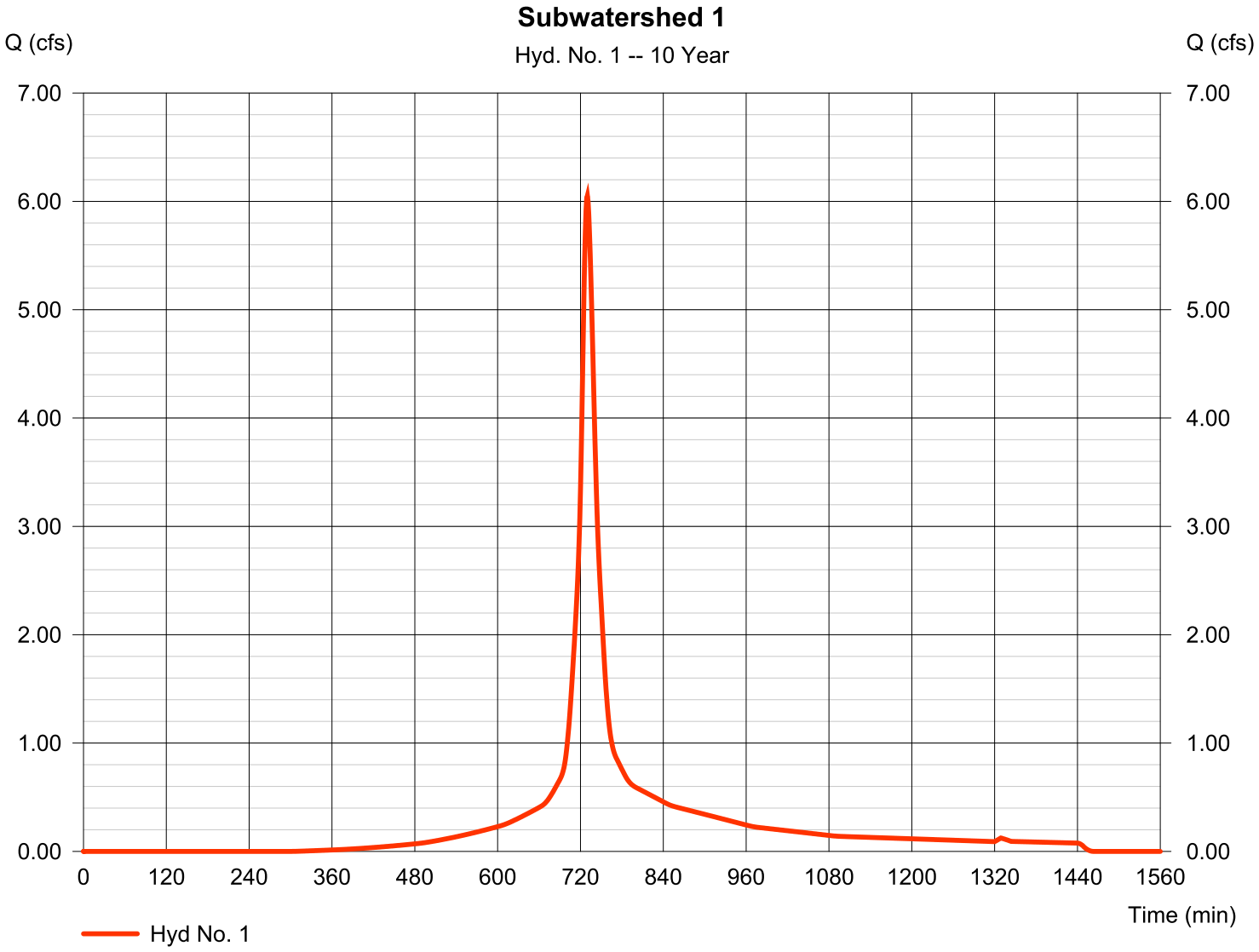
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 6.051 cfs
Storm frequency	= 10 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 24,391 cuft
Drainage area	= 1.880 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.10 min
Total precip.	= 4.90 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.170 x 98) + (0.570 x 89) + (0.480 x 87) + (0.660 x 86)] / 1.880



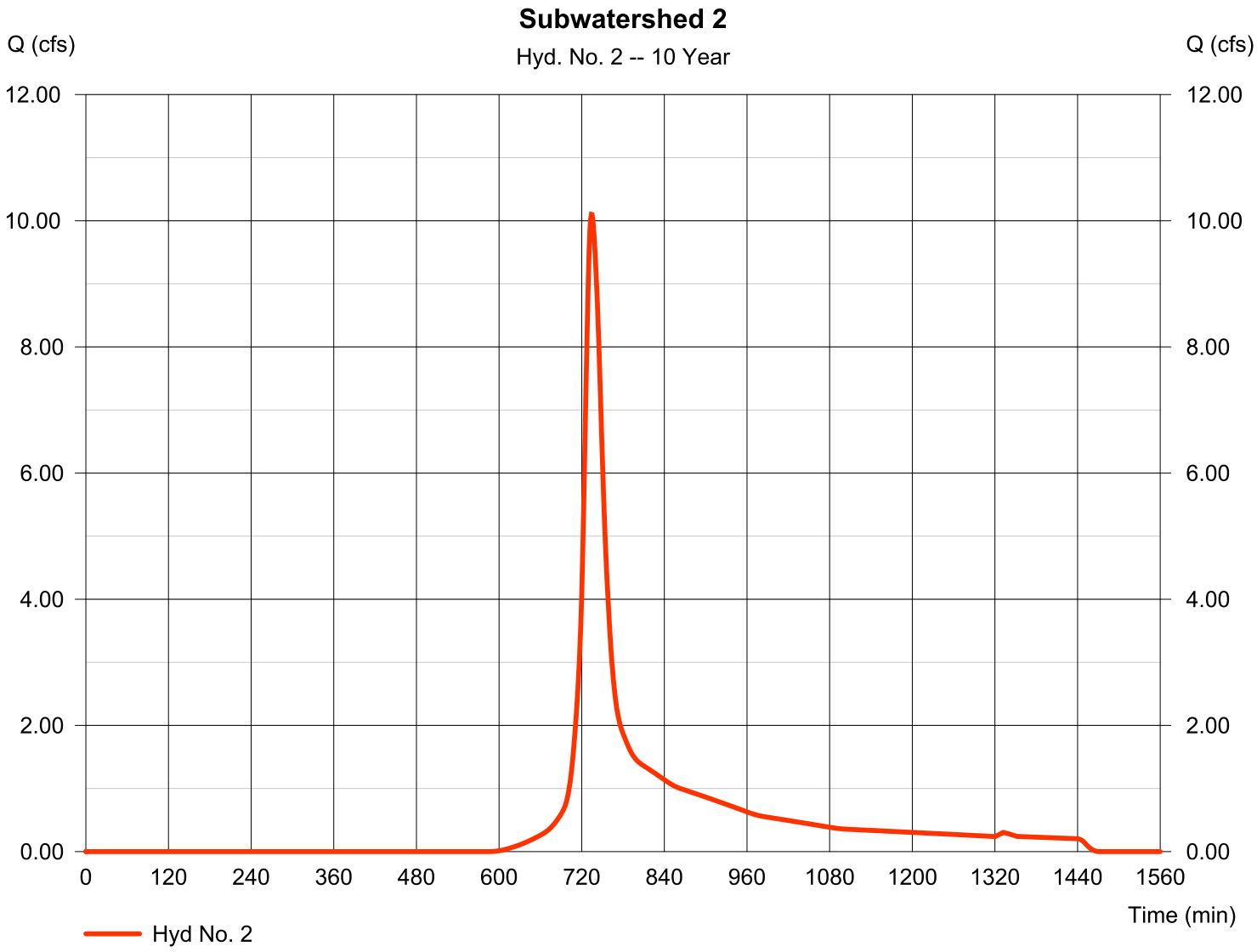
Hydrograph Report

Hyd. No. 2

Subwatershed 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.10 cfs
Storm frequency	=	10 yrs	Time to peak	=	734 min
Time interval	=	1 min	Hyd. volume	=	45,592 cuft
Drainage area	=	6.400 ac	Curve number	=	70*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.50 min
Total precip.	=	4.90 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.730 x 98) + (0.300 x 89) + (1.200 x 76) + (0.960 x 87) + (1.310 x 36) + (1.900 x 68)] / 6.400



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	8.045	1	730	32,885	------	------	------	Subwatershed 1
2	SCS Runoff	15.53	1	734	68,877	------	------	------	Subwatershed 2

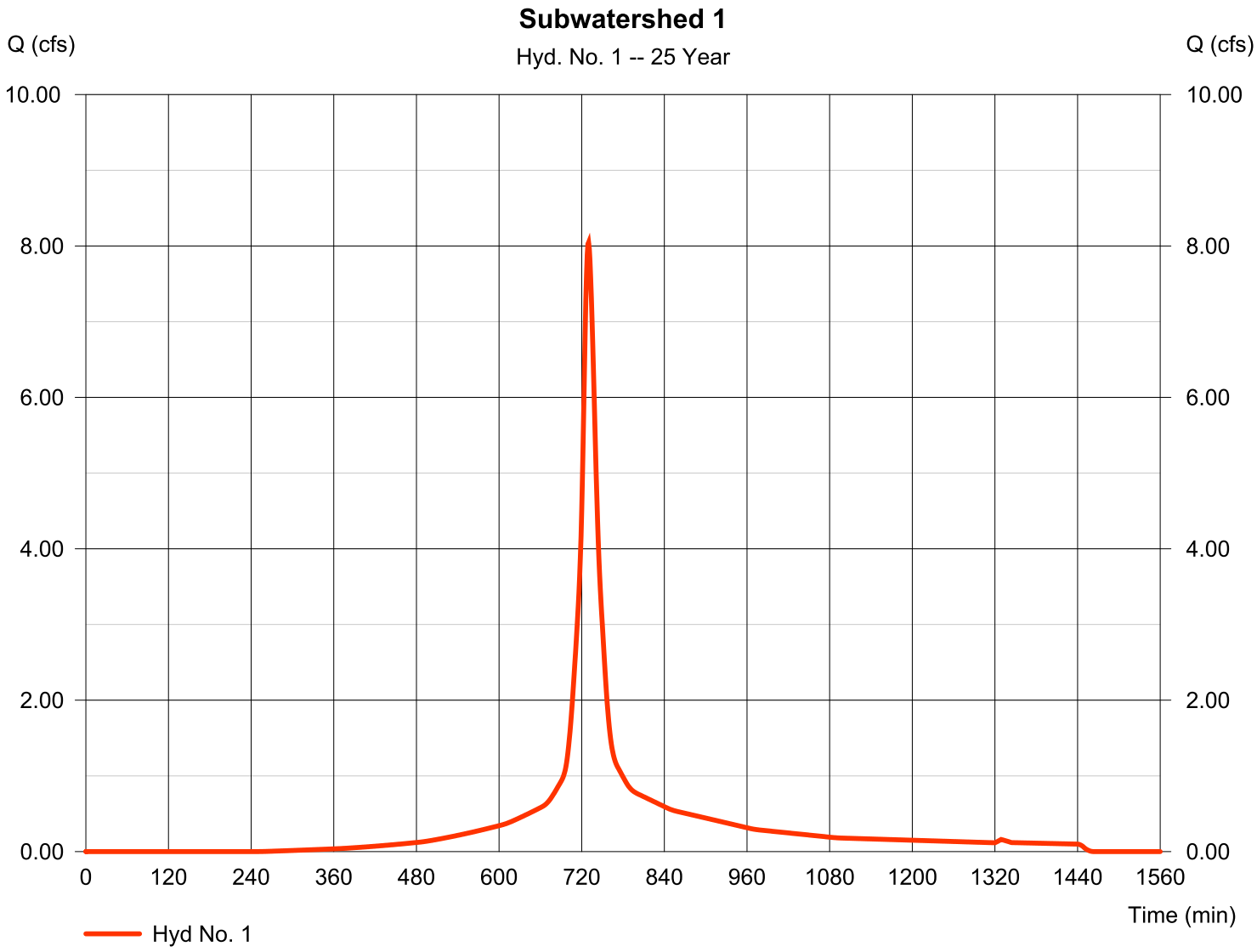
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 8.045 cfs
Storm frequency	= 25 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 32,885 cuft
Drainage area	= 1.880 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.10 min
Total precip.	= 6.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.170 x 98) + (0.570 x 89) + (0.480 x 87) + (0.660 x 86)] / 1.880



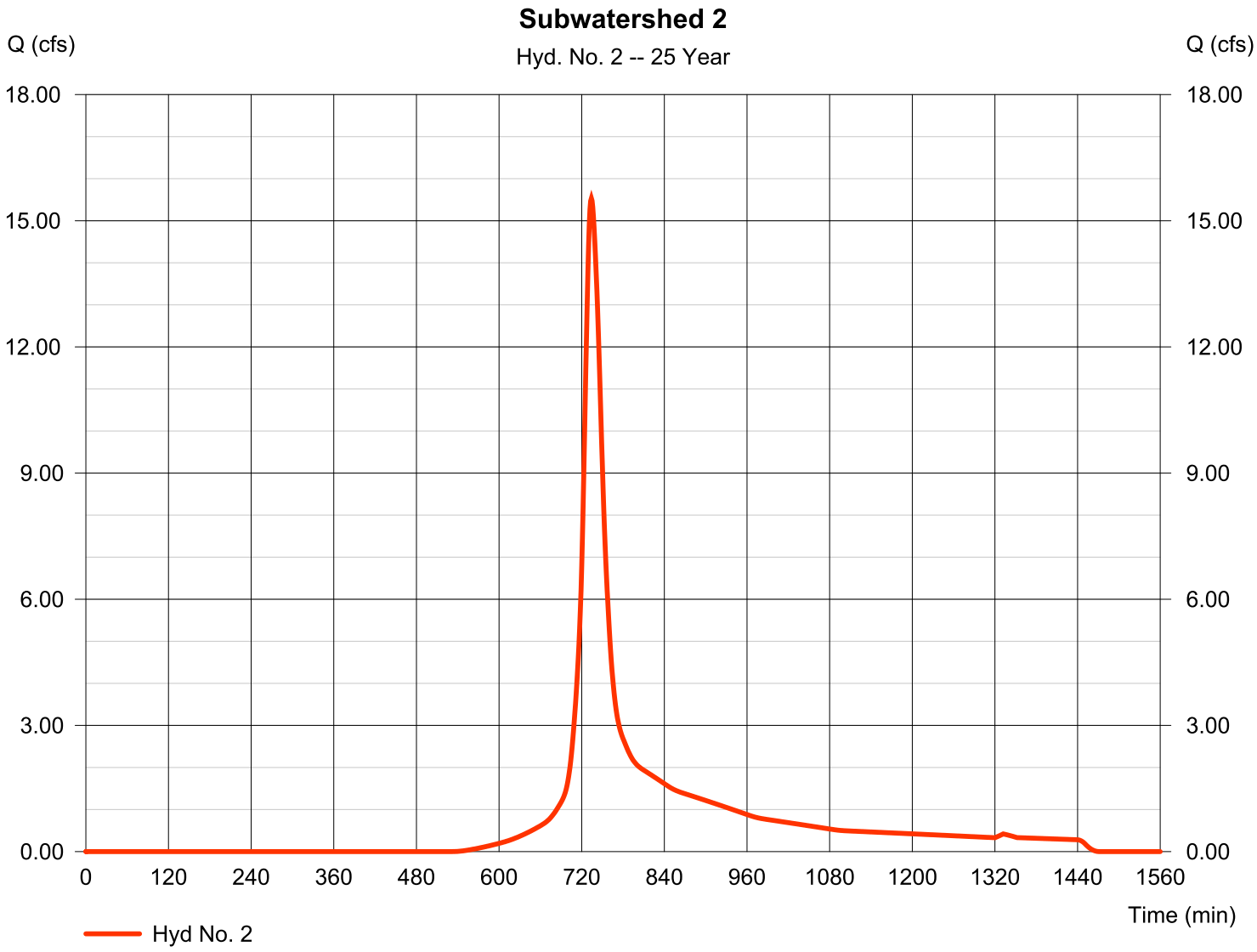
Hydrograph Report

Hyd. No. 2

Subwatershed 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	15.53 cfs
Storm frequency	=	25 yrs	Time to peak	=	734 min
Time interval	=	1 min	Hyd. volume	=	68,877 cuft
Drainage area	=	6.400 ac	Curve number	=	70*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.50 min
Total precip.	=	6.20 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.730 x 98) + (0.300 x 89) + (1.200 x 76) + (0.960 x 87) + (1.310 x 36) + (1.900 x 68)] / 6.400



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	11.69	1	730	48,832	------	------	------	Subwatershed 1
2	SCS Runoff	26.24	1	734	115,791	------	------	------	Subwatershed 2

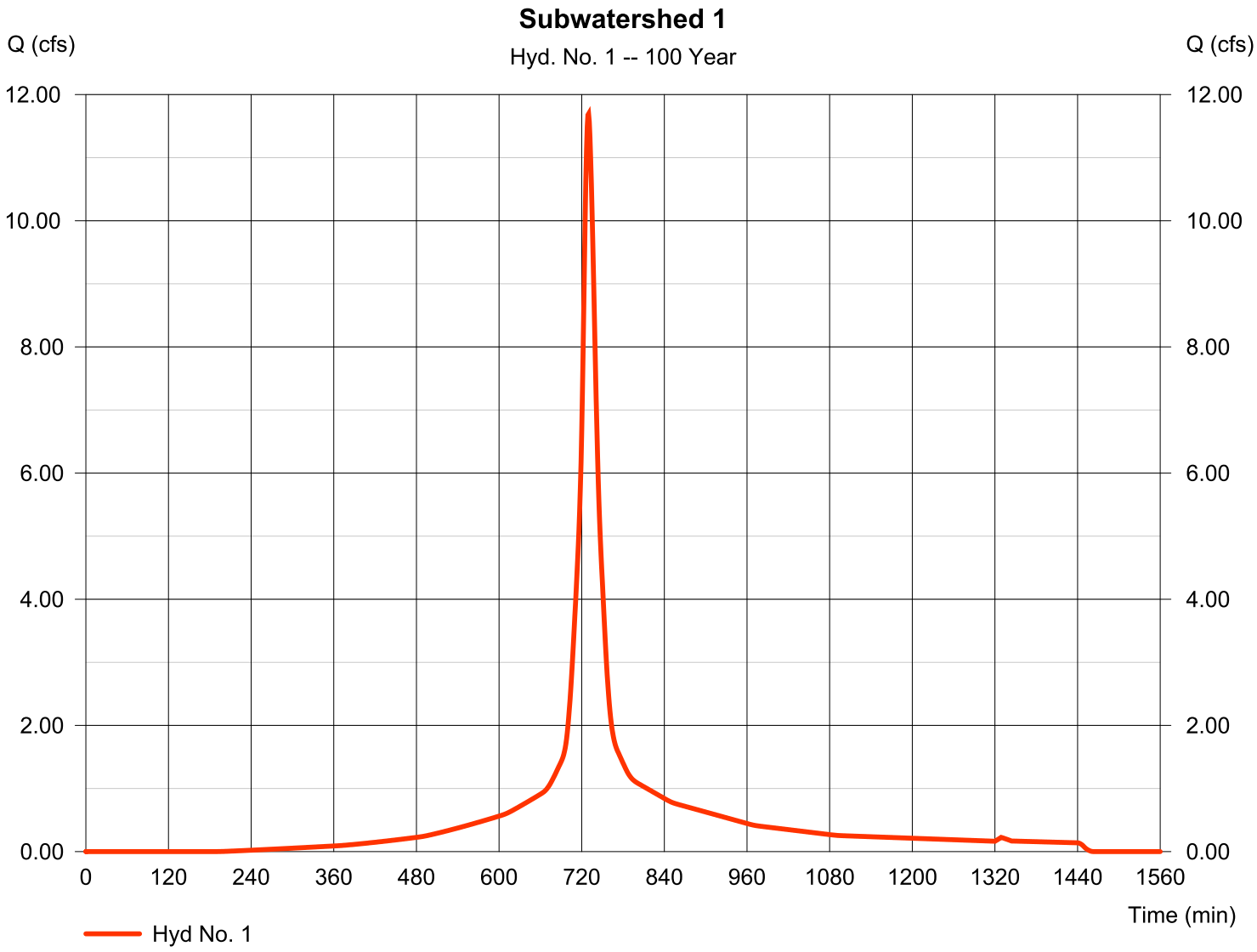
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 11.69 cfs
Storm frequency	= 100 yrs	Time to peak	= 730 min
Time interval	= 1 min	Hyd. volume	= 48,832 cuft
Drainage area	= 1.880 ac	Curve number	= 88*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 15.10 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.170 x 98) + (0.570 x 89) + (0.480 x 87) + (0.660 x 86)] / 1.880



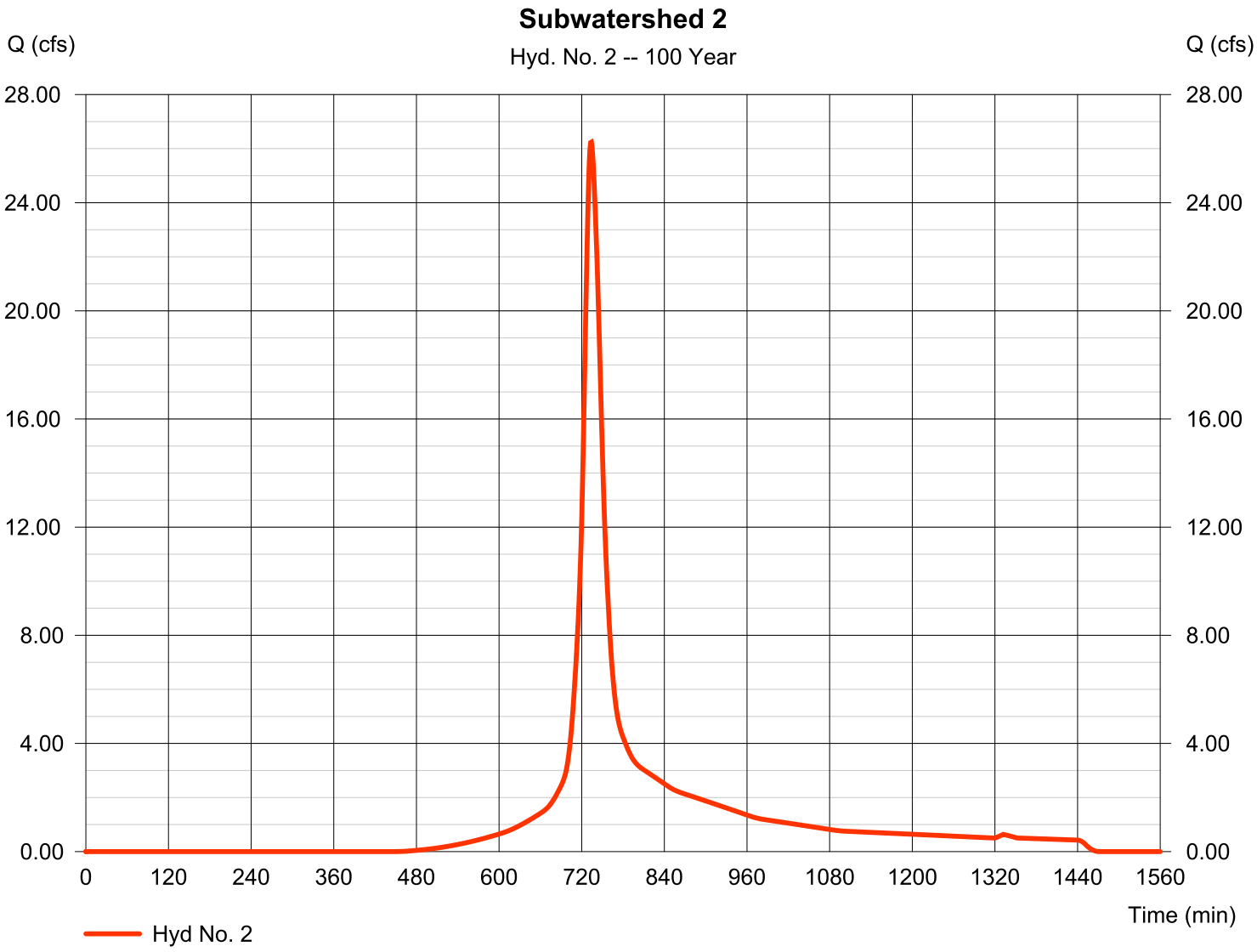
Hydrograph Report

Hyd. No. 2

Subwatershed 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	26.24 cfs
Storm frequency	=	100 yrs	Time to peak	=	734 min
Time interval	=	1 min	Hyd. volume	=	115,791 cuft
Drainage area	=	6.400 ac	Curve number	=	70*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.50 min
Total precip.	=	8.60 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.730 x 98) + (0.300 x 89) + (1.200 x 76) + (0.960 x 87) + (1.310 x 36) + (1.900 x 68)] / 6.400



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	69.8703	13.1000	0.8658	--------
3	0.0000	0.0000	0.0000	--------
5	79.2597	14.6000	0.8369	--------
10	88.2351	15.5000	0.8279	--------
25	102.6072	16.5000	0.8217	--------
50	114.8193	17.2000	0.8199	--------
100	127.1596	17.8000	0.8186	--------

File name: SampleFHA.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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.69	4.61	3.89	3.38	2.99	2.69	2.44	2.24	2.07	1.93	1.81	1.70
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.57	5.43	4.65	4.08	3.65	3.30	3.02	2.79	2.59	2.42	2.27	2.15
10	7.24	6.04	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.80	4.38	4.02	3.73	3.48	3.26	3.07	2.91
50	9.04	7.65	6.66	5.92	5.34	4.87	4.49	4.16	3.88	3.65	3.44	3.25
100	9.83	8.36	7.30	6.50	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: Precip File.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	3.30	4.90	6.20	7.30	8.60
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
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	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Appendix B

TR-20 Analysis Post-Development Conditions (2-, 10-, 25-,100-Year Design Storms

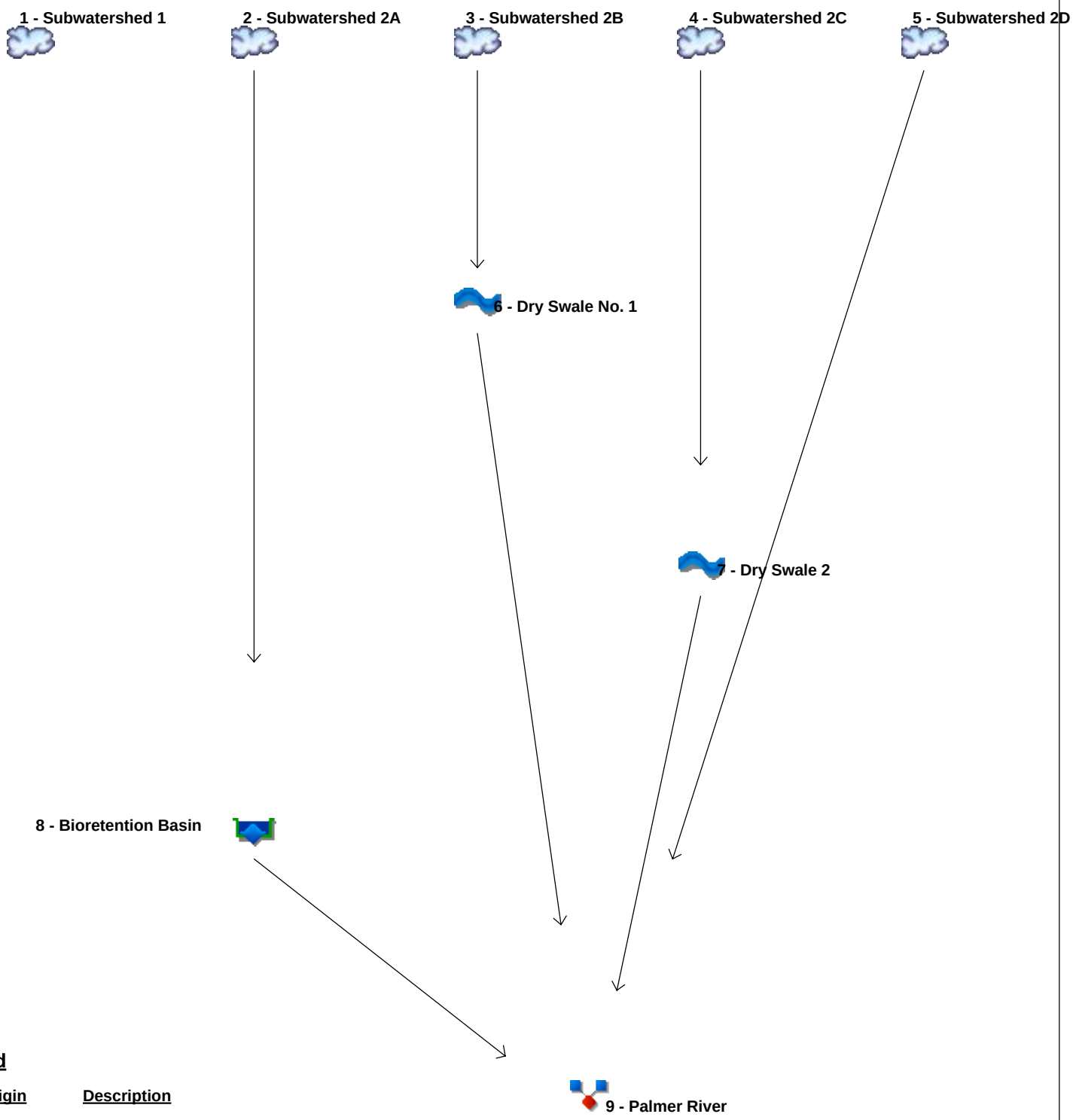
Hydraflow Table of Contents

POST_20160223.gpw

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3 Wednesday, 02 / 24 / 2016

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3



Legend

Hyd.	Origin	Description
1	SCS Runoff	Subwatershed 1
2	SCS Runoff	Subwatershed 2A
3	SCS Runoff	Subwatershed 2B
4	SCS Runoff	Subwatershed 2C
5	SCS Runoff	Subwatershed 2D
6	Reach	Dry Swale No. 1
7	Reach	Dry Swale 2
8	Reservoir	Bioretention Basin
9	Combine	Palmer River

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	------	-------	0.280	-------	-------	0.451	0.579	-------	0.842	Subwatershed 1
2	SCS Runoff	------	-------	4.021	-------	-------	8.115	11.38	-------	18.35	Subwatershed 2A
3	SCS Runoff	------	-------	1.297	-------	-------	2.793	4.012	-------	6.658	Subwatershed 2B
4	SCS Runoff	------	-------	1.043	-------	-------	2.425	3.578	-------	6.125	Subwatershed 2C
5	SCS Runoff	------	-------	0.193	-------	-------	1.862	4.152	-------	10.26	Subwatershed 2D
6	Reach	3	-------	0.959	-------	-------	2.042	2.917	-------	4.802	Dry Swale No. 1
7	Reach	4	-------	0.671	-------	-------	1.540	2.259	-------	3.833	Dry Swale 2
8	Reservoir	2	-------	1.617	-------	-------	7.854	11.06	-------	18.11	Bioretention Basin
9	Combine	5, 6, 7, 8	-------	3.102	-------	-------	12.26	19.09	-------	34.73	Palmer River

