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Introduction

This report covers the methodology and calculations used in the design of the stormwater management system for the proposed development of Block 38, Lots 3, 10, 11, 11 & P/O 2, in the Borough of Woodbury Heights, Gloucester County, New Jersey.

The stormwater management system is designed in accordance with the N.J.D.E.P. Stormwater Management Rules N.J.A.C. 7:28. The Stormwater Management Rules have requirements for groundwater recharge, stormwater quality and stormwater quantity.

The groundwater recharge requirements are determined by the utilization of the Groundwater Recharge Spreadsheet, provided by the N.J.D.E.P., or by infiltrating the difference in runoff volume between the pre-development and post-development 2-year storm events.

The stormwater quality requirements can be met by removing 80% TSS from the stormwater entering the stormwater management system. Proper TSS removal can be performed by using stormwater management measures documented in the N.J.D.E.P. Stormwater Management BMP Manual.

The stormwater quantity requirements can be satisfied by the using one of the following options:

- i. Demonstrate through hydrologic and hydraulic analysis that for stormwater leaving the site, post-construction runoff hydrographs for the two, 10, and 100-year storm events do not exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events.
- ii. Demonstrate through hydrologic and hydraulic analysis that there is no increase, as compared to the pre-construction condition, in the peak runoff rates of stormwater leaving the site for the two, 10, and 100 year storm events and that the increased volume or change in timing of stormwater runoff will not increase flood damage at or downstream of the site. This analysis shall include the analysis of impacts of existing land uses and projected land uses assuming full development under existing zoning and land use ordinances in the drainage area.
- iii. Design stormwater management measures so that the post-construction peak runoff rates for the two, 10 and 100-year storm events are 50, 75 and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be constructed.

Storm routings for this project were performed using the HydroCAD 10.00 computer program. HydroCAD 10.00 has been adjusted to calculate the impervious and pervious areas for each drainage area separately.

The roof drain leaders have been sized utilizing the Table 13.6.2 of the 2009 National Standard Plumbing Code.

Existing Conditions

The site is 1.83 Ac. and is currently developed with two, single-family homes, storage for the adjacent construction company, and associated site improvements. The site has frontage along Glassboro Road Berlin Cross Keys Road (U.R. #553) and Barlow Avenue. Glassboro Road borders the site on the east. Barlow Avenue borders the site on the west. Commercial properties border the site on the north and south.

The existing runoff consists of one (1) major drainage area as listed below:

- **EDA-01** – This drainage area drains to the existing inlet located on the subject property, which ultimately discharges to the storm sewer system within Glassboro Road.
- **EDA-02** – This drainage area ultimately drains overland to the storm sewer system within Glassboro Road.

The recent USDA soil survey indicates this site to have Fallsington Farms (UapA) Hydric Group (C1) soils, and Urban Land-Freehold Complex (USFRE:B) unclassified hydric soils. Based upon the soil investigation, the soils were modeled as Hydric Group (C) soils. We assumed a CN value of 98 for impervious areas, 80 for grassed areas, and 83 for woods in good condition.

The pre-development runoff from the site is listed in the following table:

Drainage Area	2-year Storm	10-year Storm	100-year Storm
EDA-01	2.52 CFS	4.73 CFS	9.24 CFS
EDA-02	0.96 CFS	1.89 CFS	3.83 CFS

Proposed Conditions

The proposed improvements will create two (2) drainage areas and one (1) detention node as listed below:

- **DA-01** – This drainage area drains to the proposed basin (B-01)
- **DA-02** – This drainage area ultimately drains overland towards Glassboro Road
- **B-01** – This node is the proposed detention basin which discharges to Manhole #5.

The proposed development of the site will consist of the construction of a three (3) self-storage buildings, associated site improvements, and a stormwater management system. The stormwater management system consists of one (1) detention basin and a Contech StormFilter manufactured treatment device. The stormwater management facilities have been designed to detain the entire

volume of the Water Quality Storm Event and discharge that volume through the StormFilter structure. B-01 has been designed to route runoff that exceeds the volume of the Water Quality Storm towards Manhole #5 through the proposed outlet control structure. The orifices within the outlet control structure are indicated as primary devices in the routing calculations. The discharge through the StormFilter MFD is indicated as a secondary device.

For hydrologic soil group "D" soils, we assumed CN values of 98 for impervious areas and 80 for grassed areas in good condition.

Groundwater Recharge

Soil tests were performed in the vicinity of the stormwater management system. As shown in the accompanying soil logs and soil permeability tests, the existing soils have little to no permeability. Therefore, groundwater recharge is not required and has not been provided for this project.

Stormwater Quality

In order to meet the water quality requirements one (1) Contech StormFilter device has been proposed. According to the N.J.D.E.P. Stormwater Management BMP Manual, the StormFilter provide 80% TSS removal. The entire volume of the WQ Storm is proposed to pass through the StormFilter device. The first discharge orifice within the outlet control structure is located above the volume of the WQ Storm. Therefore, the Water Quality requirements of the BMP have been met.

Stormwater Quantity

The resulting post-development runoff rates are listed in the following table:

Post-Development Peak Runoff Rates			
Drainage Area	2-year Storm	10-year Storm	100-year Storm
DA-01	4.79 CFS	7.54 CFS	13.01 CFS
DA-02	0.31 CFS	0.59 CFS	1.14 CFS
B-01	1.22 CFS	3.45 CFS	7.15 CFS

The runoff discharge from the site were analyzed using option iii of the Stormwater Quantity Standards (N.J.A.C.7:8-5.4(a)3 iii). This option requires the stormwater management measures to be designed so that the post-construction peak runoff rates for the two, 10 and 100-year storm events are 50, 75 and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be constructed. A comparison of the pre-development runoff rates, the allowable runoff rates and the post-development runoff rates for the adjacent lots are listed in the following tables:

Runoff Reduction – EDA-01 vs. B-01			
Storm	Pre-development	Allowable	Post-development
2-year	2.52 CFS	1.26 CFS (50%)	1.22 CFS
10-year	4.73 CFS	3.55 CFS (75%)	3.45 CFS
100-year	9.24 CFS	7.39 CFS (80%)	7.15 CFS

Runoff Reduction – EDA-02 vs. DA-02			
Storm	Pre-development	Allowable	Post-development
2-year	0.96 CFS	0.48 CFS (50%)	0.31 CFS
10-year	1.89 CFS	1.42 CFS (75%)	0.59 CFS
100-year	3.83 CFS	3.06 CFS (80%)	1.14 CFS

Summary

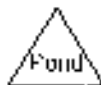
The proposed stormwater management system has been successfully designed to manage the increased runoff from the project. The stormwater management system has been designed in accordance to the appropriate regulations.



To Inlet



To Glassboro Rd.



1564-06 Drainage Calculations

NOAA 24 hr C 2 Year Rainfall=3.31"

Prepared by Hewlett-Packard Company

Printed: 2/4/2020

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Summary for Subcatchment EDA-01: To Inlet

Runoff = 2.52 cfs @ 12.20 hrs Volume= 8,862 cf, Depth= 1.72"

Runoff by SCS TR-20 method, UH-SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dl= 0.01 hrs
NOAA 24-hr C 2-Year Rainfall=3.31"

Area (sf)	CN	Description
6,625	98	Paved parking, HSG D
39,272	80	>75% Grass cover, Good, HSG D
15,966	83	Woods, Poor, HSG D
61,863	83	Weighted Average
55,229	81	89.29% Pervious Area
6,625	90	10.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass: Short n= 0.150 P2= 3.3"
1.9	155	0.0274	1.35		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fcs
0.3	47	0.0315	2.66		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps
0.2	63	0.0153	4.28	1.49	Pipe Channel, 8.0" Round Area= 0.3 sf Perm= 2.1' n= 0.17 n= 0.013 Clay tile
12.0	365	Total			

1564-06 Drainage Calculations

Prepared by Hewlett-Packard Company

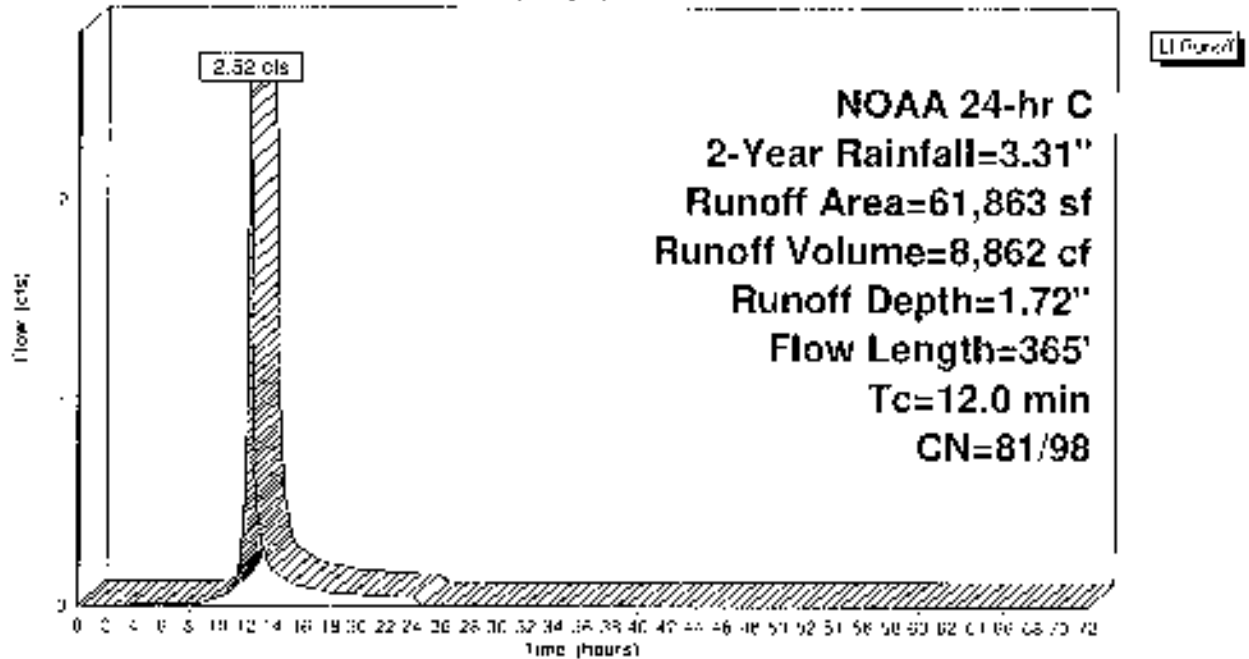
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NOAA 24-hr C 2-Year Rainfall=3.31"

Printed 2/4/2020

Subcatchment EDA-01: To Inlet

Hydrograph



1564-06 Drainage Calculations

NOAA 24 hr C 2 Year Rainfall=3.31"

Prepared by Hewlett-Packard Company

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Summary for Subcatchment EDA-02: To Glassboro Rd.

Runoff = 0.96 cfs @ 12.20 hrs, Volume= 3,285 cf, Depth= 1.50"

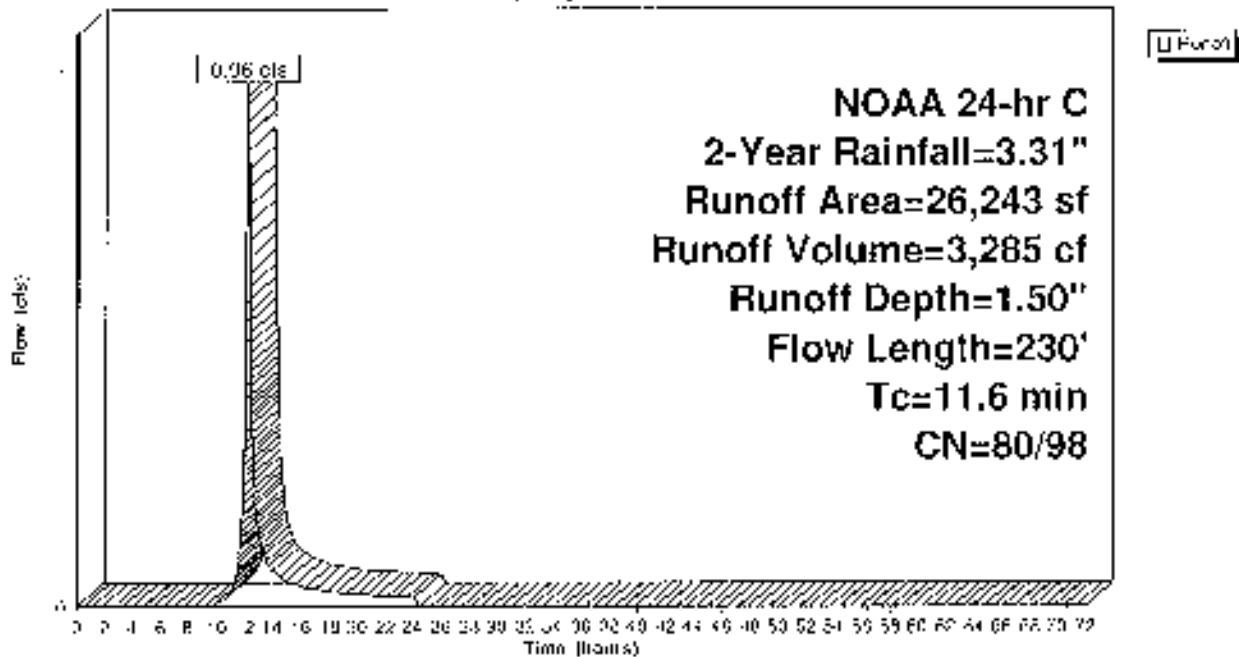
Runoff by SCS TR-20 method, III=SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 2-Year Rainfall=3.31"

Area (sf)	CN	Description
250	98	Paved parking, HSG D
25,993	80	>75% Grass cover, Good, HSG D
26,243	80	Weighted Average
25,993	80	99.05% Pervious Area
250	98	0.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass: Short n= 0.150 P2= 3.31"
2.0	130	0.0231	1.06		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
11.6	230	Total			

Subcatchment EDA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24 hr C 10 Year Rainfall=5.06"

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Summary for Subcatchment EDA-01: To Inlet

Runoff = 4.73 cfs @ 12.20 hrs, Volume= 16,619 cf, Depth= 3.23"

Runoff by SCS TR 20 method, UH=SCS, Soil Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24 hr C 10-Year Rainfall=5.06"

Area (st)	CN	Description
8.625	98	Paved parking, HSG D
39.272	80	>75% Grass cover, Good, HSG D
15.966	83	Woods, Poor, HSG D
51.863	83	Weighted Average
55.238	61	89.29% Pervious Area
6.625	98	10.71% Impervious Area

Lc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass: Short n= 0.150 P2= 3.31"
1.9	156	0.0374	1.35		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 Ips
0.3	47	0.0315	2.66		Shallow Concentrated Flow, Grasses/ Waterway Kv= 15.0 Ips
0.2	63	0.0153	4.28	1.49	Pipe Channel, 9.0" Round Area= 0.6 st Perm= 2.1' n= 0.17 Clay tile
12.0	365	Total			