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	0.280	1	724	881	------	------	------	Subwatershed 1
2	SCS Runoff	4.021	1	725	12,639	------	------	------	Subwatershed 2A
3	SCS Runoff	1.297	1	725	4,174	------	------	------	Subwatershed 2B
4	SCS Runoff	1.043	1	725	3,479	------	------	------	Subwatershed 2C
5	SCS Runoff	0.193	1	749	2,583	------	------	------	Subwatershed 2D
6	Reach	0.959	1	730	4,170	3	------	------	Dry Swale No. 1
7	Reach	0.671	1	732	3,473	4	------	------	Dry Swale 2
8	Reservoir	1.617	1	739	4,146	2	13.54	4,496	Bioretention Basin
9	Combine	3.102	1	739	14,373	5, 6, 7, 8	------	------	Palmer River

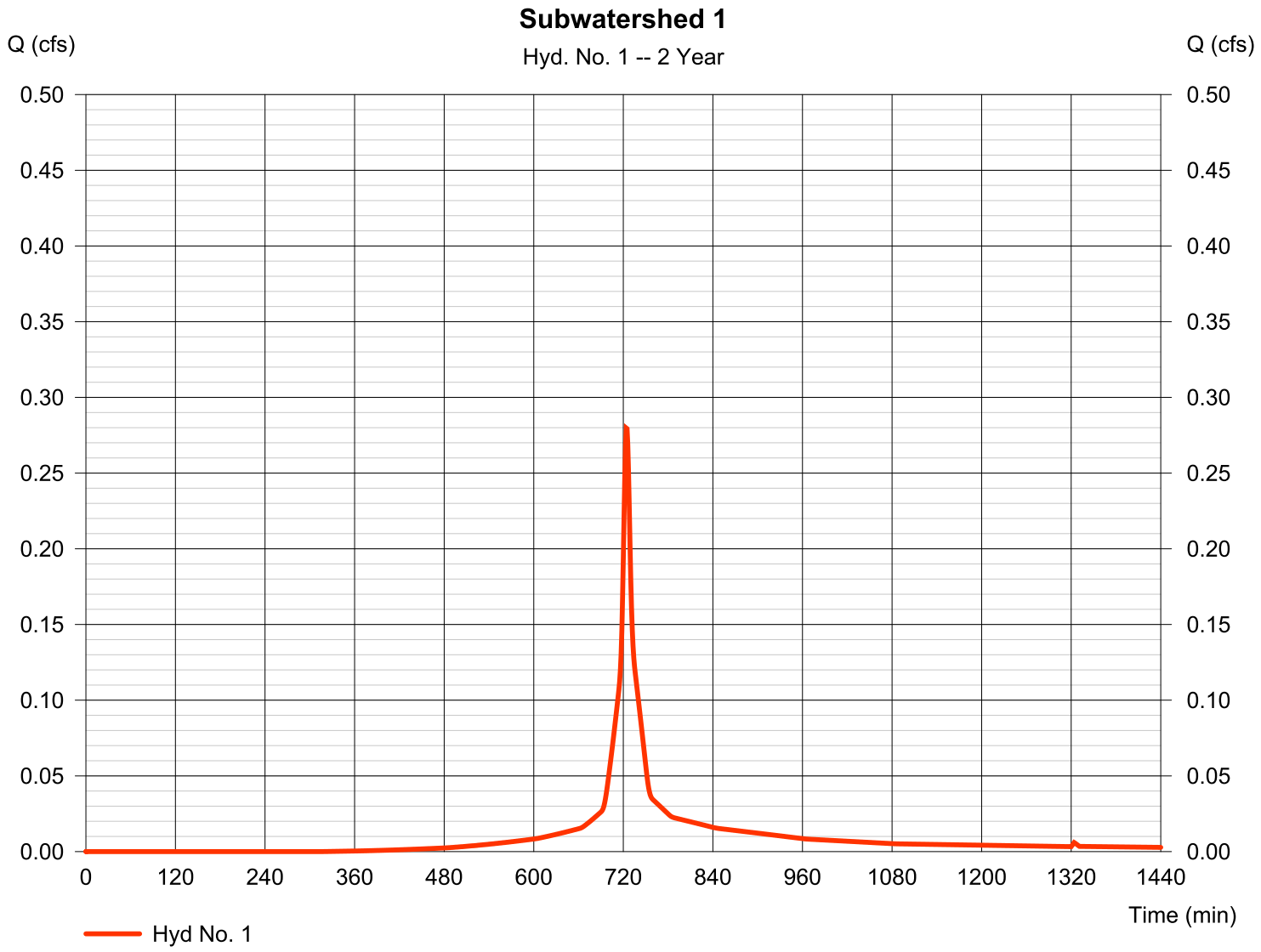
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.280 cfs
Storm frequency	= 2 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 881 cuft
Drainage area	= 0.100 ac	Curve number	= 91*
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) = [(0.070 x 98) + (0.030 x 74)] / 0.100



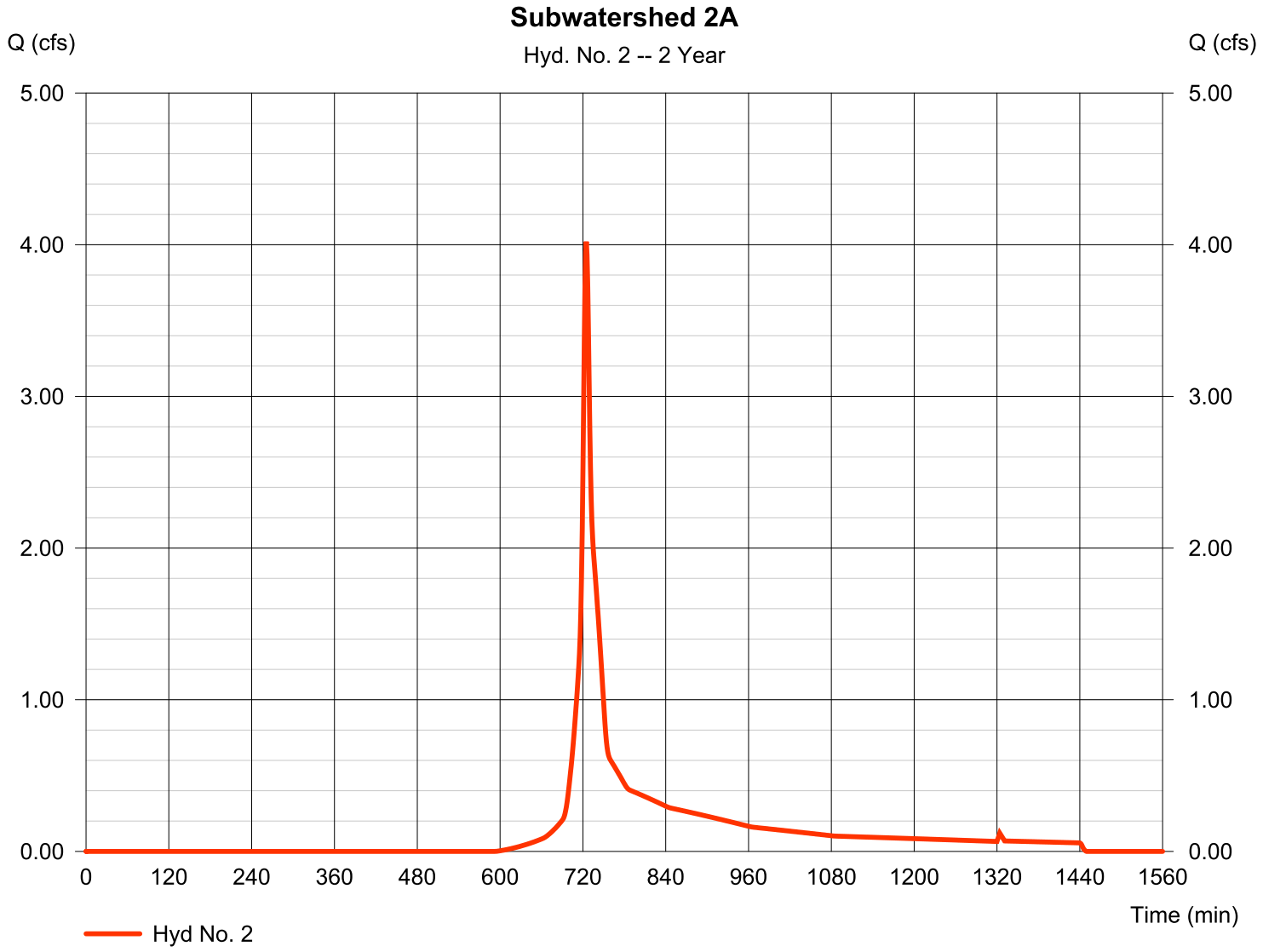
Hydrograph Report

Hyd. No. 2

Subwatershed 2A

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.021 cfs
Storm frequency	=	2 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	12,639 cuft
Drainage area	=	2.630 ac	Curve number	=	77*
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) = [(1.290 x 98) + (0.670 x 74) + (0.670 x 39)] / 2.630



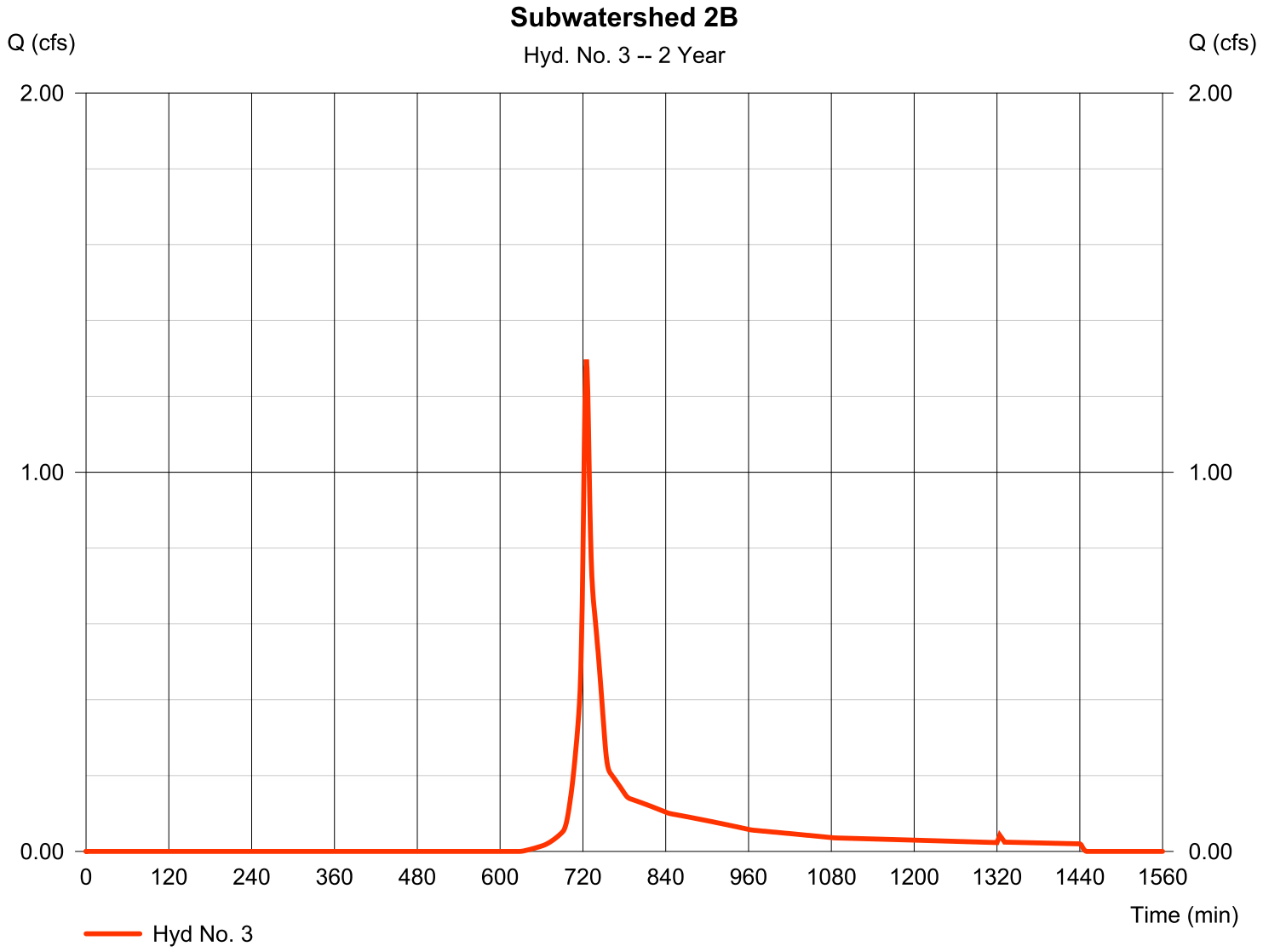
Hydrograph Report

Hyd. No. 3

Subwatershed 2B

Hydrograph type	= SCS Runoff	Peak discharge	= 1.297 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 4,174 cuft
Drainage area	= 1.010 ac	Curve number	= 74*
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) = [(0.430 x 98) + (0.290 x 74) + (0.290 x 39)] / 1.010



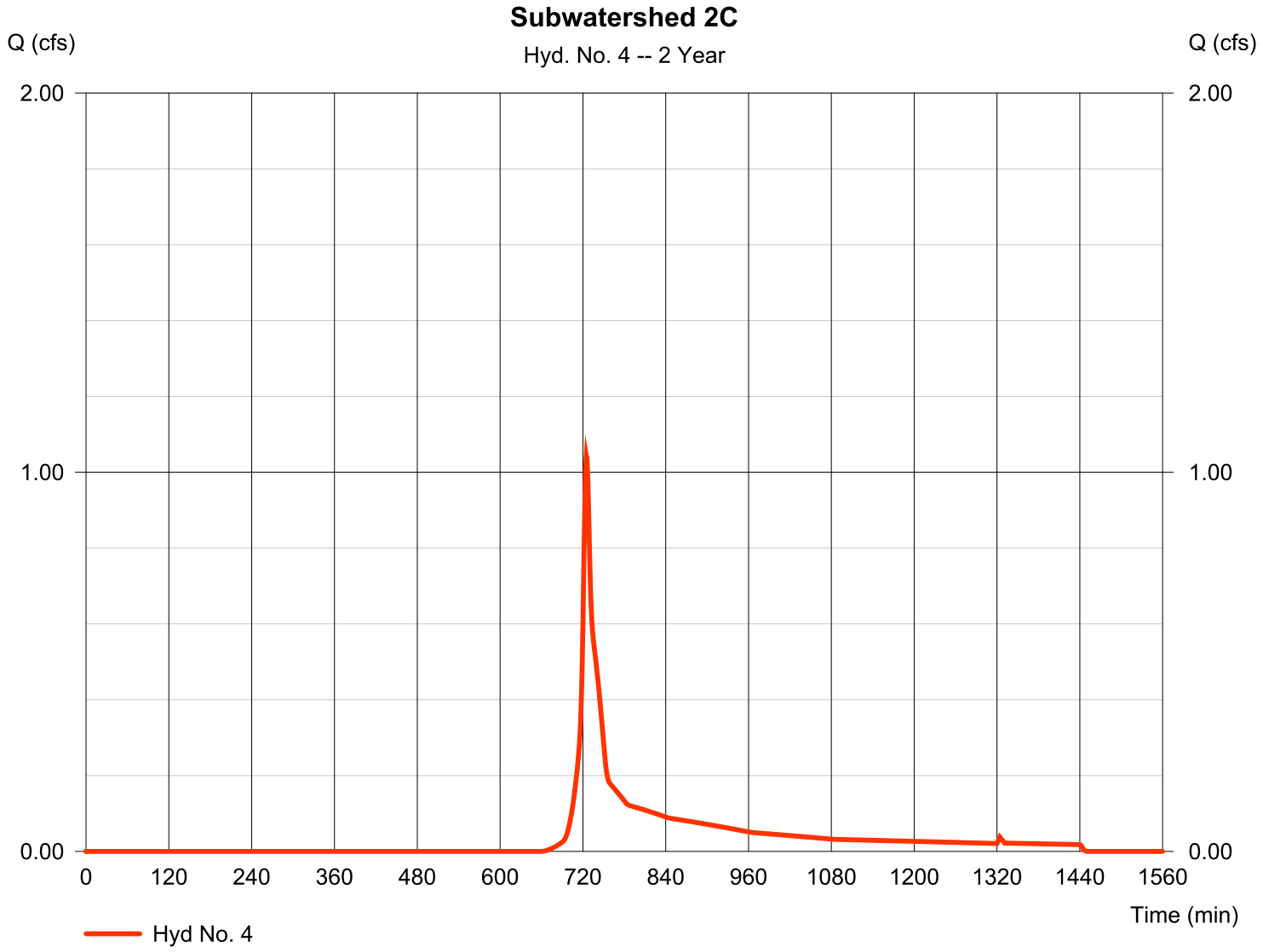
Hydrograph Report

Hyd. No. 4

Subwatershed 2C

Hydrograph type	= SCS Runoff	Peak discharge	= 1.043 cfs
Storm frequency	= 2 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 3,479 cuft
Drainage area	= 0.990 ac	Curve number	= 71*
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) = [(0.350 x 98) + (0.320 x 74) + (0.320 x 39)] / 0.990



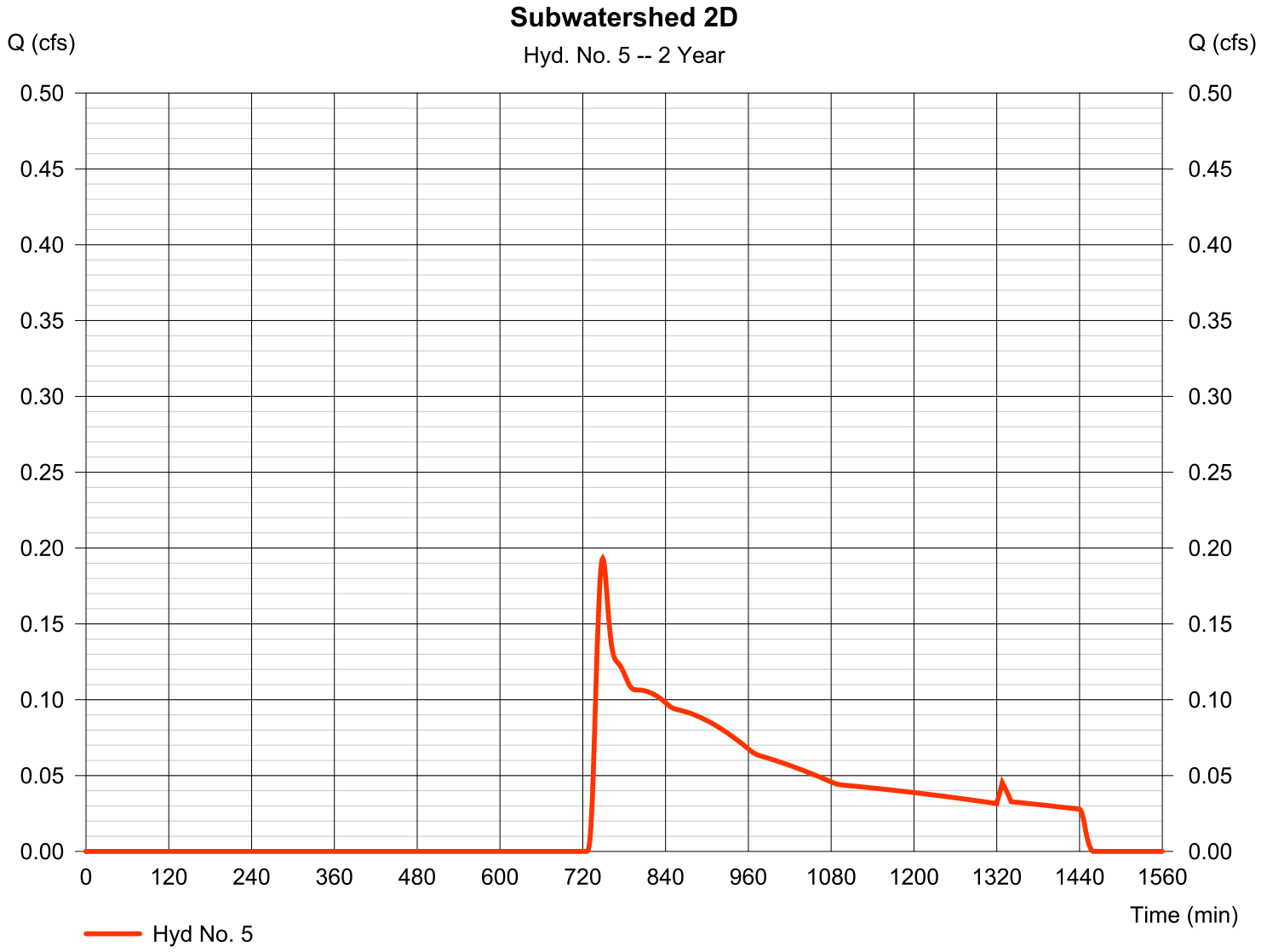
Hydrograph Report

Hyd. No. 5

Subwatershed 2D

Hydrograph type	= SCS Runoff	Peak discharge	= 0.193 cfs
Storm frequency	= 2 yrs	Time to peak	= 749 min
Time interval	= 1 min	Hyd. volume	= 2,583 cuft
Drainage area	= 4.180 ac	Curve number	= 51*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.40 min
Total precip.	= 3.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.040 x 98) + (0.790 x 39) + (1.130 x 30) + (0.120 x 36) + (1.490 x 73)] / 4.180



TR55 Tc Worksheet

Hyd. No. 5

Subwatershed 2D

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.240		0.011		0.011		
Flow length (ft)	= 100.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 3.30		0.00		0.00		
Land slope (%)	= 3.00		0.00		0.00		
Travel Time (min)	**= 11.95**	**+**	**0.00**	**+**	**0.00**	**=**	**11.95**
Shallow Concentrated Flow							
Flow length (ft)	= 132.00		154.00		0.00		
Watercourse slope (%)	= 5.00		3.50		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=3.61		3.02		0.00		
Travel Time (min)	**= 0.61**	**+**	**0.85**	**+**	**0.00**	**=**	**1.46**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

Total Travel Time, Tc ..... 13.40 min

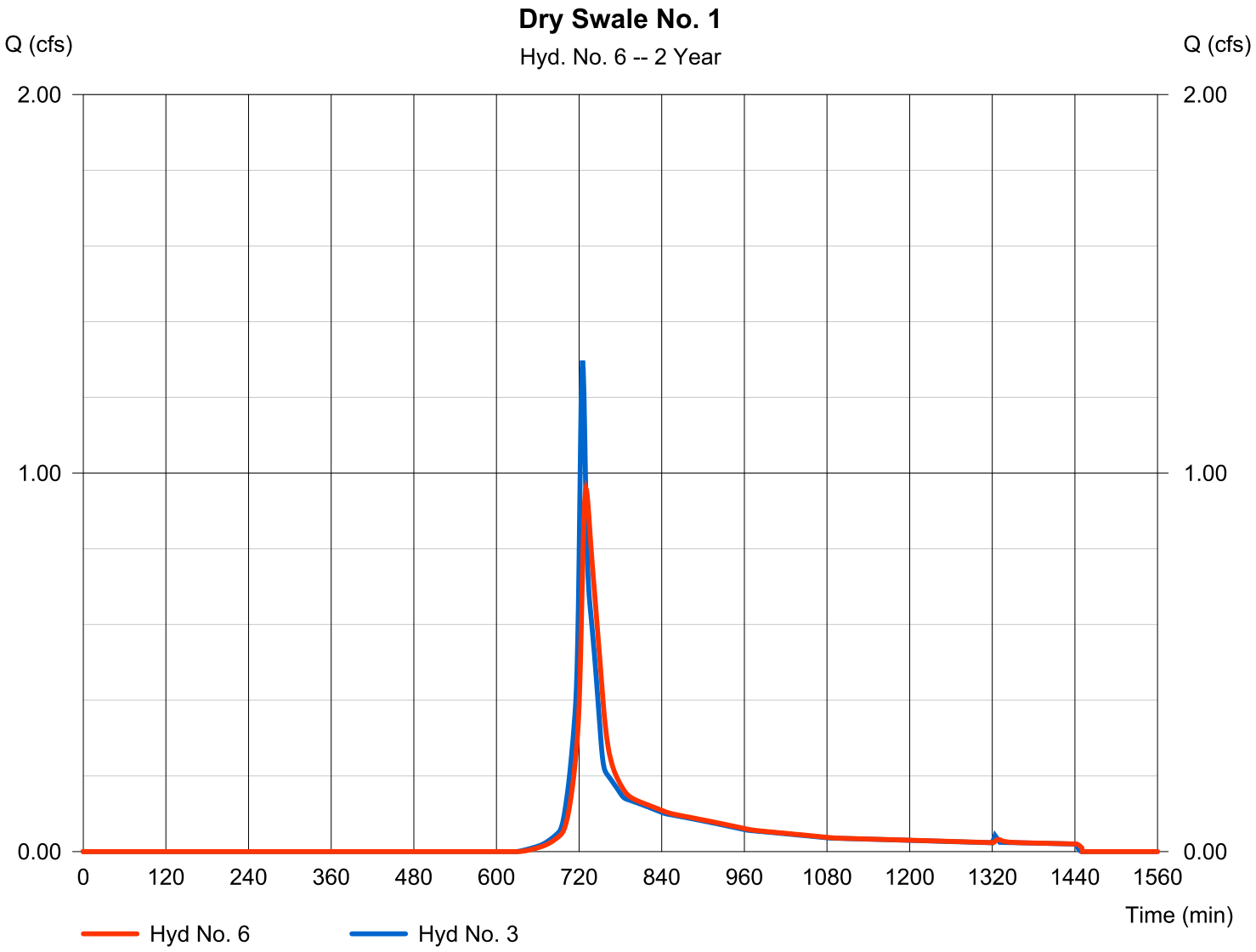
Hydrograph Report

Hyd. No. 6

Dry Swale No. 1

Hydrograph type	=	Reach	Peak discharge	=	0.959 cfs
Storm frequency	=	2 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	4,170 cuft
Inflow hyd. No.	=	3 - Subwatershed 2B	Section type	=	Trapezoidal
Reach length	=	320.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.1342

Modified Att-Kin routing method used.



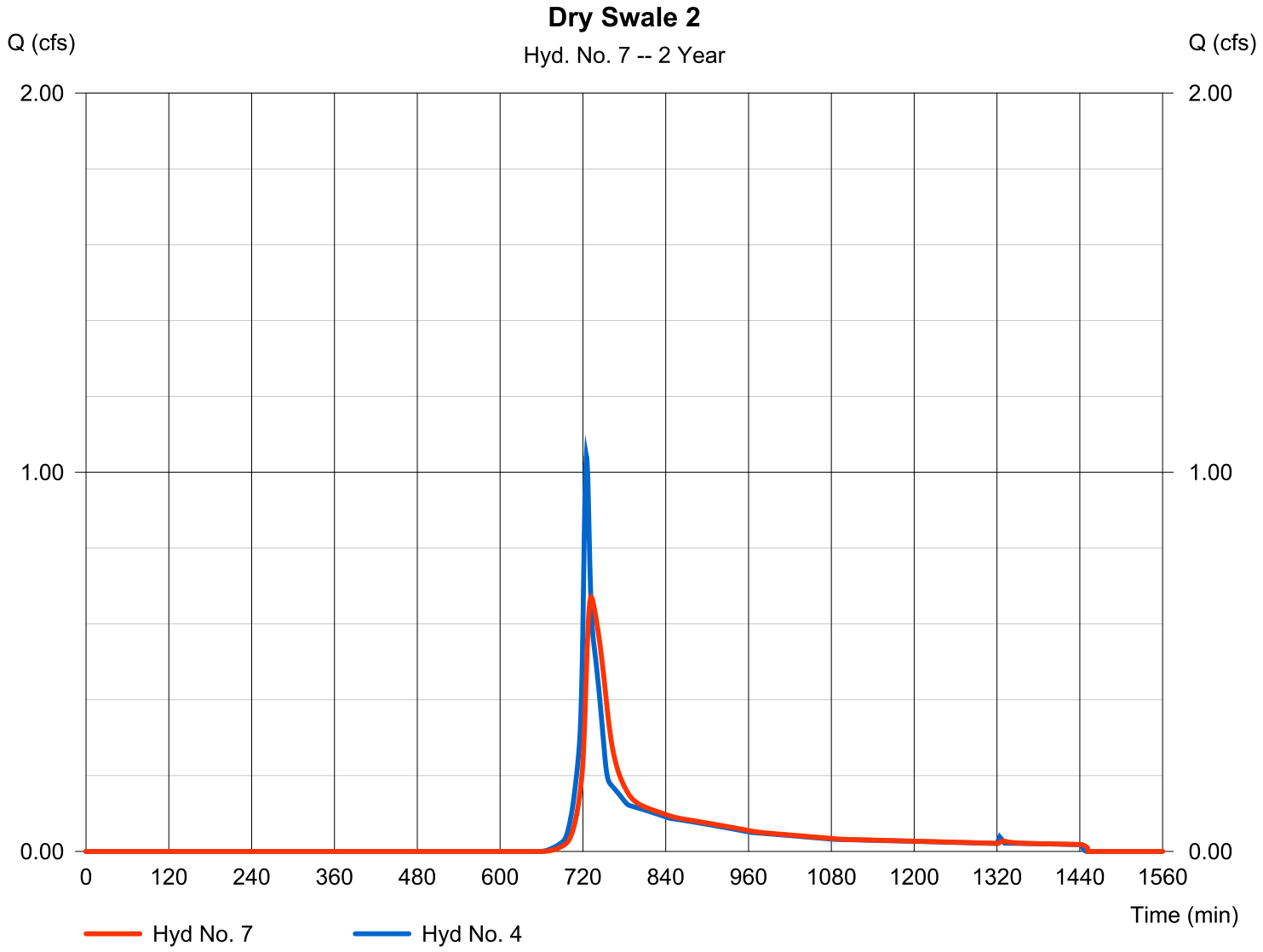
Hydrograph Report

Hyd. No. 7

Dry Swale 2

Hydrograph type	=	Reach	Peak discharge	=	0.671 cfs
Storm frequency	=	2 yrs	Time to peak	=	732 min
Time interval	=	1 min	Hyd. volume	=	3,473 cuft
Inflow hyd. No.	=	4 - Subwatershed 2C	Section type	=	Trapezoidal
Reach length	=	478.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.0938

Modified Att-Kin routing method used.