1564-06 Drainage Calculations

Prepared by Hewlett-Packard Company

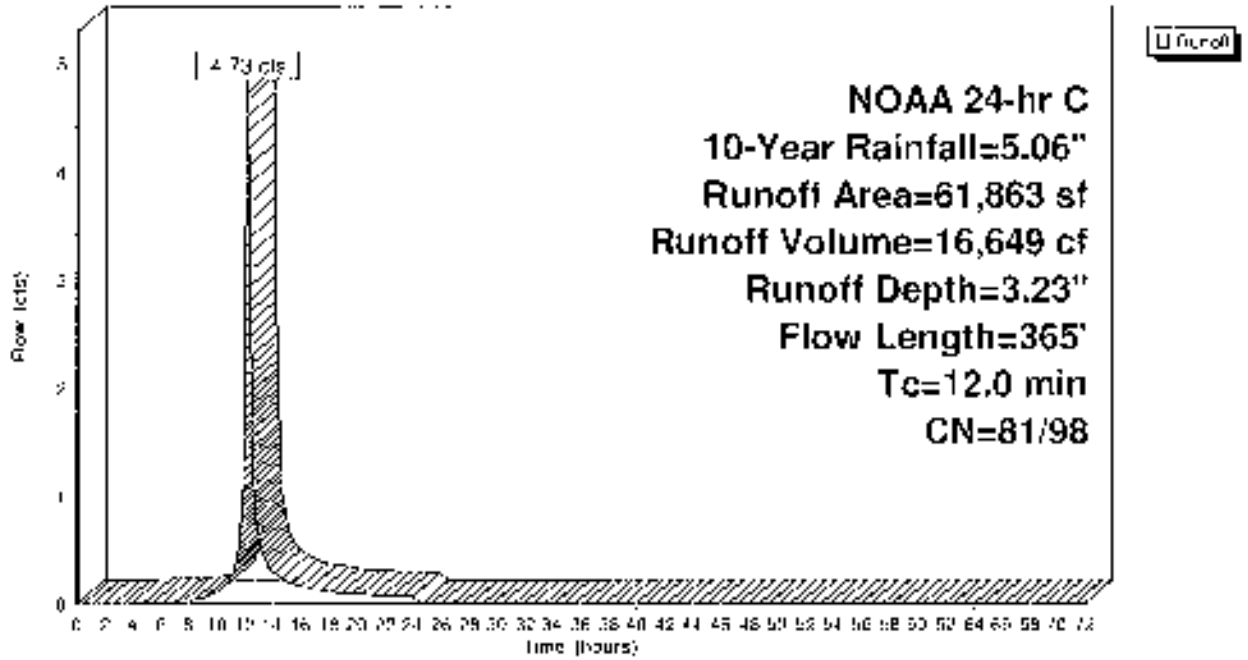
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NOAA 24-hr C 10-Year Rainfall=5.06"

Printed 2/4/2020

Subcatchment EDA-01: To Inlet

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 10-Year Rainfall=5.06"

Prepared by Hewlett-Packard Company

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Summary for Subcatchment EDA-02: To Glassboro Rd.

Runoff = 1.89 cfs @ 12.19 hrs, Volume= 6,480 cf, Depth= 2.96"

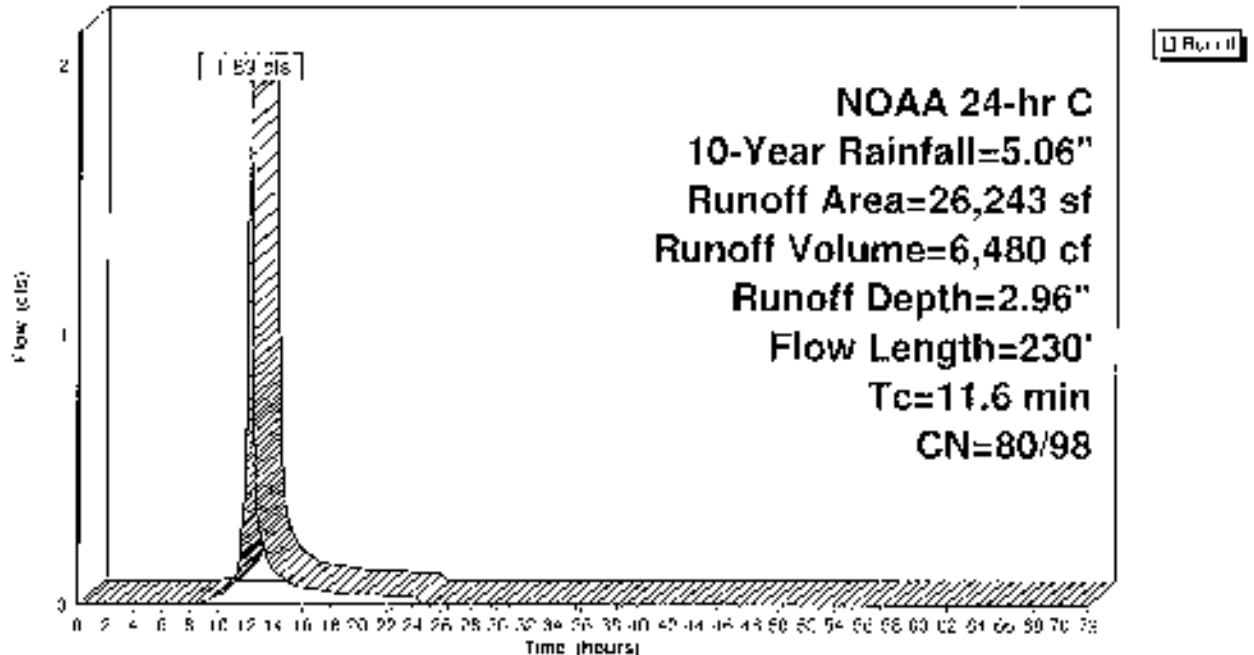
Runoff by SCS TR 20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24 hr C 10 Year Rainfall=5.06"

Area (sf)	CN	Description
250	98	Paved parking, HSG D
25,993	80	>75% Grass cover, Good, HSG D
26,243	80	Weighted Average
25,993	80	89.05% Pervious Area
250	98	0.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass Short n= 0.150 P2= 3.31"
2.0	130	0.0231	1.06		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 tps
11.6	230	Total			

Subcatchment EDA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24 hr C 25 Year Rainfall=6.28"

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Summary for Subcatchment EDA-01: To Inlet

Runoff = 6.31 cfs @ 12.20 hrs, Volume= 22,391 cf, Depth= 4.34"

Runoff by SCS TR-20 method, UH=SCS, Soil Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 25-Year Rainfall=6.28"

Area (sf)	CN	Description
6,625	98	Paved parking, HSG D
39,272	80	>75% Grass cover, Good, HSG D
15,966	83	Woods, Poor, HSG D
61,863	83	Weighted Average
55,238	81	99.29% Pervious Area
6,625	98	10.71% Impervious Area

To (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass: Short n= 0.150 P2= 3.31"
1.9	155	0.0374	1.35		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.3	47	0.0315	2.66		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps
0.2	63	0.0153	4.26	1.49	Pipe Channel, 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.013 Clay tile
12.0	365	Total			

1564-06 Drainage Calculations

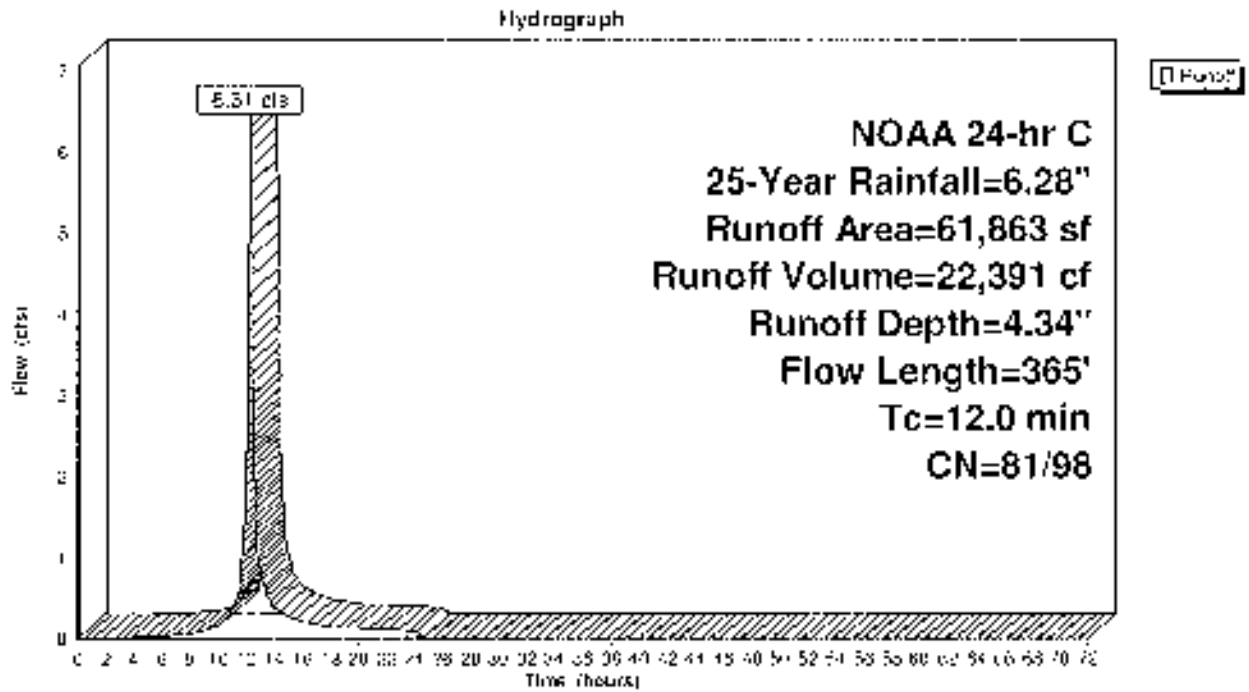
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NOAA 24-hr C 25-Year Rainfall=6.28"

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Subcatchment EDA-01: To Inlet



1564-06 Drainage Calculations

NOAA 24 hr C 25-Year Rainfall=6.28"

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Summary for Subcatchment EDA-02: To Glassboro Rd.

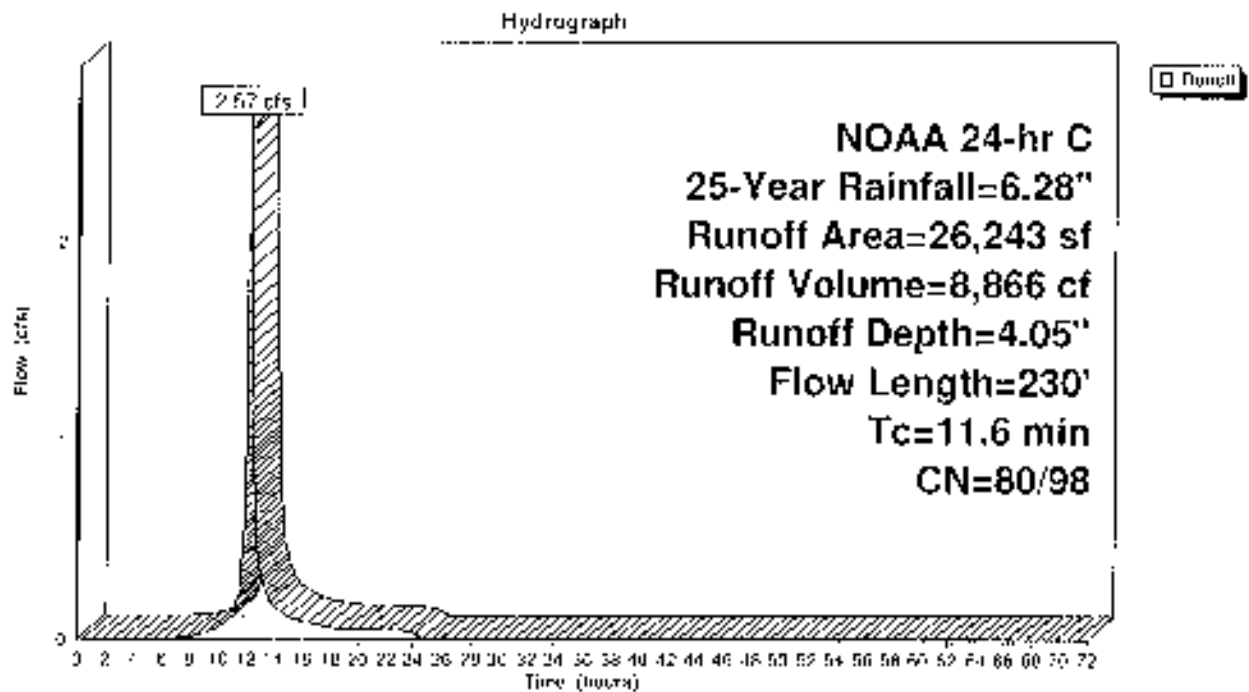
Runoff = 2.57 cfs @ 12.19 hrs. Volume= 8,866 cf. Depth= 4.05"

Runoff by SCS TR 20 method, UH=SCS, Sprit Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 25 Year Rainfall=6.28"

Area (sf)	CN	Description
250	98	Paved parking, HSG D
25,993	80	>75% Grass cover, Good, HSG D
26,243	80	Weighted Average
25,993	80	99.95% Pervious Area
250	98	0.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	100	0.0200	0.17		Sheet Flow, Grass: Short n= 0.150 P2= 3.31'
2.0	130	0.0231	1.06		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
11.6	230	Total			

Subcatchment EDA-02: To Glassboro Rd.