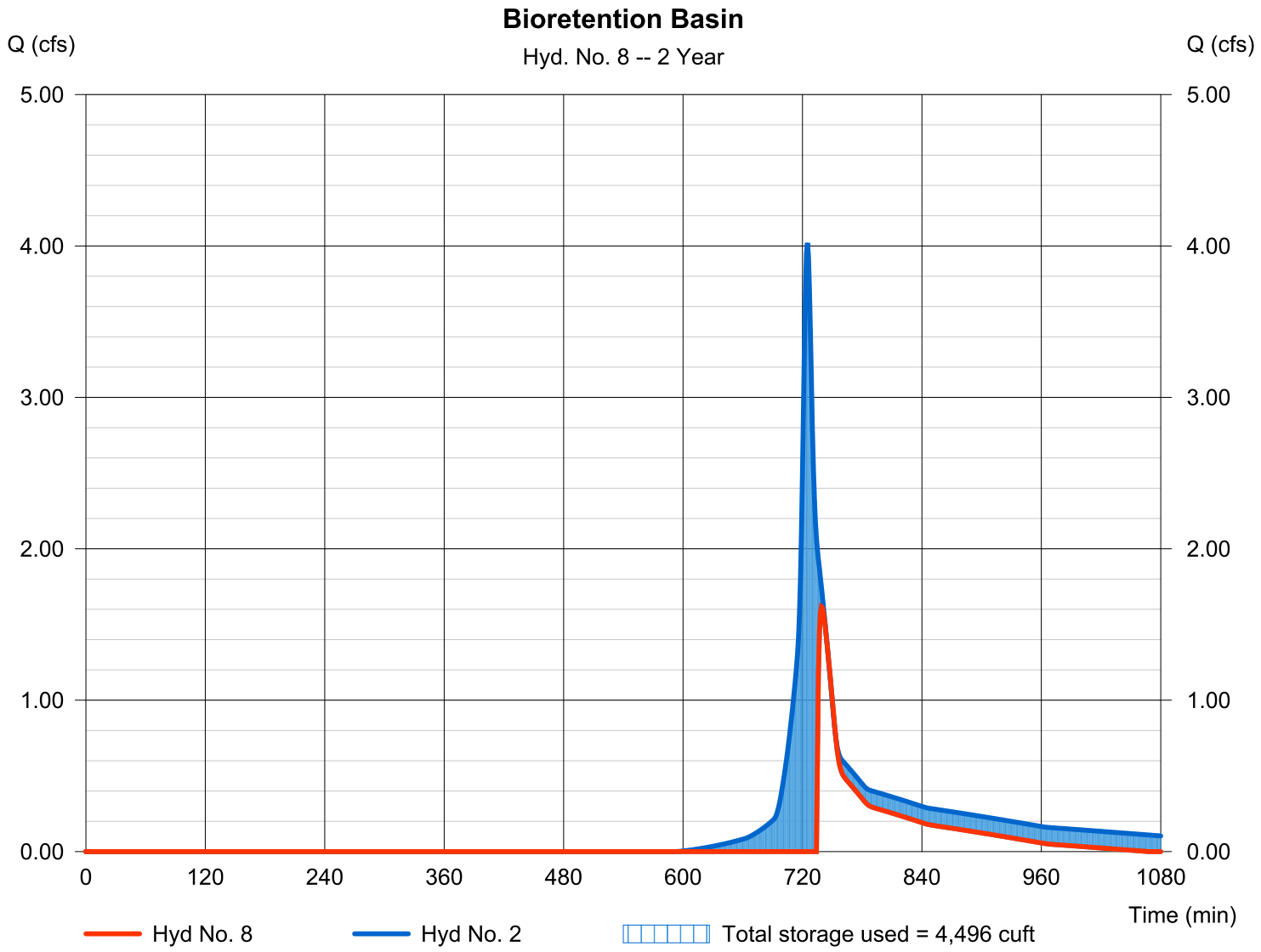
Hydrograph Report

Hyd. No. 8

Bioretention Basin

Hydrograph type	=	Reservoir	Peak discharge	=	1.617 cfs
Storm frequency	=	2 yrs	Time to peak	=	739 min
Time interval	=	1 min	Hyd. volume	=	4,146 cuft
Inflow hyd. No.	=	2 - Subwatershed 2A	Max. Elevation	=	13.54 ft
Reservoir name	=	Bioretention Basin	Max. Storage	=	4,496 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

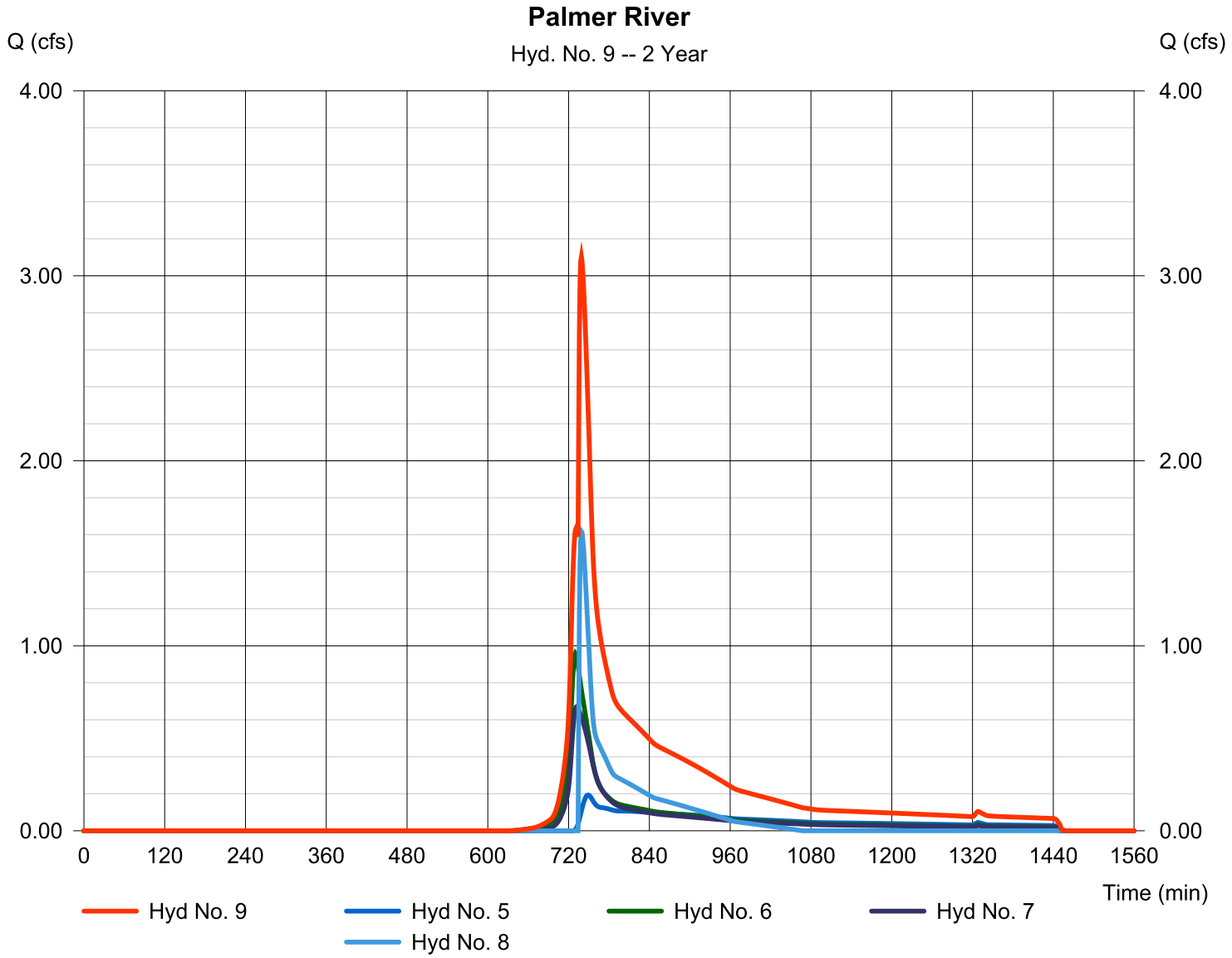


Hydrograph Report

Hyd. No. 9

Palmer River

Hydrograph type	=	Combine	Peak discharge	=	3.102 cfs
Storm frequency	=	2 yrs	Time to peak	=	739 min
Time interval	=	1 min	Hyd. volume	=	14,373 cuft
Inflow hyds.	=	5, 6, 7, 8	Contrib. drain. area	=	4.180 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	0.451	1	724	1,454	------	------	------	Subwatershed 1
2	SCS Runoff	8.115	1	725	25,003	------	------	------	Subwatershed 2A
3	SCS Runoff	2.793	1	725	8,638	------	------	------	Subwatershed 2B
4	SCS Runoff	2.425	1	725	7,565	------	------	------	Subwatershed 2C
5	SCS Runoff	1.862	1	734	10,527	------	------	------	Subwatershed 2D
6	Reach	2.042	1	730	8,634	3	------	------	Dry Swale No. 1
7	Reach	1.540	1	731	7,558	4	------	------	Dry Swale 2
8	Reservoir	7.854	1	726	15,518	2	13.64	4,983	Bioretention Basin
9	Combine	12.26	1	727	42,237	5, 6, 7, 8	------	------	Palmer River

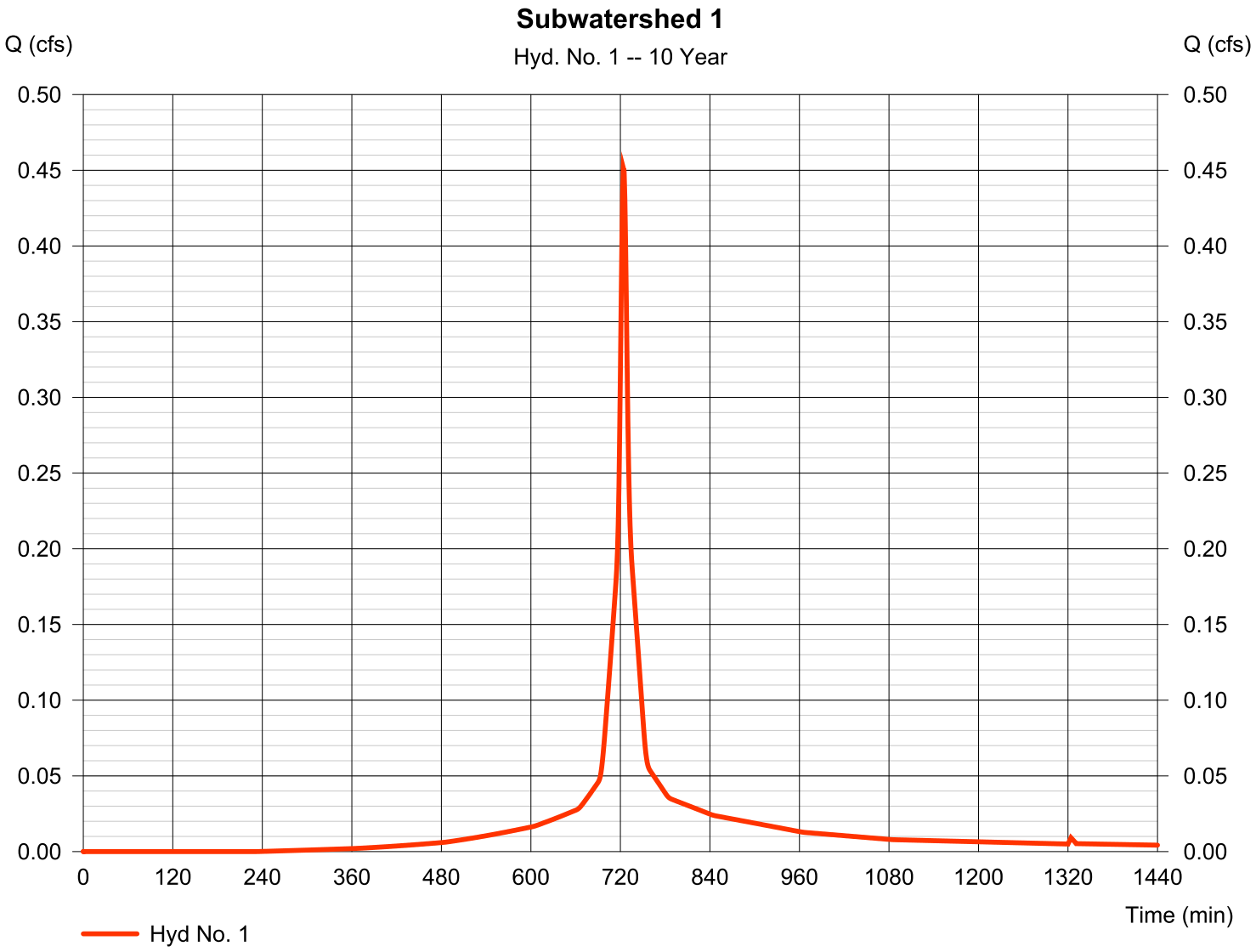
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.451 cfs
Storm frequency	= 10 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 1,454 cuft
Drainage area	= 0.100 ac	Curve number	= 91*
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) = [(0.070 x 98) + (0.030 x 74)] / 0.100



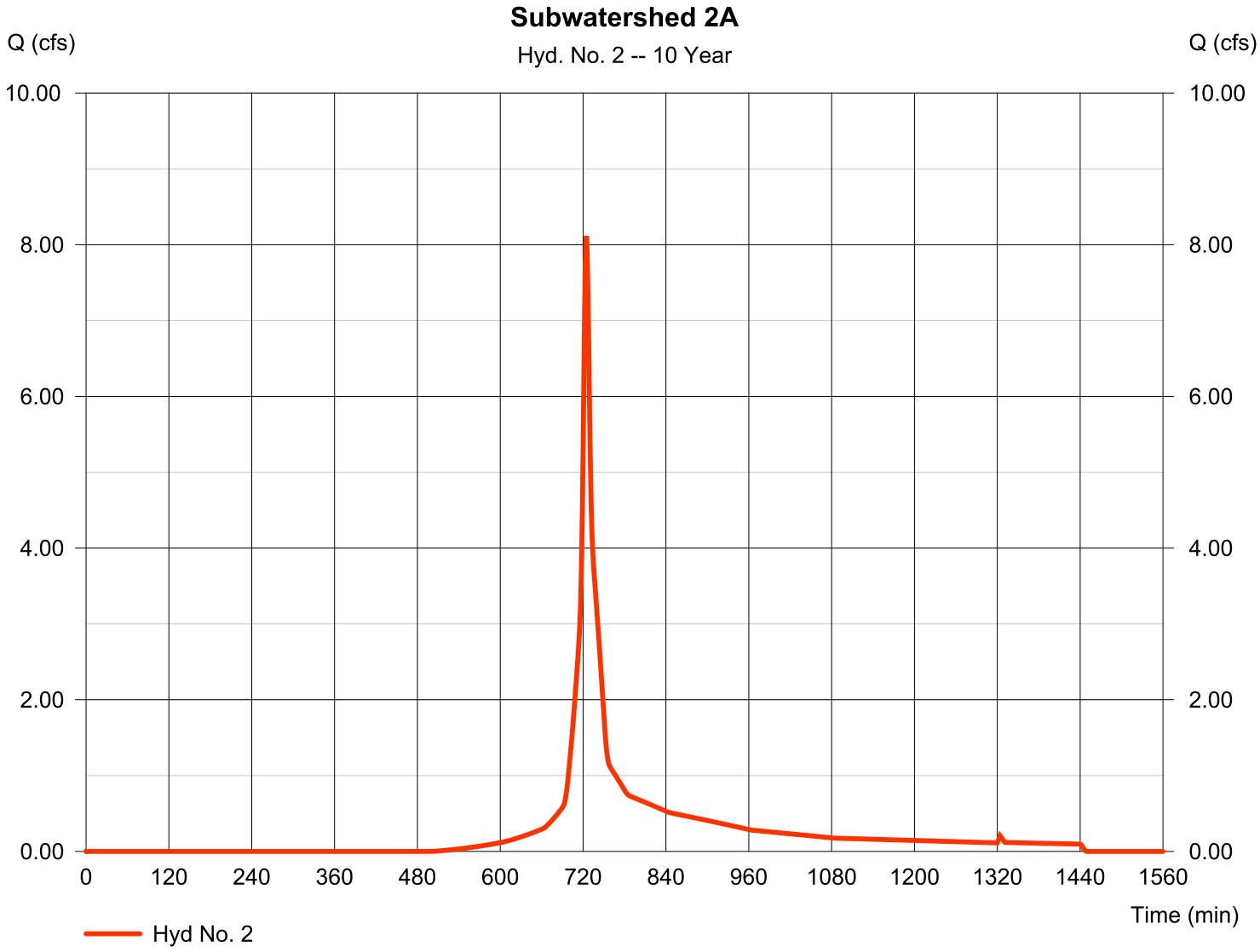
Hydrograph Report

Hyd. No. 2

Subwatershed 2A

Hydrograph type	=	SCS Runoff	Peak discharge	=	8.115 cfs
Storm frequency	=	10 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	25,003 cuft
Drainage area	=	2.630 ac	Curve number	=	77*
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) = [(1.290 x 98) + (0.670 x 74) + (0.670 x 39)] / 2.630



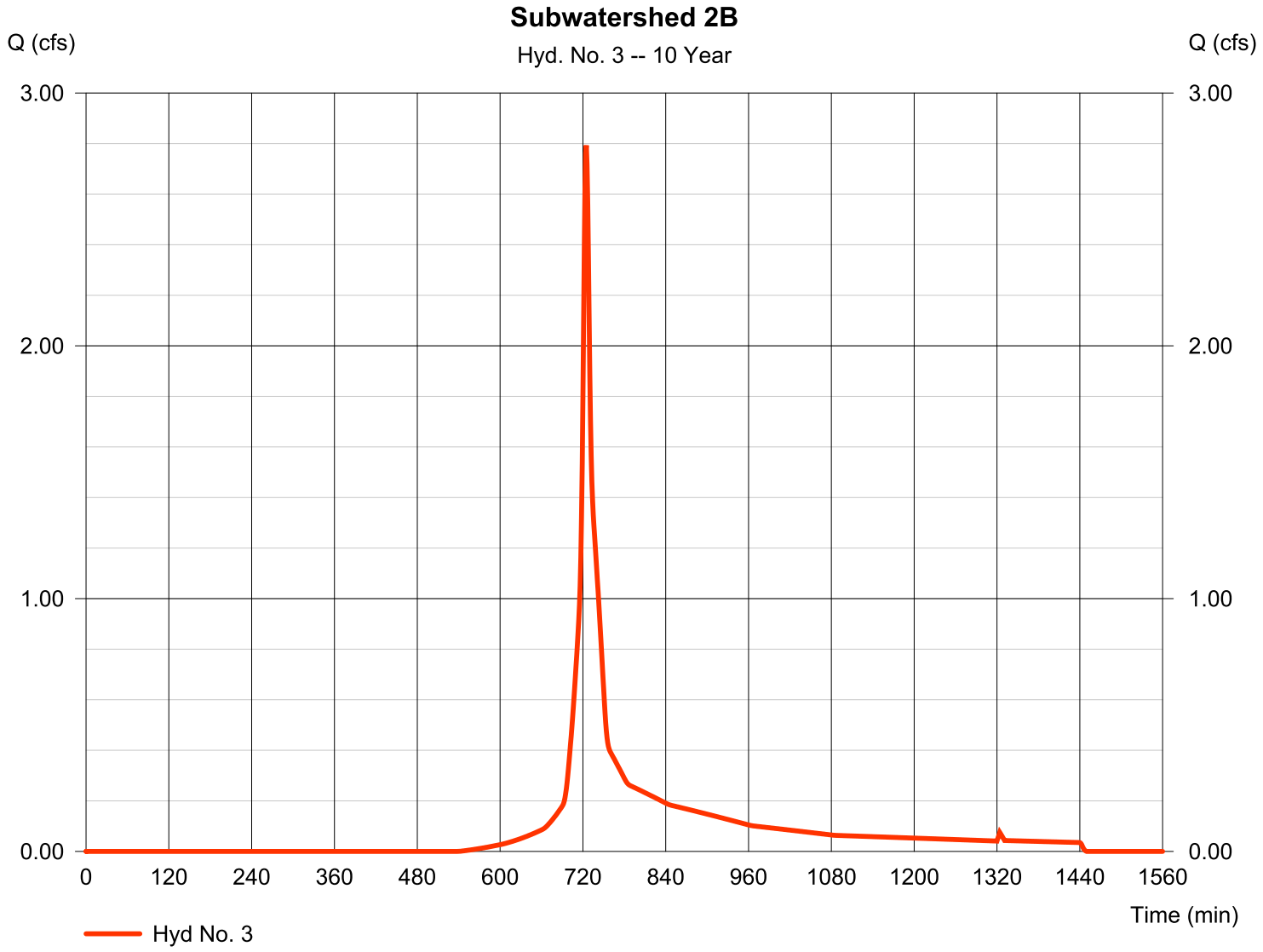
Hydrograph Report

Hyd. No. 3

Subwatershed 2B

Hydrograph type	= SCS Runoff	Peak discharge	= 2.793 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 8,638 cuft
Drainage area	= 1.010 ac	Curve number	= 74*
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) = [(0.430 x 98) + (0.290 x 74) + (0.290 x 39)] / 1.010



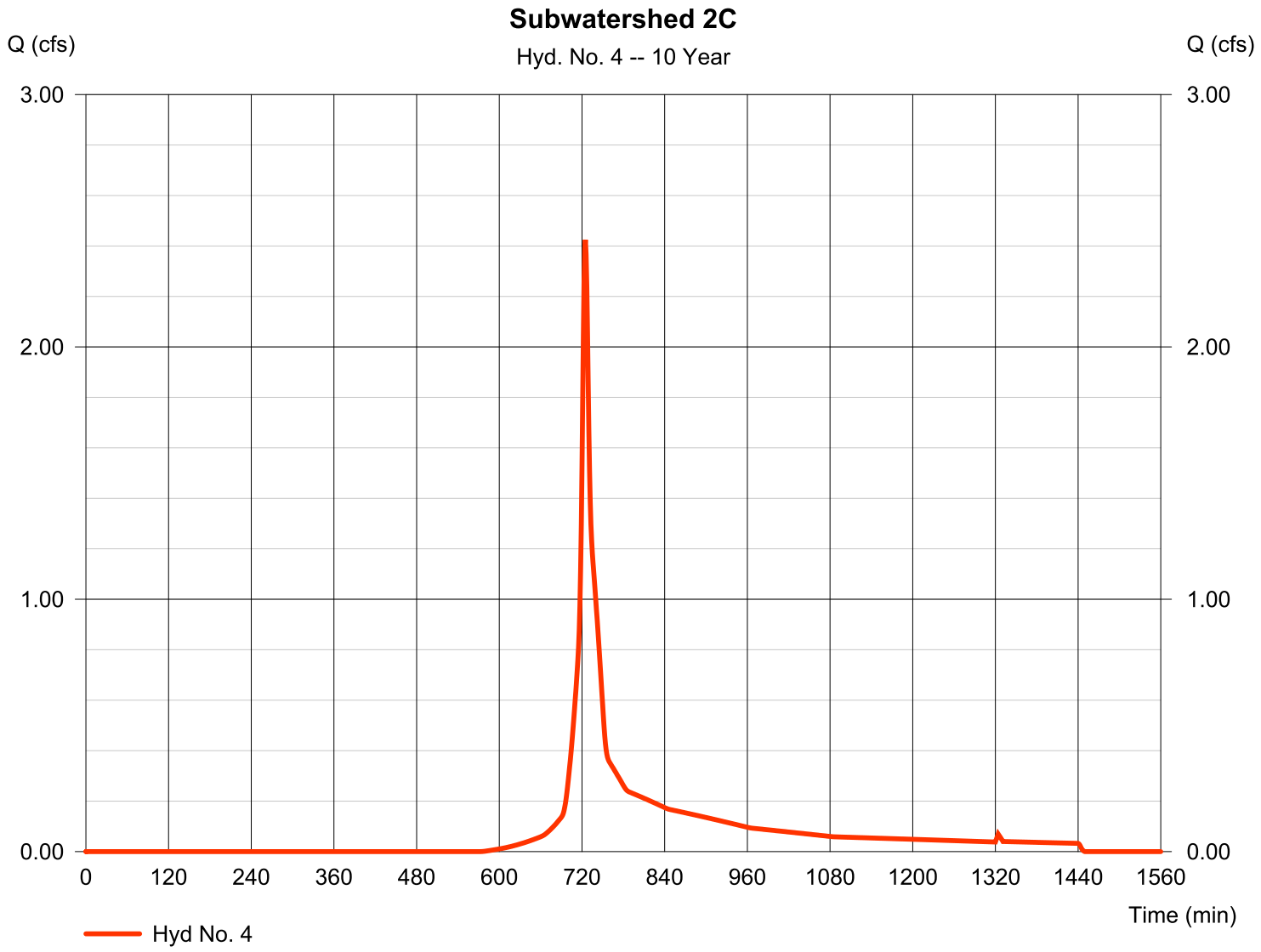
Hydrograph Report

Hyd. No. 4

Subwatershed 2C

Hydrograph type	= SCS Runoff	Peak discharge	= 2.425 cfs
Storm frequency	= 10 yrs	Time to peak	= 725 min
Time interval	= 1 min	Hyd. volume	= 7,565 cuft
Drainage area	= 0.990 ac	Curve number	= 71*
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) = [(0.350 x 98) + (0.320 x 74) + (0.320 x 39)] / 0.990



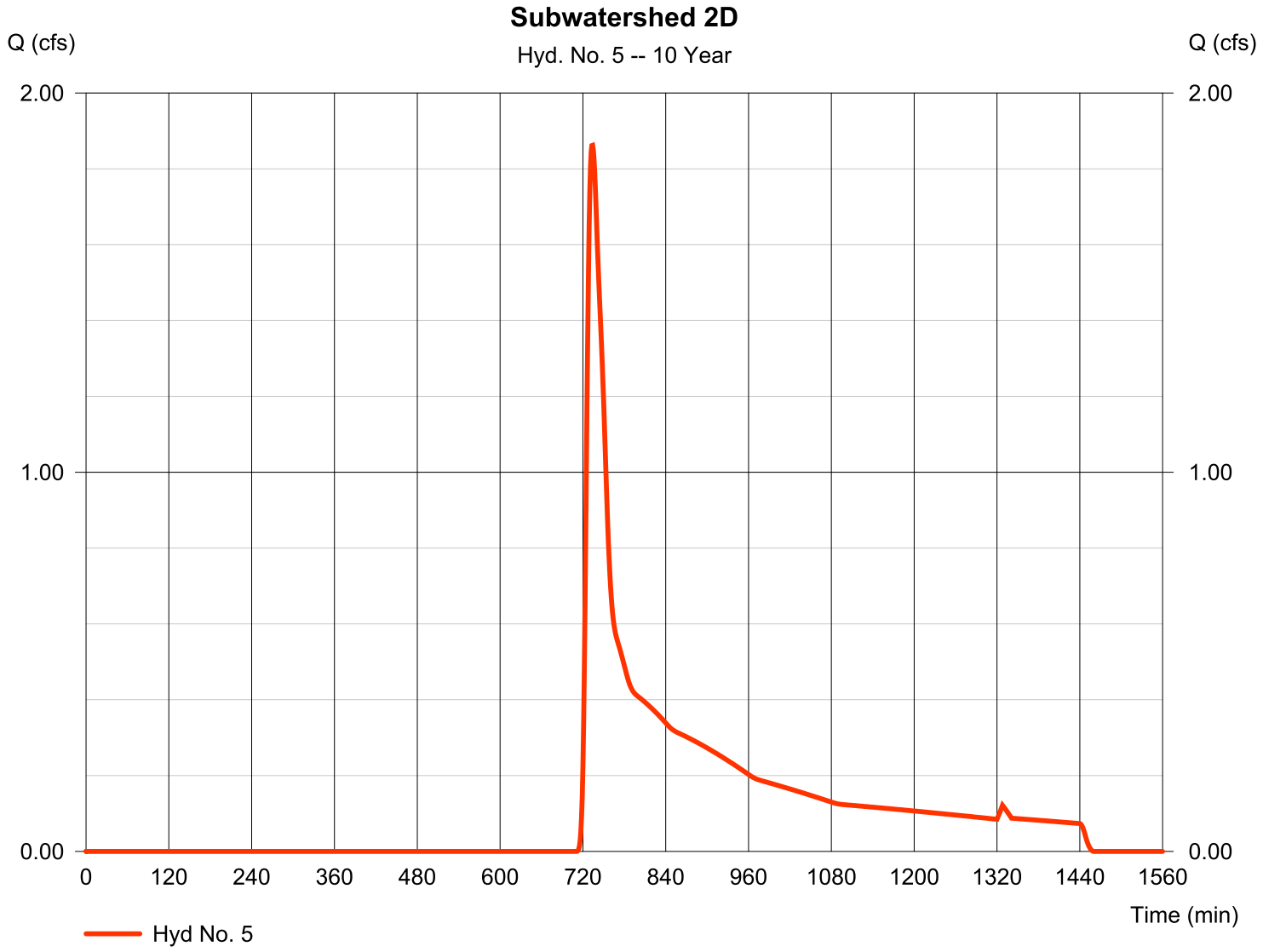
Hydrograph Report

Hyd. No. 5

Subwatershed 2D

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.862 cfs
Storm frequency	=	10 yrs	Time to peak	=	734 min
Time interval	=	1 min	Hyd. volume	=	10,527 cuft
Drainage area	=	4.180 ac	Curve number	=	51*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.40 min
Total precip.	=	4.90 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.040 x 98) + (0.790 x 39) + (1.130 x 30) + (0.120 x 36) + (1.490 x 73)] / 4.180



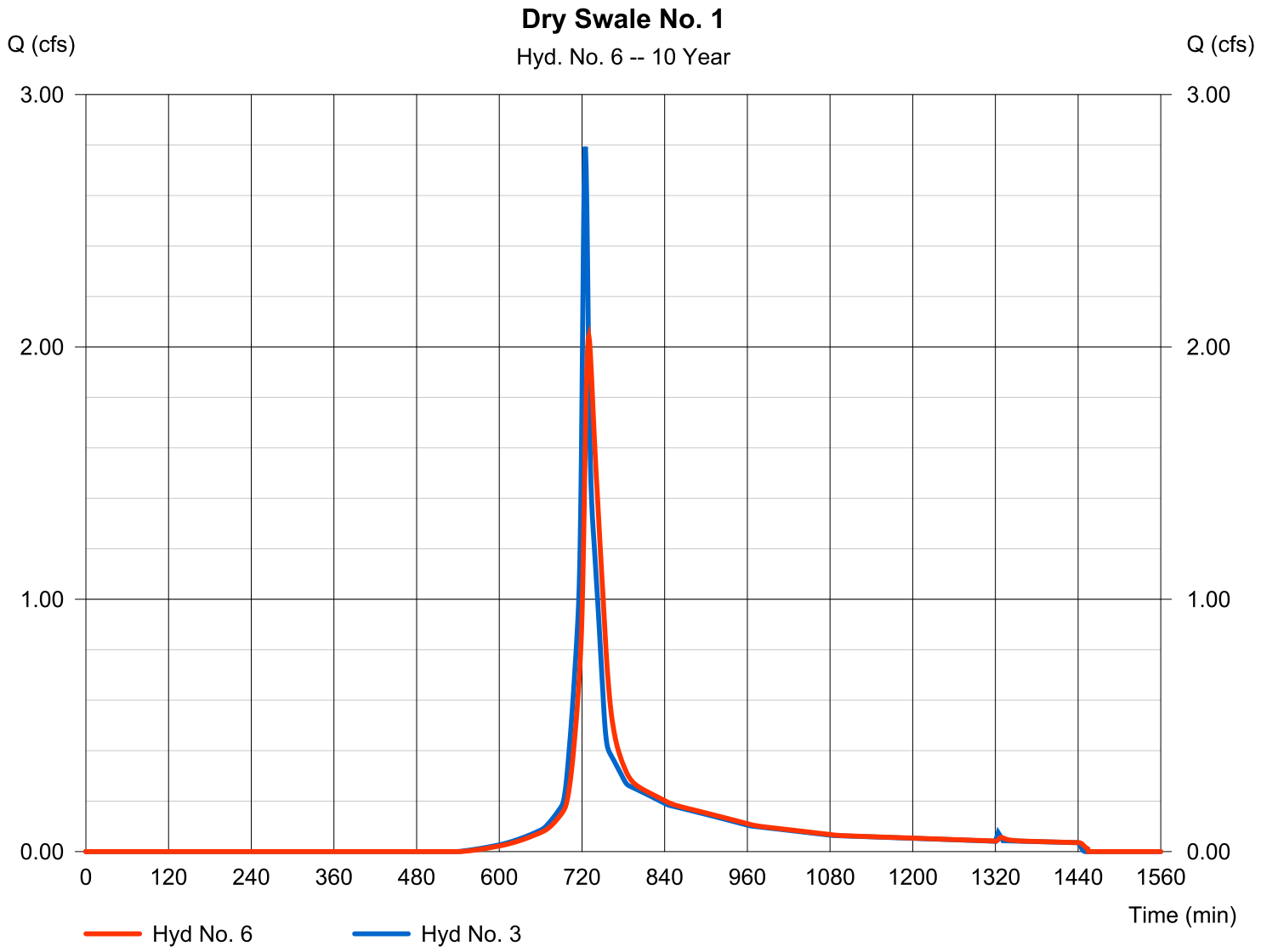
Hydrograph Report

Hyd. No. 6

Dry Swale No. 1

Hydrograph type	=	Reach	Peak discharge	=	2.042 cfs
Storm frequency	=	10 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	8,634 cuft
Inflow hyd. No.	=	3 - Subwatershed 2B	Section type	=	Trapezoidal
Reach length	=	320.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.1249

Modified Att-Kin routing method used.



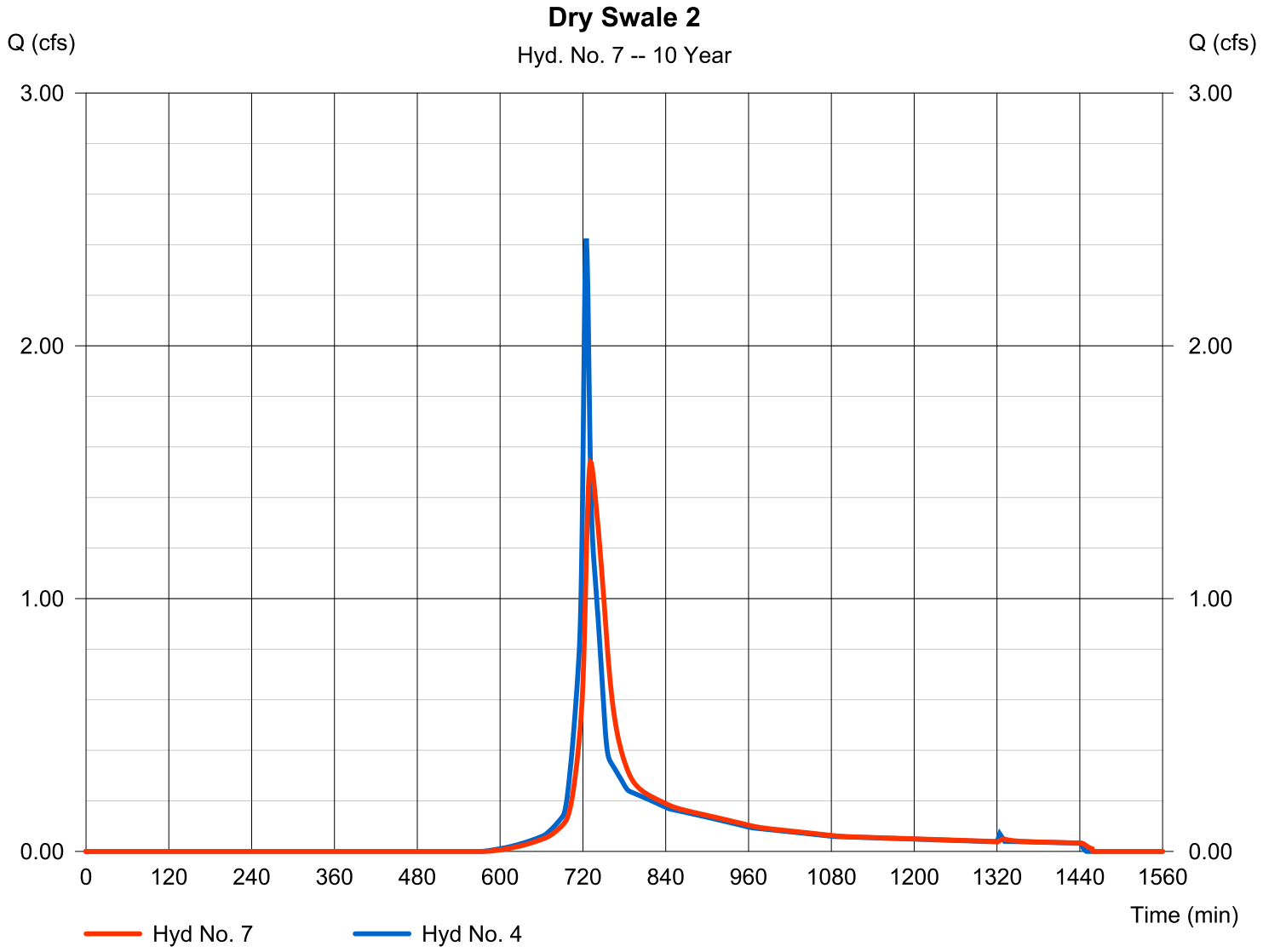
Hydrograph Report

Hyd. No. 7

Dry Swale 2

Hydrograph type	=	Reach	Peak discharge	=	1.540 cfs
Storm frequency	=	10 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	7,558 cuft
Inflow hyd. No.	=	4 - Subwatershed 2C	Section type	=	Trapezoidal
Reach length	=	478.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.0865

Modified Att-Kin routing method used.



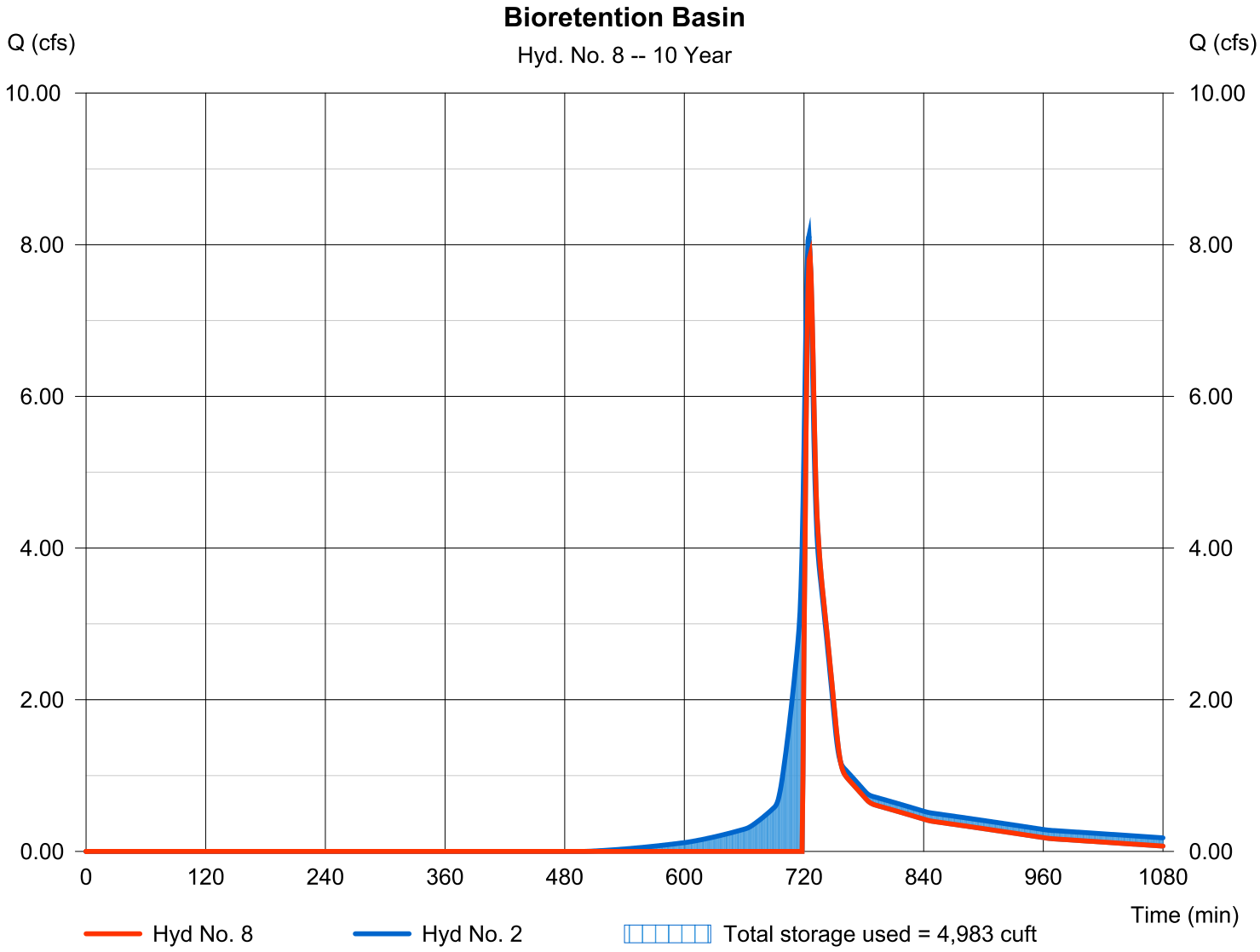
Hydrograph Report

Hyd. No. 8

Bioretention Basin

Hydrograph type	=	Reservoir	Peak discharge	=	7.854 cfs
Storm frequency	=	10 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	15,518 cuft
Inflow hyd. No.	=	2 - Subwatershed 2A	Max. Elevation	=	13.64 ft
Reservoir name	=	Bioretention Basin	Max. Storage	=	4,983 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

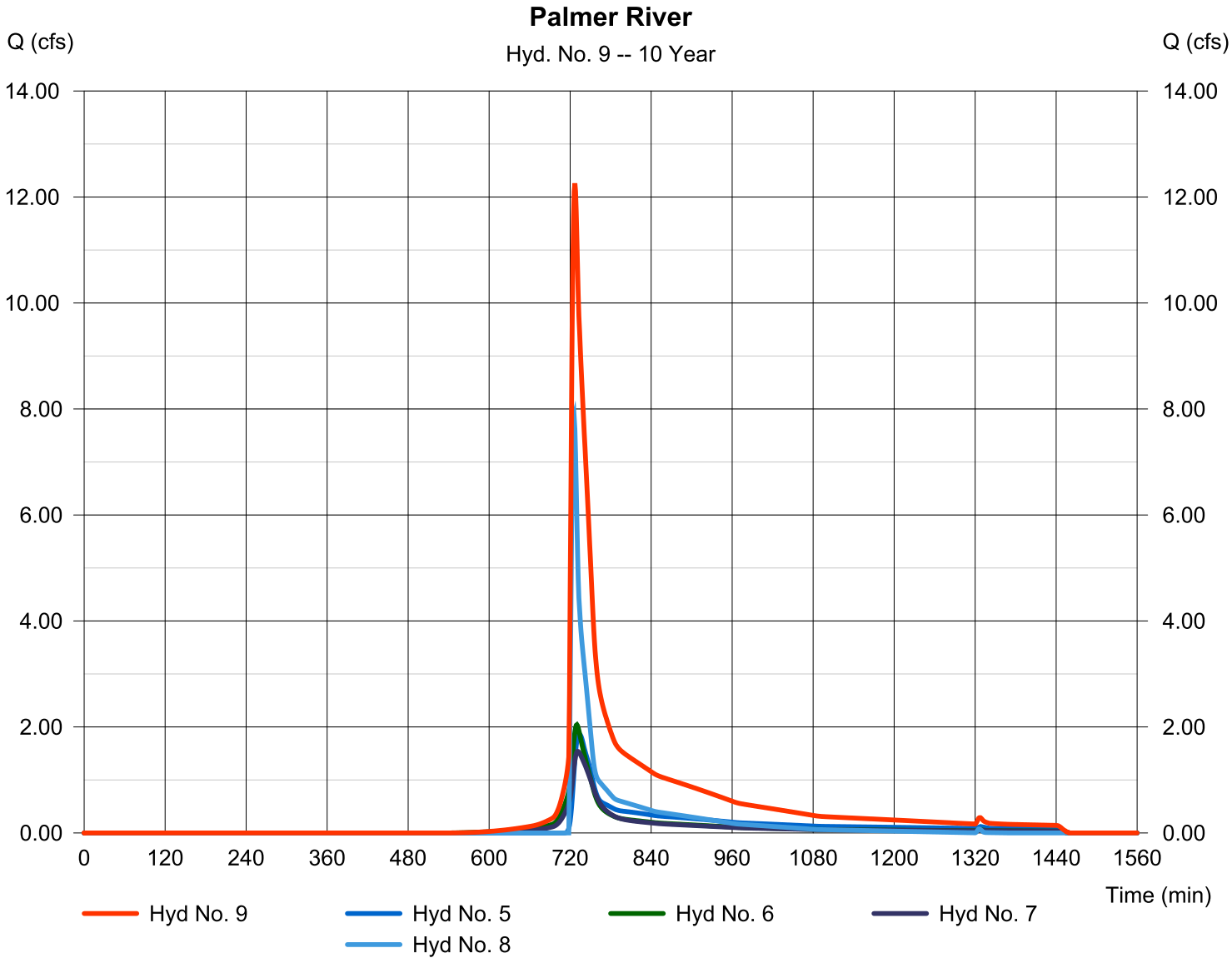


Hydrograph Report

Hyd. No. 9

Palmer River

Hydrograph type	=	Combine	Peak discharge	=	12.26 cfs
Storm frequency	=	10 yrs	Time to peak	=	727 min
Time interval	=	1 min	Hyd. volume	=	42,237 cuft
Inflow hyds.	=	5, 6, 7, 8	Contrib. drain. area	=	4.180 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	0.579	1	724	1,892	------	------	------	Subwatershed 1
2	SCS Runoff	11.38	1	725	35,114	------	------	------	Subwatershed 2A
3	SCS Runoff	4.012	1	725	12,360	------	------	------	Subwatershed 2B
4	SCS Runoff	3.578	1	725	11,042	------	------	------	Subwatershed 2C
5	SCS Runoff	4.152	1	731	18,916	------	------	------	Subwatershed 2D
6	Reach	2.917	1	730	12,356	3	------	------	Dry Swale No. 1
7	Reach	2.259	1	731	11,035	4	------	------	Dry Swale 2
8	Reservoir	11.06	1	726	25,318	2	13.68	5,164	Bioretention Basin
9	Combine	19.09	1	727	67,625	5, 6, 7, 8	------	------	Palmer River

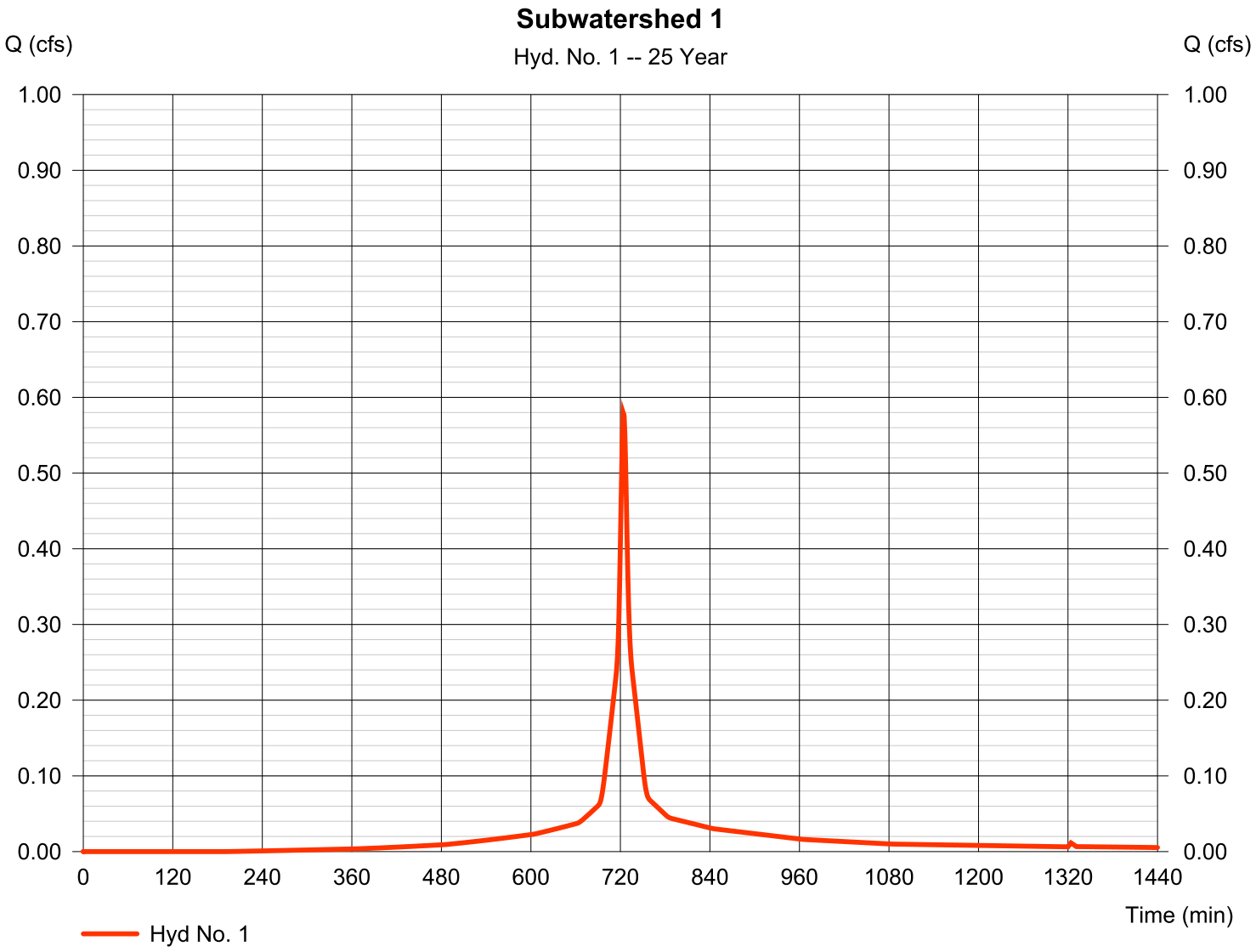
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.579 cfs
Storm frequency	= 25 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 1,892 cuft
Drainage area	= 0.100 ac	Curve number	= 91*
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) = [(0.070 x 98) + (0.030 x 74)] / 0.100



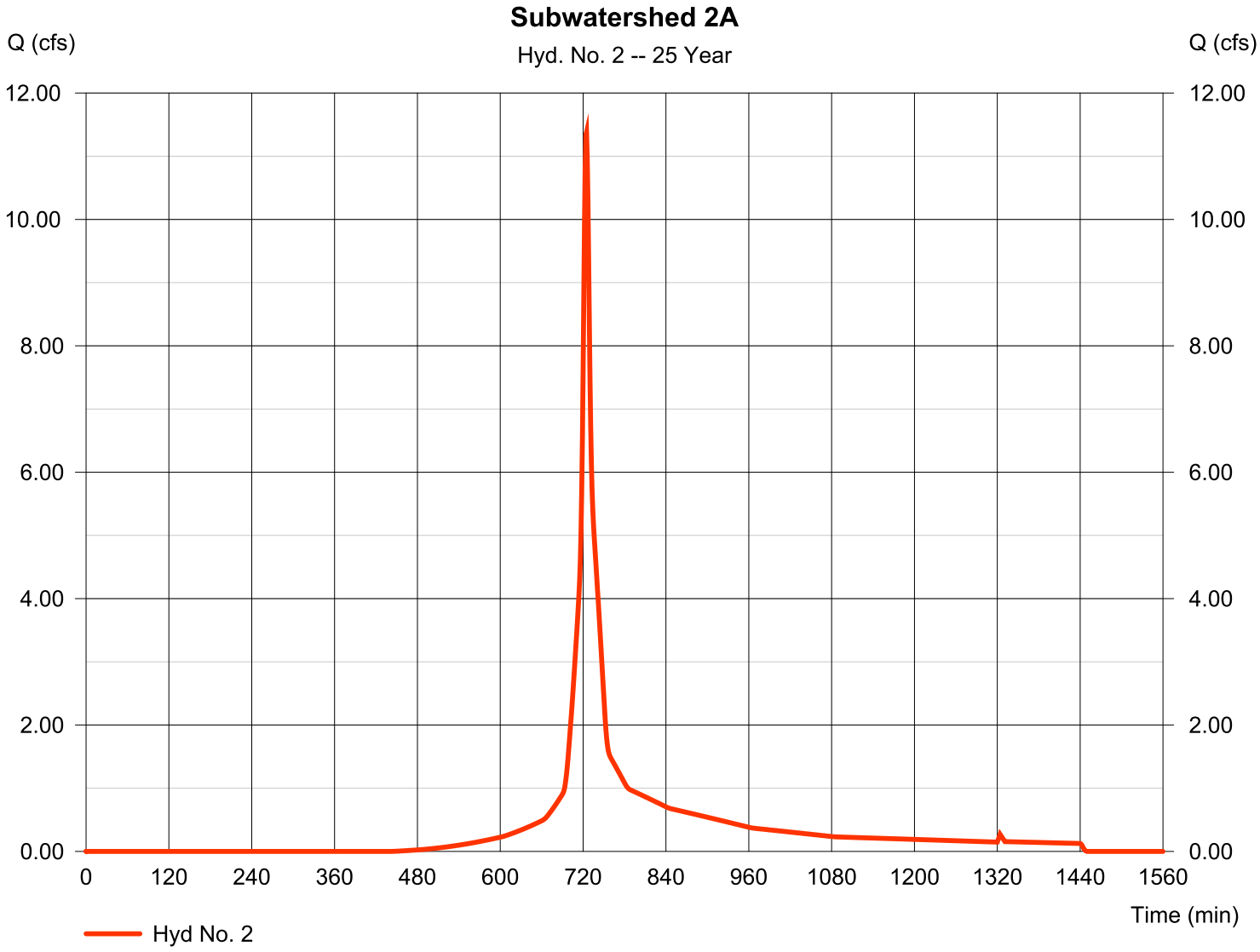
Hydrograph Report

Hyd. No. 2

Subwatershed 2A

Hydrograph type	=	SCS Runoff	Peak discharge	=	11.38 cfs
Storm frequency	=	25 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	35,114 cuft
Drainage area	=	2.630 ac	Curve number	=	77*
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) = [(1.290 x 98) + (0.670 x 74) + (0.670 x 39)] / 2.630



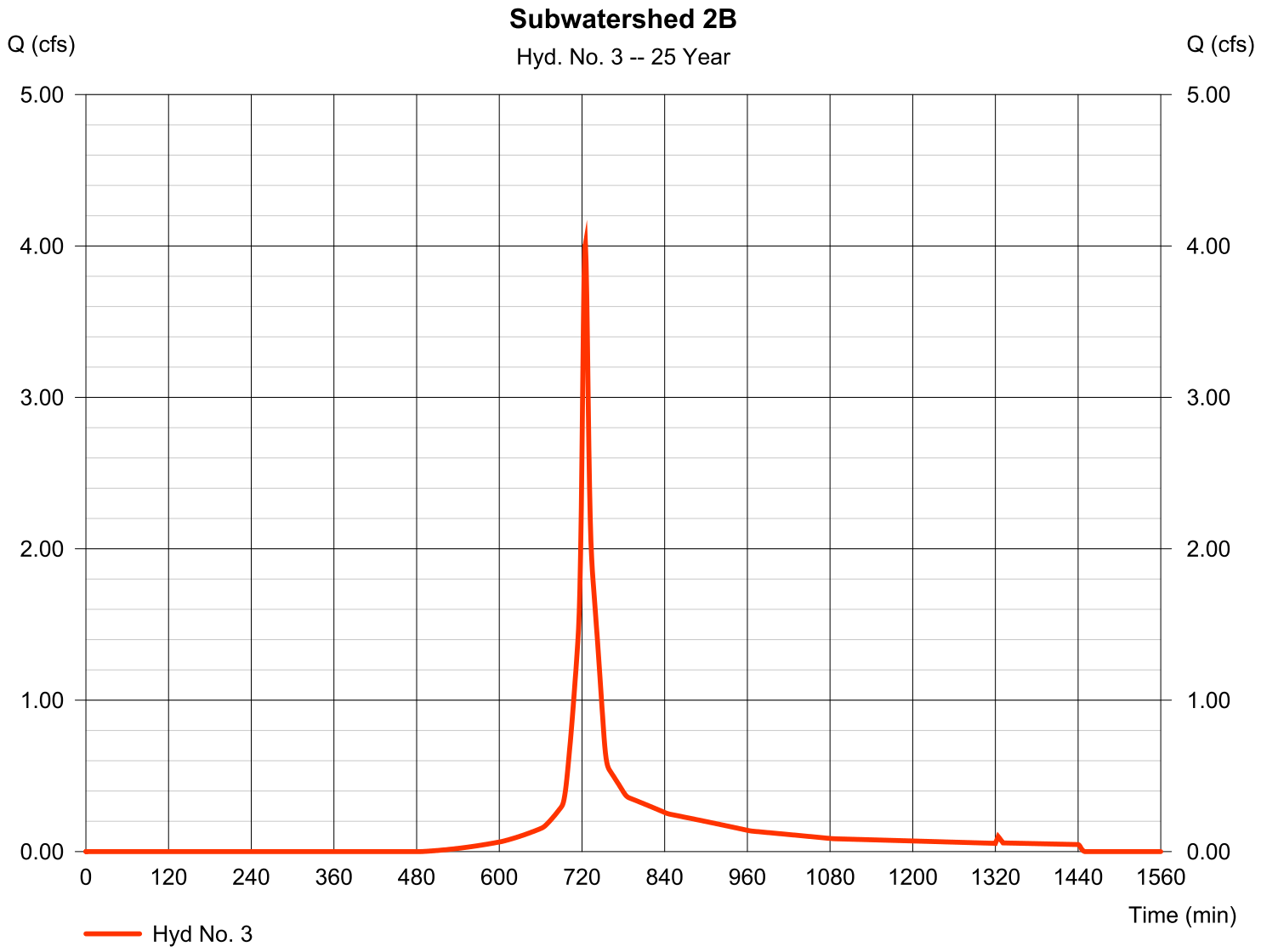
Hydrograph Report

Hyd. No. 3

Subwatershed 2B

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.012 cfs
Storm frequency	=	25 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	12,360 cuft
Drainage area	=	1.010 ac	Curve number	=	74*
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) = [(0.430 x 98) + (0.290 x 74) + (0.290 x 39)] / 1.010



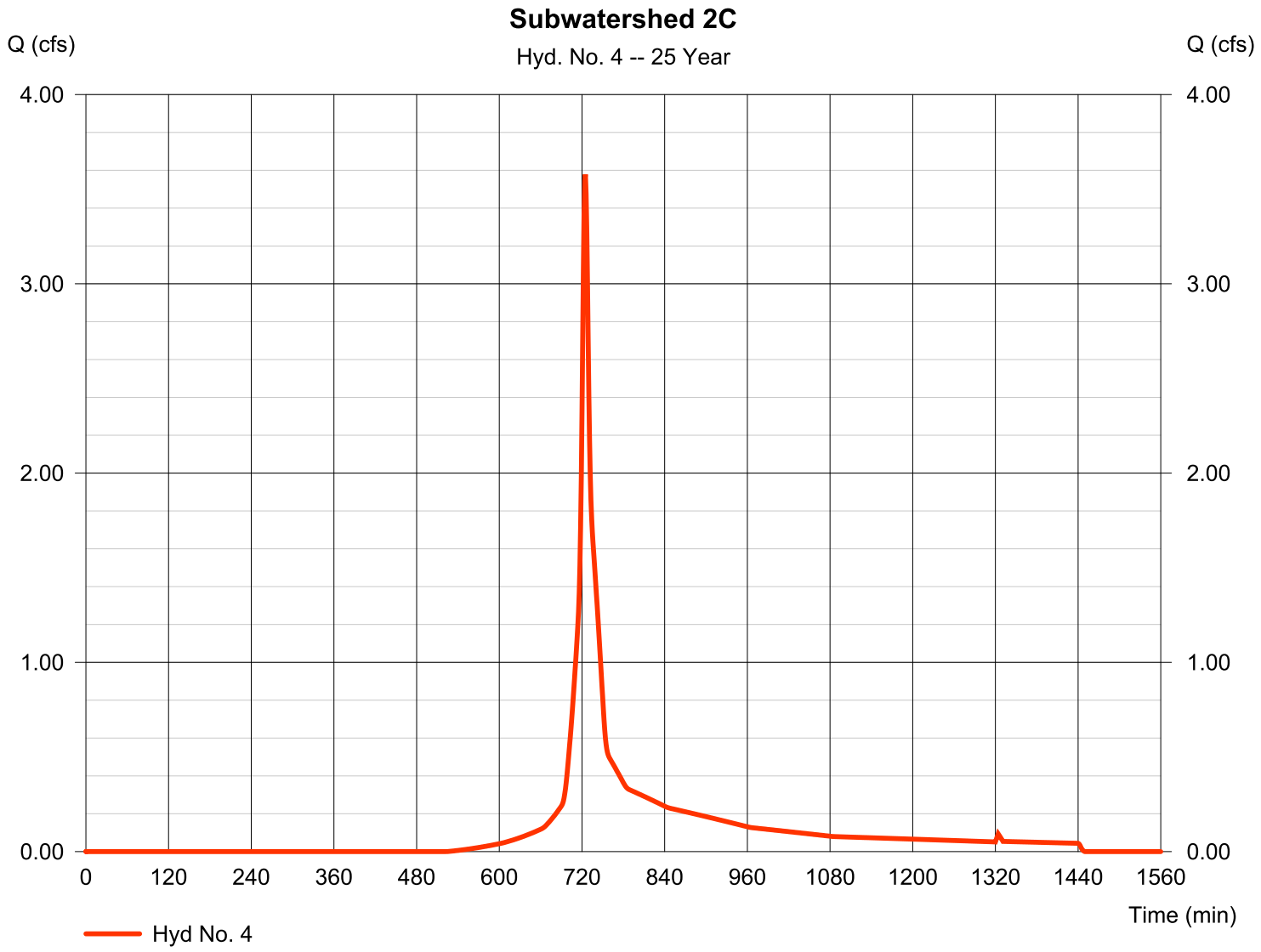
Hydrograph Report

Hyd. No. 4

Subwatershed 2C

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.578 cfs
Storm frequency	=	25 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	11,042 cuft
Drainage area	=	0.990 ac	Curve number	=	71*
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) = [(0.350 x 98) + (0.320 x 74) + (0.320 x 39)] / 0.990