1564-06 Drainage Calculations

NOAA 24-hr C 100-Year Rainfall=8.52"

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Summary for Subcatchment EDA-01: To Inlet

Runoff - 9.24 cfs @ 12.20 hrs, Volume= 33,269 cf, Depth= 6.45"

Runoff by SCS TR-20 method UH-SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, d1= 0.01 hrs
 NOAA 24-hr C 100-Year Rainfall=8.52'

Area (sf)	CN	Description
6,625	98	Paved parking, HSG D
39,272	80	>75% Grass cover, Good, HSG D
15,966	83	Woods, Pear, HSG D
61,963	83	Weighted Average
56,238	81	99.29% Pervious Area
6,625	98	10.71% Impervious Area

Ti (in.)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass, Short n= 0.150 P2= 3.91"
1.9	155	0.0374	1.35		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.3	47	0.0315	2.66		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps
0.2	63	0.0153	4.28	1.49	Pipe Channel, 8.0" Round Area= 0.5 sf Perm= 2.1' L= 8.17' n= 0.013 Clay tile
12.0	365	Total			

1564-06 Drainage Calculations

NOAA 24-hr C 100-Year Rainfall=8.52"

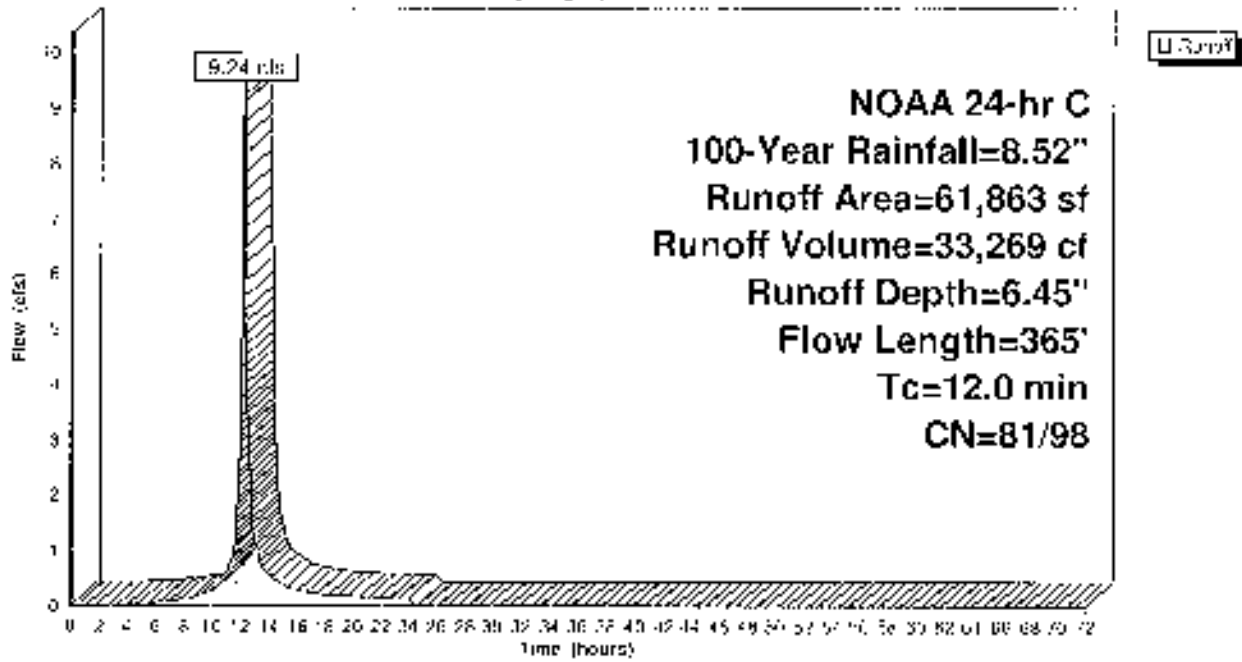
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Subcatchment EDA-01: To Inlet

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 100-Year Rainfall=8.52"

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Summary for Subcatchment EDA-02: To Glassboro Rd.

Runoff = 3.83 cfs @ 12.19 hrs, Volume= 13,416 cf, Depth= 6.13"

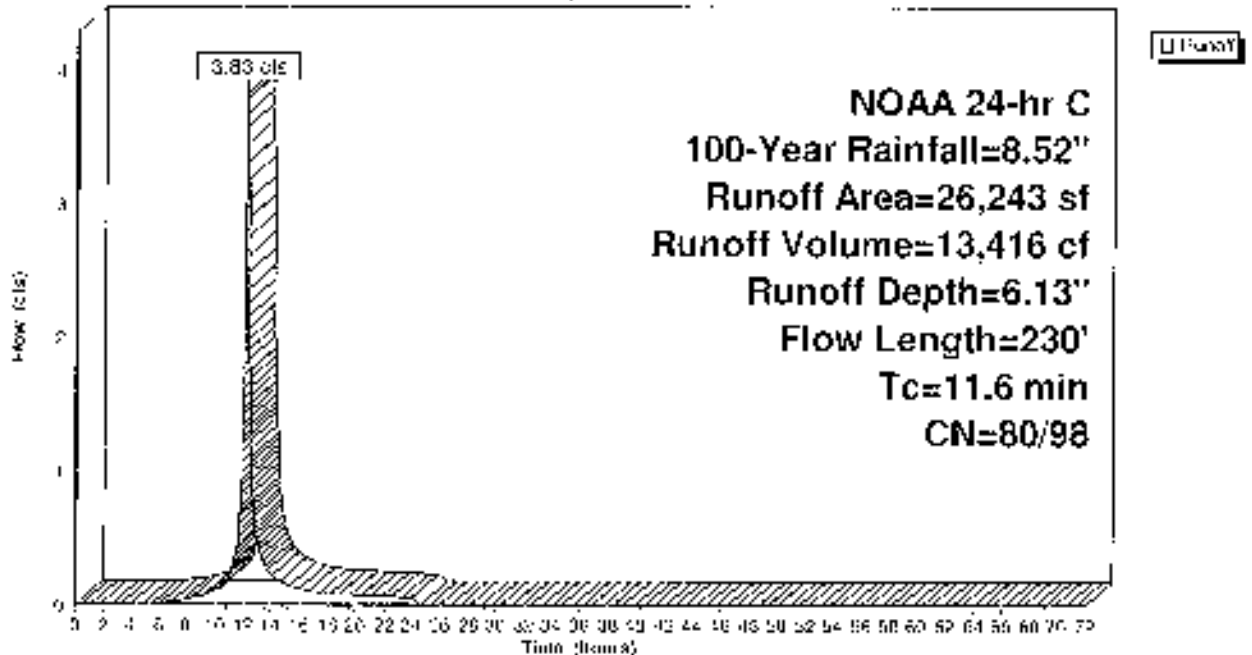
Runoff by SCS TR 20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00 72.00 hrs, dt= 0.01 hrs
 NOAA 24 hr C 100-Year Rainfall=8.52"

Area (sf)	CN	Description
250	98	Paved parking, HSG D
25,993	80	>75% Grass cover, Good, HSG D
26,243	80	Weighted Average
25,993	80	99.05% Pervious Area
250	98	0.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.0200	0.17		Sheet Flow, Grass, Short n= 0.150 P2= 3.31"
2.0	130	0.0231	1.06		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
11.6	230	Total			

Subcatchment EDA-02: To Glassboro Rd.

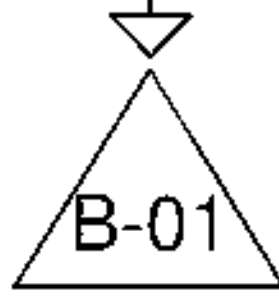
Hydrograph





To B-01

To Glassboro Rd.



To Glassboro Rd.



1564-06 Drainage Calculations

NJ DEP 2-hr -NJDEP WQ Rainfall=1.25"

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Summary for Subcatchment DA-01: To B-01

Runoff - 3.82 cfs @ 1.15 hrs, Volume= 5,551 cf, Depth= 0.91"

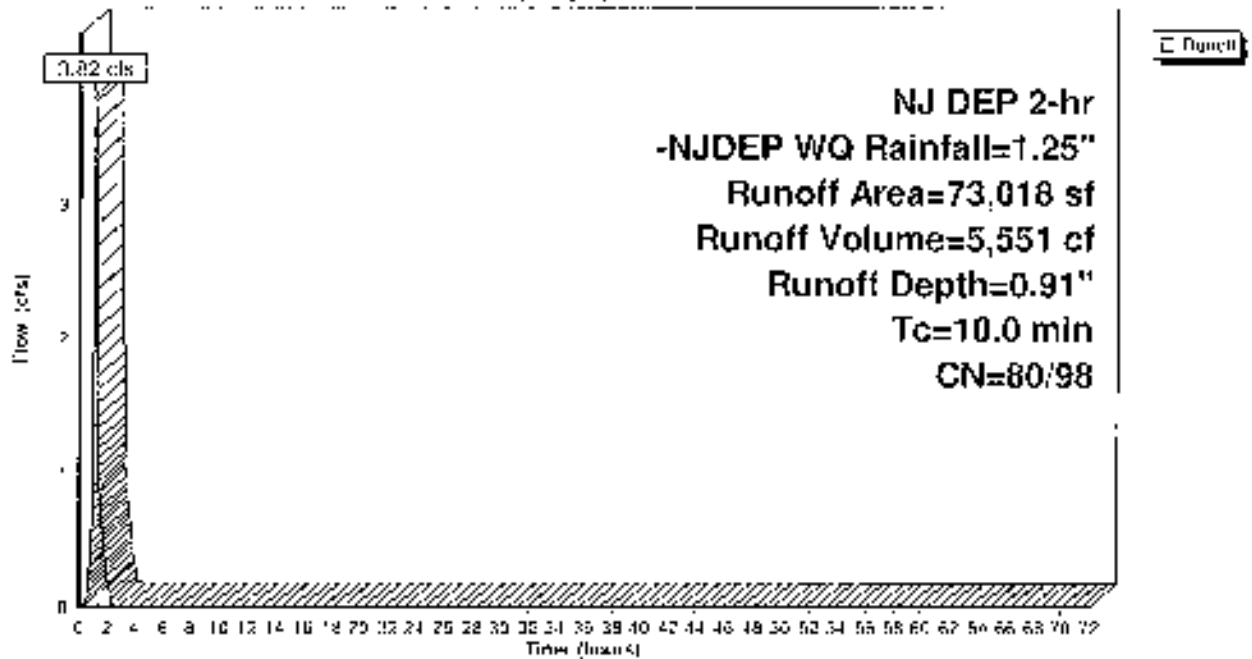
Runoff by SCS TR-20 method, UH-SCS, Split Pervious/Imperv., Time Spar= 0.00-72.00 hrs. dl= 0.01 hrs
 NJ DEP 2-hr -NJDEP WQ Rainfall=1.25"

Area (sf)	CN	Description
37,476	99	Paved parking, HSG D
25,175	99	Roofs, HSG D
10,267	90	>75% Grass cover, Good, HSG D
73,018	95	Weighted Average
10,967	90	14.20% Pervious Area
62,051	98	85.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-01: To B-01

Hydrograph



1564-06 Drainage Calculations

NJ DEP 2-hr -NJDEP WQ Rainfall=1.25"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-02: To Glassboro Rd.

Runoff - 0.12 cfs @ 1.19 hrs, Volume= 185 cf, Depth= 0.31"

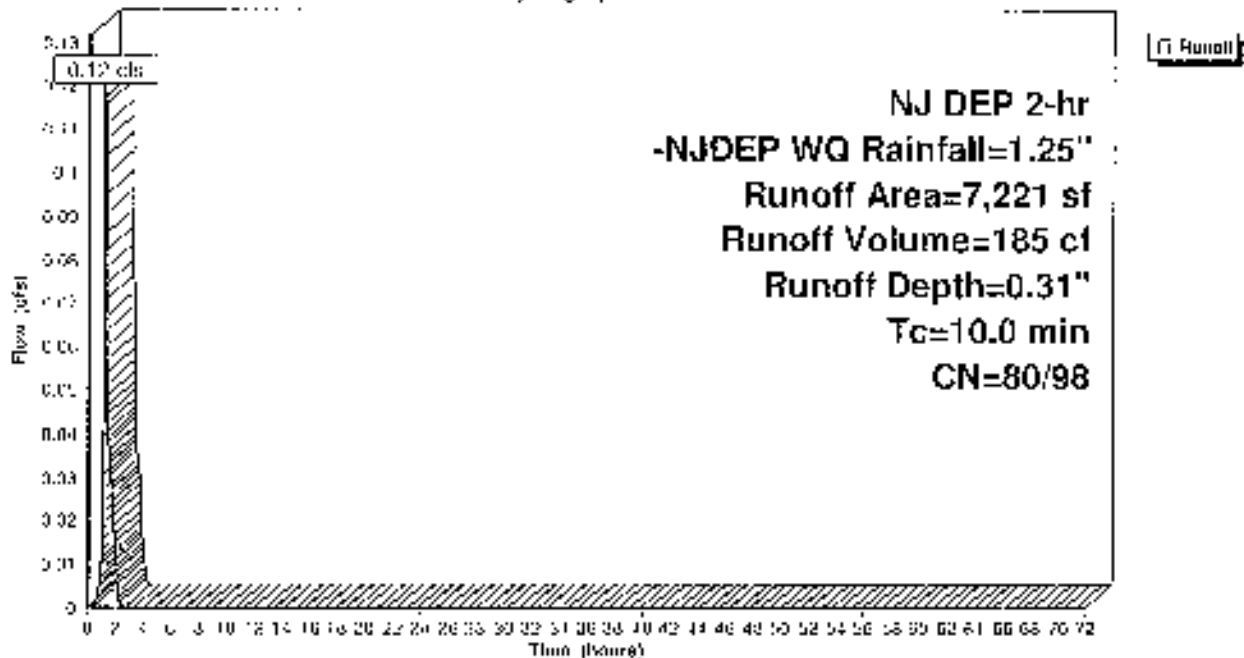
Runoff by SCS TR-20 method. UH=SCS. Split Pervious/Imperv.. Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NJ DEP 2-hr -NJDEP WQ Rainfall= 1.25"

Area (sf)	CN	Description
1,131	98	Paved parking, HSG D
6,090	80	>75% Grass cover, Good, HSG D
7,221	83	Weighted Average
6,090	80	84.24% Pervious Area
1,131	98	15.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NJ DEP 2-hr -NUDEP WO Rainfall=1.25"

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Printed 2/1/2020

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Summary for Pond B-01: To Glassboro Rd.