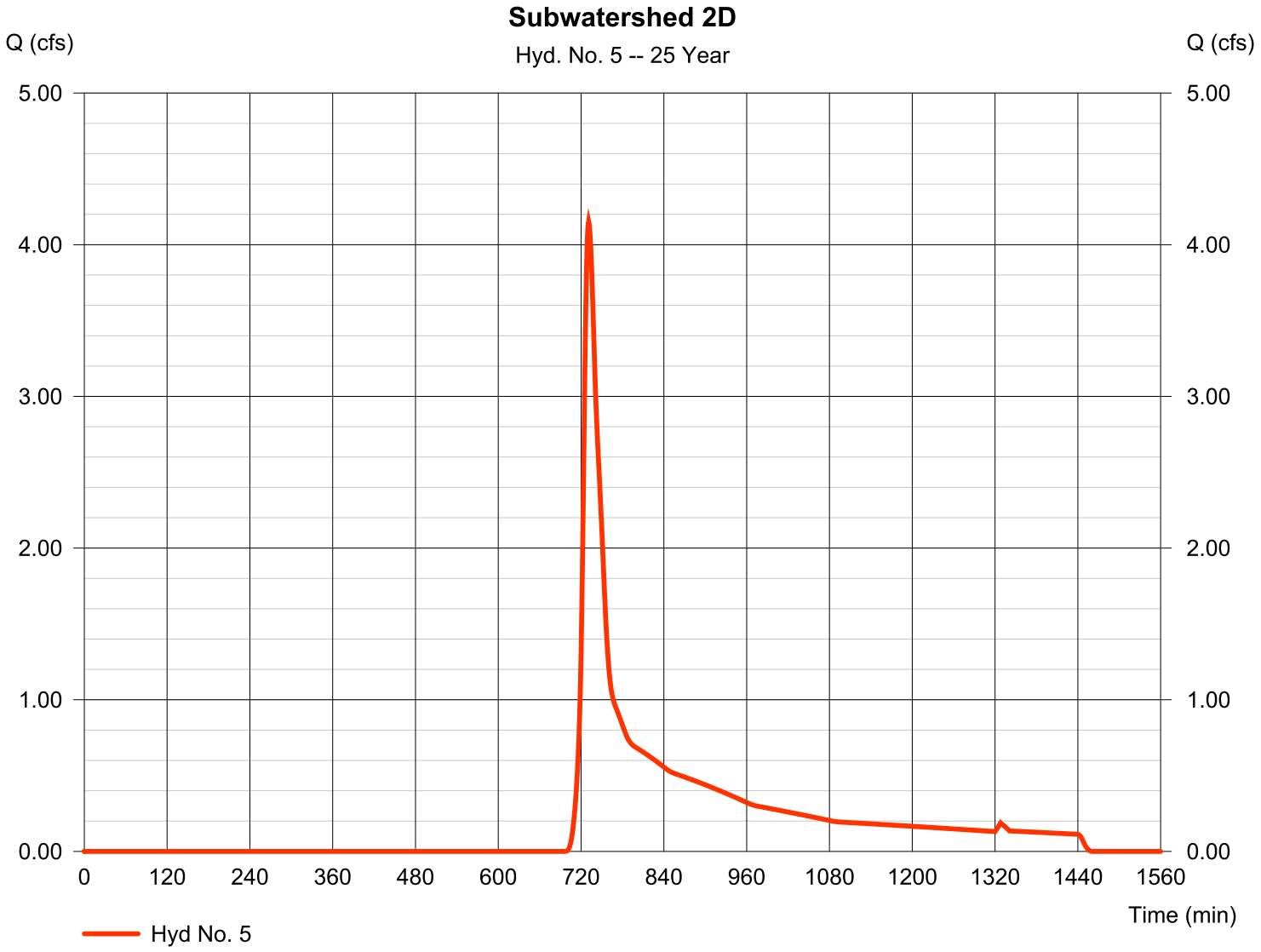
Hydrograph Report

Hyd. No. 5

Subwatershed 2D

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.152 cfs
Storm frequency	=	25 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	18,916 cuft
Drainage area	=	4.180 ac	Curve number	=	51*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.40 min
Total precip.	=	6.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.040 x 98) + (0.790 x 39) + (1.130 x 30) + (0.120 x 36) + (1.490 x 73)] / 4.180



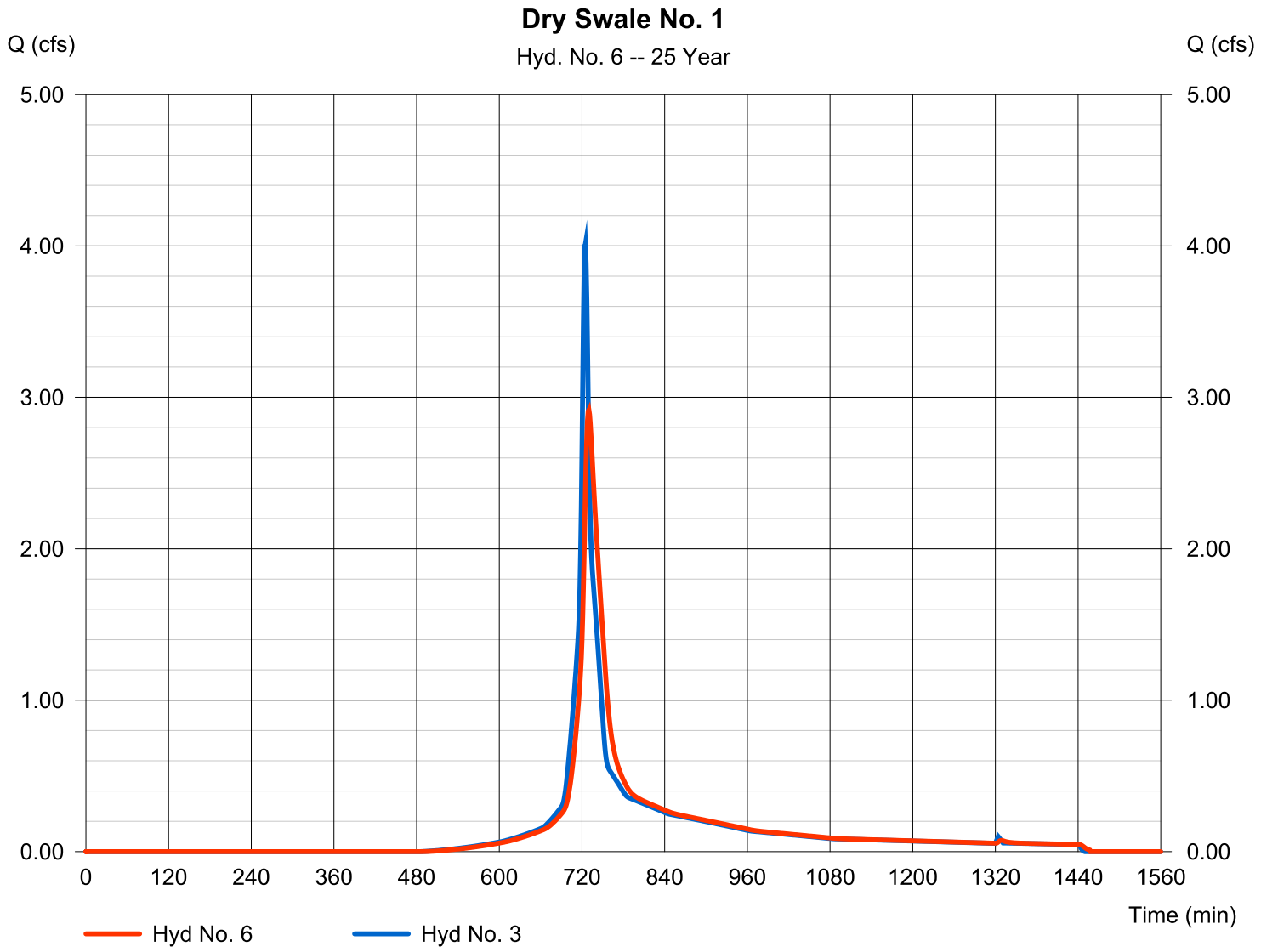
Hydrograph Report

Hyd. No. 6

Dry Swale No. 1

Hydrograph type	=	Reach	Peak discharge	=	2.917 cfs
Storm frequency	=	25 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	12,356 cuft
Inflow hyd. No.	=	3 - Subwatershed 2B	Section type	=	Trapezoidal
Reach length	=	320.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.1207

Modified Att-Kin routing method used.



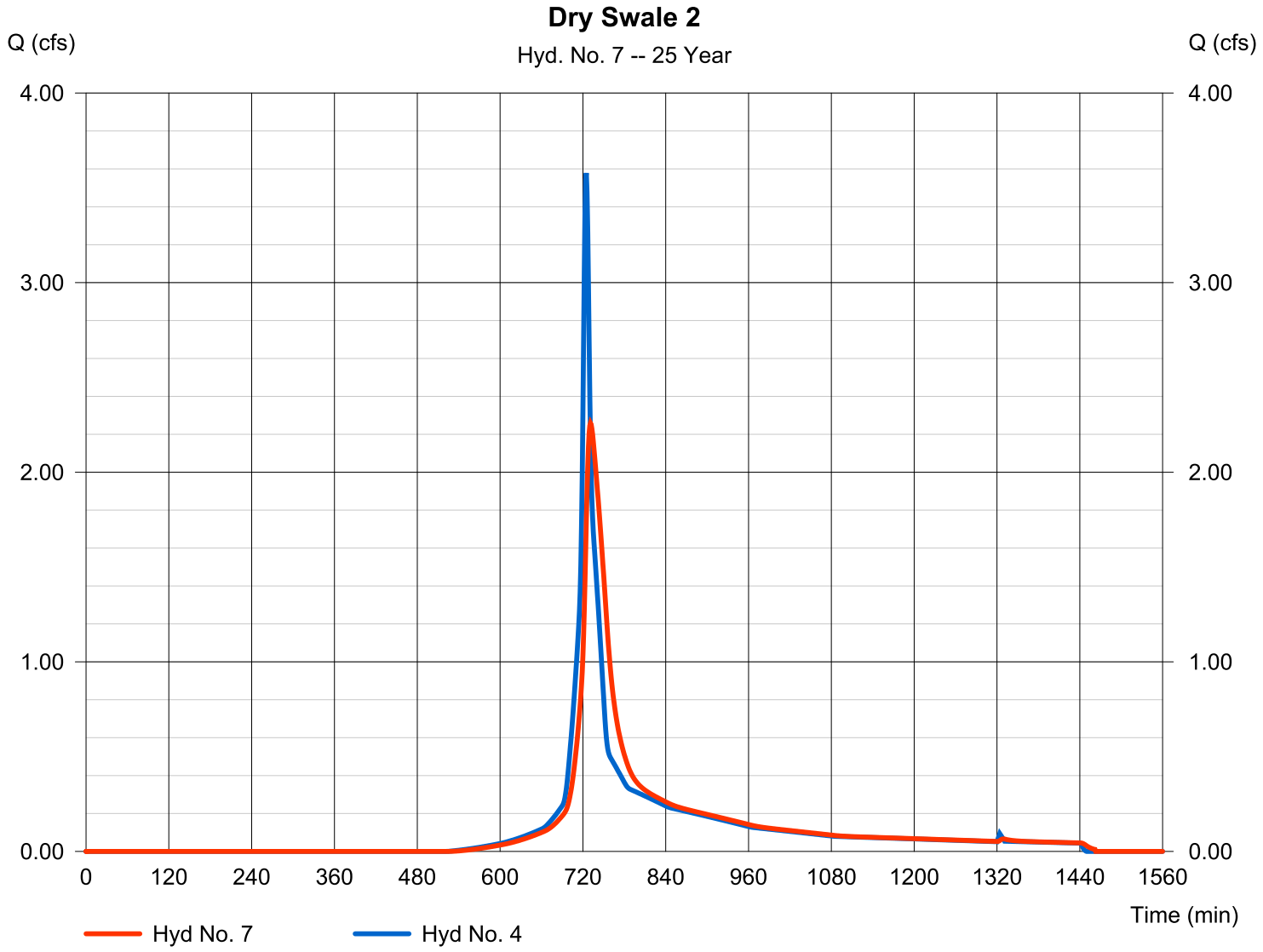
Hydrograph Report

Hyd. No. 7

Dry Swale 2

Hydrograph type	=	Reach	Peak discharge	=	2.259 cfs
Storm frequency	=	25 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	11,035 cuft
Inflow hyd. No.	=	4 - Subwatershed 2C	Section type	=	Trapezoidal
Reach length	=	478.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.0834

Modified Att-Kin routing method used.



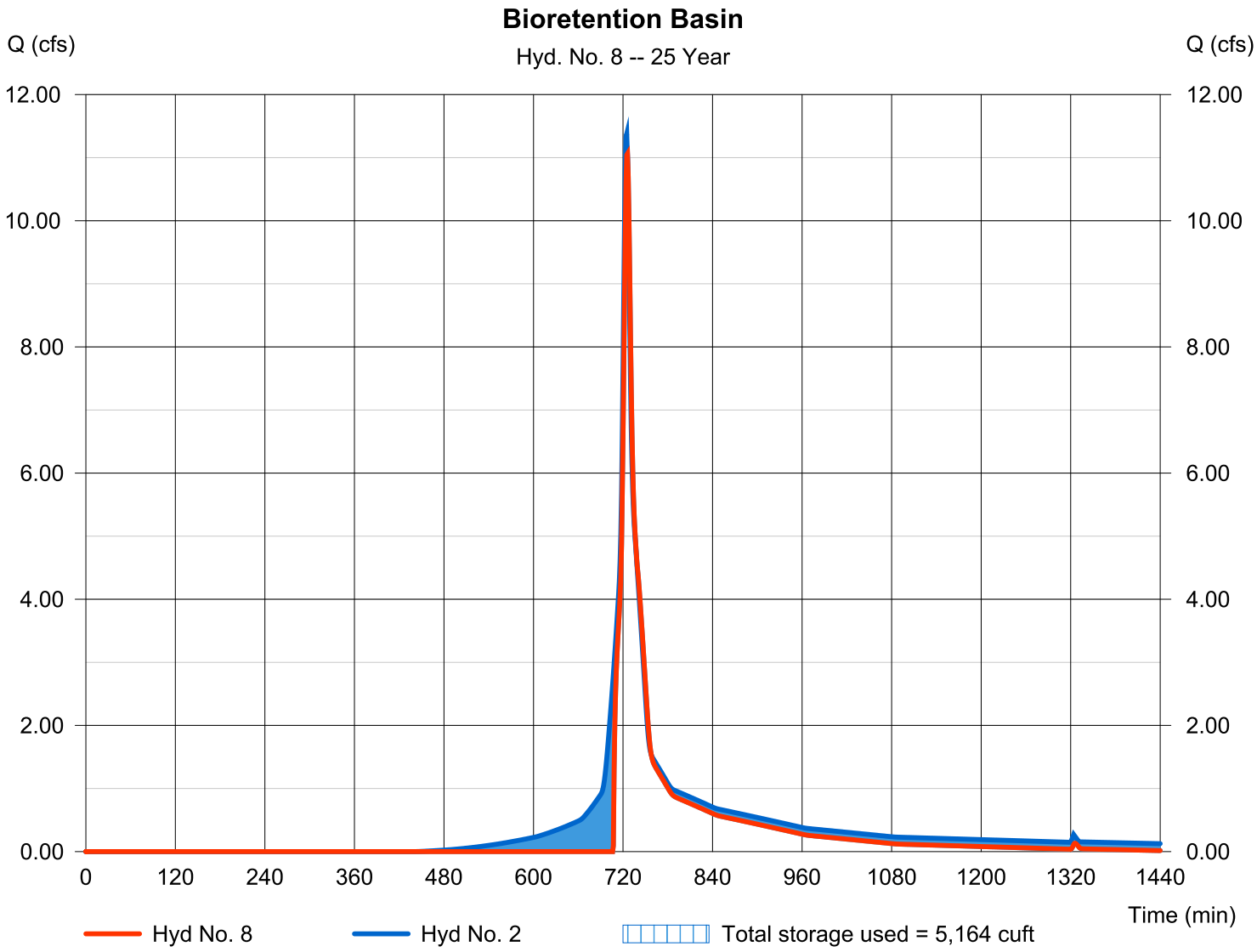
Hydrograph Report

Hyd. No. 8

Bioretention Basin

Hydrograph type	=	Reservoir	Peak discharge	=	11.06 cfs
Storm frequency	=	25 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	25,318 cuft
Inflow hyd. No.	=	2 - Subwatershed 2A	Max. Elevation	=	13.68 ft
Reservoir name	=	Bioretention Basin	Max. Storage	=	5,164 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

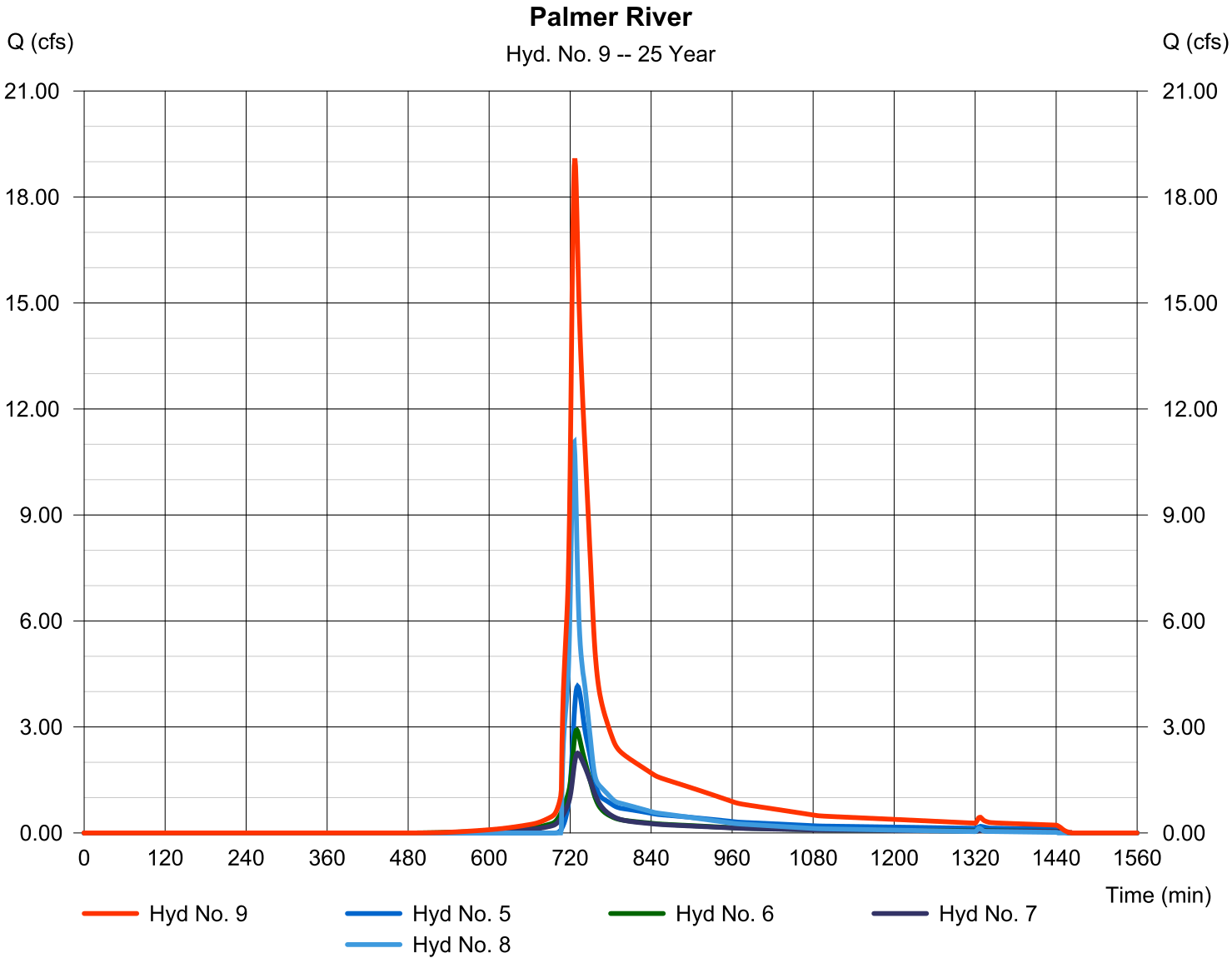


Hydrograph Report

Hyd. No. 9

Palmer River

Hydrograph type	=	Combine	Peak discharge	=	19.09 cfs
Storm frequency	=	25 yrs	Time to peak	=	727 min
Time interval	=	1 min	Hyd. volume	=	67,625 cuft
Inflow hyds.	=	5, 6, 7, 8	Contrib. drain. area	=	4.180 ac



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2014 by Autodesk, Inc. v10.3

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	0.842	1	724	2,814	------	------	------	Subwatershed 1
2	SCS Runoff	18.35	1	725	57,373	------	------	------	Subwatershed 2A
3	SCS Runoff	6.658	1	725	20,665	------	------	------	Subwatershed 2B
4	SCS Runoff	6.125	1	725	18,917	------	------	------	Subwatershed 2C
5	SCS Runoff	10.26	1	730	40,904	------	------	------	Subwatershed 2D
6	Reach	4.802	1	730	20,660	3	------	------	Dry Swale No. 1
7	Reach	3.833	1	731	18,910	4	------	------	Dry Swale 2
8	Reservoir	18.11	1	725	47,052	2	13.75	5,493	Bioretention Basin
9	Combine	34.73	1	727	127,526	5, 6, 7, 8	------	------	Palmer River

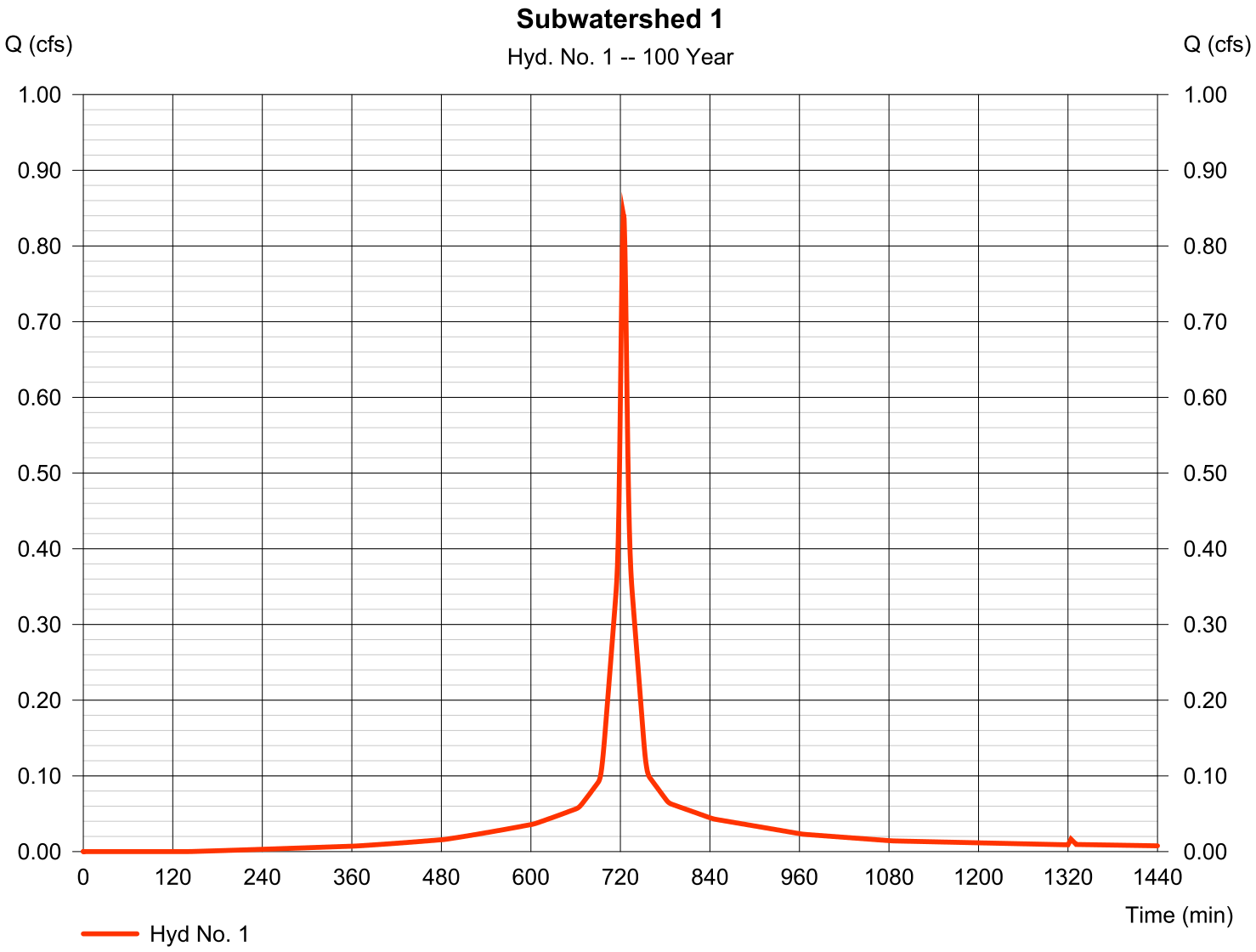
Hydrograph Report

Hyd. No. 1

Subwatershed 1

Hydrograph type	= SCS Runoff	Peak discharge	= 0.842 cfs
Storm frequency	= 100 yrs	Time to peak	= 724 min
Time interval	= 1 min	Hyd. volume	= 2,814 cuft
Drainage area	= 0.100 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.60 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.070 x 98) + (0.030 x 74)] / 0.100



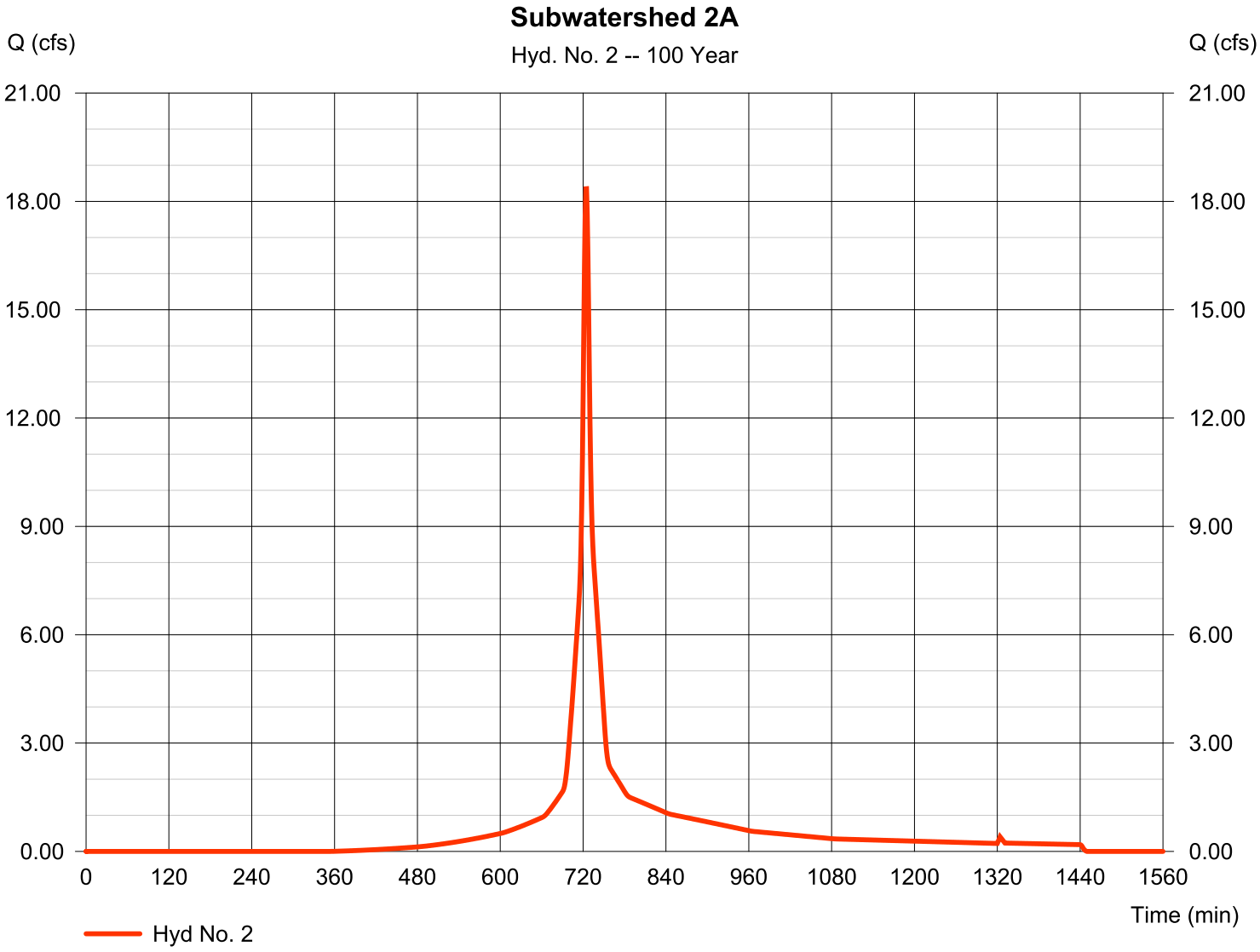
Hydrograph Report

Hyd. No. 2

Subwatershed 2A

Hydrograph type	=	SCS Runoff	Peak discharge	=	18.35 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	57,373 cuft
Drainage area	=	2.630 ac	Curve number	=	77*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	8.60 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(1.290 x 98) + (0.670 x 74) + (0.670 x 39)] / 2.630



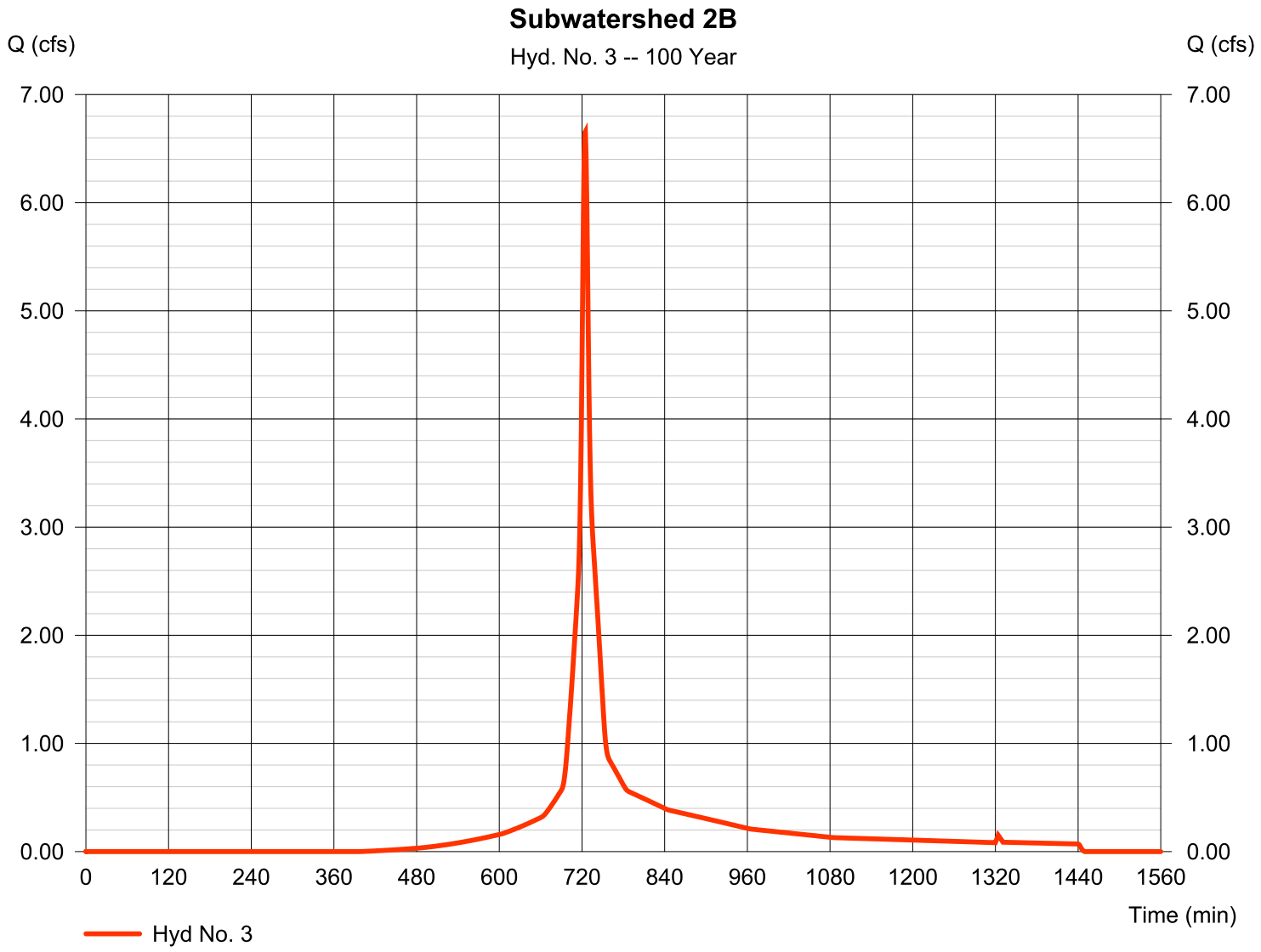
Hydrograph Report

Hyd. No. 3

Subwatershed 2B

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.658 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	20,665 cuft
Drainage area	=	1.010 ac	Curve number	=	74*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	8.60 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.430 x 98) + (0.290 x 74) + (0.290 x 39)] / 1.010



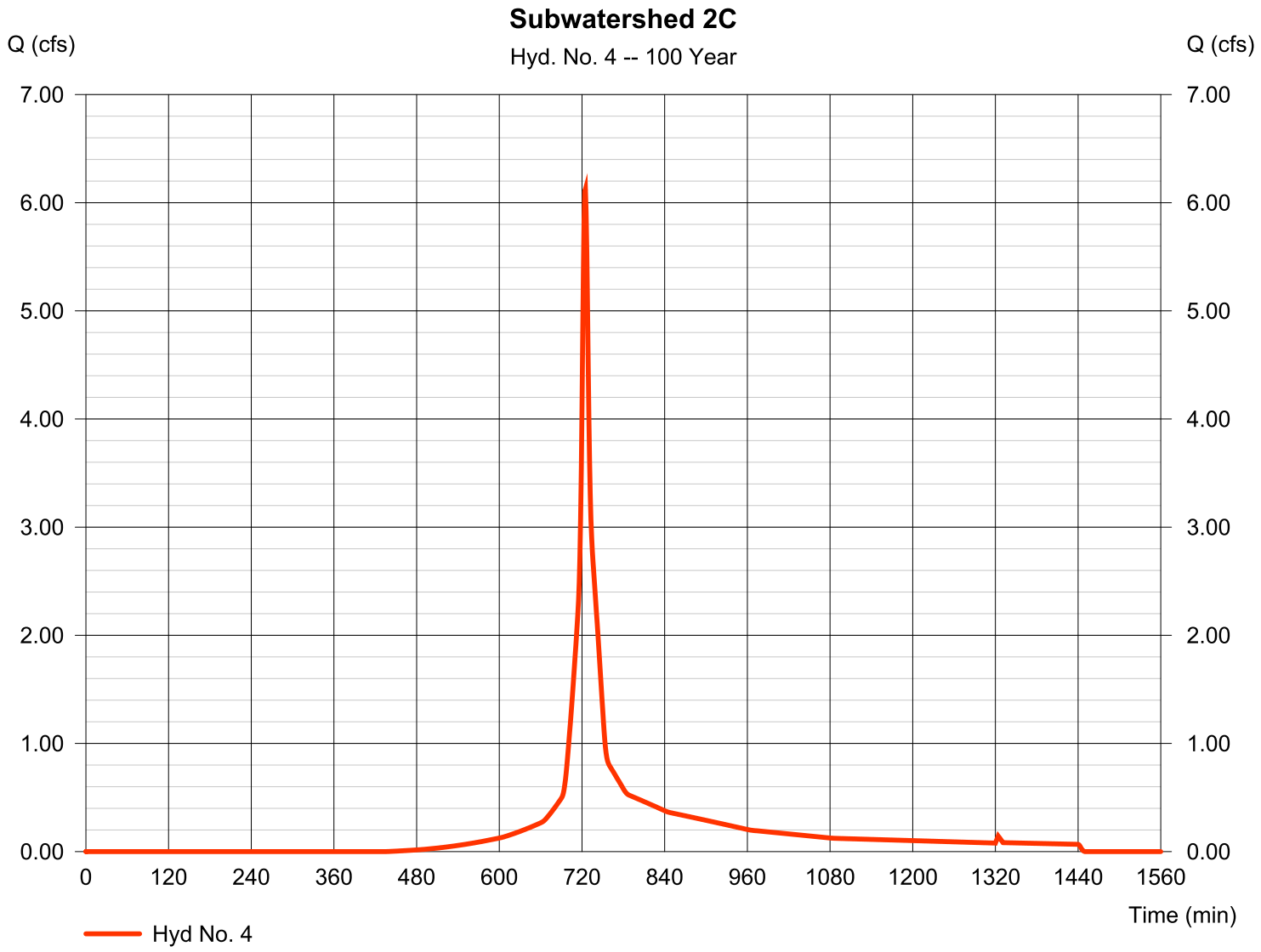
Hydrograph Report

Hyd. No. 4

Subwatershed 2C

Hydrograph type	=	SCS Runoff	Peak discharge	=	6.125 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	18,917 cuft
Drainage area	=	0.990 ac	Curve number	=	71*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	5.00 min
Total precip.	=	8.60 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.350 x 98) + (0.320 x 74) + (0.320 x 39)] / 0.990



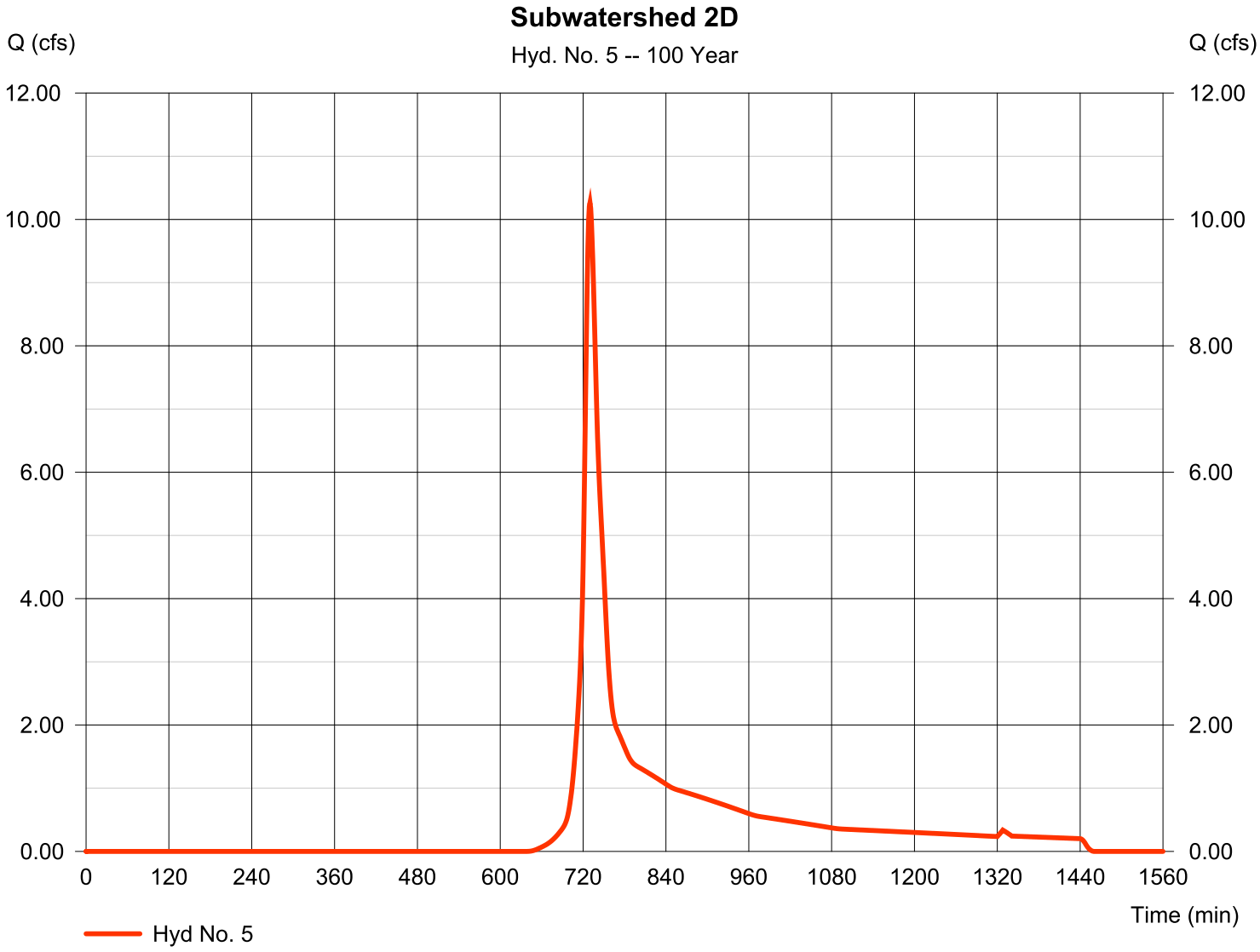
Hydrograph Report

Hyd. No. 5

Subwatershed 2D

Hydrograph type	=	SCS Runoff	Peak discharge	=	10.26 cfs
Storm frequency	=	100 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	40,904 cuft
Drainage area	=	4.180 ac	Curve number	=	51*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	13.40 min
Total precip.	=	8.60 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.040 x 98) + (0.790 x 39) + (1.130 x 30) + (0.120 x 36) + (1.490 x 73)] / 4.180



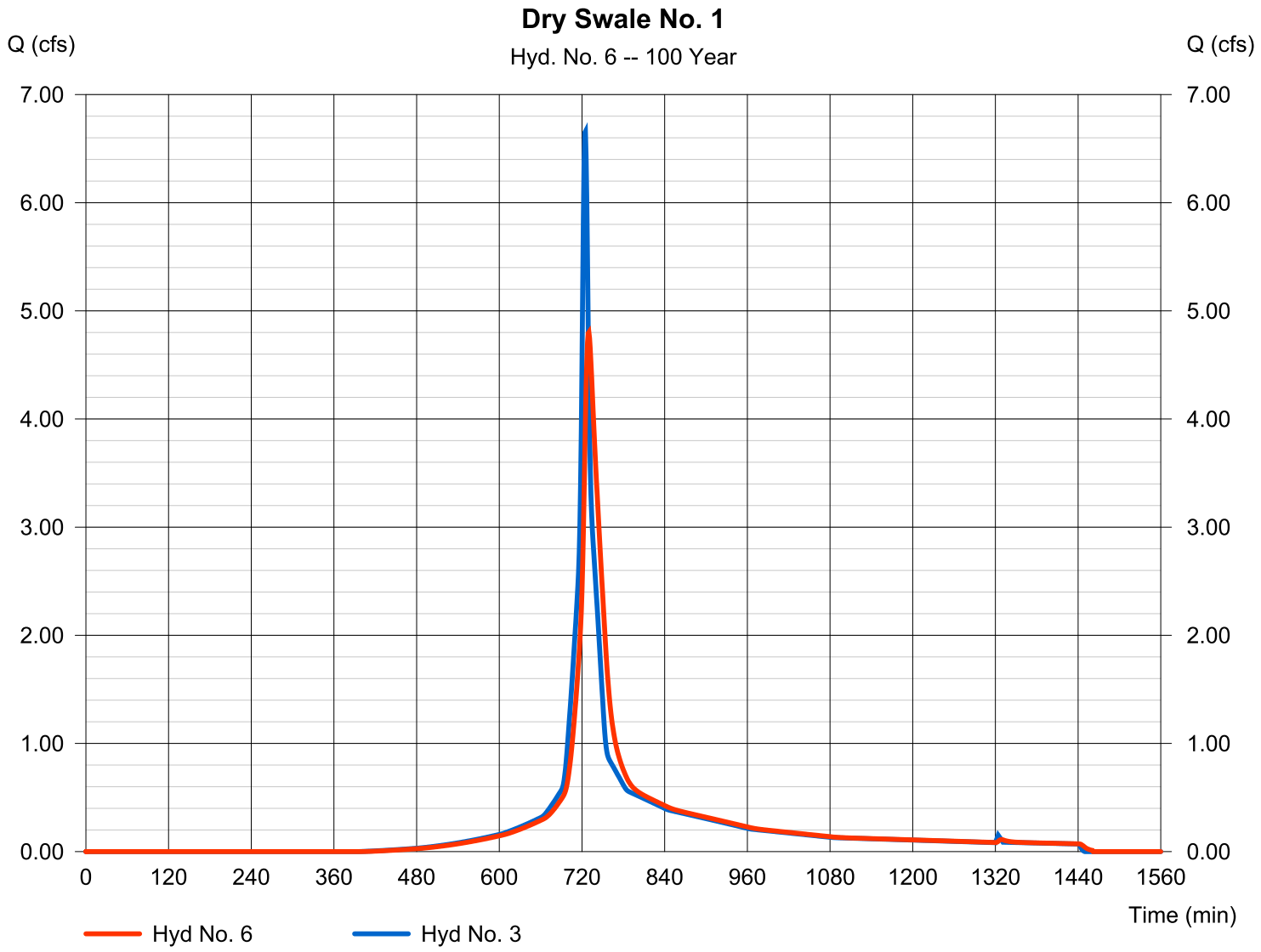
Hydrograph Report

Hyd. No. 6

Dry Swale No. 1

Hydrograph type	=	Reach	Peak discharge	=	4.802 cfs
Storm frequency	=	100 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	20,660 cuft
Inflow hyd. No.	=	3 - Subwatershed 2B	Section type	=	Trapezoidal
Reach length	=	320.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.1151

Modified Att-Kin routing method used.



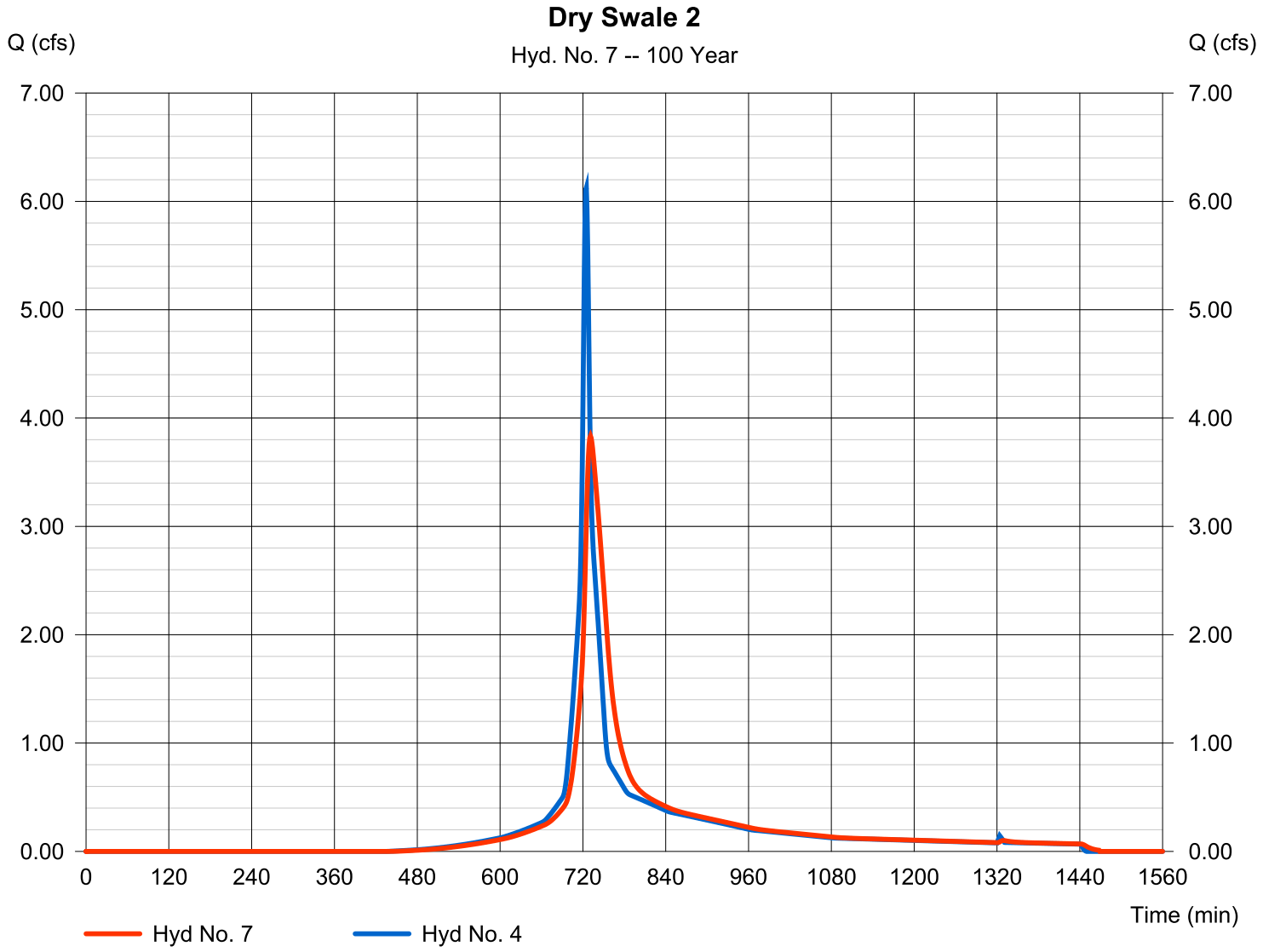
Hydrograph Report

Hyd. No. 7

Dry Swale 2

Hydrograph type	=	Reach	Peak discharge	=	3.833 cfs
Storm frequency	=	100 yrs	Time to peak	=	731 min
Time interval	=	1 min	Hyd. volume	=	18,910 cuft
Inflow hyd. No.	=	4 - Subwatershed 2C	Section type	=	Trapezoidal
Reach length	=	478.0 ft	Channel slope	=	1.5 %
Manning's n	=	0.100	Bottom width	=	3.0 ft
Side slope	=	3.0:1	Max. depth	=	0.8 ft
Rating curve x	=	0.877	Rating curve m	=	0.909
Ave. velocity	=	0.00 ft/s	Routing coeff.	=	0.0792

Modified Att-Kin routing method used.



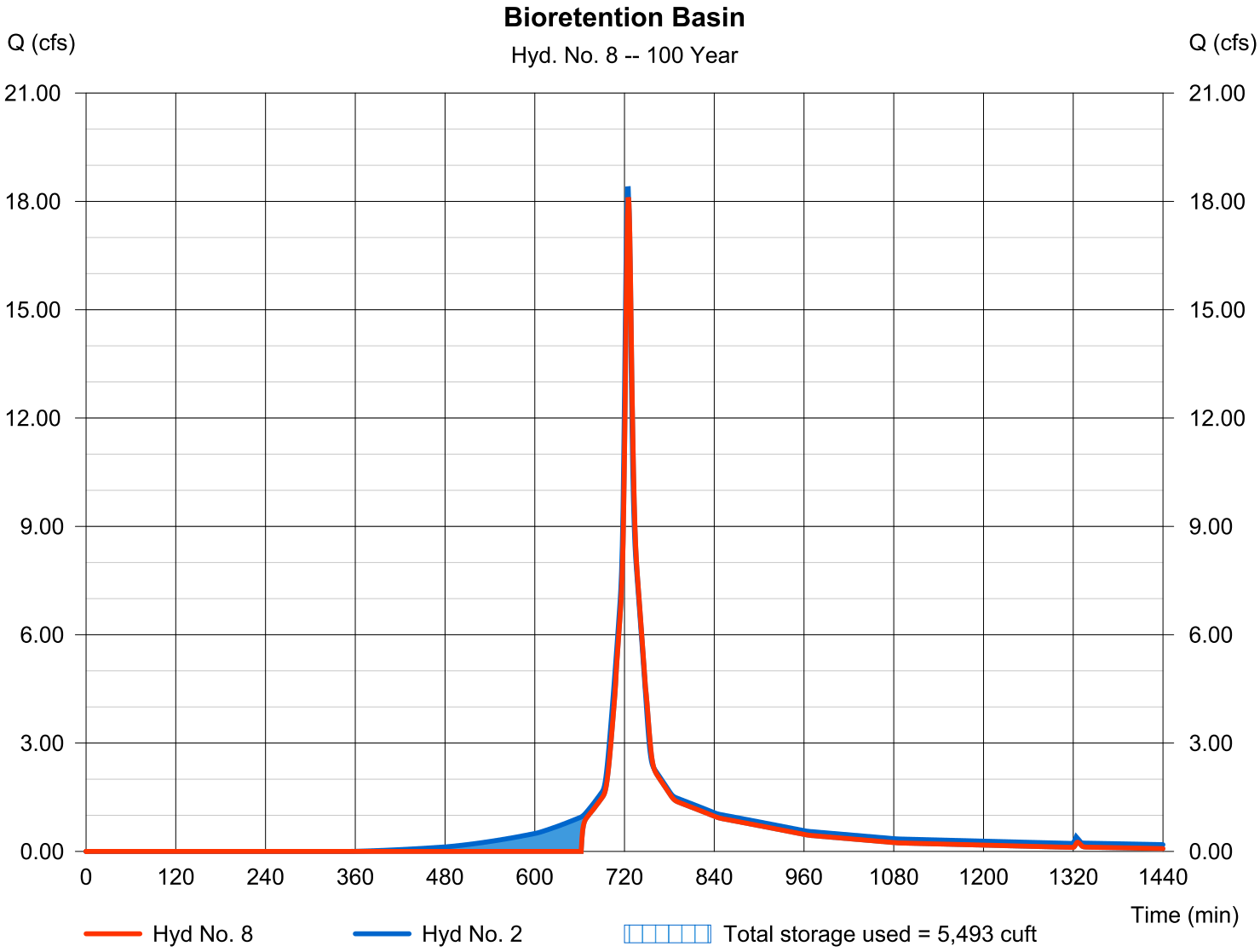
Hydrograph Report

Hyd. No. 8

Bioretention Basin

Hydrograph type	=	Reservoir	Peak discharge	=	18.11 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	47,052 cuft
Inflow hyd. No.	=	2 - Subwatershed 2A	Max. Elevation	=	13.75 ft
Reservoir name	=	Bioretention Basin	Max. Storage	=	5,493 cuft

Storage Indication method used. Exfiltration extracted from Outflow.

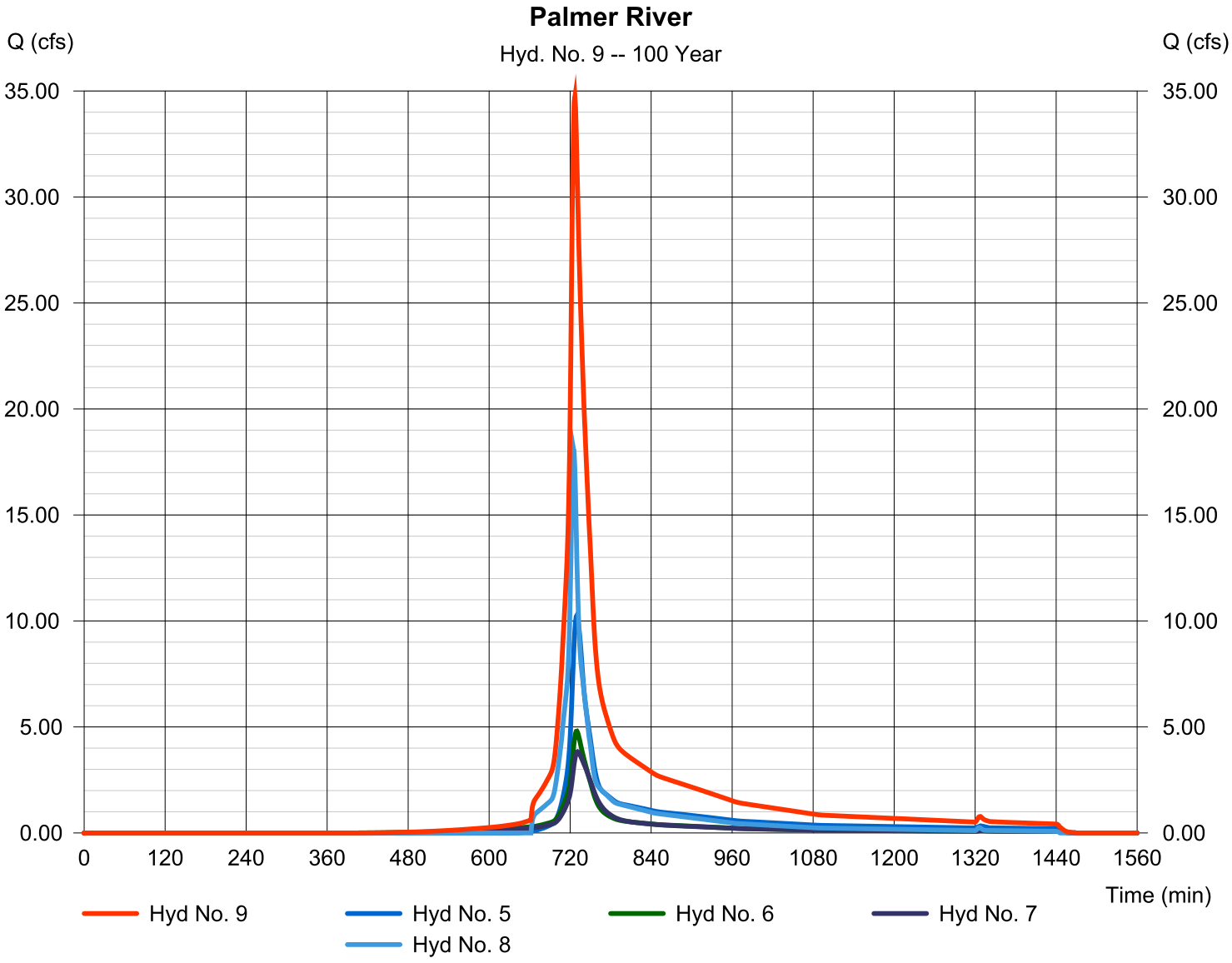


Hydrograph Report

Hyd. No. 9

Palmer River

Hydrograph type	=	Combine	Peak discharge	=	34.73 cfs
Storm frequency	=	100 yrs	Time to peak	=	727 min
Time interval	=	1 min	Hyd. volume	=	127,526 cuft
Inflow hyds.	=	5, 6, 7, 8	Contrib. drain. area	=	4.180 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	69.8703	13.1000	0.8658	--------
3	0.0000	0.0000	0.0000	--------
5	79.2597	14.6000	0.8369	--------
10	88.2351	15.5000	0.8279	--------
25	102.6072	16.5000	0.8217	--------
50	114.8193	17.2000	0.8199	--------
100	127.1596	17.8000	0.8186	--------

File name: SampleFHA.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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.69	4.61	3.89	3.38	2.99	2.69	2.44	2.24	2.07	1.93	1.81	1.70
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.57	5.43	4.65	4.08	3.65	3.30	3.02	2.79	2.59	2.42	2.27	2.15
10	7.24	6.04	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.80	4.38	4.02	3.73	3.48	3.26	3.07	2.91
50	9.04	7.65	6.66	5.92	5.34	4.87	4.49	4.16	3.88	3.65	3.44	3.25
100	9.83	8.36	7.30	6.50	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: Precip File.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	2.80	3.30	0.00	4.10	4.90	6.10	7.30	8.60
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	0.00	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
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	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

Appendix C

BMP Sizing Calculations

FUSS & O'NEILL

Bioretention Basin- Subwatershed 2A

This BMP has been sized in accordance with Section 5.5 of the Rhode Island Stormwater Design and Installation Standards Manual, 2015

1) Calculate Impervious Area Directed to Sand Filter (A_{IMP})

Cover Description	Area (S.F.)
Total Impervious Area (A_{IMP})	*56,400*
Impervious Area Excluding Roof Area	44,026

2) Size on the larger of Water Quaility Volume or Recharge Volume

a) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

$WQ_v = (1" * A_{IMP}) / 12 =$ *4700 cf*

b) Calculated Recharge Volume (Re_v) in accordance with Section 3.3.2

$Re_v = (1")(F)(A_{IMP})/12 =$ 1,175 cf

C — Hydrologic Soil Group from RI Soil Survey

0.25 — F (Recharge Factor from Table 3-4 of the RISDISM)

56,400 sf — A_{IMP} (Impervious Area)

*WQv is greater than Recharge Volume, therefore size BMP for WQv

3) Size Sediment Forebay to Store 25% WQ_v in accordance with Section 5.5.3

a) Calculated 25% WQ_v is 917 cf

*Excludes Roof Area

b) $Storage_{FOREBAY} = [(A_{BOTTOM} + A_{SPILL})/2] * D_{FOREBAY} =$ 1397 cf

566 sf — A_{BOTTOM} (surface area of bottom of forebay)

1296 sf — A_{SPILL} (surface area at spillway elevation)

1.5 ft — $D_{FOREBAY}$ (depth of forebay)

*Storage provided is greater than 25% WQv; forebay is adequately sized

4) Calculate Minimum Surface Area of Bottom of Forebay ($A_{MIN,FOREBAY}$) in accordance with Section 6.4.1

$A_{MIN,FOREBAY} = 5,750 *[(0.25*WQ_V)/86,400 sec]=$ 61 sf

917 cf — 25% WQ_V (Water Quality Volume)

Surface area provided = 566 sf

*Surface area provided is greater than minimum surface area required; forebay is adequately sized

5) Calculate Total Storage Provided in accordance with Section 5.5.4

a) 75% WQv= 3525 cf

b) $Storage_{POND} = [(A_{FILTER} + A_{POND})/2] * D_{POND}$ = 2046 cf

2100	sf	A_{FILTER} (surface area of bottom of basin)
3357	sf	A_{POND} (surface area at ponding elevation)
0.75	ft	D_{POND} (depth of basin)

c) $Storage_{FILTER} = A_{FILTER}*df*p$= 1386 cf

2100	sf	A_{FILTER} (surface area of filter media)
2	ft	df (depth of filter bed)
0.33		p (porosity of filter bed)

d) $Storage_{TOTAL}= (Storage_{POND})+(Storage_{FILTER})+(Storage_{FOREBAY})$= 4829 cf

*Storage provided is greater than 75% WQv; filter is adequately sized

6) Calculate Minimum Surface Area of Filter ($A_{MIN,FILTER}$) in accordance with Section 5.5.4

$A_{MIN,FILTER} = (WQ_v*df) / (k*((D_{POND}/2)+df)*tf)$ = 1979 sf

4700	cf	WQ_v (Water Quality Volume)
2	feet	df (depth of filter bed)
1	ft/day	k (coefficient of permeability)
0.75	ft	D_{POND} (depth of ponding)
2	days	tf (drain time)

7) Calculate Drawdown Time (tf_{ACTUAL})