Inflow Area = 73.018 sf, 85.80% Impervious, Inflow Depth = 0.91" for -NUDEP WO event
 Inflow = 2.82 cfs @ 1.15 hrs. Volume= 5,551 cf
 Outflow = 0.95 cfs @ 0.87 hrs. Volume= 5,554 cf, Attenu= 75%, Lag= 0.0 min
 Primary = 0.00 cfs @ 0.00 hrs. Volume= 0 cf
 Secondary = 0.95 cfs @ 0.87 hrs. Volume= 5,554 cf

Routing by Dyr-Stor-Ind method. Time Span= 0.00-72.00 hrs. dt= 0.01 hrs
 Peak Elev= 33.76' @ 1.41 hrs Surf.Area= 3,170 sq-ft Storage= 7,506 cf

Plug-Flow detention time= 25.7 min calculated for 5,551 cf (100% of inflow)
 Center-of-Mass det. time= 25.7 min (100.0 - 74.3)

Volume #	Invert	Avail. Storage	Storage Description
	29.74'	3,084 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf Area (sq-ft)	Inc. Store (cubic-feet)	Cum. Store (cubic-feet)
29.74	1	0	0
32.25	10	14	14
33.00	1,712	646	660
34.00	2,639	2,676	3,335
35.00	4,860	4,250	7,585
36.00	8,130	5,499	13,084

Device	Routing	Invert	Outlet Devices
#1	Secondary	32.75'	StormFilter Discharge X 19.00 Discharges@29.75' Turns Off@29.75'
#2	Primary	33.80'	6.0" W x 3.0" H Vert. Orifice/Grate C= 0.600
#3	Primary	34.15'	21.0" W x 6.0" H Vert. Orifice/Grate C= 0.600
#4	Primary	34.75'	12.0" W x 4.0" H Vert. Orifice/Grate C= 0.600
#5	Primary	35.50'	20.0" x 20.0" Horiz. Grate C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=29.74' (Free Discharge)

- ↑ 2=Orifice/Grate ; Controls 0.00 cfs)
- ↑ 3=Orifice/Grate ; Controls 0.00 cfs)
- ↑ 4=Orifice/Grate ; Controls 0.00 cfs)
- ↑ 5=Grate ; Controls 0.00 cfs)

Secondary OutFlow Max=0.95 cfs @ 0.87 hrs HW=32.74' (Free Discharge)

- ↑ 1=StormFilter Discharge (Pump Controls 0.95 cfs)

1564-06 Drainage Calculations

NJ DEP 2 hr NJDEP WC Rainfall=1.25"

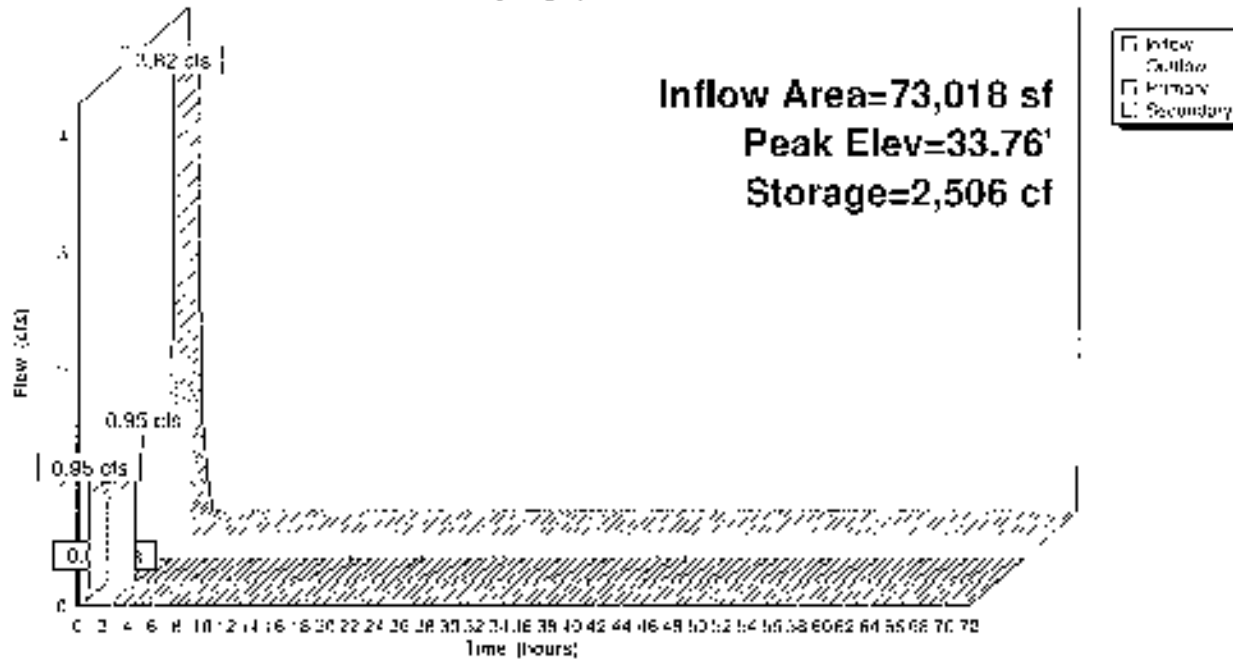
Prepared by Hewlett-Packard Company

Printed 7/1/2020

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Pond B-01: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 2-Year Rainfall 3.31"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-01: To B-01

Runoff - 4.79 cfs @ 12.17 hrs, Volume= 17,350 cf, Depth= 2.85"

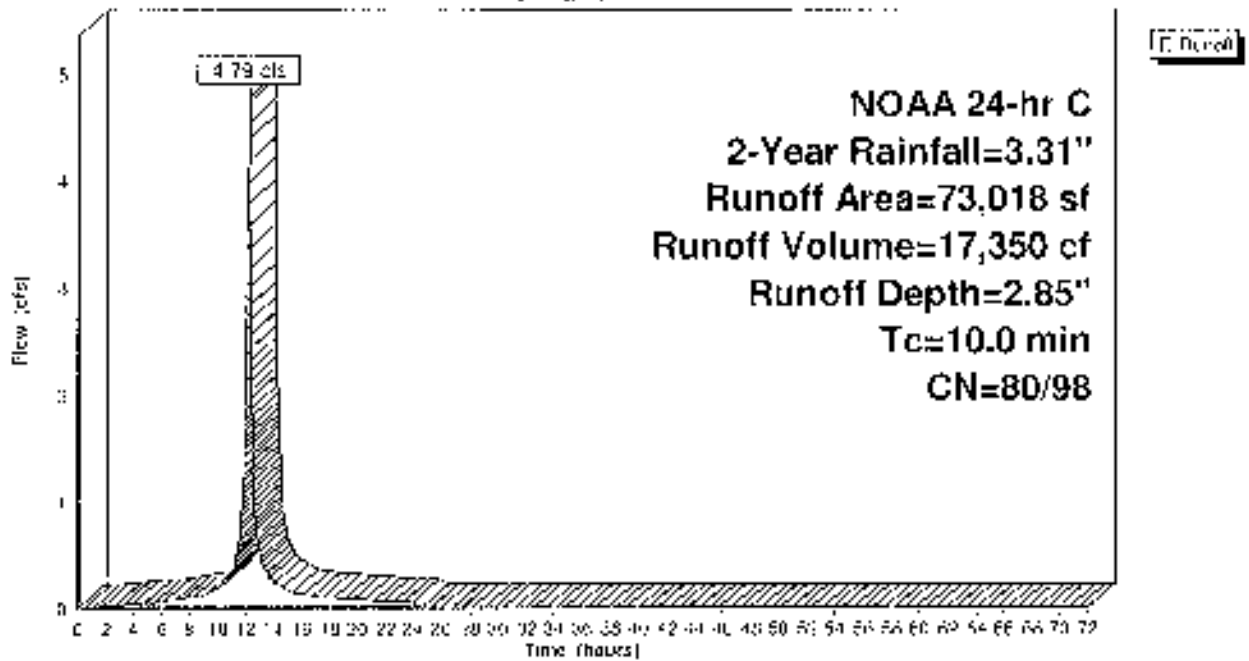
Runoff by SCS TR-20 method, UH-SOS, Split Pervious/Imperv., Time Spac= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 2-Year Rainfall 3.31"

Area (sf)	CN	Description
37,476	98	Paved parking, HSG D
25,175	98	Roofs, HSG D
10,367	80	>75% Grass cover, Good, HSG D
73,019	95	Weighted Average
10,267	80	14.20% Pervious Area
62,651	99	85.80% Impervious Area

To (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-01: To B-01

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 2-Year Rainfall=3.31"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-02: To Glassboro Rd.

Runoff = 0.31 cfs @ 12.18 hrs, Volume= 1,045 cf, Depth= 1.74"

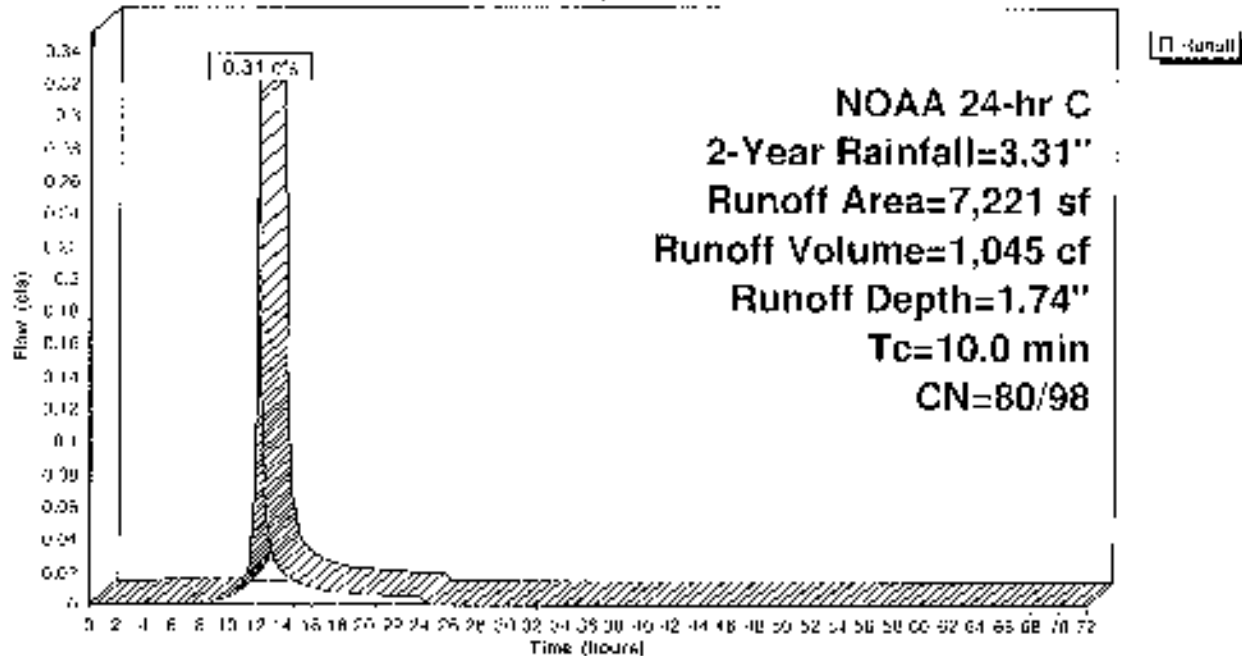
Runoff by SCS TR-20 method, UH--SCS Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 2-Year Rainfall=3.31"

Area (sf)	CN	Description
1,131	98	Paved parking, HSG D
6,090	80	>75% Grass cover, Good, HSG D
7,221	83	Weighted Average
6,090	80	84.34% Pervious Area
1,131	98	15.66% Impervious Area

To (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24 hr G 2 Year Rainfall=3.31"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Pond B-01: To Glassboro Rd.

[87] Warning: Oscillations may require smaller dt or Finer Routing (severely: 19)

Inflow Area = 73,018 sf, 85.80% Impervious, Inflow Depth = 2.85" for 2-Year event
 Inflow = 4.79 cfs @ 12.17 hrs, Volume= 17,350 cf
 Outflow = 1.22 cfs @ 12.52 hrs, Volume= 17,359 cf, Atten= 74%, Lag= 20.9 min
 Primary = 0.27 cfs @ 12.52 hrs, Volume= 604 cf
 Secondary = 0.95 cfs @ 4.60 hrs, Volume= 16,756 cf

Routing by Dyn-Skin-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 34.13' @ 12.52 hrs Surf.Area= 2,798 sf Storage= 2,922 cf

Plug-Flow (detention time = (not calculated, outflow precedes inflow)
 Center-of-Mass del. time = 27.4 min (788.4 / 767.0)

Volume #1	Invert 29.74'	Avail.Storage 15,034 cf	Storage Description Custom Stage Data (Prismatic) Listed below (Recalc)
-----------	---------------	-------------------------	---

Elevation (feet)	Surf Area (sq-ft)	Inc Store (cubic-feet)	Cum.Store (cubic-feet)
29.74	1	0	0
32.25	10	14	14
33.00	1,712	646	660
34.00	3,639	2,676	3,335
35.00	4,860	4,250	7,585
36.00	6,138	5,499	13,084

Device	Routing	Invert	Outlet Devices
#1	Secondary	32.75'	StormFilter Discharge X 19.00 Discharges@29.75' Turns Off@29.75'
#2	Primary	33.80'	6.0" W x 3.0" H Vert. Orifice/Grate C= 0.600
#3	Primary	34.15'	21.0" W x 6.0" H Vert. Orifice/Grate C= 0.600
#4	Primary	34.75'	12.0" W x 4.0" H Vert. Orifice/Grate C= 0.600
#5	Primary	35.50'	20.0" x 20.0" Horiz. Grate C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.27 cfs @ 12.52 hrs HW=34.12' (Free Discharge)

- ↑ 2=Orifice/Grate (Orifice Controls 0.27 cfs @ 2.15 fps)
- ↑ 3=Orifice/Grate (Controls 0.00 cfs)
- ↑ 4=Orifice/Grate (Controls 0.00 cfs)
- ↑ 5=Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.95 cfs @ 4.60 hrs HW=32.73' (Free Discharge)

- ↑ 1=StormFilter Discharge (Pump Controls 0.95 cfs)

1564-06 Drainage Calculations

Prepared by Hewlett-Packard Company

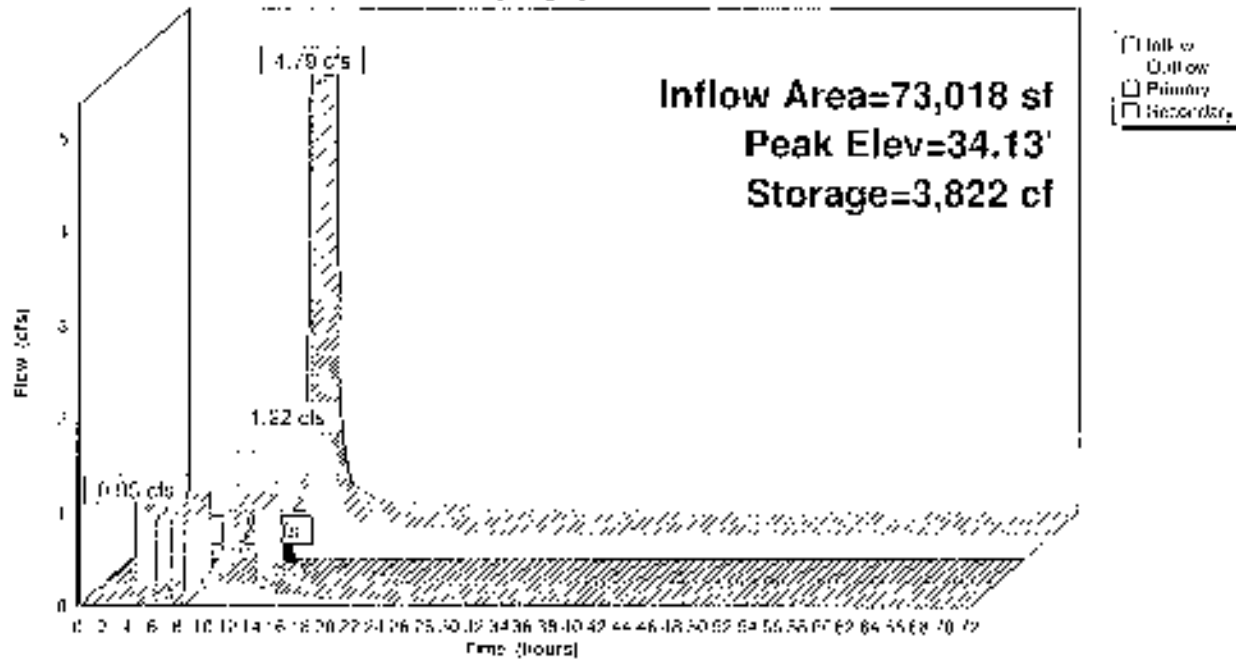
HydroCAD® 11.0111-21 s/n 04841 © 2011 HydroCAD Software Solutions LLC

NOAA 24-hr C 2-Year Rainfall 3.31"

Printed 2/4/2020

Pond B-01: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24 hr C 10-Year Rainfall 5.06"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-01: To B-01

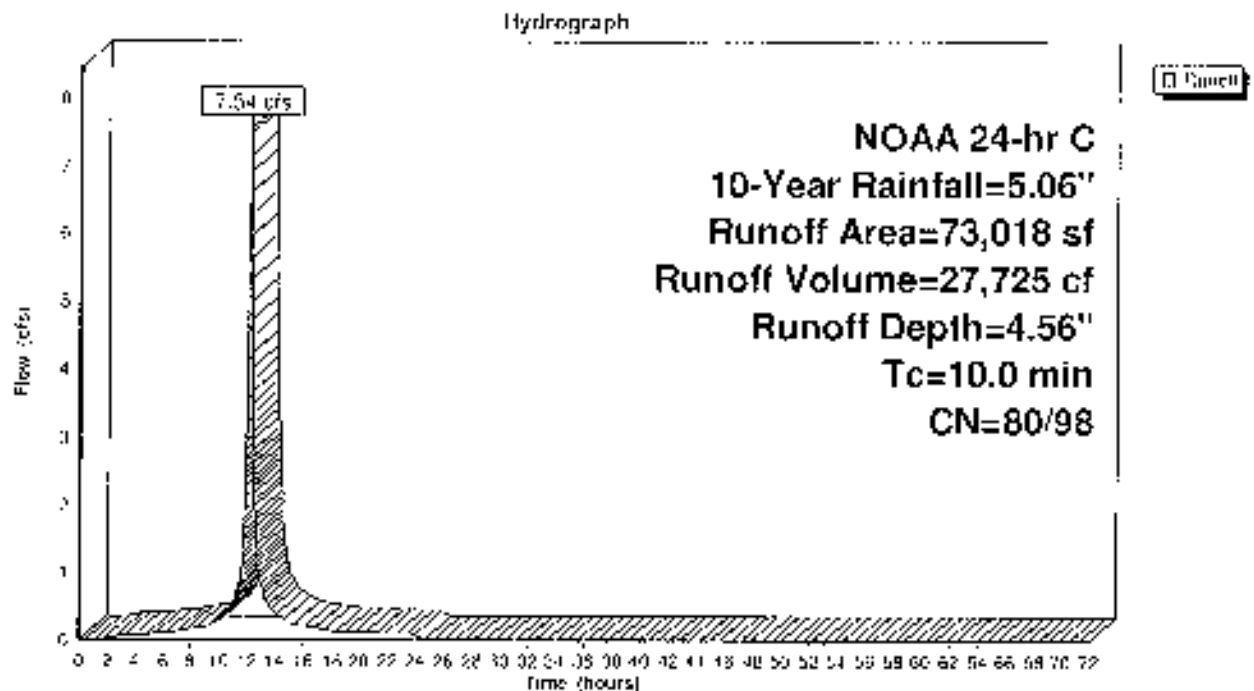
Runoff - 7.54 cfs @ 12.17 hrs, Volume= 27,725 cf, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 10-Year Rainfall=5.06"

Area (sf)	CN	Description
27,476	98	Paved parking, HSG D
25,175	98	Roofs, HSG D
10,367	80	>75% Grass cover, Good, HSG D
73,018	85	Weighted Average
10,367	80	14.20% Pervious Area
62,651	98	85.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-01: To B-01



1564-06 Drainage Calculations

NOAA 24-hr C 10-Year Rainfall 5.06"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-02: To Glassboro Rd.

Runoff = 0.53 cfs @ 12.17 hrs, Volume= 1,949 cf, Depth= 3.24"

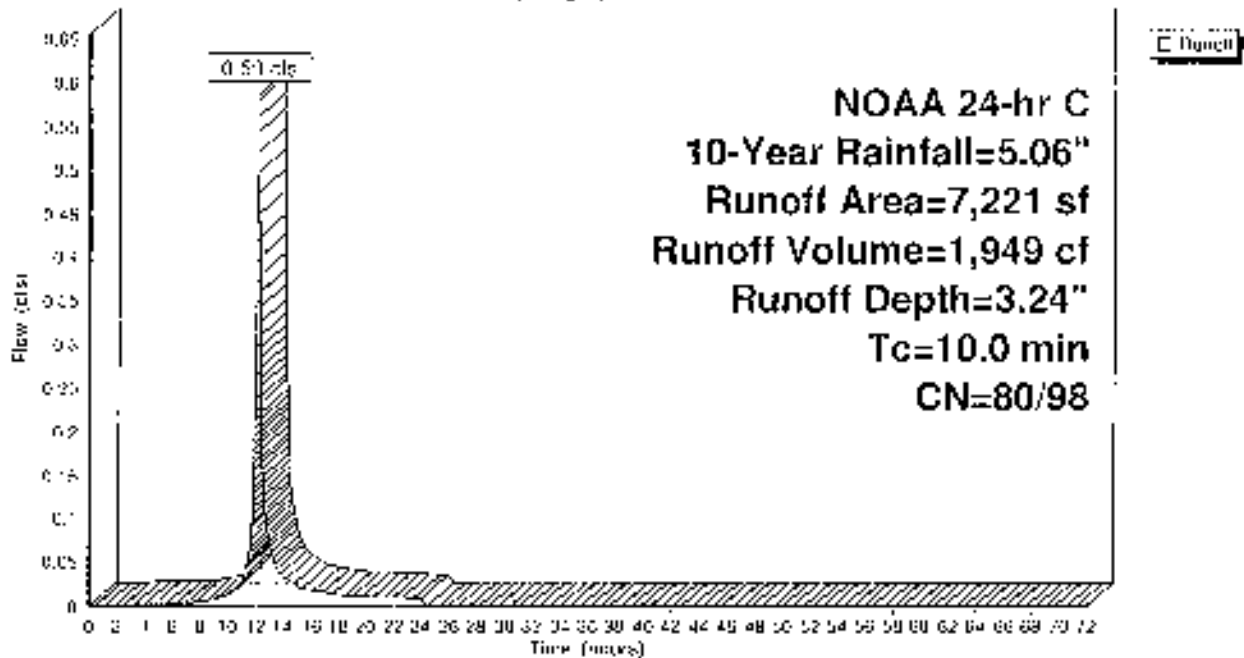
Runoff by SCS TR 20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00 72.00 hrs, dt= 0.01 hrs
 NOAA 24 hr C 10-Year Rainfall=5.06"

Area (sf)	CN	Description
1,131	98	Paved parking, HSG D
6,090	80	>7% Grass cover, Good, HSG D
7,221	83	Weighted Average
6,090	80	84.34% Pervious Area
1,131	98	15.66% Impervious Area

To (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr G 10-Year Rainfall 5.06"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Pond B-01: To Glassboro Rd.

[B7] Warning: Oscillations may require smaller dt or Finer Routing (severity=19)

Inflow Area = 73,018 sf, 65.80% Impervious Inflow Depth = 4.56" for 10 Year event
 Inflow - 7.54 cfs @ 12.17 hrs. Volume= 27,725 cf
 Outflow - 3.45 cfs @ 12.34 hrs. Volume= 27,734 cf, Atten= 54%, Lag= 10.4 min
 Primary - 2.49 cfs @ 12.34 hrs. Volume= 4,892 cf
 Secondary - 0.95 cfs @ 3.23 hrs. Volume= 22,842 cf

Routing by Dyn-Store-Ind method, Time Span= 0.00-72.00 hrs. dt= 0.01 hrs
 Peak Elev= 34.65' @ 12.34 hrs Surf.Area= 4,432 sf Storage= 5,955 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
 Center-of-Mass det. time= 21.5 min (780.8 / 759.3)

Volume #1	Invert	Avail.Storage	Storage Description
	29.74'	13,084 cf	Custom Stage Data (Prismatic) Listed below (Ficalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum Store (cubic-feet)
29.74	1	0	0
32.25	10	14	14
33.00	1,712	646	660
34.00	3,659	2,676	3,335
35.00	4,860	4,250	7,585
36.00	6,138	5,499	13,084

Device	Routing	Invert	Outlet Devices
#1	Secondary	32.75'	StormFilter Discharge X 19.00 Discharges@29.75' Turns Off@29.75'
#2	Primary	33.80'	6.0" W x 3.0" H Vert. Orifice/Grate C= 0.500
#3	Primary	34.15'	21.0" W x 6.0" H Vert. Orifice/Grate C= 0.600
#4	Primary	34.75'	12.0" W x 4.0" H Vert. Orifice/Grate C= 0.600
#5	Primary	35.50'	20.0" x 20.0" Horiz. Grate C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.49 cfs @ 12.34 hrs HW=34.65' (Free Discharge)
 ↑ 2=Orifice/Grate (Orifice Controls 0.51 cfs @ 4.05 fps)
 ↓ 3=Orifice/Grate (Orifice Controls 1.99 cfs @ 2.27 fps)
 ↓ 4=Orifice/Grate (Controls 0.00 cfs)
 ↓ 5=Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.95 cfs @ 3.23 hrs HW=32.73' (Free Discharge)
 ↑ 1=StormFilter Discharge (Pump Controls 0.95 cfs)

1564-06 Drainage Calculations

Prepared by Hewlett-Packard Company

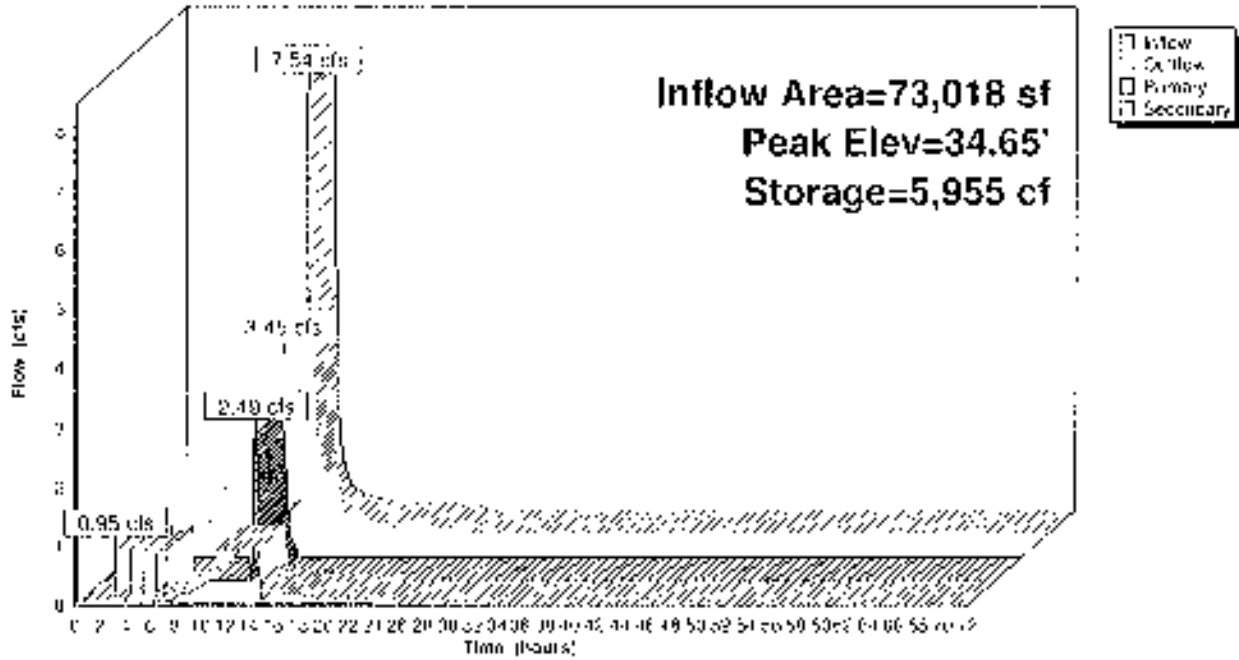
HydroCAD® 10.00-21 s/n 0484 © 2019 HydroCAD Software Solutions LLC

NOAA 24-hr C 10-Year Rainfall=5.06"

Printed 2/4/2020

Pond B-01: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 25-Year Rainfall=6.28"

Prepared by Hewlett-Packard Company

Printed: 2/4/2020

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Summary for Subcatchment DA-01: To B-01

Runoff = 9.47 cfs @ 12.17 hrs. Volume= 35,028 cf, Depth= 5.76"

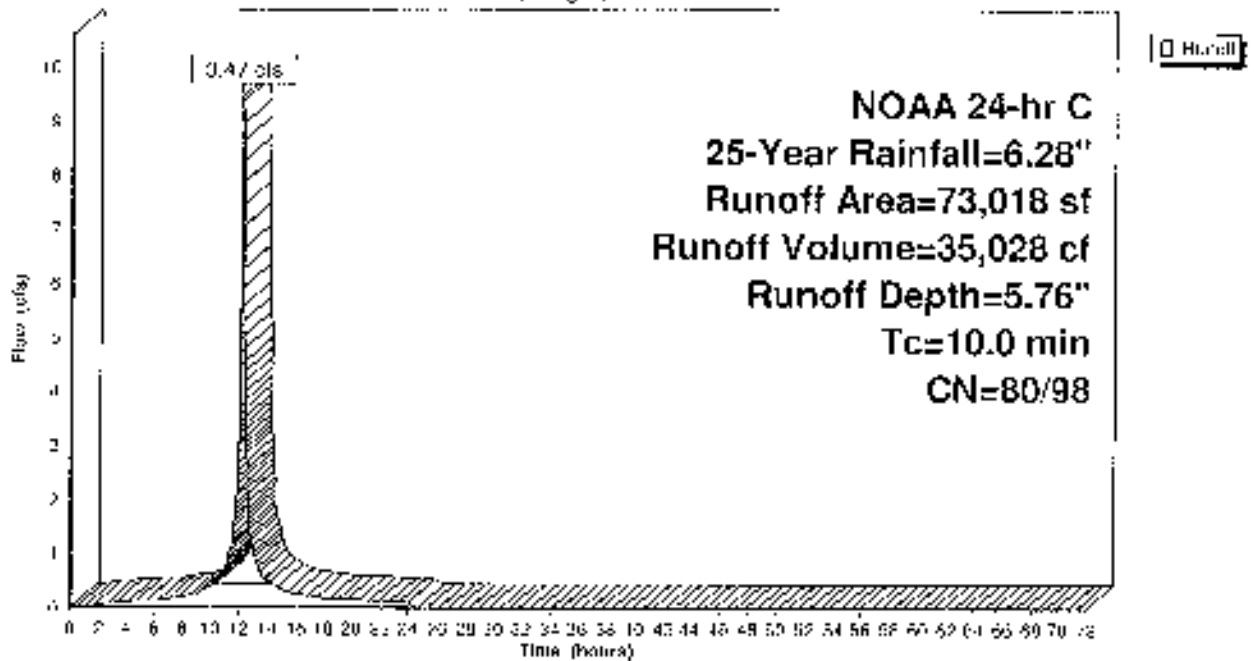
Runoff by SCS TR-20 method, UH-SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 25-Year Rainfall=6.28"

Area (sf)	CN	Description
37,176	98	Paved parking, HSG D
25,175	98	Roofs, HSG D
10,367	90	>75% Grass cover, Good, HSG D
73,018	95	Weighted Average
10,367	90	14.20% Pervious Area
62,651	98	85.80% Impervious Area

Lc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry

Subcatchment DA-01: To B-01

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 25-Year Rainfall=6.28"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-02: To Glassboro Rd.

Runoff = 0.78 cfs @ 12.17 hrs, Volume= 2,617 cf, Depth= 4.35"

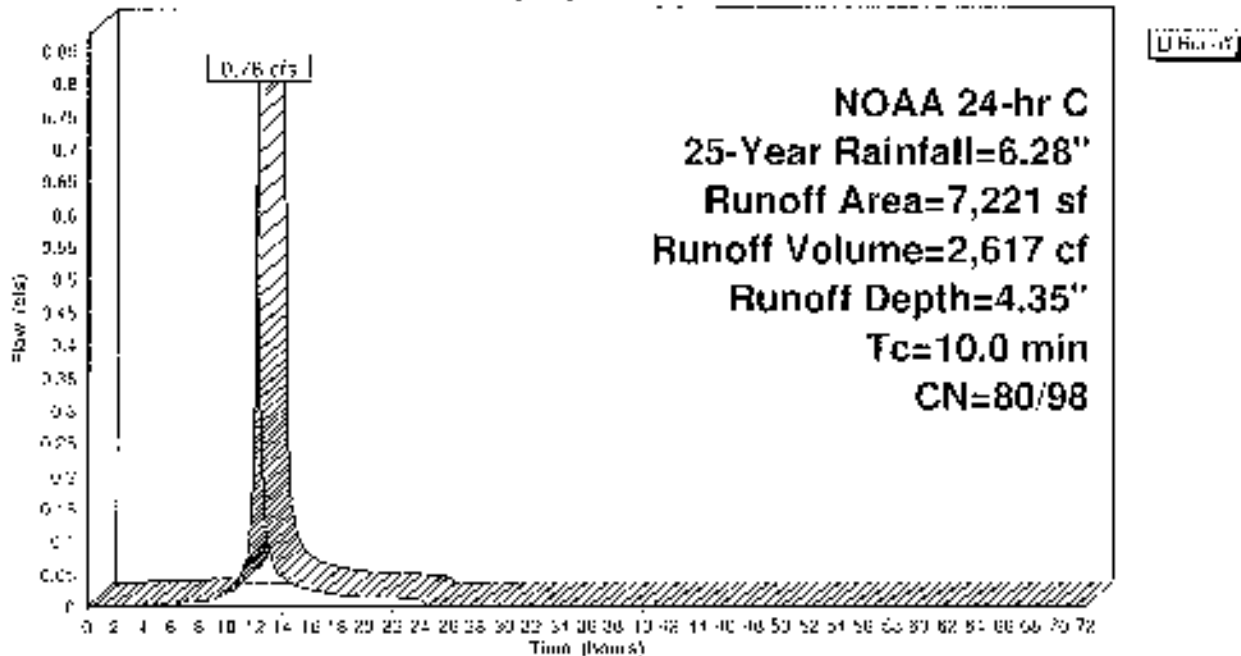
Runoff by SCS TR 20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 25-Year Rainfall=6.28"

Area (sf)	CN	Description
1,131	98	Paved parking, HSG D
6,090	80	>75% Grass cover, Good, HSG D
7,221	83	Weighted Average
6,090	80	84.34% Pervious Area
1,131	98	15.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 25-Year Rainfall=6.28"

Prepared by Howlett-Packard Company

Printed 2/4/2020

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Summary for Pond B-01: To Glassboro Rd.

[E7] Warning: Oscillations may require smaller dt or Finer Routing (severity=15)

Inflow Area = 73,018 sf, 85.80% Impervious, Inflow Depth = 5.76' for 25-Year event
 Inflow = 9.47 cfs @ 12.17 hrs, Volume= 35,028 cf
 Outflow = 4.92 cfs @ 12.32 hrs, Volume= 35,028 cf, Atten= 48%, Lag= 8.7 min
 Primary = 3.97 cfs @ 12.32 hrs, Volume= 8,513 cf
 Secondary = 0.95 cfs @ 2.69 hrs, Volume= 26,493 cf

Routing by Dyn-Step-Ind method, Time Span= 0.00-72.00 hrs. dt 0.01 hrs
 Peak Elev= 34.95' @ 12.32 hrs Surf.Area= 4,793 sf Storage= 7,321 cf

Plug-Flow detention time = (not calculated; outflow precedes inflow)
 Center-of-Mass det. time = 20.4 min (776.3 - 755.9)

Volume	Invert	Avail. Storage	Storage Description
#1	29.74'	13,084 cf	Custom Stage Data (Prismatic) Listed below (Recall)
Elevation (feet)	Surf. Area (sq-ft)	Inc. Store (cubic-foot)	Cum. Store (cubic-foot)
29.74	1	0	0
32.75	10	14	14
33.00	1,712	646	660
34.00	3,639	2,676	3,336
35.00	4,660	4,250	7,586
36.00	6,138	5,499	13,084

Device	Routing	Invert	Outlet Devices
#1	Secondary	32.75'	StormFilter Discharge X 19.00 Discharges@29.75' Turns Off@29.75'
#2	Primary	33.90'	6.0" W x 3.0" H Vert. Orifice/Grate C= 0.600
#3	Primary	34.15'	21.0" W x 6.0" H Vert. Orifice/Grate C= 0.600
#4	Primary	34.75'	12.0" W x 4.0" H Vert. Orifice/Grate C= 0.600
#5	Primary	35.50'	20.0" x 20.0" Horiz. Grate C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.97 cfs @ 12.32 hrs HW=34.95' (Free Discharge)

- ↑ 2=Orifice/Grate (Orifice Controls 0.61 cfs @ 4.86 fps)
- ↑ 3=Orifice/Grate (Orifice Controls 3.08 cfs @ 3.52 fps)
- ↑ 4=Orifice/Grate (Orifice Controls 0.26 cfs @ 1.42 fps)
- ↑ 5=Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.95 cfs @ 2.69 hrs HW=32.73' (Free Discharge)

- ↑ 1=StormFilter Discharge (Pump Controls 0.95 cfs)

1564-06 Drainage Calculations

Prepared by Hewlett-Packard Company

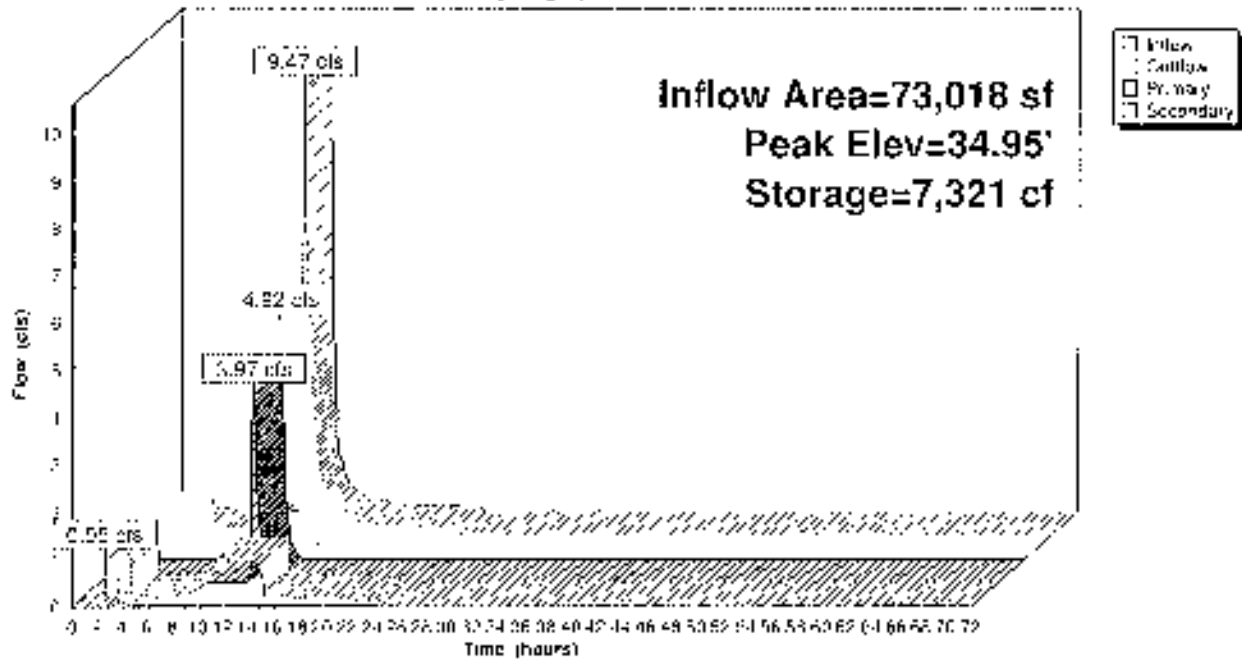
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NOAA 24-hr C 25-Year Rainfall=6.28"

Printed 2/4/2020

Pond B-01: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 100-Year Rainfall=8.52"

Prepared by Hewlett-Packard Company

Printed: 2/1/2020

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Summary for Subcatchment DA-01: To B-01

Runoff = 13.01 cfs @ 12.17 hrs, Volume= 48,511 cf, Depth= 7.97"

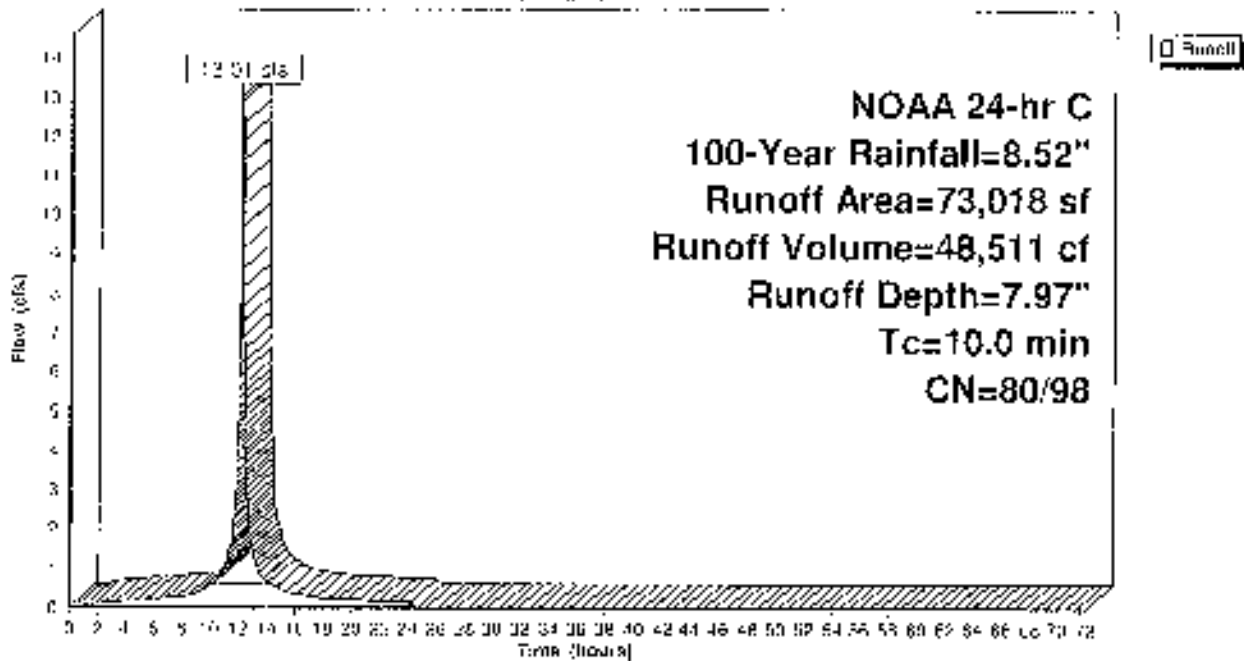
Runoff by SCS TR-20 method, UH-SCS, Split: Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 100-Year Rainfall=8.52"

Area (sf)	CN	Description
37,476	98	Paved parking, HSG D
25,175	98	Roofs, HSG D
10,367	80	>75% Grass cover, Good, HSG D
73,018	95	Weighted Average
10,367	90	1<.20% Pervious Area
62,651	98	85.80% Impervious Area

Lc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry

Subcatchment DA-01: To B-01

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr C 100-Year Rainfall=8.52"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Subcatchment DA-02: To Glassboro Rd.

Runoff = 1.14 cfs @ 12.17 hrs. Volume= 3,883 cf. Depth= 6.45"

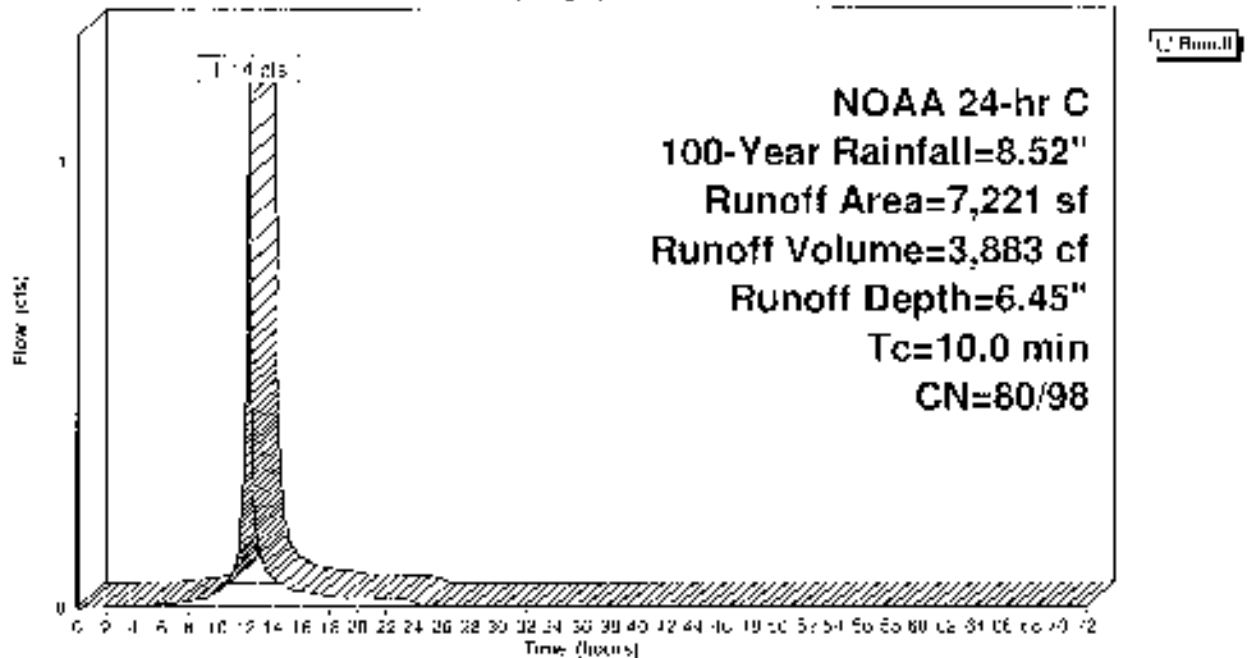
Runoff by SCS IH-25 method, LH=SCS, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 NOAA 24-hr C 100-Year Rainfall=8.52"

Area (sf)	CN	Description
1,131	98	Paved parking, HSG D
6,090	80	>75% Grass cover, Good, HSG D
7,221	83	Weighted Average
6,090	80	84.34% Pervious Area
1,131	98	15.66% Impervious Area

To (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment DA-02: To Glassboro Rd.

Hydrograph



1564-06 Drainage Calculations

NOAA 24-hr G 100-Year Rainfall=8.52"

Prepared by Hewlett-Packard Company

Printed 2/4/2020

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Summary for Pond B-01: To Glassboro Rd.

(8.7) Warning: Oscillations may require smaller dt or Finer Routing (seventy-10)

Inflow Area = 73,018 sf, 85.60% Impervious, Inflow Depth = 7.97" for 100-Year event
 Inflow = 13.01 cfs @ 12.17 hrs, Volume= 48,511 cf
 Outflow = 7.15 cfs @ 12.30 hrs, Volume= 48,509 cf, Atten= 45%, Lag= 8.9 min
 Primary = 6.20 cfs @ 12.30 hrs, Volume= 15,911 cf
 Secondary = 0.95 cfs @ 2.07 hrs, Volume= 22,598 cf

Routing by Dyn-Store-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 35.45' @ 12.30 hrs Surf.Area= 5,429 sf Storage= 13,876 cf

Plug-Flow detention time= (not calculated, outflow precedes inflow)
 Center-of-Mass det. time= 19.9 min (771.4 - /61.5)

Volume	Invert	Avail.Storage	Storage Description
#1	29.74'	13,084 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
29.74	1	0	0
32.25	10	14	14
33.00	1,712	646	660
34.00	3,638	2,676	3,336
35.00	4,860	4,250	7,586
36.00	6,138	5,499	13,084

Device	Routing	Invert	Outlet Devices
#1	Secondary	32.75'	StormFilter Discharge X 19.00 Discharges@29.75' Turns Off@29.75'
#2	Primary	33.80'	6.0" W x 3.0" H Vert. Orifice/Grate C= 0.600
#3	Primary	34.15'	21.0" W x 6.0" H Vert. Orifice/Grate C= 0.600
#4	Primary	34.75'	12.0" W x 4.0" H Vert. Orifice/Grate C= 0.600
#5	Primary	35.50'	20.0" x 20.0" Horiz. Grate C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=6.20 cfs @ 12.30 hrs HW=35.45' (Free Discharge)

- ↑ 2=Orifice/Grate (Orifice Controls 0.74 cfs @ 5.93 fps)
- 3=Orifice/Grate (Orifice Controls 4.90 cfs @ 4.91 fps)
- 4=Orifice/Grate (Orifice Controls 1.16 cfs @ 3.49 fps)
- 5=Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.95 cfs @ 2.07 hrs HW=32.74' (Free Discharge)

- ↑ 1=StormFilter Discharge (Pump Controls 0.95 cfs)

1564-06 Drainage Calculations

Prepared by Hewlett-Packard Company

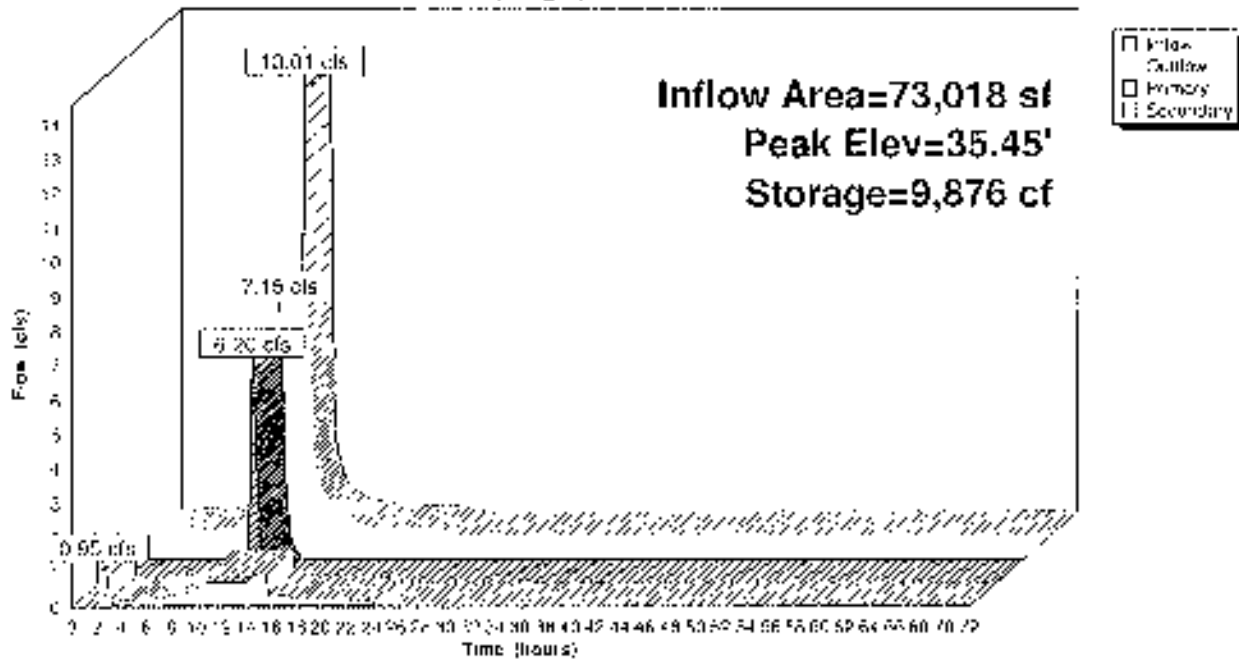
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NOAA 24-hr C 100 Year Rainfall=8.52"

Printed 2/4/2020

Pond B-01: To Glassboro Rd.

Hydrograph



**NEW JERSEY SOIL EROSION & SEDIMENT CONTROL STANDARDS
FOR
CONDUIT OUTLET PROTECTION**

25 Year Storm
Structure: FFS-1

DESIGN CRITERIA:		APRON DIMENSIONS	
Design Storm	25 yr	Length	19.07 Ft
Flow Rate (Q)	8.73 CFS	Width of Culvert	4.50 Ft
Culvert Inlet Dia.	1.50 Ft	Width @ End	28.87 Ft
Tailwater Depth	0.70 Ft	D(50) calc.	8 in
Filter Fabric Used ¹	5 (Y/N)	D(50) to be used	8 in
D(50) min.	4 in	Thickness	17 in

SCOUR HOLE DIMENSIONS	
Culvert Vent Dia.	1.50 Ft
Depth of Hole	0.75 Ft
Length of Bottom	4.50 Ft
Width of Bottom	3.00 Ft
Length of Scour Hole	9.00 Ft
Width of Scour Hole	7.50 Ft
D(50) calc.	5 in
D(50) to be used	5 in
Thickness	11 in

SCOUR HOLE DIMENSIONS	
Culvert Vent Dia.	1.50 Ft
Depth of Hole	1.50 Ft
Length of Bottom	4.50 Ft
Width of Bottom	3.00 Ft
Length of Scour Hole	13.50 Ft
Width of Scour Hole	12.00 Ft
D(50) calc.	3 in
D(50) to be used	4 in
Thickness	5 in

EMERGENCY SPILLWAY DESIGN

Discharge Coefficient	2.8
Design Storm	100 yr.
Equation	$Q = C1.13^{1.7}$

The spillways are designed such that the entire inflow for 100 year storm event will safely pass through the spillways and the outlet structures are assumed to be blocked.

Detention Basin #1

Length	15.00 ft.
Outflow	1,361 cfs
Water Height	0.46 ft.
Velocity	1.74 ft/sec

SEDIMENT BASIN

- C** = Total Capacity of Basin
I = Average Annual Surface Runoff Ac./Yr.

Disturbed Areas:

Basin #1	=	1.68	Ac.
Total		1.68	Ac.

Median Curve (Curve 24-1)

70% Trap Efficiency

C = 1 = 0.045 (75% Efficiency on the Median Curve)

Average Annual Surface Runoff (in) = 18 (Figure 24-1)

$$I = (18 \times 12") \times 1.68 = 2.52 \text{ Ac./Yr.}$$

$$C = 2.52 \times 0.045 = 0.11 \text{ Ac./Yr.} = 4,939.70 \text{ Cu./Yr.}$$

2-Year Storm Volume Method (Per page 24-4, Table 24-1 & Curve 24-2)				
Sediment Volume =	463	Cu./Yr.	DA =	1.68
Storm Volume =	17,350	Cu./Yr.	A =	50
Total Volume =	17,813	Cu./Yr.	DR =	90

Basin Capacity at elevation = 36.00 = 13,084 Cu./Yr.

All inlets shall be covered with filter fabric during construction. Inlet #13 shall be plugged and the grate of the outlet control structure shall be covered during construction.



June 13, 2019

Terrence H. Combs PP, LLA
The Pettit Group, LLC
497 Center Street
Sewell, NJ 08080

RE: Stormwater Investigation Letter

Site Address: Block 38, Lots 3 & 11
Woodbury Heights, Gloucester City, New Jersey

Project #: 20191067

Dear Mr. Combs:

Acer Associates, LLC (ACER) was retained by The Pettit Group, LLC (Pettit) to perform a stormwater investigation at the above referenced site address. This letter serves to summarize the results of our investigation.

FIELD INVESTIGATION

At the request of Pettit, ACER mobilized to the site on June 5 and June 6, 2019 in order to perform a subsurface investigation for proposed stormwater management facilities. A total of four (4) test pits, referenced as TP-1 through TP-4, were conducted at locations selected by Pettit, and field located by ACER during our investigation. The test pits were excavated to depths ranging from approximately 5 to 7 feet below ground surface (bgs). The soils encountered within the test pits were visually analyzed and classified in the field using the United States Department of Agriculture (USDA) Textural Soil Classification System.

In order to evaluate the permeability of the soils within these locations, ACER performed field percolation testing within test holes installed adjacent to the aforementioned test pit locations. Four (4) percolation tests, referenced as PT-1 through PT-4, were performed adjacent to test pits TP-1 through TP-4, respectively, at depths ranging from approximately 1 to 1.5 feet bgs. The percolation testing was conducted in accordance with the *NJ Stormwater BMP Manual – Appendix E*.

The locations of the test pits are shown on the *Test Location Plan* included in Attachment A. Soil descriptions, depths to compositional changes, and groundwater information encountered in the test pits were recorded in the field, and are presented in the *Test Pit Logs* included in Attachment B, and are summarized in the following sections.



Summary of Subsurface Conditions Encountered

Test pit TP-1 was advanced to a depth of approximately 5 feet bgs. The surface at the test pit location was covered by an approximately 8-inch thick layer of topsoil, which was underlain by fill consisting of strong brown sandy loam to pale yellow loam sand with brick fragments to a depth of approximately 3 feet bgs, which was underlain by very dark clay to the termination depth of the test pit excavation. Within this test pit, the groundwater table was encountered at approximately 2 feet bgs. Prominent redoximorphic features, are often indicators of the seasonal high groundwater table, could not be identified within this test pit. Percolation test PT-1 was performed within an 8-inch diameter borehole, installed adjacent to test pit TP-1, at a depth of approximately 1 foot bgs. The soils at this depth were found to have a percolation rate exceeding 60 minutes per inch.

Test pit TP-2 was advanced to a depth of approximately 5 feet bgs. The surface at the test pit location was covered by an approximately 12-inch thick layer of topsoil with concrete and brick fragments, which was underlain by yellowish brown sandy clay to a depth of approximately 2 feet bgs, which was underlain by gray sandy clay to the termination depth of the test pit excavation. Within this test pit the groundwater table was encountered at approximately 2.7 feet bgs. Prominent redoximorphic features, which may be indicators of the seasonal high groundwater table, were observed at approximately 2 feet bgs. Percolation test PT-2 was performed within an 8-inch diameter borehole, installed adjacent to test pit TP-2, at a depth of approximately 1 foot bgs. The soils at this depth were found to have a percolation rate exceeding 60 minutes per inch.

Test pit TP-3 was advanced to a depth of approximately 7 feet bgs. The surface at the test pit location was covered by an approximately 18-inch thick layer of topsoil with many roots and cloth fabric debris, which was underlain by strong brown sandy clay to a depth of approximately 3 feet bgs, which was underlain by gray sandy clay to the termination depth of the test pit excavation. Within this test pit the groundwater table was encountered at approximately 5 feet bgs. Prominent redoximorphic features, which may be indicators of the seasonal high groundwater table, were observed at approximately 3 feet bgs. Percolation test PT-3 was performed within an 8-inch diameter borehole, installed adjacent to test pit TP-3, at a depth of approximately 1.5 feet bgs. The soils at this depth were found to have a percolation rate exceeding 60 minutes per inch.

Test pit TP-4 was advanced to a depth of approximately 7 feet bgs. The surface at the test pit location was covered by an approximately 18-inch thick layer of topsoil with many roots, vinyl flooring debris and metal fragments, which was underlain by brownish yellow sandy clay with trace gravel and cobbles, which was underlain by gray sandy clay to the termination depth of the test pit excavation. Within this test pit the groundwater table was encountered at approximately 5 feet bgs. Prominent redoximorphic features, which may be indicators of the seasonal high groundwater table, were observed at approximately 3 feet bgs. Percolation test



PT-4 was performed within an 8-inch diameter borehole, installed adjacent to test pit TP-4, at a depth of approximately 1.5 feet bgs. The soils at this depth were found to have a percolation rate exceeding 60 minutes per inch.

Bedrock

The competent bedrock surface was not encountered within any of the test pit excavations.

Seasonal High Groundwater Table Evaluation

As part of our investigation, ACER reviewed the subsurface for the indicators of the seasonal high groundwater table.

These seasonal high groundwater indicators are produced during periods of alternating wetting and drying cycles, in which periodic saturated conditions, coupled with rapid drying in areas around pores, cracks and root channels, may produce soil conditions characterized by blotches of gray and reddish-brown soil colors occurring at the same depth. This pattern of spots or blotches of different color, or shades of color interspersed with the dominant color, is referred to as "redoximorphic features", which is often indicative of the seasonal high groundwater table.

Based on ACER's review of the subsurface profile within the test pits, prominent redoximorphic features, which may represent the seasonal high groundwater table, were observed within test pits TP-2, TP-3 and TP-4 at depths ranging from approximately 1 to 1.5 feet bgs.

Redoximorphic features could not be clearly identified within test pit TP-1; however, the seasonal high groundwater table at this location should be assumed to be no deeper than the observed groundwater table of 2 feet bgs at the time of ACER's subsurface investigation.

Groundwater

As previously stated, groundwater was encountered within all the test pits performed at the site, at depths ranging from approximately 2 to 5 feet bgs. It should be noted that these observations were made at the time of the field investigation and that groundwater table elevations may vary with daily, seasonal, and climatic variations.

Percolation Testing

As previously discussed, four (4) percolation tests, referenced as PT-1 through PT-4, were performed at the site within 8-inch diameter auger holes installed adjacent to test pits TP-1 through TP-4, respectively. The tests were performed at depths ranging from approximately 1 foot to 1.5 feet bgs, following discussions with Pettit following the test pit operation. The



results of the percolation tests, which were performed in accordance with the *NJ Stormwater BMP Manual – Appendix E*, are presented below.

Results of Field Percolation Testing

Test No.	Location	Depth	Soil Description	Permeability Rate
PT-1	IP-1	1 foot	FILL consisting of strong brown (7.5YR 5/8) sandy loam to pale yellow (7.5YR 8/4) silty sand, with brick fragments; structureless, loose	Not Determined* (> 60 min/in)
PT-2	TP-2	1 foot	Yellowish brown (10YR 5/8) sandy clay, strong, medium, subangular blocky; friable	Not Determined* (> 60 min/in)
PT-3	IP-3	1.5 feet	Strong brown (7.5YR 5/6) sandy clay; strong, medium, subangular blocky, friable	Not Determined* (> 60 min/in)
PT-4	TP-4	1.5 feet	Brownish yellow (10YR 5/6) sandy clay, trace gravel, cobbles moderate, medium, subangular blocky	Not Determined* (> 60 min/in)

*As per *NJ Stormwater BMP Manual – Appendix E*, permeability rates cannot be determined for measured percolation rates slower than 60 minutes per inch.

LIMITATIONS

This letter was prepared for The Pettit Group, LLC of Sewell, New Jersey.

The conclusions and recommendations contained in this letter are based upon the subsurface data collected and on details stated in this letter. Should these conditions arise which differ from those specifically stated herein, our office should be notified immediately so that our recommendations can be reviewed and revised, if necessary.

The test pit logs are ACER's interpretation of the subsurface conditions found by collecting samples within the test pits as they progressed downward. Detailed soil descriptions and interfaces between each stratum are interpretive, and actual changes are gradational. The test pit logs are descriptive only of the subsurface conditions in the specific locations of the excavations at the exact time the test pits were performed. Subsurface conditions at other locations in the project area may differ from those in the location of the test pits.

ACER does not assume any responsibility in using this letter to generate design other than at the specific site addressed.



Should you have any questions or require additional information, please call our office at (856) 809-1202.

Prepared By:

Steven W. Speak
Project Manager

Reviewed By:

J. Scott Horn, PG, CHMM
President

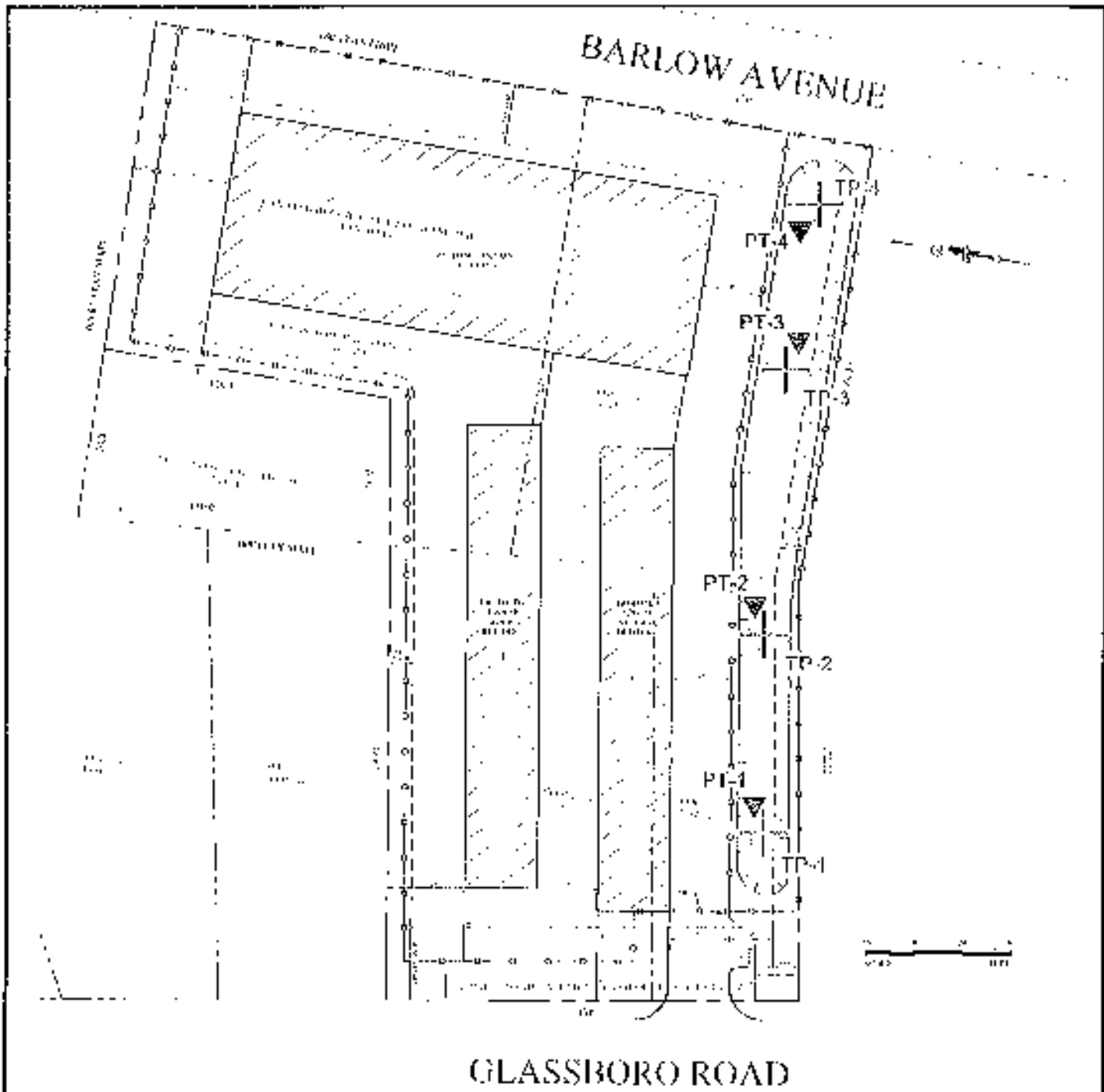
Attachments:

- A. Test Location Plan
- B. Test Pit Logs



ATTACHMENT A

TEST LOCATION PLAN



TEST LOCATION PLAN

Proposed Stormwater Management Facilities
 Block 38, Lots 3 & 11
 Woodbury Heights, Gloucester County, NJ

- TP-# — Indicates number and approximate location of test pit excavation
- PT-# ▼ Indicates number and approximate location of field percolation test



ACER ASSOCIATES, LLC
 1012 INDUSTRIAL DRIVE
 WEST BERLIN, NEW JERSEY 08091
 Tel (856)-809-1202 / Fax (856)-809-1203



ATTACHMENT B

TEST PIT LOGS



ACER ASSOCIATES, LLC

Environmental & Geotechnical Services

Project Proximal Site Water Monitoring Facility & Location Woodbury Heights Gloucester County, New Jersey		Project Number 20191067	SR	Started: 05/29/19
Excavating Contractor Donnelly Excavating		Client The PHL Group, LLC		Completed: 06/20/19
Test Pit No. TP 1	Logged By GWS	Surface Elev. (Estimated) 216	Groundwater Depth: 2	

Depth (feet)	Depth (feet)	Percolation Test Data	Graphic Log	Description	Remarks
0	0.5	PT-1 @ 1 > 50 minutes/inch		approx 1.5' Fill consisting of strong brown (7.5YR 4/3) sandy loam to pale yellow (7.5YR 8/4) heavy sand with black fragments, structureless, loose, diffuse, irregular boundary.	Seasonal High Water Table Not Determined
3	3.5			Very dark gray (10YR 3/1) clay, moderate, medium, subangular, blocky, sticky, diffuse, irregular boundary.	
5				END OF TEST PIT AT 3 FEET	
10					
15					
20					
25					



Saturated Groundwater



Groundwater at Time of Test Pit

Test Pit Log Sheet 1 of 1



ACER

ASSOCIATES, LLC

Environmental & Geotechnical Services

Project Proposed Stormwater Management Facilities		Project Number DC-01067	Date Started: 8/5/2015 Completed: 8/6/2015
Location Wardensburg Heights, Gloucester County, New Jersey		Client The Perol Group LLC	
Excavating Contractor Donnelly Excavating		Excavator Type Rubber-tire backhoe	
Test Pit No. TP-2	Logged By. GWS	Surface Elev. (estimate) N/A	Groundwater Depth 2.7

Depth (feet)	Depth (feet)	Percolation Test Data	Graphic Log	Description	Remarks
0.1	0.1	PT-2 @ 1' > 60 minutes/inch		Tan soil, with calcareous and hard fragments (12")	Seasonal High Water Table @ 2'
1.2	1.2			Yellowish brown (10YR 5/6); sandy clay; strong medium, subangular blocky, friable, clear, wavy boundary	
2.5	2.5			Gray (7.5YR 5/1); sandy clay; weak to coarse, prismatic, recombining features (5YR 5/8); strong medium, subangular blocky, stony, gradual, irregular boundary	
				END OF TEST PIT AT 5 FEET	
5					
10					
15					
20					
25					



Stabilize Groundwater



Groundwater At Time of Test Pit



ACER ASSOCIATES, LLC

Environmental & Geotechnical Services

Project: Proposed Sewer Management Facilities		Project Number: 2019-0087	Date: 6/5/2019
Location: Woodbury Heights, Gloucester County, New Jersey		Client: The Pezzi Group LLC	Completed: 6/5/2019
Excavating Contractor: Dorville Excavating		Excavator Type: Rubber-tire backhoe	
Test Pit No: TP-3	Logged By: SWS	Surface Elev. (feet/meter): N/A	Groundwater Depth: 5'

Depth (feet)	Depth (feet)	Percolation Test Data	Graphic Log	Description	Remarks
0	0 - 1.5	PT-3 @ 1.5' > 50 in/100sqft		<p>0 - 1.5 ft: Fossil. with many roots, cloth fabric debris (10')</p> <p>1.5 - 3 ft: Strong brown (7.5YR 5/6) sandy clay, strong, medium subangular blocky fracture, clear irregular boundary</p> <p>3 - 7 ft: Gray (10YR 5/1) sandy clay with many, common prominent root-like features (7.5YR 5/6) strong, medium subangular blocky, sticky, clear irregular fracture</p>	<p>Searchlight Water Tank @ 3'</p>
1.5	3 - 7			END OF TEST PIT AT 7 FEET	
7.5					




ACER

ASSOCIATES, LLC

Environmental & Geotechnical Services

Project: Proposed Stormwater Management Facilities	Project Number: 2019-057	Start/End Date: Started: 5/5/2019 Completed: 5/26/2019
Location: Montbary Heights, Gloucester County, New Jersey	Client: The Hill Group, LLC	
Excavating Contractor: Dorland Foundation	Excavator Type: Rubber-tired backhoe	Groundwater Depth: 5
Test Pit No.: TP-4	Logged By: SWS	

Depth (feet)	Depth (feet)	Percolation Test Data	Graphic Log	Description	Remarks
0 - 1.5				Topsoil, with many roots, vinyl flooring debris, metal fragments (18")	
1.5 - 3		PT-4 @ 1.5 = 40 minutes/feet		Orange-yellow (10YR 6/6) sandy clay, trace gravel, (0.14%) moderate, medium, subangular blocky, inelastic; clay; irregular lenticular	Seasonal High Water Table @ 4"
3 - 7				Gray (7.5YR 5/1) sandy clay with many common, prominent redoximorphic features (7.5YR 5/9), strong-medium, subangular blocky, clayey, diffuse irregular boundary	
				END OF TEST PIT AT 7 FEET	



Stabilized Groundwater



Groundwater (1 Time of Test Pit)

Test Pit Log Page 1 of 1

Hydrologic Soil Group—Gloucester County, New Jersey
 11564-03 Soils Map



Map Scale: 1 Inch = 100 Feet (Horizontal Distance)



Natural Resources
 Conservation Service

Aerial and Survey
 National Cooperative Soil Survey

MAP LEGEND

Area of Interest (AOI)	<input type="checkbox"/> 1
Area of Interest (AOI)	<input type="checkbox"/> 200
Soils	
Soil Rating Polygons	
A	<input type="checkbox"/> 2
A0	<input type="checkbox"/> 3
B	<input type="checkbox"/> 4
B0	<input type="checkbox"/> 5
C	<input type="checkbox"/> 6
C0	<input type="checkbox"/> 7
D	<input type="checkbox"/> 8
Not rated or not available	<input type="checkbox"/> 9
Soil Rating Lines	
A	<input type="checkbox"/> 10
A0	<input type="checkbox"/> 11
E	<input type="checkbox"/> 12
B0	<input type="checkbox"/> 13
C	<input type="checkbox"/> 14
C0	<input type="checkbox"/> 15
D	<input type="checkbox"/> 16
Not rated or not available	<input type="checkbox"/> 17
Soil Rating Points	
A	<input type="checkbox"/> 18
A0	<input type="checkbox"/> 19
B	<input type="checkbox"/> 20
B0	<input type="checkbox"/> 21

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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

Enlargement of maps beyond the scale of mapping can cause misrepresentation 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.sc.egov.usda.gov> Web browser (IE/Firefox/887)

Maps from the Web Soil Survey are based on the Web Mercator projection which preserves east-west 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 details listed below.

Soil Survey Area: Gloucester County, New Jersey
Survey Area Date: Version 7, Sep 11, 2013

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

Datums/ aerial images were projected: Aug 11, 2014—Sep 7, 2014

The cartographic or time 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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres In ADI	Percent of ADI
FapA	Fallsington Farms, 0 to 2 percent slopes, Northern Coastal Plain	C/D	12	59.3%
USFRFA	Urban land Freehold complex, 0 to 5 percent slopes		8	40.7%
Totals for Area of Interest			21	100.0%

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

THE PERITZ-KAPLAN, LLC
 1000 WEST 10TH AVENUE, SUITE 100
 DENVER, COLORADO 80202
 (303) 733-1111

NO.	DATE	DESCRIPTION

FOR APPROVAL
 PURPOSE ONLY

THIS PLAN IS TO BE USED FOR THE PURPOSES OF THE PERMITS AND IS NOT TO BE USED FOR ANY OTHER PURPOSES.

DATE: 10/15/2013
 DRAWN BY: [Name]
 CHECKED BY: [Name]
 PROJECT NO.: [Number]

PROJECT: [Name]
 LOCATION: [Address]

OPENED
 DRAINAGE
 AREA MAP

2 of 3