$tf_{ACTUAL}=(Storage_{TOTAL})/(k*A_{FILTER})$= 2.299645 hrs

4829	cf	$Storage_{TOTAL}$
1	ft/day	k (coefficient of permeability)
2100	sf	A_{FILTER} (surface area of filter media)

*Actual drawdown time is less than 48 hours; filter is adequately sized

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Dry Swale- Subwatershed 2B

This BMP has been sized in accordance with Section 5.5 of the Rhode Island Stormwater Design and Installation Standards Manual, 2015

1) Calculate Impervious Area Directed to Sand Filter (A_{IMP})

Cover Description	Area (S.F.)
Total Impervious Area (A_{IMP})	*18,819*
Impervious Area Excluding Buildings	*10,054*

2) Size on the larger of Water Quaility Volume or Recharge Volume

a) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

$WQ_v = (1" * A_{IMP}) / 12 =$ *1568 cf*

b) Calculated Recharge Volume (Re_v) in accordance with Section 3.3.2

$Re_v = (1")(F)(A_{IMP})/12 =$ 392 cf

C	Hydrologic Soil Group from RI Soil Survey	*WQv is greater than Recharge Volume, therefore size
0.25	F (Recharge Factor from Table 3-4 of the RISDISM)	BMP for WQv
18,819 sf	A_{IMP} (Impervious Area)	

3) Size Sediment Forebays to Store 10% WQ_v in accordance with Section 5.5.3

a) Required Pretreatment volume (excludes building area) 84 cf

b) $Storage_{FOREBAY\ No.\ 1} = [(A_{BOTTOM} + A_{SPILL})/2] * D_{FOREBAY} =$ 66 cf

27 sf	A_{BOTTOM} (surface area of bottom of forebay)
150 sf	A_{SPILL} (surface area at spillway elevation)
0.75 ft	$D_{FOREBAY}$ (depth of forebay)

c) $Storage_{FOREBAY\ No.\ 2} = [(A_{BOTTOM} + A_{SPILL})/2] * D_{FOREBAY} =$ 66 cf

27 sf	A_{BOTTOM} (surface area of bottom of forebay)
150 sf	A_{SPILL} (surface area at spillway elevation)
0.75 ft	$D_{FOREBAY}$ (depth of forebay)

d) Total Forebay Storage = $Storage_{Forebay\ No.\ 1}$ + $Storage_{\ Forebay\ No.\ 2}$ 133 cf

4) Calculate Minimum Surface Area of Bottom of Forebay ($A_{MIN,FOREBAY}$) in accordance with Section 6.4.1

$A_{MIN,FOREBAY}$ = 5,750 *[(0.10*WQ_V)/86,400 sec]= 6 sf

Surface area provided = 27 sf

3) Calculate Minimum Surface Area of Swale Filter Bed (A_{MIN}) in accordance with Section 5.7.4

$A_{MIN, FILTER}$ = (WQ_V*df) / (k*((D_{POND}/2)+df)*tf) = 729 sf

1568	CF	WQ_V (Water Quality Volume)
2.5	FT	df (depth of filter bed)
1	ft/day	k (coef of permeability)
0.375	ft	D_{POND} (average depth of ponding) *depth midway between check dams
2	days	tf (drain time)

4) Calculate Actual Surface Area of Swale Filter Bed (A_{ACTUAL})

A_{FILTER} = L*W = **960** sf

320	LF	L(Length of Swale)
3.0	LF	W (Width of Swale)

5) Calculate Total Storage Provided in accordance with Section 5.5.4

a) 75% WQv= 1176 cf

b) $Storage_{POND}$ = [(A_{FILTER} + A_{POND})/2] * D_{POND} = 603 cf

1165	sf	A_{FILTER} (surface area of bottom of swale)
2052	sf	A_{POND} (surface area at ponding elevation)
0.375	ft	D_{POND} (depth of swale)

c) $Storage_{FILTER}$ = A_{FILTER}*df*p= 961 cf

1165	sf	A_{FILTER} (surface area of filter media)
2.5	ft	df (depth of filter bed)
0.33		p (porosity of filter bed)

d) $Storage_{TOTAL}$= ($Storage_{POND}$)+($Storage_{FILTER}$)+($Storage_{FOREBAYS}$)= 1697 cf *Storage provided is greater than 75% WQv; filter is adequately sized

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Dry Swale- Subwatershed 2C

This BMP has been sized in accordance with Section 5.5 of the Rhode Island Stormwater Design and Installation Standards Manual, 2015

1) Calculate Impervious Area Directed to Sand Filter (A_{IMP})

Cover Description	Area (S.F.)
Total Impervious Area (A_{IMP})	*15,237*
Impervious Area Excluding Buildings	*8,157*

2) Size on the larger of Water Quaility Volume or Recharge Volume

a) Calculated Water Quality Volume (WQ_v) in accordance with Section 3.3.3

$WQ_v = (1" * A_{IMP}) / 12 =$ *1270 cf*

b) Calculated Recharge Volume (Re_v) in accordance with Section 3.3.2

$Re_v = (1")(F)(A_{IMP})/12 =$ 317 cf

C	Hydrologic Soil Group from RI Soil Survey	*WQv is greater than Recharge Volume, therefore size
0.25	F (Recharge Factor from Table 3-4 of the RISDISM)	BMP for WQv
15,237 sf	A_{IMP} (Impervious Area)	

3) Size Sediment Forebays to Store 10% WQ_v in accordance with Section 5.5.3

a) Required Pretreatment volume (excludes building area) 68 cf

b) $Storage_{FOREBAY\ No.\ 1} = [(A_{BOTTOM} + A_{SPILL})/2] * D_{FOREBAY} =$ 66 cf

27 sf	A_{BOTTOM} (surface area of bottom of forebay)
150 sf	A_{SPILL} (surface area at spillway elevation)
0.75 ft	$D_{FOREBAY}$ (depth of forebay)

c) $Storage_{FOREBAY\ No.\ 2} = [(A_{BOTTOM} + A_{SPILL})/2] * D_{FOREBAY} =$ 66 cf

27 sf	A_{BOTTOM} (surface area of bottom of forebay)
150 sf	A_{SPILL} (surface area at spillway elevation)
0.75 ft	$D_{FOREBAY}$ (depth of forebay)

d) Total Forebay Storage = $Storage_{Forebay\ No.\ 1}$ + $Storage_{\ Forebay\ No.\ 2}$ 133 cf

3) Calculate Minimum Surface Area of Swale Filter Bed (A_{MIN}) in accordance with Section 5.7.4

$A_{MIN, FILTER} = (WQ_V * df) / (k*((D_{POND}/2)+df)*tf) =$ 189 sf

1270	cf	WQ_V (Water Quality Volume)
2.5	ft	df (depth of filter bed)
1	ft/day	k (coef of permeability)
0.375	ft	D_{POND} (depth of ponding)
2	days	tf (drain time)

4) Calculate Actual Surface Area of Swale Filter Bed (A_{ACTUAL})

$A_{FILTER} = L*W =$ **1434** sf

478	LF	L(Length of Swale)
3.0	LF	W (Width of Swale)

*Surface area provided is greater than minimum surface area required; swale is adequately sized

5) Calculate Total Storage Provided in accordance with Section 5.5.4

a) 75% WQv= 952.3 cf

b) $Storage_{POND} = [(A_{FILTER} + A_{POND})/2] * D_{POND} =$ 678 cf

1434	sf	A_{FILTER} (surface area of bottom of swale)
2184	sf	A_{POND} (surface area at ponding elevation)
0.375	ft	D_{POND} (depth of swale)

c) $Storage_{FILTER} = A_{FILTER}*df*p=$ 1183 cf

1434	sf	A_{FILTER} (surface area of filter media)
2.5	ft	df (depth of filter bed)
0.33		p (porosity of filter bed)

d) $Storage_{TOTAL} = (Storage_{POND})+(Storage_{FILTER})+(Storage_{FOREBAY})=$ 1994 cf

*Storage provided is greater than 75% WQv; filter is adequately sized

Appendix D

Pipe Sizing Calculations

Pipe Sizing Spreadsheet
Palmer Pointe Neighborhood
Barrington, Rhode Island

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25-YEAR DESIGN STORM

PIPE SEGMENT			*DRAINAGE AREA*		*TIME (min)*		*RUNOFF 25 Yr Storm Event*		*PROPOSED PIPE DESIGN VARIABLES*									
U/S Struct.	*Pipe*	*D/S Struct.*	*Increment CA*	*CA*	*Tc*	*Time In Section*	*Intensity (In/Hr)*	*Design Flow*	*Diam (In.)*	*Length (Ft.)*	*Slope (Ft./Ft.)*	*Manning Coeff.*	*Capacity (Cfs)*	*Velocity (Fps)*	*Depth (Ft.)*	*Velocity (Fps.)*	*Angle*	*Hydraulic Radius*
CB-1	to	FLARED END	0.00 0.65 0.65	0.65	5.0 0.0 5.0	0.1 5.1	6.5	4.23	15	23	0.022	0.013	9.60	7.8	0.58	7.5	2.99	0.30
CB 6	to	DMH-5	0.00 0.42 0.42	0.42	0.0 5.0 5.0	0.3 5.3	6.5	2.73	12	50	0.004	0.013	2.26	2.9	0.95	3.1	0.87	0.29
CB-5	to	DMH-5	0.00 0.36 0.36	0.36	0.0 5.2 5.2	0.4 5.6	6.5	2.34	12	58	0.003	0.013	1.96	2.5	0.95	2.7	0.94	0.29
DMH-5	to	DMH-4	0.78 0.00 0.78	0.78	5.0 5.6 5.6	0.5 6.1	6.5	5.07	15	113	0.004	0.013	4.09	3.3	1.22	3.6	0.67	0.35
DMH-4	to	DMH-3	0.78 0.00 0.78	0.78	5.0 0.0 5.0	0.4 5.4	6.5	5.07	15	84	0.004	0.013	4.09	3.3	1.22	3.6	0.67	0.35
CB-4	to	DMH-3	0.00 0.17 0.17	0.17	5.0 5.1 5.1	0.1 5.2	6.5	1.11	12	32	0.016	0.013	4.52	5.7	0.34	4.7	2.48	0.19
DMH-3	to	DMH-2	0.95 0.00 0.95	0.95	5.0 5.4 5.4	0.5 5.9	6.5	6.18	18	134	0.004	0.013	6.66	3.8	1.16	4.3	1.98	0.45

Pipe Sizing Spreadsheet
Palmer Pointe Neighborhood
Barrington, Rhode Island

FUSS & O'NEILL

25-YEAR DESIGN STORM

PIPE SEGMENT			*DRAINAGE AREA*		*TIME (min)*		*RUNOFF 25 Yr Storm Event*		*PROPOSED PIPE DESIGN VARIABLES*									
U/S Struct.	*Pipe*	*D/S Struct.*	*Increment CA*	*CA*	*Tc*	*Time In Section*	*Intensity (In/Hr)*	*Design Flow*	*Diam (In.)*	*Length (Ft.)*	*Slope (Ft./Ft.)*	*Manning Coeff.*	*Capacity (Cfs)*	*Velocity (Fps)*	*Depth (Ft.)*	*Velocity (Fps.)*	*Angle*	*Hydraulic Radius*
CB-2	to	DMH-2	0.00 0.20 0.20	0.20	0.0 5.7 5.7	0.0 5.7	6.5	1.30	12	17	0.040	0.013	7.14	9.1	0.30	7.0	2.30	0.17
CB-3	to	DMH-2	0.00 0.26 0.26	0.26	0.0 6.0 6.0	0.1 6.1	6.5	1.69	12	29	0.020	0.013	5.05	6.4	0.39	5.7	2.72	0.21
DMH-2	TO	DMH-1	1.41 0.00 1.41	1.41	0.0 5.0 5.0	0.4 5.4	6.5	9.17	18	127	0.007	0.013	8.81	5.0	1.27	5.7	1.61	0.46
DMH-1	to	FLARED END	0.00 1.41 1.41	1.41	0.0 5.0 5.0	0.2 5.2	6.5	9.17	18	52	0.005	0.013	7.44	4.2	1.45	4.5	0.72	0.42

Appendix E

Pollutant Loading Calculations

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Pre- and Post-Development Pollutant Loading Calculations

Subwatershed 1 Pre-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.40	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Commerical Use, from Table H-2 of RISDISM
Drainage Area	A	1.88	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	15.95	lbs TN/year	

Subwatershed 2 Pre-Development				
Description	Variable	Quantity	Units	`
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.26	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Commerical Use, from Table H-2 of RISDISM
Drainage Area	A	7.07	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	38.78	lbs TN/year	

Subwatershed 1 Post-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.56	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Residential Use, from Table H-2 of RISDISM
Drainage Area	A	0.91	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	10.78	lbs TN/year	

Subwatershed 2A Post-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.49	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Residential Use, from Table H-2 of RISDISM
Drainage Area	A	2.64	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	27.14	lbs TN/year	

Subwatershed 2B Post-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.43	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Residential Use, from Table H-2 of RISDISM
Drainage Area	A	1.02	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	9.19	lbs TN/year	

Subwatersheds 2C Post-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.37	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Residential Use, from Table H-2 of RISDISM
Drainage Area	A	0.98	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	7.64	lbs TN/year	

Subwatersheds 2D Post-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.06	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Residential Use, from Table H-2 of RISDISM
Drainage Area	A	4.18	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	5.14	lbs TN/year	

Subwatersheds 2 Post-Development				
Description	Variable	Quantity	Units	Notes
Rainfall Depth	P	49	Inches	From Figure H-8, RISDISM
Rainfall Correction Factor	Pj	0.9	-	Percent annual rainfall that produces runoff
Runoff Coefficient	Rv	0.27	-	Rv = 0.05 + (0.009 (%Impervious))
Concentration	C	2.1	mg/l	Residential Use, from Table H-2 of RISDISM
Drainage Area	A	8.82	acres	
Conversion Factor 1	C1	12	-	
Conversion Factor 2	C2	2.72	-	
Pollutant Load	L	49.31	lbs TN/year	

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Net Pollutant Loading Calculations

Post-Development BMP Pollutant Removal

Subwatershed	Pollutant Load (lbs TN/year)	BMP No. 1	Efficiency	Pollutant Removal (lbs TN/year)	Post-Development Pollutant Load (lbs TN/year)
Subwatershed 1	10.78	Tree Filter	55%	5.93	4.85
Subwatershed 2A	27.14	Bioretention	55%	14.93	12.21
Subwatershed 2B	9.19	Dry Swale	55%	5.06	4.14
Subwatershed 2C	7.64	Dry Swale	55%	4.20	3.44
Subwatershed 2D	5.14	None	0%	0.00	5.14
Subwatershed 2 Total	49.12	N/A		24.19	24.93

Summary of Pollutant Loading Analysis Subwatershed 1		
Pre-Development Pollutant Load	15.95	lbs
Post-Development Pollutant Load	4.85	lbs
Net Pollutant Load to Sowams Road	-11.10	lbs

Summary of Pollutant Loading Analysis Subwatershed 2 (to Palmer River)		
Pre-Development Pollutant Load	38.78	lbs
Post-Development Pollutant Load	24.93	lbs
Net Pollutant Load to Palmer River	-13.85	lbs

Appendix F

Stormwater Management Checklist

APPENDIX A: STORMWATER MANAGEMENT CHECKLIST

The first thing that applicants and designers must do before beginning a project is to make sure they are familiar with the 11 minimum standards listed in Manual Chapter Three, as all projects must meet each of the 11 standards unless otherwise exempted. Next, designers should review the available LID site planning and design strategies and BMPs in Manual Chapters Four through Seven to determine which would work best at their site. This checklist serves as a guide for engineers and designers to refer to during all stages of a project to ensure that they are meeting all applicable requirements. In addition, designers must include a completed checklist with their final stormwater management plan.

A.1 STORMWATER SITE PLANNING, ANALYSIS, AND DESIGN

A.1.1 General Information

- ☒ Applicant name, mailing address, and telephone number
- ☒ Contact information for the licensed professional(s) responsible for site plans and stormwater management plan
- ☒ Common address and legal description of project site
- ☒ Vicinity map
- ☒ Existing zoning and land use at the project site
- ☒ Proposed land use – indicate if land use meets definition of a LUHPPL (see Manual Table 3-2)
- ☒ General Project Narrative
- ☒ Project type (new development or redevelopment)
- ☒ Site Disturbance ≥ 1 acre or ☐ Site Disturbance < 1 acre

A.1.2 Existing and Proposed Mapping and Plans

- ☒ Existing and proposed mapping and plans (scale not greater than 1" = 40') with North arrow that illustrate at a minimum:
  - ☒ Existing and proposed site topography (2-foot contours required). 10-foot contours accepted for off-site areas.
  - ☒ Existing and proposed drainage area delineations and drainage flow paths, mapped according to the DEM *Guidance for Preparation of Drainage Area Maps* (included in Appendix K). Drainage area boundaries need to be complete; include off-site areas in both mapping and analyses, as applicable.

- [x] Perennial and intermittent streams, in addition to areas subject to storm flowage (ASSFs)
- [x] Mapping of predominant soils from USDA soil surveys, especially hydric soil groups as well as location of site-specific borings and/or test pits (on drainage area maps only – not site plans)
- [x] Boundaries of existing predominant vegetation and proposed limits of clearing
- [x] Location and field-verified boundaries of resource protection areas such as freshwater and coastal wetlands, lakes, ponds, coastal shoreline features and required setbacks (e.g., buffers, water supply wells, septic systems)
- [x] Location of floodplain and, if applicable, floodway limits and relationship of site to upstream and downstream properties and drainages
- [x] Location of existing and proposed roads, buildings, and other structures including limits of disturbance
- [x] Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements
- [x] Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains
- [x] Location and dimensions of channel modifications, such as bridge or culvert crossings
- [x] Location, size, and limits of proposed LID planning and site design techniques (type of practice, depth, area). LID techniques should be labeled clearly on the plan and a key should be provided that corresponds to a tabular description.
- [x] Location, size, and limits of disturbance of proposed stormwater treatment practices (type of practice, depth, area). Stormwater treatment practices (BMPs) should be labeled with numbers that correspond to Table A.2-1.
- [x] Soils information from test pits or borings at the location of proposed stormwater management facilities, including but not limited to soil descriptions, depth to seasonal high groundwater, depth to bedrock, and estimated hydraulic conductivity. Soils information will be based on site test pits or borings logged by a DEM-licensed Class IV soil evaluator or RI-registered P.E.

A.1.3 Minimum Stormwater Management Standards

☒ **Minimum Standard 1: LID Site Planning and Design Strategies**

Document specific LID site planning and design strategies and associated methods that were employed for the project in the following table. If a redevelopment project site has 40% or more existing impervious surface coverage, Minimum Standard 1: LID Site Planning and Design Strategies does not apply.

Table A.1-1 LID Site Planning and Design Checklist

The applicant must document specific LID site planning and design strategies applied for the project (see Manual Chapter Four and the *RI Community LID Guidance Manual* for more details regarding each strategy). If a particular strategy was not used, a justification and description of proposed alternatives must be provided. If a strategy is not applicable (N/A), applicants must describe why a certain method is not applicable at their site. For example, preserving wetland buffers may be not applicable for sites located outside any jurisdictional wetland buffers. In communities where conservation development or other low-impact development site planning and design processes exist, following the local community conservation development option may help a project achieve this standard.

1. Strategies to Avoid the Impacts

A. Preservation of Undisturbed Areas

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Limits of disturbance clearly marked on all construction plans.
- ☒ Mapped soils by Hydrologic Soil Group (HSG).
- ☐ Building envelopes avoid steep slopes, forest stands, riparian corridors, HSG D soils, and floodplains.
- ☒ New lots, to the extent practicable, have been kept out of freshwater and coastal wetland jurisdictional areas.
- ☐ Important natural areas (i.e., undisturbed forest, riparian corridors, and wetlands) identified and protected with permanent conservation easement.
- ☐ Percent of natural open space calculation is provided.
- ☐ Other (describe):

Explain constraints when a strategy is applied and/or proposed alternatives in space below:

Proposed site improvements are within a previously disturbed area of the property.

Table A.1-1 LID Site Planning and Design Checklist

B. Preservation of Buffers and Floodplains

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following:

- ☒ Applicable vegetated buffers of coastal and freshwater wetlands and perennial and intermittent streams have been preserved, where possible.
- ☐ Limits of disturbance included on all construction plans that protect applicable buffers
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

The coastal wetland buffer will be preserved and restored with native vegetation.

C. Minimized Clearing and Grading

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Site fingerprinting to extent needed for building footprints, construction access and safety (i.e., clearing and grading limited to 15 feet beyond building pad or 5 feet beyond road bed/shoulder).
- ☒ Other (describe):

Explain constraints and/or proposed alternatives in space below:

Site clearing and grading was minimized to the extent practicable while maintaining positive drainage.

D. Locating Sites in Less Sensitive Areas

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ A site design process, such as conservation development, used to avoid or minimize impacts to sensitive resources such as floodplains, steep slopes, erodible soils, wetlands, hydric soils, surface waters, and their riparian buffers.
- ☐ Development located in areas with least hydrologic value (e.g., soil groups A and B)
- ☐ Development on steep slopes, grading and flattening of ridges has been avoided to the maximum extent practicable.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

The site improvements are proposed upgradient of the flood zone and coastal buffer, and are in an area previously developed as a Nursery.

Table A.1-1 LID Site Planning and Design Checklist

E. Compact Development

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ A site design technique (e.g., conservation development) used to concentrate development to preserve as much undisturbed open space as practicable and reduce impervious cover.
- ☐ Reduced setbacks, frontages, and right- of- way widths have been used where practicable.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

The proposed development is concentrated to the west of the site to minimize the roadway and sidewalk areas. Roadway and driveway widths are the minimum permitted by the Town of Barrington.

F. Work with the Natural Landscape Conditions, Hydrology, and Soils

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Stormwater management system mimics pre-development hydrology to retain and attenuate runoff in upland areas (e.g., cuts and fills limited and BMPs distributed throughout site; trees used for interception and uptake).
- ☐ The post-development time of concentration (t_c) should approximate pre-development t_c.
- ☐ Flow velocity in graded areas as low as practicable to avoid soil erosion (i.e., slope grade minimized). Velocities shall not exceed velocities in Appendix B, Table B-2.
- ☐ Plans show measures to prevent soil compaction in areas designated as Qualified Pervious Areas (QPAs) for better infiltration.
- ☒ Site designed to locate buildings, roadways and parking to minimize grading (cut and fill quantities)
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

See Stormwater Management Report.

2. Strategies to Reduce the Impacts

A. Reduce Impervious Cover

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Reduced roadway widths
- ☐ Reduce driveway areas
- ☐ Reduced building footprint
- ☐ Reduced sidewalk area
- ☐ Reduced cul-de-sacs
- ☐ Reduced parking lot area
- ☒ Other (describe):

Explain constraints and/or proposed alternatives in space below:

See Stormwater Management Report.

Table A.1-1 LID Site Planning and Design Checklist

3. Strategies to Manage the Impacts

A. Disconnecting Impervious Area

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Impervious surfaces have been disconnected to QPAs to the extent possible.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

See Stormwater Report.

B. Mitigation of Runoff at the point of generation

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Roof runoff has been directed to a QPA, such as a yard or vegetated area.
- ☐ Roof runoff has been directed to a lower impact practice such as a rain barrel or cistern.
- ☐ A green roof has been designed to reduce runoff.
- ☐ Small-scale BMPs applied at source.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

See Stormwater Management Report.

C. Stream/Wetland Restoration

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Historic drainage patterns have been restored by removing closed drainage systems and/or restoring degraded stream channels and/or wetlands.
- ☐ Removal of invasive species.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

See Stormwater Management Report.

Table A.1-1 LID Site Planning and Design Checklist

D. Reforestation

☒ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☒ Low maintenance, native vegetation has been proposed.
- ☒ Trees are proposed to be planted or conserved to reduce runoff volume, increase nutrient uptake, and provide shading and habitat.
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

Low maintenance meadow vegetation is proposed to the west of the conservation lot, and native buffer vegetation is proposed west of the existing coastal wetland within the conservation lot. Existing trees will be protected during construction and additional trees and shrubs will be planted throughout the site.

Table A.1-2 LID Stormwater Credit

Description of stormwater credit, if applicable. Label qualifying pervious areas (QPAs) on the site map, and document that all stormwater credit requirements listed in Manual Section 4.6 are met. For each QPA, note the impervious area (in acres) that drains to it, and place a check in the appropriate box to demonstrate that it meets the following criteria:

Not Applicable

	QPA 1	QPA 2	QPA 3	QPA 4
Impervious Area Draining to QPA (acres)				
QPA Criteria	**Criterion Met?**			
Construction vehicles shall not be allowed to drive over the QPA during construction. If the area becomes compacted, soil must be suitably amended, tilled, and revegetated once construction is complete to restore infiltration capacity.				
QPA infiltration area is at least 10ft from building foundation.				
Contributing impervious area does not exceed 1,000 ft^2.				
Length of QPA in feet is equal to or greater than the contributing rooftop area in ft^2 divided by 13.3. The maximum contributing flow path from non-rooftop impervious areas is 75ft.				
QPA does not overlap any other QPA.				

	QPA 1	QPA 2	QPA 3	QPA 4
Lot is greater than 6,000 ft^2.				
The slope of the QPA is less than or equal to 5.0%.				
Disconnected downspouts draining to QPA are at least 10 feet away from the nearest impervious surface.				
Runoff from rooftops without gutters / downspouts that drains to QPA flows away from the structure as low-velocity sheet flow.				
QPA is located on Hydrologic Soil Group (HSG) A or B soils.				
Depth to groundwater within QPA is 18 inches or greater (has been confirmed by evaluation by a DEM-licensed Class IV soil evaluator or RI-registered PE).				
Runoff is directed over soft shoulders, through curb cuts or level spreaders to QPA.				
Measures are employed at discharge point to prevent erosion and promote sheet flow.				
The flow path through the QPA complies with the setback requirements for structural infiltration BMPs.				
Rooftop runoff draining to QPA from LUHPPLs does not commingle with runoff from any paved surface or areas that may generate higher pollutant loads				
Inspection and maintenance of the QPA is included in the site Operation and Maintenance Plan (Minimum Standard 11).				
The QPA is owned or controlled by the property owner				
There is no history of groundwater seepage and / or basement flooding on the property				

☒ **Minimum Standard 2: Groundwater Recharge**

Demonstrate that groundwater recharge criteria for the site have been met. Include:

☒ The required recharge volume (Re_v) in acre-feet (See Manual Section 3.3.2)

☐ LID Stormwater Credit from Table A.1-2 to be applied to recharge requirement, if applicable, with the following calculations (See Manual Section 4.6.1):

- the recharge area (Re_a) in acres for the site
- the site impervious area draining to QPAs
- the new Re_v requirement

☒ Specific BMPs from Table A.2-1 that will be used to meet the recharge requirement. *Note: Only BMPs listed in Manual Table 3-5, List of BMPs Acceptable for Recharge may be used to meet the recharge requirement.*

☒ **Minimum Standard 3: Water Quality**

Demonstrate that the water quality criteria for the site have been met. Include:

☒ Required water quality volume (WQ_v) in acre-feet or ft^3 (see Manual Section 3.3.3).

☒ LID Stormwater Credit from Table A.1-2 to be applied to water quality requirement, if applicable, with the following calculations (see Manual Section 4.6.1):

- the new impervious area (in acres) for the site
- the new WQ_v in acre-feet or ft^3

☒ Specific BMPs from Table A.2-1 that will be used to meet water quality volume requirement. *Note: Only BMPs listed in Manual Table 3-6, Acceptable BMPs for Water Quality Treatment may be used to meet the water quality requirement.*

☒ Specify any additional 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 4: Conveyance and Natural Channel Protection**

Demonstrate that the conveyance and natural channel protection criteria for the site have been met. Include:

☒ Justification for channel protection criterion waiver, if applicable (see Manual Section 3.3.4).

☐ Required channel protection volume (CP_v) (see Manual Section 3.3.4).

☐ Specific BMPs from Table A.2-1 that will be used to meet the channel protection requirement. Hydrologic and hydraulic site evaluation as described

in Manual Section 3.3.4 should be included in Table A.2-1 for each channel protection BMP.

☒ **Minimum Standard 5: Overbank Flood Protection**

Demonstrate that the overbank flood protection criteria for the site have been met. Include:

☒ Justification for overbank flood protection criterion waiver, if applicable (see Manual Section 3.3.5).

☐ Pre- and post-development peak discharge rates.

☐ Specific BMPs from Table A.2-1 that will be used to meet the overbank flood protection requirement. Hydrologic and hydraulic site evaluation as described in Manual Section 3.3.5 should be included in Table A.2-1 for each overbank flood protection BMP.

☒ **Minimum Standard 6: Redevelopment and Infill Projects**

Determine if project meets the criteria for redevelopment and/or infill projects. If applicable, include:

☐ Description of site that meets redevelopment/infill definition.

☐ Approved off-site location within watershed where stormwater management requirements will be met, if applicable (see Manual Section 3.2.6).

☒ Not Applicable.

☒ **Minimum Standard 7: See page A-15**

☒ **Minimum Standard 8: LUHPPLs**

Demonstrate that the project meets the criteria for LUHPPLs, if applicable. Include:

☐ Description of any land use activities considered stormwater LUHPPL (see Manual Table 3-2).

☐ Specific BMPs listed in Table A.2-1 that receive stormwater from LUHPPL drainage areas. These BMP types must be listed in Manual Table 3-3, "Acceptable BMPs for Use at LUHPPLs."

☐ Additional BMPs, if any, that meet RIPDES MSGP requirements.

☒ Not Applicable.

☒ **Minimum Standard 9: Illicit Discharges**

Applicant asserts that no illicit discharges exist or are proposed to the stormwater

management system in accordance with State regulations.

☒ **Minimum Standard 10: See page A-13 Minimum Standard 11: See p. A-15**

A.2 BEST MANAGEMENT PRACTICES

Provide detailed information for all structural stormwater best management practices (BMPs) to be implemented. *Note: If a BMP cannot meet the required design criteria in Manual Chapters Five, Six and Seven, a different BMP should be considered*.

Table A.2-1 Best Management Practices

Fill in the following table to document which proposed practices meet which requirement(s). Number each BMP and label them accordingly on the site map:

BMP No.	Type of BMP	Check the function provided by the BMP				
		Pretreatment	Re_v	WQ_v	CP_v	Q_p
1	Dry Swale			X		X
2	Dry Swale			X		X
3	Forebay	X		X		X
4	Forebay	X		X		X
5	Forebay	X		X		X
6	Forebay	X		X		X
7	Forebay	X		X		X
8	Bioretention Basin			X		X

In addition, for all structural components of stormwater system (e.g., storm drains, open channels, swales, stormwater BMPs, etc.) provide the following, if applicable:

☒ Hydrologic and hydraulic analysis, including:

- Study design/analysis points. The existing and proposed condition analyses need to compare the same overall area; thus, common study points are needed for both existing and proposed conditions.
- Existing condition analysis for drainage area boundaries, curve numbers, times of concentration, runoff rates, volumes, velocities, and water surface elevations showing methodologies used and supporting calculations.
- Proposed condition analysis for drainage area boundaries, curve numbers, times of concentration, runoff rates, volumes, velocities, water surface elevations, and routing showing the methodologies used and supporting calculations.
- Downstream Analysis, where required (see Manual Section 3.3.6).
- Final sizing calculations for structural stormwater BMPs including, contributing drainage area, storage, and outlet configuration.
- Stage-discharge or outlet rating curves and inflow and outflow hydrographs for storage facilities (e.g., detention, retention, or infiltration facilities).
- Dam breach analysis, where necessary, for earthen embankments over six (6) feet in height, or a capacity of 15 acre-feet or more, and that is a significant or high hazard dam.

☒ Drainage Area Maps prepared in accordance with DEM's *Guidance for Preparation of Drainage Area Maps* (included in Appendix K).

☒ Representative cross-section and profile drawings, notes and details of structural stormwater management practices and conveyances (i.e., storm drains, open channels, swales, etc.), which include:

- Locations, cross sections, and profiles of all streams and drainage swales and their method of stabilization.
- Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.).
- Design water surface elevations.
- Structural details of outlet structures, embankments, spillways, stilling basins, grade control structures, conveyance channels, etc.
- Logs of borings and/or test pit investigations along with supporting soils/geotechnical report.

☒ Planting plans for structural stormwater BMPs, including:

- Species, size, planting methods, and maintenance requirements of proposed planting.

n/a ☐ Structural calculations, where necessary.

☒ Applicable construction specifications.

☒ Identification of all anticipated applicable local and State permits.

☒ Identification of all anticipated legal agreements related to stormwater (e.g., off-site easements, deed restrictions, and covenants).

A.3 EROSION AND SEDIMENT CONTROL (ESC) AND STORMWATER POLLUTION PREVENTION PLANS (SWPPP)

A.3.1 All Projects

☒ **Minimum Standard 10: Construction Erosion and Sedimentation Control**

All projects must demonstrate that ESC practices will be used during the construction phase and land disturbing activities. Include:

☒ Description of temporary sediment trapping and conveyance practices, including sizing calculations and method of temporary and permanent stabilization (see Manual Section 3.2.10 and *the Rhode Island Soil Erosion and Sediment Control Handbook*).

☒ Description of sequence of construction. Activities should be phased to avoid compacting soil during construction, particularly in the location of infiltrating stormwater practices and qualifying pervious areas for stormwater credits.

☒ Location of construction staging and material stockpiling areas.

A.3.2 Construction Projects Disturbing ≥ 1 Acre

Demonstrate the project meets the criteria of the Rhode Island Pollutant Discharge Elimination System (RIPDES) General Permit for Stormwater Discharge Associated with Construction Activity (RIPDES Construction General Permit). A ***Stormwater Pollution Prevention Plan (SWPPP)*** must be kept on-site during the active construction phase of the project. Include:

☒ Estimates of the total area of the site and the total area of the site that is expected to undergo soil disturbance.

☒ A determination regarding whether or not the site is within or directly discharges to a Natural Heritage Area (NHA) or has discharge related activities that potentially affect a listed or proposed to be listed endangered or threatened species or its critical habitat. To determine if your site is within or directly discharges to an NHA complete the following steps:

1. Go to http://www.dem.ri.gov/maps/index.htm
2. Click on the “Environmental Resource Map” link.
3. Open the “Regulatory Overlays” Group/Folder listed under the LAYERS heading.
4. Select Natural Heritage Area – Rare Species as a visible layer from the menu and press the “Refresh Map” button (*Note: Menu may not

list all layers if scale factor is too large. If this is the case, then use the "zoom in" feature until all layers are listed in menu).

5. Select any other layer that may be useful in determining the location of the construction activity relative to a NHA (such as roads).
6. Check the appropriate box to indicate whether or not your site is located within or directly discharges to an NHA or has discharge related activities that potentially affect a listed or proposed to be listed endangered or threatened species or its critical habitat.

☐ Yes or ☒ No

If Yes, your project requires an additional review and approval by the DEM. In order to begin this process, the Stormwater Management Plan must include a specific request for NHA review and approval of the proposed project.

☒ Description of potential sources of pollution that may reasonably be expected to affect the quality of stormwater discharges from the site, such as exposed, unstabilized soil stockpiles.

☒ Existing data on the quality of any known discharges from the site if available.

☒ List of sources of allowable non-stormwater discharges, as described in Part I.B.2 of the 2008 RIPDES Construction General Permit (except flows from fire fighting activities). If allowable non-stormwater discharges are occurring at the site, then the SWPPP shall identify how such discharges shall be visually observed and recorded in accordance with the weekly inspection procedures contained in the 2008 RIPDES Construction General Permit.

☒ Description of how wastes generated at the site will be disposed of in a manner consistent with State Law and/or regulations.

☒ Spill Prevention and Response Procedure which meets the following minimum requirements: Areas where potential spills can occur, and their accompanying drainage points, shall be identified clearly in the Stormwater Pollution Prevention Plan (SWPPP). The potential for spills to enter the stormwater drainage system shall be eliminated wherever feasible. Where appropriate, specific material handling procedures, storage requirements, and procedures for cleaning up spills shall be identified in the SWPPP and made available to the appropriate personnel. The necessary equipment to implement a cleanup must also be made available to personnel.

☒ Description of how construction waste is managed and properly disposed of at the end of each working day and how the operator will minimize the exposure of construction debris to precipitation, including, but not limited to, insulation, wiring, paints and paint cans, solvents, wall board, etc.

☒ Graveled access entrance and exit drives and parking areas to reduce the tracking of sediment onto public and private roads in accordance with the Rhode Island Soil Erosion and Sediment Control Handbook, as amended.

☒ Appropriate vegetative practices on all disturbed areas as soon as possible,

but not more than fourteen (14) days after the construction activity in that area has temporarily or permanently ceased, unless the activity is to resume within twenty one (21) days.

☒ Provisions for all stormwater control measures, disturbed areas, areas used for the storage of materials that are exposed to precipitation (including unstabilized soil stockpiles), discharge locations, and locations where vehicles enter or exit the site to be inspected by or under the supervision of the applicant at least once every seven (7) calendar days and within twenty-four (24) hours after any storm event which generates at least 0.25 inches of rainfall per twenty four (24) hour period and/or after a significant amount of runoff.

☒ Procedures for maintaining inspection reports which summarize the inspection and corrective actions taken in accordance with Part II.B and C of the 2008 RIPDES Construction General Permit. These inspection reports and associated records must be retained for five (5) years from the date that the site has undergone final stabilization.

A.4 OPERATION & MAINTENANCE AND POLLUTION PREVENTION PLANS

☒ **Minimum Standard 7: Pollution Prevention**

Demonstrate that the project meets the criteria for pollution prevention. Include:

☒ Appendix G Pollution Prevention and Source Controls

☐ If applicable, a RIPDES Industrial Stormwater Pollution Prevention Plan as required by the Multi-Sector General Permit for Stormwater Discharge Associated with Industrial Activity.

☒ **Minimum Standard 11: Stormwater Management System Operation and Maintenance (O&M) See Appendix E for guidance**

Provide a stormwater management system operation and maintenance plan that at a minimum includes:

☒ Name, address, and phone number of responsible parties for maintenance

☒ 8-1/2 X 11 inch plan depicting the locations of all BMPs requiring O&M as numbered in Table A.2-1.

☒ Description of annual maintenance tasks

☒ Description of applicable easements

☒ Description of funding source

☒ Minimum vegetative cover requirements

☒ Access and safety issues

Appendix G

Soil Evaluation Summary

FUSS & O'NEILL

M E M O R A N D U M

TO: File 20121033.A20

FROM: Shawn M. Marin, PE, CNU-A

DATE: February 5, 2016

RE: Soil Evaluation Summary
Palmer Pointe Residential Subdivision
Sowams Road, Barrington, RI
Fuss & O'Neill Reference No. 20121033.A20

INTRODUCTION

Fuss & O'Neill has prepared this memorandum to summarize the findings of subsurface investigations (test pits) conducted at the above referenced property (the Site) by Fuss & O'Neill personnel on the 22nd and 23rd of December 2015. Ten (10) test pits and were conducted to determine the soil lithology and depth to groundwater throughout the Site. Three (3) soil samples were obtained for laboratory determination of infiltration rates. The test pits were excavated by Site Tech using a wheeled backhoe.

BACKGROUND

The subject property is comprised of six (6) parcels located east of Sowams Road, between Colonial Avenue and Lillis Avenue, in the Town of Barrington. The parcels are identified as Lots 72, 73, 246, 248, 249, and 263 of Assessor's Plat 28.

According to the NRCS Soil Report, the western portion of the Site is underlain by Merrimac-Urban land complex (MU) soils with 0 to 8 percent slopes, and the central portion of the Site is underlain by Merrimac fine sandy loam (MmB) of 3 to 8 percent slopes. Both Merrimac-Urban land complex and Merrimac fine sandy loam have very low runoff potential, are somewhat excessively drained, and typically have greater than an 80 inch depth to the water table or restrictive feature. The eastern portion of the Site is underlain by Walpole Sandy Loam (Wa) of 0 to 3 percent slopes, and the shoreline consists of frequently flooded Sandyhook mucky fine sand (Sa) with 0 to 2 percent slopes. Walpole sandy loam is poorly drained, has a very high runoff potential, and has a 0 to 4 inch depth to the water table. Sandyhook mucky fine sand is very poorly drained and typically has a 0 inch depth to the water table.

Test Pit Nos. 1 through 7 were located within Merrimac fine sandy loam, and Test Pit Nos. 8 through 10 were located within the Merrimac-Urban land complex. Test pits were dug until a restrictive feature was reached or a maximum 10-foot depth, with an bench at a depth of 4 feet deep to inspect the pit and collect soil samples.

SUMMARY OF INVESTIGATIONS

On-site soils generally share the same soil profile to a depth of approximately 2-feet. Below the first few inches of organic material, a dark layer of sandy loam was observed in all test pits to a depth of about 8 inches. In Test Pit No. 4 this layer of sandy loam material was identified as fill material. Beneath this, a layer of brown sandy loam is present in all test pits to a depth of approximately 16 inches. This is followed by a layer of light brown sandy loam in Test Pit No's. 7 through 10, and by a layer of light brown loamy sand in Test Pit Nos. 2 through 6.

The primary differences in observed soil profiles occur in the C Horizon, at depths greater than 2-feet. Greyish loamy sand is present in test Pit No's 2, 4, and 5 to the bottom of the pit (90- to 120-inches). In Test Pit No. 1, a gravely, dark grey layer of fine sand is present from a depth of 24-inches to a depth of 120-inches. Dark grey silt loam was observed in test Pit No's 2, 3, and 4 to the bottom of the excavations. In Test Pit No's. 3 and 4, this silt loam layer is very gravely. In Test Pit No's. 6 through 10, the C Horizon is comprised mainly of light-colored sand and fine sand, with varying gavel contents. Test Pit No's. 8 through 10 also contained a layer of grey silt from a depth of approximately 75-inches to the bottoms of excavations.

Evidence of mottling[1] was observed around rock within Test Pits Nos. 3, 4, and 8 indicating a potential perched water table in those areas. In Test Pit No. 5, mottles were recorded at a depth of 84-inches. Faint mottling was also apparent in Test Pit No. 6 at a depth of 90-inches. No standing water was observed in any of the test pits.

The soil profiles observed are generally consistent with the typical profiles for Merrimac fine sandy loam and Merrimac-Urban land complex, as described by NRCS.

Soil samples were taken from the Test Pit Nos. 5, 8, and 9 in order to perform laboratory determination of infiltration rates. These samples were obtained from within the C Horizon at approximate 4-foot depths. Infiltration test results have not been received at this time.

Attachments: Test Pit Logs
Test Pit Location Map
NRCS Soil Report

[1] Soil mottling occurs when soils are frequently wet for long periods of time and is therefore an indication of the presence of groundwater.

Test Pit No. 1

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 22, 2015
Time:	9:45 AM - 10:45 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 12"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
12" - 24"	Bc	Sandy Loam	10YR 4/4		5% Gravel	Subangular Blocky	Friable
24" - 120"	C	Fine Sand	2.5Y 4/1		50% Gravel 10% Stone	Massive	Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	6' by 15'
TOTAL DEPTH:	120" (bench at 48")
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	Not observed
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS: - Inconsistant transition depth between Ap and Bc horizons.
- Larger stones excavated between 8 - 10 foot depth, but not bedrock.

Test Pit No. 2

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 22, 2015
Time:	11:00 AM - 12:00 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
8" - 16" (8" -14")	Bc (Bw)	Sandy Loam (Sandy Loam)	2.5Y 5/4 (10 YR 4/6)		5% Gravel	Subangular Blocky	Friable
16" - 30" (14" - 22")	C1 (C1)	Loamy Sand (Loamy Sand)	2.5Y 4/3 (2.5Y 6/4)		10% Gravel	Massive	Firm
30" - 120"	C2	Silt Loam	2.5Y 4/1		10% Gravel	Massive	Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	6' by 16'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	Not observed
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Classification of southeast and southwest sides of pit.
- Pocket of soil on northeast and northwest sides of pit noted in parentheses.

Test Pit No. 3

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 22, 2015
Time:	12:00 PM - 1:00 PM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
8" - 12"	Bc	Sandy Loam	10YR 4/6		10% Gravel	Subangular Blocky	Friable
12" - 37"	C1	Loamy Sand	10YR 3/3		50% Gravel	Massive	Firm
37" - 84"	C2	Silt Loam	2.5Y 4/1		50% Gravel 20% Stones	Massive	Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 16'
TOTAL DEPTH:	84"
DEPTH TO BEDROCK:	48"
DEPTH TO MOTTLING:	Not observed
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Fractured bedrock encountered at 4-foot depth.
- Mottles gathered around rock.

Test Pit No. 4

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 22, 2015
Time:	1:00 PM -2:00 PM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Fill	Sandy Loam	10YR 3/3		5% Gravel		
8" - 12"	Bc	Sandy Loam	2.5Y 5/4		10% Gravel	Subangular Blocky	Friable
12" - 20"	C1	Loamy Sand	10YR 5/3		50% Gravel 10% Stones	Subangular Blocky	Friable
20" - 90"	C2	Loamy Sand	2.5Y 3/1		50% Gravel 10% Stones	Subangular Blocky	Friable
90" - 120"	C4	Silt Loam	2.5Y 4/1		50% Gravel 20% Stones	Massive	Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	6' by 15'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	66"
DEPTH TO MOTTLING:	Not observed
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Fractured bedrock encountered at 4-foot depth.
- Mottles gathered around rock.

Test Pit No. 5

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 23, 2015
Time:	7:15 AM -8:30 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Ap	Sandy Loam	7.5YR 3/4		10% Gravel 10% Stone	Subangular Blocky	Friable
8" - 14"	Bc	Sandy Loam	2.5Y 5/4		10% Gravel 10% Stone	Subangular Blocky	Friable
14" - 22"	C1	Loamy Sand	2.5Y 4/3		10% Gravel 10% Stone	Subangular Blocky	Friable
22" - 108"	C2	Loamy Sand	2.5Y 4/3	25%, - , 84"	20% Gravel 10% Stone	Massive	Loose
108" - 120"	C3	Fine Sand	2.5Y 5/1		0% Coarse	Massive	Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 14'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	84"
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Pocket of Bw (similar to TP No. 2) on east side of pit.
- Soil material too coarse to conduct infilration test with infiltrometer.
- Soil sample taken within C2 horizon (4-foot depth) to perform laboratory determination of infiltration rate.

Test Pit No. 6

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 23, 2015
Time:	8:45 AM -9:15 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Ap	Sandy Loam	10YR 3/3		0% Coarse	Subangular Blocky	Friable
8" - 14"	Bw	Sandy Loam	10YR 4/6		0% Coarse	Subangular Blocky	Friable
14" - 26"	Bc	Loamy Sand	2.5Y 4/4		10% Stone	Subangular Blocky	Friable
26" - 54"	C1	Sand	2.5Y 5/3		50% Gravel	Massive	Loose
54" - 84"	C2	Fine Sand	2.5Y 6/4		0% Coarse	Massive	Single Grain
84" - 108"	C3	Sand	2.5Y 5/3	10% , - , 90"	50% Gravel 20% Stone	Massive	Loose

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 14'
TOTAL DEPTH:	108"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	90"
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Prominent horizons between C1, C2, and C3.
- Faint mottling was apparent within granual C horizons.

Test Pit No. 7

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 23, 2015
Time:	9:15 AM - 10:15 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
8" - 14"	Bw	Sandy Loam	10YR 4/6		10% Gravel 10% Stone	Subangular Blocky	Friable
14" - 26"	Bc	Sandy Loam	2.5Y 4/4		10% Gravel 10% Stone	Subangular Blocky	Friable
26" - 90"	C1	Sand	2.5Y 4/2		50% Gravel 20% Stone	Single Grain	Loose
90" - 120"	C2	Fine Sand	2.5Y 5/4		0% Coarse	Massive	Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 16'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	See note
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS: - No mottling apparent within granular C horizons.

Test Pit No. 8

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 23, 2015
Time:	10:15 AM - 11:00 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 1"	O				0% Coarse		
1" - 8"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
8" - 16"	Bw	Sandy Loam	10YR 4/6		5% Gravel	Subangular Blocky	Friable
16" - 32"	Bc	Sandy Loam	2.5Y 4/4		5% Gravel 5% Stone	Subangular Blocky	Friable
32" - 72"	C1	Sand	2.5Y 5/3		20% Gravel	Massive	Firm
72" - 120"	C2	Silt	2.5Y 3/1		5% Gravel	Massive	Very Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 16'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	See note
DEPTH TO MOTTLING:	See note
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Boulders encountered between 1 and 4-foot depth.
- Inconsistent mottling within C1 horizon located around stones.
- Pockets of cemented C1 layer.
- Soil sample taken within C1 horizon (4-foot depth) to perform laboratory determination of infiltration rate.

Test Pit No. 9

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 23, 2015
Time:	11:00 AM - 11:45 AM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 3"	O				0% Coarse		
3" - 14"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
14" - 18"	Bw	Sandy Loam	10YR 4/6		5% Gravel	Subangular Blocky	Friable
18" - 24"	Bc	Sandy Loam	2.5Y 4/4		5% Gravel	Subangular Blocky	Friable
24" - 60"	C1	Sand	2.5Y 4/3		20% Gravel 10% Stone	Massive	Firm
60" - 80"	C2	Fine Sand	2.5Y 5/3		20% Gravel 10% Stone	Massive	Firm
80" - 120"	C3	Silt	2.5Y 3/1		10% Gravel	Massive	Very Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 14'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	Not observed
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:
- Surface was mulched.
- Inconsistant depth between Bw and Bc horizons.
- Soil sample taken within C1 horizon (4-foot depth) for laboratory determination of infiltration rate.

Test Pit No. 10

Project Name:	Palmer Pointe
Project Number:	20121033.A20
Date:	December 23, 2015
Time:	12:00 PM - 1:15 PM
Logged By:	Andy Glines, EIT
Checked By:	Shawn Martin, PE

Contractor:	Site Tech
Operator:	Dave
Backfill:	Native

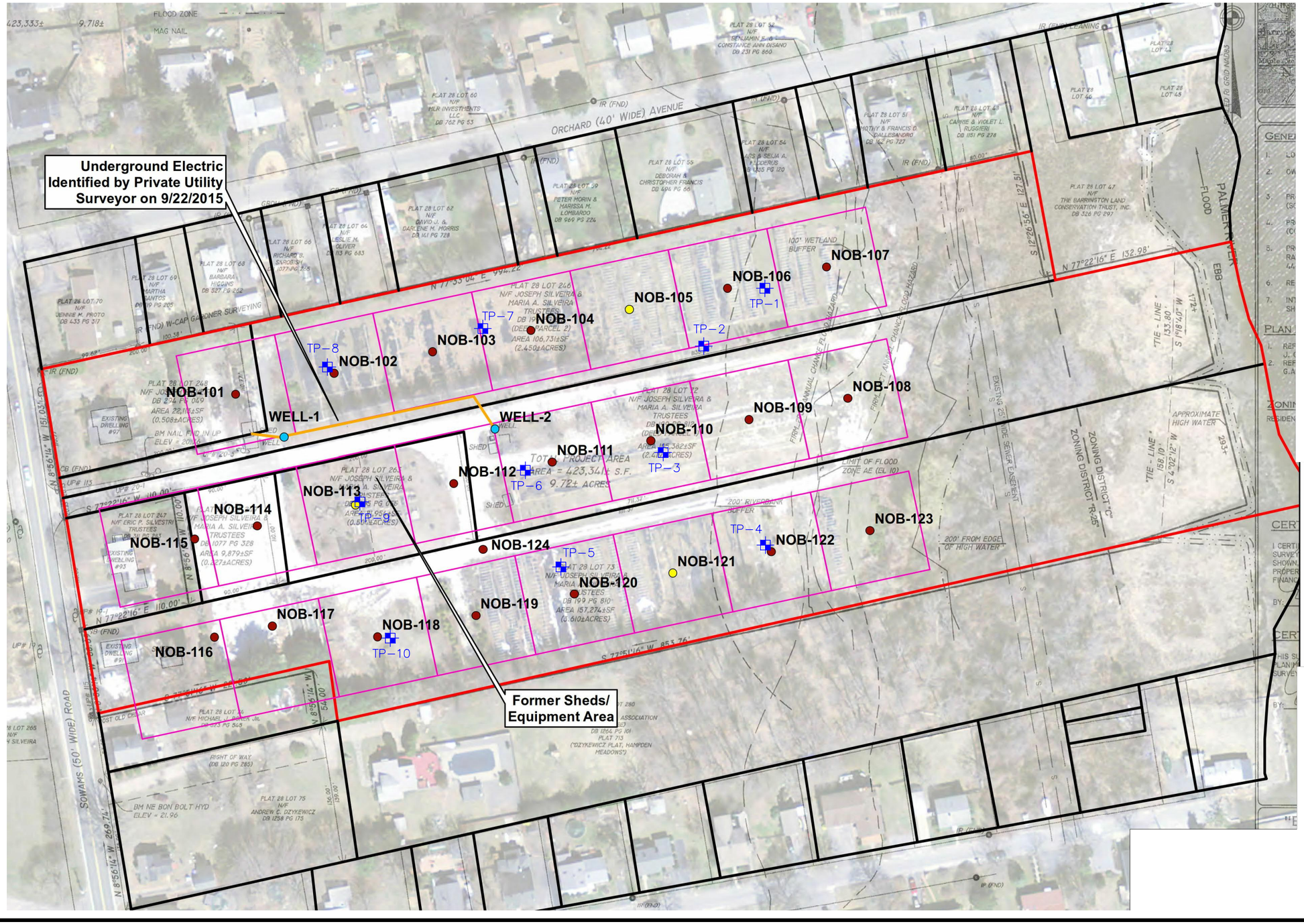
FUSS & O'NEILL

DEPTH	HORIZON	SOIL TEXTURE	SOIL MATRIX	MOTTLES (PERCENT, COLOR, DEPTH)	COARSE FRAGMENT % BY VOLUME	SOIL STRUCTURE	SOIL CONSISTENCE
0" - 2"	O						
2" - 8"	Ap	Sandy Loam	10YR 3/3		5% Gravel	Subangular Blocky	Friable
8" - 16"	Bw	Sandy Loam	10YR 4/6		5% Gravel	Subangular Blocky	Friable
16" - 24"	Bc	Loamy Sand	2.5Y 4/3		5% Gravel	Subangular Blocky	Friable
24" - 78"	C1	Sand	2.5Y 4/3		20% Gravel 10% Stone	Massive	Firm
78" - 120"	C2	Silt	2.5Y 3/1		10% Gravel	Massive	Very Firm

APPROX. SURFACE EL:	TBD by survey
DIMENSIONS OF PIT:	7' by 14'
TOTAL DEPTH:	120"
DEPTH TO BEDROCK:	Not encountered
DEPTH TO MOTTLING:	Not observed
DEPTH TO ROOTS:	N/A
DEPTH TO WATER:	N/A
METHOD OF SAMPLE COLLECTION:	N/A

TEST PIT SKETCH:

COMMENTS:



Legend

- Boring Location
- Temporary Monitoring Well
- Approximate Location of Existing Well
- 100 Foot Grid
- Site Boundary
- Other Property Lines
- TEST PIT

NOTES:

1. BORING AND MONITORING WELLS CONDUCTED AND INSTALLED BY NOBIS ENGINEERING, INC. LOCATIONS SHOWN FOR REFERENCE ONLY.
2. TEST PIT LOCATIONS ARE APPROXIMATE ONLY AND NOT FIELD SURVEYED.

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER
1.				

SCALE:
HORZ.: 1"=100±
VERT.:
DATUM:
HORZ.:
VERT.:
0 50 100
GRAPHIC SCALE

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

EAST BAY CMMUNITY DEVELOPMENT CORPORATION

TEST PIT LOCATION MAP

PALMER POINTE NEIGHBORHOOD

BARRINGTON RHODE ISLAND

PROJ. No.: 20121033.A10
DATE: JANUARY 2016

FIGURE 1

File Path: J:\DWG\P2012\1033\A10\Civil\Plan\20121033A10_SAM01.dwg Layout: FIG 1 Plotted: Fri, February 05, 2016 - 10:27 AM User: aglines
MS VIEW: LAYER STATE:
Plotter: DWG TO PDF.PC3 CTB File: FO HALF.STB

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

Palmer Pointe

December 21, 2015

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 (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

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

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

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

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Contents

Soil Map

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

Custom Soil Resource Report
Soil Map

Map Scale: 1:4,510 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 200 400 800 1200

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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: http://websoilsurvey.nrcs.usda.gov
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 14, Sep 22, 2015

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

Date(s) aerial images were photographed: Apr 8, 2011—Apr 9, 2011

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

Map Unit Legend

State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties (RI600)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
MmB	Merrimac fine sandy loam, 3 to 8 percent slopes	33.2	40.3%
MU	Merrimac-Urban land complex, 0 to 8 percent slopes	22.4	27.2%
Sa	Sandyhook mucky fine sand, 0 to 2 percent slopes, very frequently flooded	1.7	2.1%
Sb	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	0.0	0.1%
Ss	Sudbury sandy loam	2.4	2.9%
Wa	Walpole sandy loam, 0 to 3 percent slopes	11.5	13.9%
Ws	Water, saline	11.3	13.6%
Totals for Area of Interest		**82.5**	**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

MmB—Merrimac fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyqs
Elevation: 0 to 1,290 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Merrimac

Setting

Landform: Eskers, kames, outwash plains, outwash terraces, moraines
Landform position (two-dimensional): Backslope, footslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A

Minor Components

Hinckley

Percent of map unit: 5 percent
Landform: Deltas, eskers, kames, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear

Sudbury

Percent of map unit: 5 percent
Landform: Deltas, outwash plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

Windsor

Percent of map unit: 3 percent
Landform: Deltas, dunes, outwash plains, outwash terraces
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex

Agawam

Percent of map unit: 2 percent
Landform: Eskers, kames, outwash plains, outwash terraces, moraines, stream terraces
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex

MU—Merrimac-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyr9
Elevation: 0 to 820 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Merrimac and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Eskers, kames, outwash plains, outwash terraces, moraines
Landform position (two-dimensional): Backslope, footslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A

Description of Urban Land

Typical profile

H - 0 to 6 inches: material

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D

Minor Components

Hinckley

Percent of map unit: 5 percent
Landform: Deltas, eskers, kames, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, crest, head slope, side slope, rise
Down-slope shape: Convex

Across-slope shape: Convex, linear

Sudbury

Percent of map unit: 5 percent
Landform: Deltas, outwash plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

Windsor

Percent of map unit: 5 percent
Landform: Deltas, dunes, outwash plains, outwash terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex

Sa—Sandyhook mucky fine sand, 0 to 2 percent slopes, very frequently flooded

Map Unit Setting

National map unit symbol: 2tyql
Elevation: 0 to 10 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 59 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Sandyhook and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sandyhook

Setting

Landform: Back-barrier beaches, back-barrier flats
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy marine deposits

Typical profile

Oe - 0 to 4 inches: mucky peat
Cg - 4 to 8 inches: sand
Ab - 8 to 11 inches: mucky coarse sand
C'g - 11 to 51 inches: sand
A'b - 51 to 59 inches: coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Very frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to strongly saline (0.7 to 111.6 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 20.0
Available water storage in profile: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: A/D
Ecological site: Tidal Salt High Marsh mesic very frequently flooded (R144AR002CT), Tidal Salt Low Marsh mesic very frequently flooded (R144AR001CT)

Minor Components

Pawcatuck

Percent of map unit: 5 percent
Landform: Tidal marshes
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Tidal Salt High Marsh mesic very frequently flooded (R144AR002CT), Tidal Salt Low Marsh mesic very frequently flooded (R144AR001CT)

Matunuck

Percent of map unit: 5 percent
Landform: Tidal marshes
Landform position (three-dimensional): Dip
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Tidal Salt High Marsh mesic very frequently flooded (R144AR002CT), Tidal Salt Low Marsh mesic very frequently flooded (R144AR001CT)

Sb—Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svky
Elevation: 0 to 1,320 feet

Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Scarboro

Setting

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

Typical profile

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

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: About 0 to 2 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Wareham

Percent of map unit: 5 percent

Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave

Walpole
Percent of map unit: 5 percent
Landform: Deltas, depressions, depressions, outwash plains, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Concave
Across-slope shape: Concave

Ss—Sudbury sandy loam

Map Unit Setting
National map unit symbol: 9lx8
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 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Sudbury and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sudbury

Setting
Landform: Outwash plains, terraces
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Sandy and gravelly glaciofluvial deposits derived from granite and/or schist and/or gneiss

Typical profile
Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 5 inches: sandy loam
Bw1 - 5 to 17 inches: gravelly sandy loam
Bw2 - 17 to 25 inches: sandy loam
2C - 25 to 60 inches: Error

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None

Frequency of ponding: None
Available water storage in profile: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B

Minor Components

Hinckley

Percent of map unit: 3 percent
Landform: Eskers, kames, outwash plains, terraces
Down-slope shape: Convex
Across-slope shape: Convex

Ninigret

Percent of map unit: 2 percent
Landform: Outwash plains, terraces
Down-slope shape: Linear
Across-slope shape: Concave

Agawam

Percent of map unit: 1 percent
Landform: Outwash plains
Down-slope shape: Linear
Across-slope shape: Linear

Deerfield

Percent of map unit: 1 percent
Landform: Outwash plains, terraces
Down-slope shape: Linear
Across-slope shape: Concave

Merrimac

Percent of map unit: 1 percent
Landform: Kames, outwash plains, terraces
Down-slope shape: Linear
Across-slope shape: Linear

Walpole

Percent of map unit: 1 percent
Landform: Depressions on terraces, drainageways on terraces
Down-slope shape: Concave, linear
Across-slope shape: Concave, linear

Windsor

Percent of map unit: 1 percent
Landform: Kames, outwash plains, terraces
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear

Wa—Walpole sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkl
Elevation: 0 to 1,020 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Walpole

Setting

Landform: Deltas, depressions, depressions, outwash plains, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from igneous, metamorphic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: mucky peat
A - 1 to 7 inches: sandy loam
Bg - 7 to 21 inches: sandy loam
BC - 21 to 25 inches: gravelly sandy loam
C - 25 to 65 inches: very gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 4 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D

Minor Components

Scarboro

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Sudbury

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

Ws—Water, saline

Map Unit Setting

National map unit symbol: bqv1
Elevation: 0 to 20 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Water, saline: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Minor Components

Beaches, sandy surface

Percent of map unit: 5 percent
Landform: Barrier beaches, beaches, shores, back-barrier beaches
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear