STORMWATER MANAGEMENT REPORT

For

PROPOSED RETAIL DEVELOPMENT

Prepared for:

Grunin Properties

Block 44, Lots 2, 3, 4, 5 & 9
Township of Manchester

and

Block 505, Lots 14 & 15
Township of Toms River

NJ State Highway Route 37 & Northampton Blvd.
Ocean County, New Jersey

Prepared by:

BOHLER
ENGINEERING

35 Technology Drive
Warren, NJ 07059
908-668-8300

D. F. Wisotsky, P.E.
New Jersey Professional Engineer License No. 42951

November 2017

BENJ File No. JM170508

Stormwater Management Report – NJDEP Index Page

Project Name: Proposed Retail Development
Project Location: Manchester Township and Toms River Township, Ocean County, New Jersey

The following table summarizes typical additional information as requested by the New Jersey Department of Environmental Protection. Details can be found throughout this Stormwater Management Report, Appendices and Supplemental Reports as indicated.

NJDEP Information	Location of Information
Total Amount of Land Disturbed on Site – 27+/- acres	Page 5
Acreage of New Impervious Surfaces within project site – 9+/- acres	Page 5
Type of Basin Proposed (e.g., infiltration, detention)	Page 7
Proof that Groundwater Recharge Standards are met	Page 13
Recharge Worksheet	Appendix B
Proof that Runoff Quantity Standards are met	Page 11 ~12 and Appendix A
Proof that Water Quality Standards are met	Appendix A
Low Impact Development Checklist	Appendix B
USGS and HUC-14 Site Location Map	Appendix C
Copy of the State Study Plan and Profile (N/A)	Appendix (N/A)
Permeability Test Locations	Geotechnical Report (Separate Document)
Permeability Test Results	Geotechnical Report (Separate Document)
Boring data at the proposed basin locations (if applicable)	Geotechnical Report (Separate Document)
Location of proposed basin in relation to depth of the seasonal high groundwater table	Page 10
Operations and Maintenance Manual	Operations and Maintenance Manual (Separate Document)

Table of Contents

Appendices

A. Pre-Development and Post-Development Hydrographs

- Water Quality Storm Event
- 2-Year Storm Event
- 10-Year Storm Event
- 100-Year Storm Event

B. Design Calculations

- Emergency Spillway Calculations
- Infiltration Rate and Basin Drain Time Calculations
- Recharge Calculations
- Storm Drain Sizing, Curb Cut Calculations
- Pipe Capacity Check for Underground Basin
- Scour Hole Design
- Township-Specific Requirements Evaluation
- Sediment Basin Design
- Low-Impact Development Checklist

C. Maps & Documentation

- Location Map
- USGS & HUC14 Location Map
- Soil Map
- Drainage Area Maps
  - Existing Drainage Area Map
  - Proposed Drainage Area Map

1. Introduction

The intention of this study is to analyze the stormwater drainage conditions that will occur as a result of the proposed retail development situated at the southwest corner of NJSH Route 37 and Northampton Boulevard within the townships of Manchester and Toms River, in Ocean County, New Jersey. The subject site is more specifically defined as Block 44, Lots 2, 3, 4, 5 & 9 in the Township of Manchester, and Block 505, Lots 14 and 15 in the Township of Toms River. Said lots shall be referenced herein as the Site, and are located on the USGS map and Site Location Map within the Appendix of this report. The Site consists of approximately 73+/- acres after dedication for off-site roadway improvements including NJDOT improvements. The Site is bordered to the northeast by NJSH Route 37 and a retail center with various businesses on the premises, a four-lane divided highway; to the southeast by Northampton Boulevard; to the southwest by a one-track railroad owned and operated by Conrail; and to the northwest by residential use.

The proposed development includes one (1) 111,186 SF retail building, three (3) 4,800 SF restaurants and one (1) 9,322 SF retail building. Additional improvements include parking and circulation areas, landscaping areas, stormwater management facilities, associated utilities, and related site improvements.

The scope of this study includes analysis of runoff generated by the proposed buildings, driveways, paved parking areas, and landscaped areas, as well as an analysis of the resulting stormwater collection system and the aboveground stormwater management basins as shown on the accompanying engineering drawings. The following items shall be addressed within this report:

- Narrative of pre- and post-development conditions with calculations to substantiate derived runoff coefficients and times of concentration.
- Analysis of pre-and post-development annual groundwater recharge.
- Calculations for water quality utilizing the NJDEP 1.25 inch/2-hour water quality design storm.
- Stormwater pollutant (TSS) removal.
- Calculations and comparisons of the peak runoff rates for the 2-, 10- and 100-year design storm events under pre- and post-development conditions.
- Calculations for the proposed aboveground infiltration basin system including inflow and outflow hydrographs, and a storage volume versus depth table.
- Calculations to substantiate capacity of the proposed stormwater conveyance system.

The primary design constraints for this project are based on the Township of Toms River and Township of Manchester Land Use Ordinances, the CAFRA Department of the New Jersey Department of Environmental Protection (NJDEP) rules and regulations, and Ocean County design standards, as follows:

Township of Toms River:

- NJDEP requirements must be met regarding water quantity (peak runoff rate reduction), water quality (TSS removal), and groundwater recharge.
- For detention facilities, the design frequency shall be a 24-hour storm with return period not less than 50 years for the tributary area not exceeding 50 acres.
- For retention facilities, the required capacity must be doubled.

Township of Manchester:

- NJDEP requirements must be met regarding water quantity (peak runoff rate reduction), water quality (TSS removal), and groundwater recharge.
- Only one half (0.5) of the area devoted to the detention or retention facilities shall be considered non-impervious.
- Retention facilities shall be required to provide one-hundred percent (100%) storage capacity for the 50-year storm.

NJDEP – CAFRA (based on NJDEP Stormwater Management Regulations):

- NJDEP requirements must be met regarding water quantity (peak runoff rate reduction), water quality (TSS removal), and groundwater recharge.
- 100% of infiltration basin bottom area to be considered as impervious area per NJDEP comment.

NJDOT:

- Same requirements as NJDEP.

Note: The design of the NJDOT improvements associated with this site improvement will be prepared by the Project Traffic Engineers.

Ocean County:

- Post-development peak runoff rates for the Site will be reduced to below the pre-development stormwater runoff rates for the 2-, 10- and 100-year storms.
- Provide water quality.

Ocean County Soil Conservation District:

- Post-development peak runoff rates for the site will be reduced to below the pre-development stormwater runoff rates and will be required to meet the percent reductions for the 2- and 10-year design storm frequencies of 50% and 25%, respectively.

The stormwater management system proposed on the Site has been designed using the above requirements. Calculations documenting the design of the stormwater management system as illustrated on the accompanying engineering drawings prepared by Bohler Engineering are included within the appendices attached hereto.

2. Pre-Development Conditions

Under existing conditions, the property is primarily wooded with 2 +/- acres of impervious area along the Route 37 frontage that is being utilized by a gasoline service station facility.

2.1 Topography

The topography for the majority of the Site can be described as gentle, with slopes in the range of 1 to 5 percent. A few small areas within the center and rear of the property have steeper slopes of approximately 10 percent.

2.2 Freshwater Wetlands

Existing freshwater wetlands exist along the rear portion of the Site, with associated buffer as verified by the NJDEP (File No. 1500-04-0001.1, FWW 040001 and recently File No. 1500-04-0001.3 for Lot 9). The proposed development will fill a portion of the wetland buffer; however, additional wetland buffer will be provided on the same wetland to compensate the wetland buffer taken for the proposed development. The proposed wetland/buffer disturbance with associated compensation area will be submitted to NJDEP for approval.

2.3 100-Year Flood Elevation

A portion of the site is within the 100-year floodplain along the south western property line, and a Stream Encroachment Permit / delineation was obtained from NJDEP (File No. 1500-04-0001.1, FHA 04.0001.1). The proposed development is located at the eastern portion of the property, more than 400 feet (approximately) away from the stream encroachment line. The finished floor elevation (FFE) is set greater than six (6) feet above the 100-year flood elevation.

2.4 Pine Snake Habitat

A portion of the site has been classified as pine snake habitat, and is protected under the proposed development. More specifically, the current site development plan is limited to a portion of the property in question, and proposes a greatly reduced footprint of disturbance when compared with the previous three (3) applications. Based on the current design drawings and several meetings with the NJDEP, it is our understanding that the NJDEP's intent to protect and preserve the pine snake habitat is achieved by the proposed development.

2.5 Drainage

Under existing conditions, the Site is divided into five (5) drainage areas defined as EDA-1, EDA-2, EDA-3, EDA-4 and EDA-5, more specifically described as follows:

- **EDA-1** (approximately 19.20 +/- acres) is located along the easterly side of the property and drains in a north to south direction. The majority of this drainage area is wooded with a very limited grass area. A portion of Northampton Boulevard is also included in the drainage area. The stormwater runoff from EDA-1 is tributary to the lower area at the southern corner of the property and eventually to the drainage ditch located near the southern property corner.
- **EDA-2** (approximately 3.74 +/- acres) is located along the northeast property line adjacent to NJSH Route 37. The stormwater runoff from EDA-2 is tributary to a local depression.
- **EDA-3** (approximately 4.85 +/- acres) is located at the northern property line along NJSH Route 37. The stormwater runoff from this drainage area is tributary to Block 44, Lot 7, of Manchester Township, and eventually to a stream located at the western side of the property.
- **EDA-4** (approximately 17.40+/- acres) is located along the southwest property line and represents the area between the two on-site wetlands where no development is anticipated, except for portions of the snake barrier requested by the NJDEP. The stormwater runoff from this area drains in an east to west direction and is tributary to the southwest wetland area and stream mentioned above.
- **EDA-5** (approximately 29.30 +/- acres) is located along the western property line and encompasses a large wooded area with existing wetlands and stream where no development is anticipated. The stormwater runoff from this area drains in a north to south direction and is tributary to the southwest wetland area and stream mentioned above.

Per the USGS map, all drainage areas are tributary to the Sunken Branch, a tributary of Wrangle Brook, and eventually drain into the Toms River bay.

2.6 Site Soils

The northeasterly portion of the site along Route 37 is depicted by the Ocean County Soil Survey as Lakewood sand (LasB). The majority of the southern portion of the site is depicted as Lakehurst sand (LakB). Per *Urban Hydrology for Small Watersheds*, both soil series belong to hydrologic soil group "A". It should be noted that the entire proposed development is within the perimeter of these two soil series. For the remaining undeveloped portion of the Site, specifically in the area of the existing wetlands, the Ocean County Soil Survey depicts Atsion sand (AtsA) along the northwestern corner of the property, and Mullica sandy loam (MumA) at the southern portion of the property. Per *Urban Hydrology for Small Watersheds*, the Atsion series belongs to groups "A/D", while the Mullica sandy loam series belongs to group "D". Additional information on these soil types are contained in the Appendix of this report.

3. Post-Development Conditions

3.1 Post-Development Conditions

3.1.1 Surface Cover / Development:

As previously mentioned, under proposed conditions, one (1) 111,186 SF retail building, three (3) 4,800 SF restaurants and one (1) 9,322 SF retail building together with parking fields, driveways, landscaped areas, stormwater management facilities, associated utilities and related site improvements will be constructed. The total proposed land disturbance on site is approximately 27 +/- acres with approximately 9 +/- acres of new impervious area within the project site. A proposed stormwater conveyance system will collect the runoff from the proposed building and pavement areas, and redirect the stormwater to the proposed basins.

3.1.2 Drainage:

The stormwater management facilities for the proposed development have been designed to respect and maintain the natural, existing drainage patterns to the fullest extent possible, and to meet the governing agencies' requirements with respect to groundwater recharge, water quality, and peak flow reductions. Under post-development conditions, five major drainage areas are proposed as depicted on the accompanying engineering plans, as follows:

- **Drainage Area PDA-1** is further divided into five (5) sub-drainage areas, as follows:
  - PDA-1A – This area encompasses 11.35+/- acres and includes the majority of the front parking field and with portion of Retail "A" roof area. The stormwater runoff from the

parking field and the roof area will be collected by a series of inlets and conveyance pipes, and discharged directly to the aboveground Basin #1.

- **PDA-1B** – This area encompasses 5.03+/- acres and includes driveway at the back of the proposed retail "A", portion of retail "A" roof area, and portion of the Northampton Boulevard. The stormwater runoff from these areas will be collected by the proposed inlets, and discharge directly to the aboveground Basin #2. Any outflow from Basin #2 will discharge to the existing drainage ditch located near the southern property corner.

- **PDA-1C** – This area encompasses 0.43+/- acres and includes the area which is not tributary to proposed Basin #2 due to elevation. The land cover for this area is primarily grass, and stormwater runoff from this area will travel via overland flow to the existing ditch located near the southern property corner.

- **PDA-1D** – This area encompasses only 0.17+/- acres and includes the area which is not tributary to proposed Basin #1 due to elevation. The stormwater from this area will travel via overland flow to the wetland, and eventually to the existing ditch located near the southern property corner.

- **PDA-1E** – This area encompasses 0.20+/- acres and includes a small portion of the property that is graded to drain towards the right of way and a portion of the Northampton Boulevard. The stormwater from this area is not detained, but, eventually drains to the existing ditch located near the southern property corner.

- **Drainage Area PDA-2**

  - **PDA-2** – This area encompasses 3.77+/- acres and includes the existing local depression surrounded by the proposed snake barrier. Stormwater runoff from this area is expected to drain to this local depression and eventually infiltrate into the ground.

- **Drainage Area PDA-3** encompasses 6.84+/- acres and includes a portion of the proposed entrance road, proposed restaurant "C" and proposed Basin #3. The stormwater runoff from this area will drain to proposed Basin #3 and eventually infiltrate into the ground.

- **Drainage Area PDA-4** is the same as area EDA-4 under existing conditions, and will remain undeveloped except for a portion of the snake barrier requested by the NJDEP. The

stormwater runoff from this area is expected to maintain the same characteristics as under existing conditions.

- **Drainage Area PDA-5** is the same as area EDA-5 under existing conditions, and will remain undeveloped. The stormwater runoff from this area is expected to maintain the same characteristics as under existing conditions.

3.2 Non-Structural Stormwater Management Facilities

All of the non-structural strategies have been considered in the design of the proposed development. By protecting the wetlands and associated buffers, land disturbance has been minimized. No disturbance, including clearing and grubbing, will take place in those areas which encompass over forty (40) acres of natural wooded area (a portion of which is classified as pine snake habitat by the NJDEP). An extensive landscaping plan has been incorporated which minimizes the use of lawn, fertilizers and pesticides. In addition, grass swales are proposed along the site access drive, which will convey stormwater runoff from portion of the pavement area via curb cut.

3.3 Structural Stormwater Management Facilities

3.3.1 Infiltration / Detention Basin

Proposed Basin #1 is an infiltration/detention basin and consists of two portions. The aboveground portion is located to the west of the front parking field and has a six-inch (6") sand layer at the basin bottom. The underground portion include 24" RCP pipes under the front parking area with very flat slope. It has an outlet structure which discharges to proposed Basin #2. A valve is also proposed within this overflow structure so that the basin can be drained completely for maintenance purposes.

Proposed Basin #2 is an infiltration/detention basin similar to Basin #1, and has a six-inch (6") sand layer at the bottom. It has an outlet structure which discharges to the existing drainage ditch via an existing stormwater pipe located within Northampton Boulevard. A valve is proposed within this outlet structure as well so the basin can be drained completely for maintenance purposes.

Proposed Basin #3 is aboveground infiltration/detention basin, and similar to Basin #1 and #2, it has a six-inch (6") sand layer at the basin bottom as well. The stormwater collected by these basins is expected to infiltrate into the ground.

3.4 Soil Erosion and Sediment Control Design

3.4.1 Sediment Basin

Two (2) temporary sediment basins are proposed during construction to prevent the sediment created during site construction from affecting downstream areas. Calculations for these sediment basins are included within Appendix B of this report.

Please note that in order to avoid sedimentation which may result in clogging and reduction of infiltration capacity, and to maintain maximum soil infiltration capacity during the course of construction, the use of heavy equipment will be minimized for the construction of the proposed detention/infiltration basins. In addition, a two-foot-thick natural soil buffer shall be maintained above the proposed basin bottom until the entire upstream area has been stabilized.

3.4.2 Other Soil Erosion and Sediment Control Measures

Other standard soil erosion and sediment control measures and BMPs will be employed during site construction such as silt fences, inlet protection, stabilized construction entrances, soil stockpiles, jute matting, temporary diversion berms, etc. These details are also included within the accompanying site plan set.

4. Methodology

The stormwater management facilities have been designed in accordance with the local, county and state requirements mentioned above.

4.1 Calculation Software

The calculations included within this report were performed using hydrologic software, HydroCAD (Version 9.00) by HydroCAD Software Solutions, LLC. The HydroCAD software was used to develop runoff hydrographs, outlet structure configurations, and basin routings using the SCS TR-20 methodology. Time of concentration calculations for the pre and post-development calculations were generated utilizing the SCS Method. All storm runoff data for this project were generated using the DelMarva unit hydrographs.

4.2 Runoff "CN" Values

As described above, soil classifications for use with runoff curve numbers (CN) were taken from the Ocean County Soil Survey (see Appendix C). Evaluation of these maps indicates that soils within the

proposed disturbed areas consists of hydrologic soil groups A and D as defined within the United State Soil Conservation Service Manual, *"Urban Hydrology for Small Watersheds"*, v. 1986.

Runoff CN values for the soil groups were assigned to various surfaces as follows:

	Soil Group:	**A**	**D**
Ground Cover	**CN Values:**		
Wooded Areas (good condition)		30	77
Landscaped/Lawn (good condition)		39	80
Impervious/Building Areas		98	98

Please note, under pre-developed conditions, all pervious areas (dirt path and grass area) are considered wooded areas in good condition. Under post-development conditions, 100% of the infiltration basin bottom area is considered as impervious area per NJDEP. Runoff CN value calculations for pre- and post-developed conditions were generated using HydroCAD software and are included within the Appendix of this report.

4.3 Time of Concentration

The time of concentration (Tc) and travel time calculations have been completed in accordance with Chapter 3 of the SCS Technical Release 55 Manual. As required by NJDEP, the stormwater runoff from impervious and pervious areas is calculated separately. When Tc for impervious areas is less than 10 minutes, 10 minutes is used. This is true for the Tc used for impervious areas under pre-developed conditions, and the Tc used for both pervious and impervious areas within the limit of disturbance under post-development conditions. Please refer to the Existing and Proposed Drainage Area maps for travel path information for times of concentration other than 10 minutes.

4.4 Pipe Sizing

The majority of the stormwater pipes proposed under the main parking field are part of the detention facility, and the purpose of these pipes is more for storage than for conveyance. However, the pipe capacity is confirmed for the 100-year storm event to ensure that no ponding will occur on the pavement surface. In addition, inlet capacity is confirmed to ensure that no more than 4 cfs will be tributary to any of the proposed inlets, as per the ordinance of Toms River Township.

4.5 Infiltration Rates

Infiltration rates were based on field tests conducted at the proposed development by Whitestone Associates, Inc. in the areas of the proposed detention/infiltration basins. Please see the following table for a summary of permeability rate data used in the design. Basin drain time is estimated for all proposed basins. For the detention/infiltration basins, a factor of safety of three (3) was used for each tested permeability rate in conjunction with the Darcy Equation, Q = KIA, as indicated in the New Jersey Stormwater Best Management Practices Manual. Please note infiltration rate is used for calculating basin drain down time only, and is not used in the basin routing. Please refer to Appendix B for basin drain time calculations.

Test Pit #	Permeability (in/hr)	Proposed Basin Number
SPP-1S	4.7	1
SPP-2S	9.4	1
SPP-3S	>20.0	2
SPP-4S	11.8	2
SPP-11S	>20.0	3
SPP-14	NT	3

4.6 Seasonal Groundwater

The seasonal high groundwater table was based on field tests conducted at the site by Whitestone Associates, Inc., in the area of the proposed infiltration basins. A two-foot minimum clearance has been maintained between the seasonal high groundwater elevation and the bottom of the infiltration basins (bottom of the 6" sand layer). See summary table below:

Test Pit #	SHGW	Proposed Basin #	Proposed Basin Bottom (*)	Separation
SPP-1S	54.1	1	56.4	>2'
SPP-2S	54.4	1	56.4	=2'
SPP-3S	49.5	2	51.5	=2'
SPP-4S	48.2	2	51.5	>2'
SPP-11S	55.0	3	57.0	=2'
SPP-14	55.0	3	57.0	=2'

(*) For infiltration basins, the basin bottom (for calculating the separation to seasonal high groundwater proposed) is calculated as the bottom of the 6-inch sand layer.

4.7 Water Quality / TSS Removal

Water quality for the proposed development is achieved by storing and infiltrating the entire water quality design storm in the proposed detention/infiltration basins #1, #2, and #3. Per the New Jersey Stormwater Best Management Practices Manual, the adopted TSS removal rate for infiltration basins is 80%, and the total phosphorous and total nitrogen removal rate for the infiltration basin is 60% and 50%, respectively. As a result, the proposed stormwater management system for the proposed development meets the NJDEP requirement regarding water quality.

4.8 Water Quantity

The quantity reduction for post-construction development as detailed in the NJDEP Stormwater Management Regulations includes a 50% reduction for the 2-year storm, a 25% reduction for the 10-year storm and 20% reduction for the 100-year storm per N.J.A.C. 7:8-5.4 (3)(iii).

The following tables show the comparison between the pre-development and the post-development stormwater runoff rates for various discharge points and demonstrate that the site design meets the quantity reduction (peak runoff rate reduction) requirement.

To Existing Drainage Ditch Located Near the Southern Property Corner

Pre-Development vs. Post-Development Peak Flow Rate Comparison

NJDEP EDA-1 VS PDA-1 (PDA-1A + PDA-1B + PDA-1C + PDA-1D + PDA-1E)			
	2 YEAR	10 YEAR	100 YEAR
Pre-Development Flow Rate	1.31	2.09	3.59
NJDEP Reduction Rate	50%	25%	20%
Maximum Allowable Post-Development Flow Rate	0.66	1.57	2.87
Post Development Flow Rate	0.41	1.11	2.46
NJDEP Reduction Rate Achieved?	YES	YES	YES

To Existing Local Depression Area

Pre-Development vs. Post-Development Peak Flow Rate Comparison
EDA-2 vs. PDA-2

The local depression under existing conditions is large enough to hold the entire volume of the 100-year storm. Under proposed conditions, drainage PDA-2 will have similar drainage area as EDA-2 but with greatly reduced impervious area; therefore, the entire volume of the 100-year storm will be contained in the local depression as well. As a result, under both the pre- and post-development conditions, there is no increase in peak stormwater runoff rate in PDA-2 when compared with EDA-2.

To Block 44, Lot 7

Pre-Development vs. Post-Development Flow Rate & Volume Comparison

EDA-3 VS PDA-3			
	2 YEAR	10 YEAR	100 YEAR
Pre-Development Flow Rate	1.71	2.72	4.68
NJDEP Reduction Rate	50%	25%	20%
Maximum Allowable Post-Development Flow Rate	0.86	2.04	3.74
Post Development Flow Rate	0	0	1.37
NJDEP Reduction Rate Achieved?	YES	YES	YES

To Existing Stream

EDA-4 vs. PDA-4

Due to the fact that no development is proposed within PDA-4 except a portion of the snake barrier requested by the NJDEP, the drainage conditions will remain the same. There is no increase in the peak stormwater runoff rate in PDA-4 when compared with EDA-4.

To Existing Stream

EDA-5 vs. PDA-5

Due to the fact that no development is proposed within PDA-5, the drainage conditions will remain the same. There is no increase in the peak stormwater runoff rate in PDA-5 when compared with EDA-5.

4.9 Groundwater Recharge

Per the New Jersey Stormwater Best Management Practices Manual, the proposed development shall comply with one of the following two groundwater recharge requirements:

Requirement 1: That 100 percent of the Site's average annual pre-developed groundwater recharge volume be maintained after development; or

Requirement 2: That 100 percent of the difference between the Site's pre- and post-development 2-year runoff volumes be infiltrated.

For this development, as illustrated in the calculations, Requirement #1 is met to satisfy the groundwater recharge requirement. Please refer to the Groundwater Recharge Analysis located in Appendix B of this report.

5. Conclusions

In summary, the proposed stormwater management system illustrated on the drawings prepared by Bohler Engineering meets the requirements set forth by all reviewing jurisdictional agencies and the NJDEP Stormwater Regulations. Specifically, the design meets water quality, peak runoff rate reduction, and groundwater recharge requirements. In addition, the development proposes minimal disturbance to the wetland transition area and provides water quality for the stormwater runoff generated from a portion of Northampton Boulevard. No encroachment is proposed in the Flood Hazard Area, and it is anticipated that the pine snake habitat will be protected and preserved in accordance with NJDEP requirements. As a result, we would anticipate the proposed development will have no negative impact on the existing stormwater management system in the vicinity of the subject parcel.

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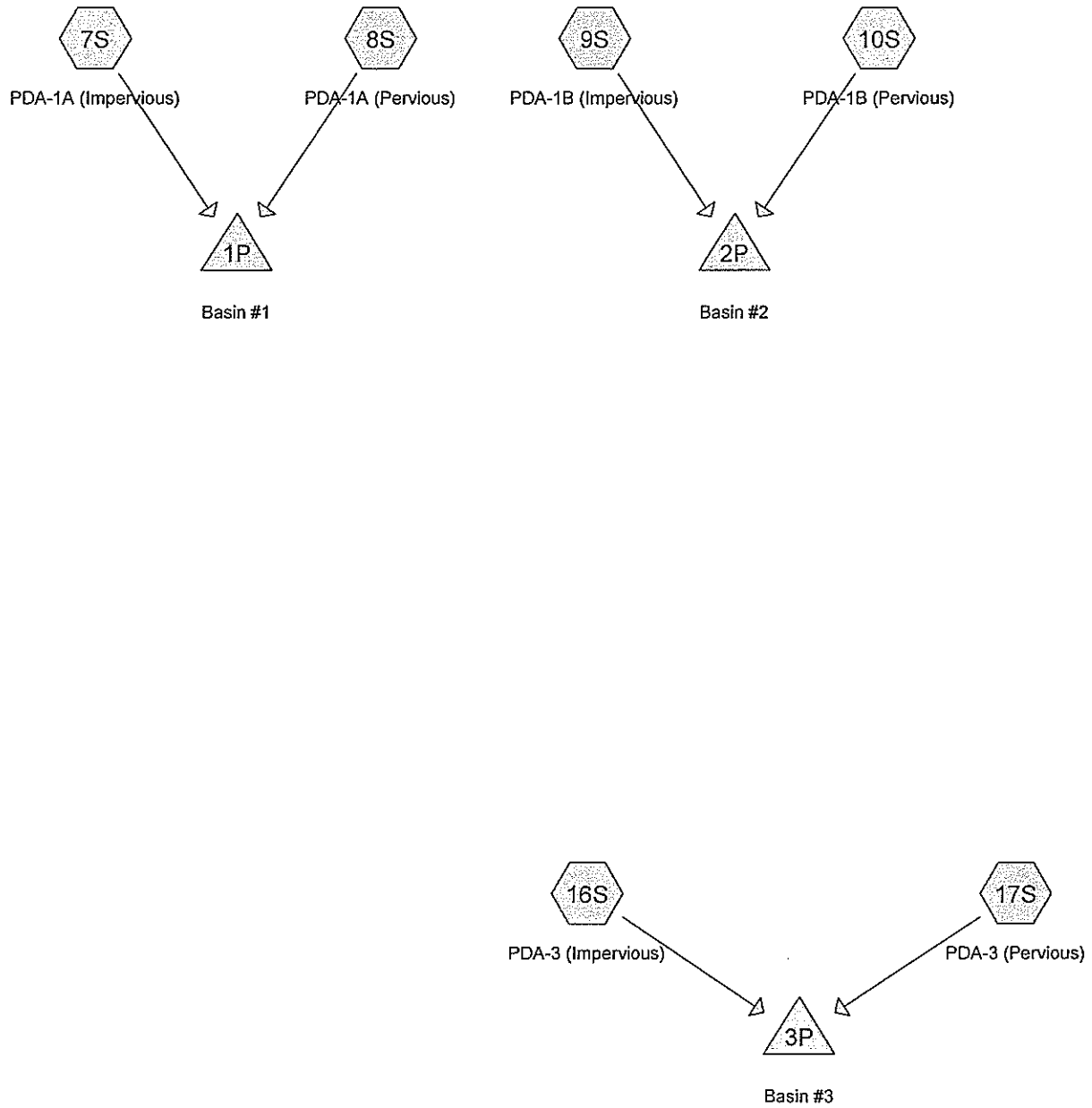
A. Pre-Development and Post-Development Hydrographs

- Water Quality Storm Event
- 2-Year Storm Event
- 10-Year Storm Event
- 100-Year Storm Event

WATER QUALITY STORM EVENT



Drainage Diagram for Ex-Pr
Prepared by Bohler Engineering, Printed 12/4/2017
HydroCAD® 9.00 s/n 02612 © 2009 HydroCAD Software Solutions LLC

Summary for Subcatchment 7S: PDA-1A (Impervious)

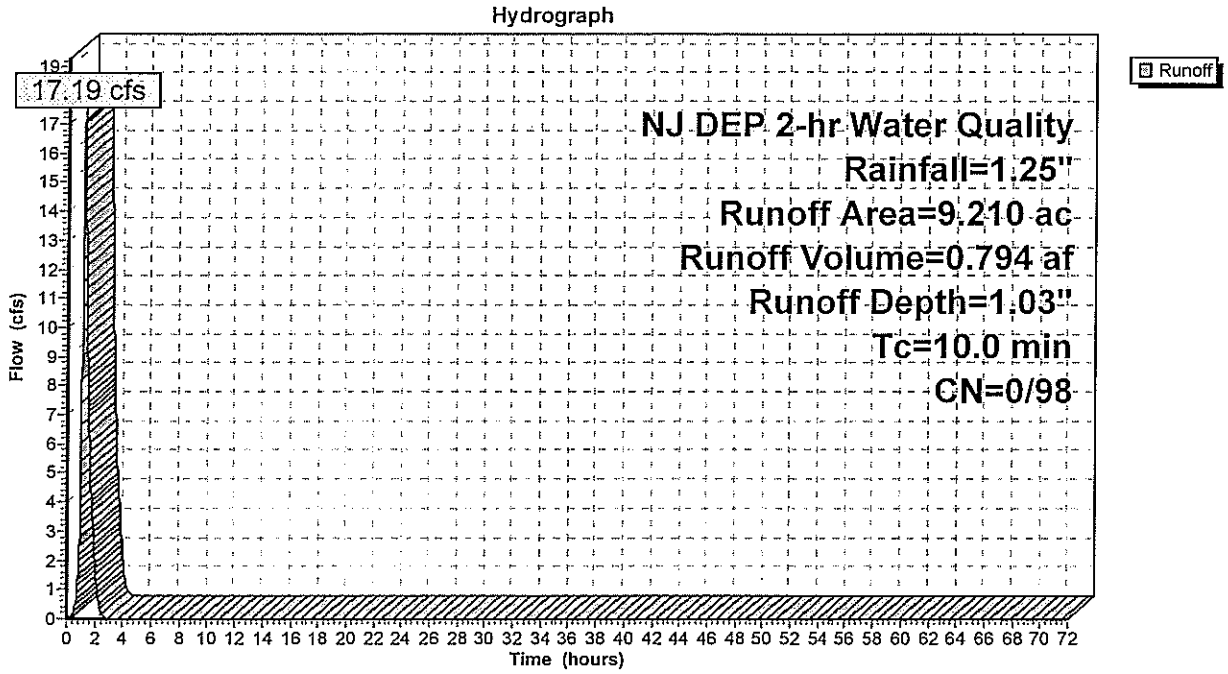
Runoff = 17.19 cfs @ 1.17 hrs, Volume= 0.794 af, Depth= 1.03"

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

	Area (ac)	CN	Description
	6.970	98	Paved parking, HSG A
*	2.240	98	Basin Bottom
	9.210	98	Weighted Average
	9.210	98	100.00% Impervious Area

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

Subcatchment 7S: PDA-1A (Impervious)



Summary for Subcatchment 8S: PDA-1A (Pervious)

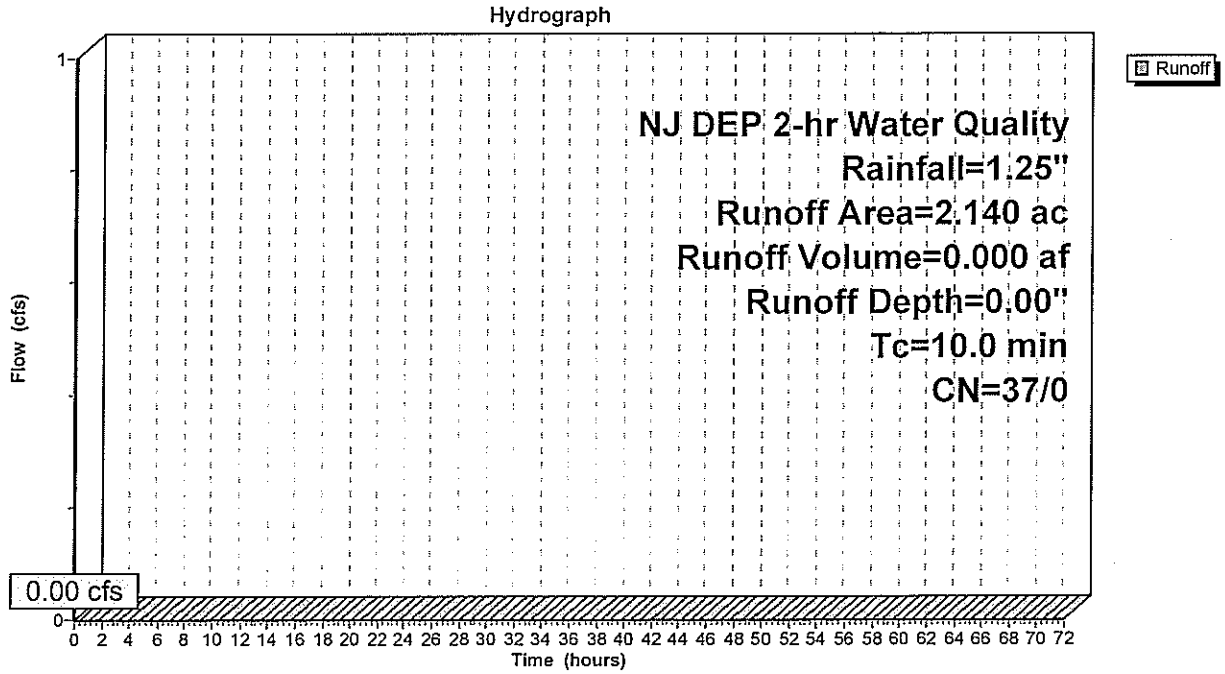
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

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

Area (ac)	CN	Description
0.490	30	Woods, Good, HSG A
1.650	39	>75% Grass cover, Good, HSG A
2.140	37	Weighted Average
2.140	37	100.00% Pervious Area

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

Subcatchment 8S: PDA-1A (Pervious)



Summary for Subcatchment 9S: PDA-1B (Impervious)

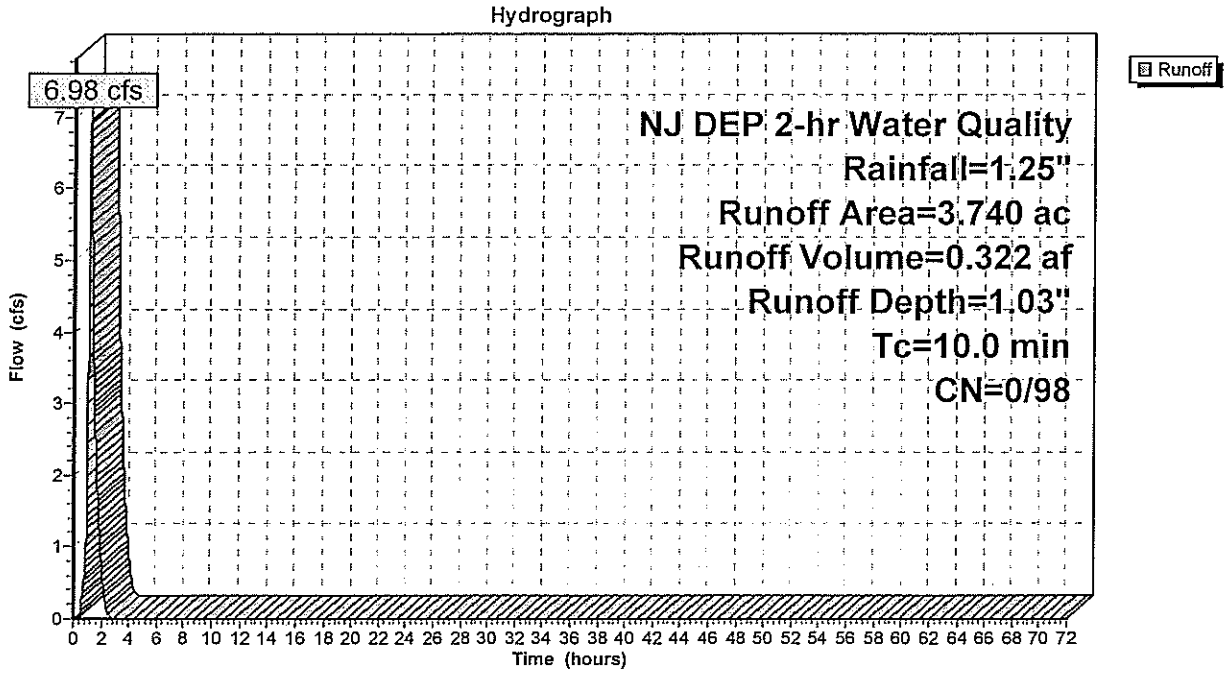
Runoff = 6.98 cfs @ 1.17 hrs, Volume= 0.322 af, Depth= 1.03"

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

	Area (ac)	CN	Description
	2.840	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	3.740	98	Weighted Average
	3.740	98	100.00% Impervious Area

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

Subcatchment 9S: PDA-1B (Impervious)



Summary for Subcatchment 10S: PDA-1B (Pervious)

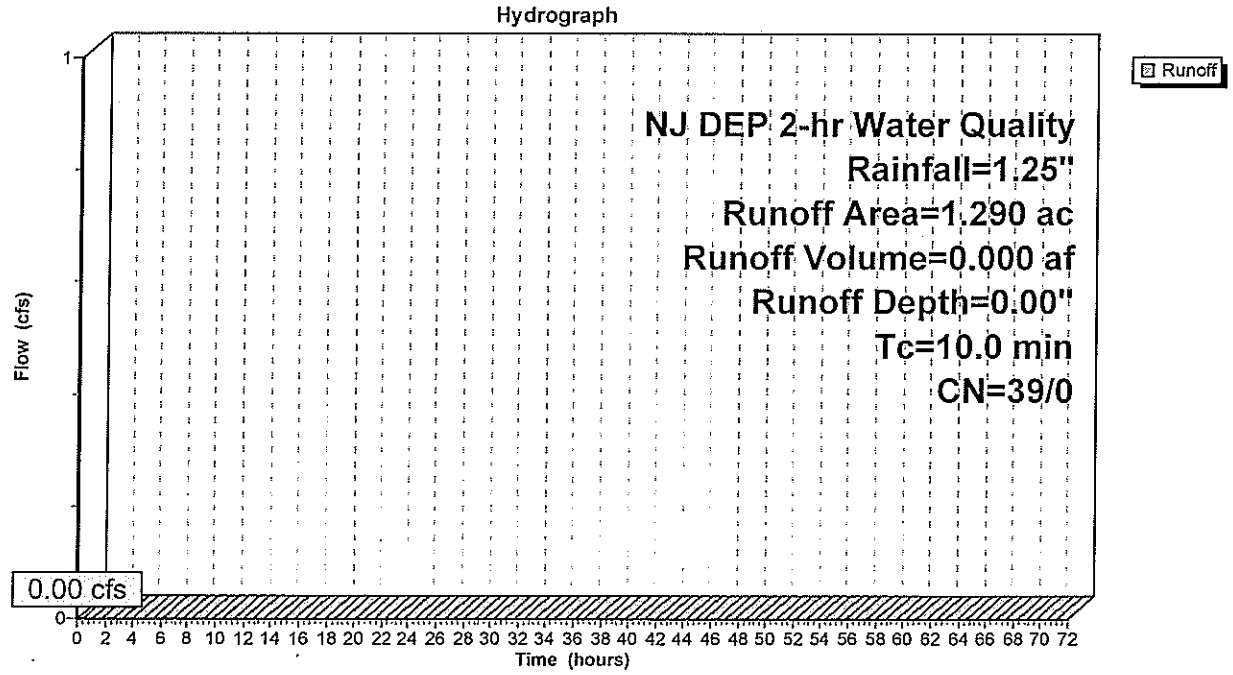
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

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

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
1.290	39	100.00% Pervious Area

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

Subcatchment 10S: PDA-1B (Pervious)



Summary for Subcatchment 16S: PDA-3 (Impervious)

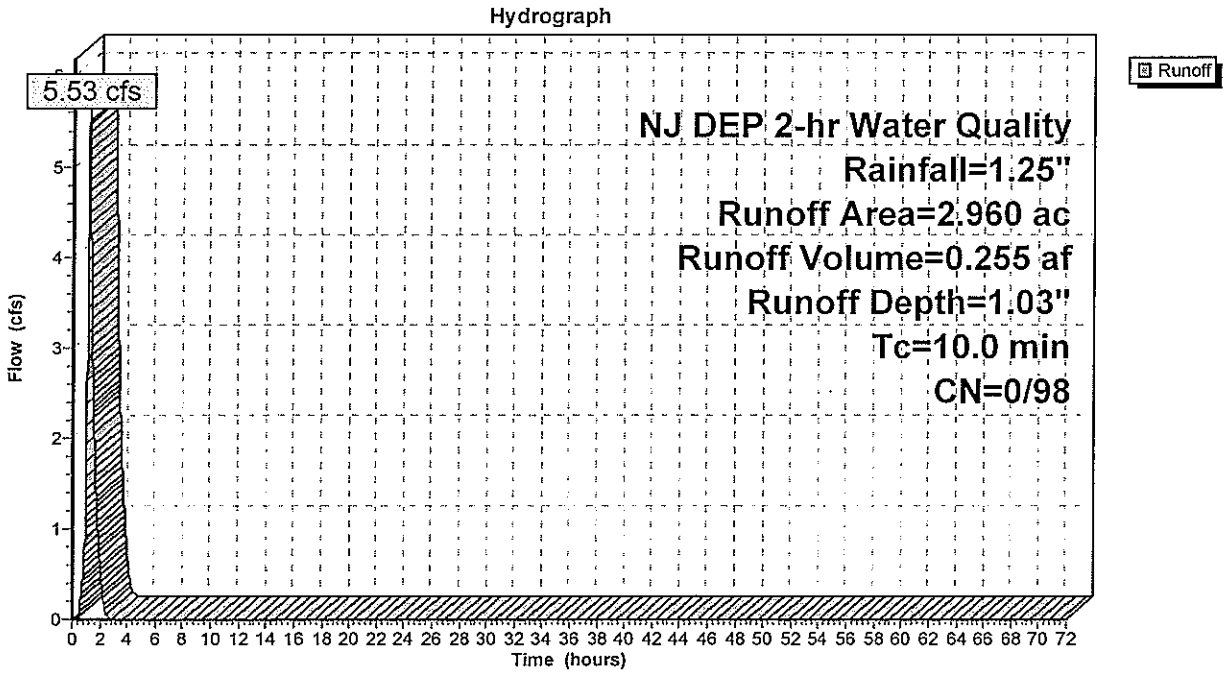
Runoff = 5.53 cfs @ 1.17 hrs, Volume= 0.255 af, Depth= 1.03"

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

	Area (ac)	CN	Description
	2.060	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	2.960	98	Weighted Average
	2.960	98	100.00% Impervious Area

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

Subcatchment 16S: PDA-3 (Impervious)



Summary for Subcatchment 17S: PDA-3 (Pervious)

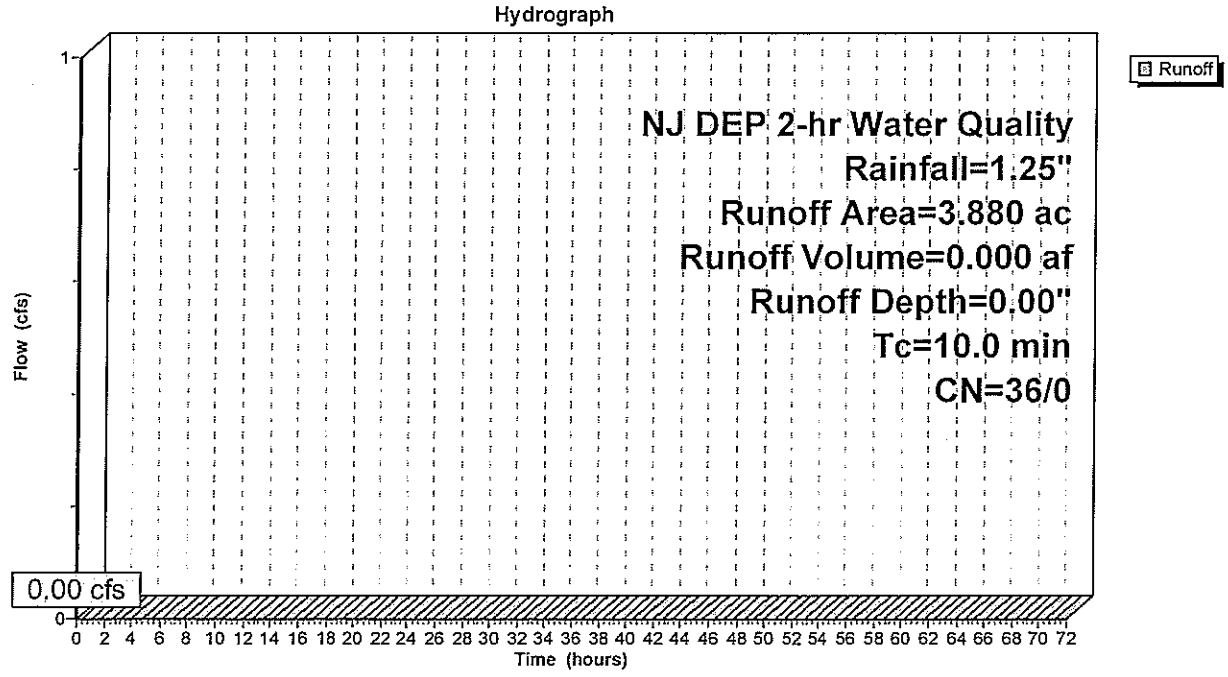
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

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

Area (ac)	CN	Description
2.420	39	>75% Grass cover, Good, HSG A
1.460	30	Woods, Good, HSG A
3.880	36	Weighted Average
3.880	36	100.00% Pervious Area

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

Subcatchment 17S: PDA-3 (Pervious)



Summary for Pond 1P: Basin #1

Inflow Area =	11.350 ac,	81.15% Impervious,	Inflow Depth =	0.84" for Water Quality event
Inflow =	17.19 cfs @	1.17 hrs, Volume=	0.794 af	
Outflow =	0.00 cfs @	0.00 hrs, Volume=	0.000 af, Atten= 100%, Lag= 0.0 min	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.25' @ 3.10 hrs Surf.Area= 99,591 sf Storage= 34,588 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	56.90'	432,566 cf	**Basin #1 (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
56.90	97,675	0	0
57.00	98,767	9,822	9,822
58.00	102,067	100,417	110,239
59.00	105,401	103,734	213,973
60.00	108,770	107,086	321,059
61.00	114,245	111,508	432,566

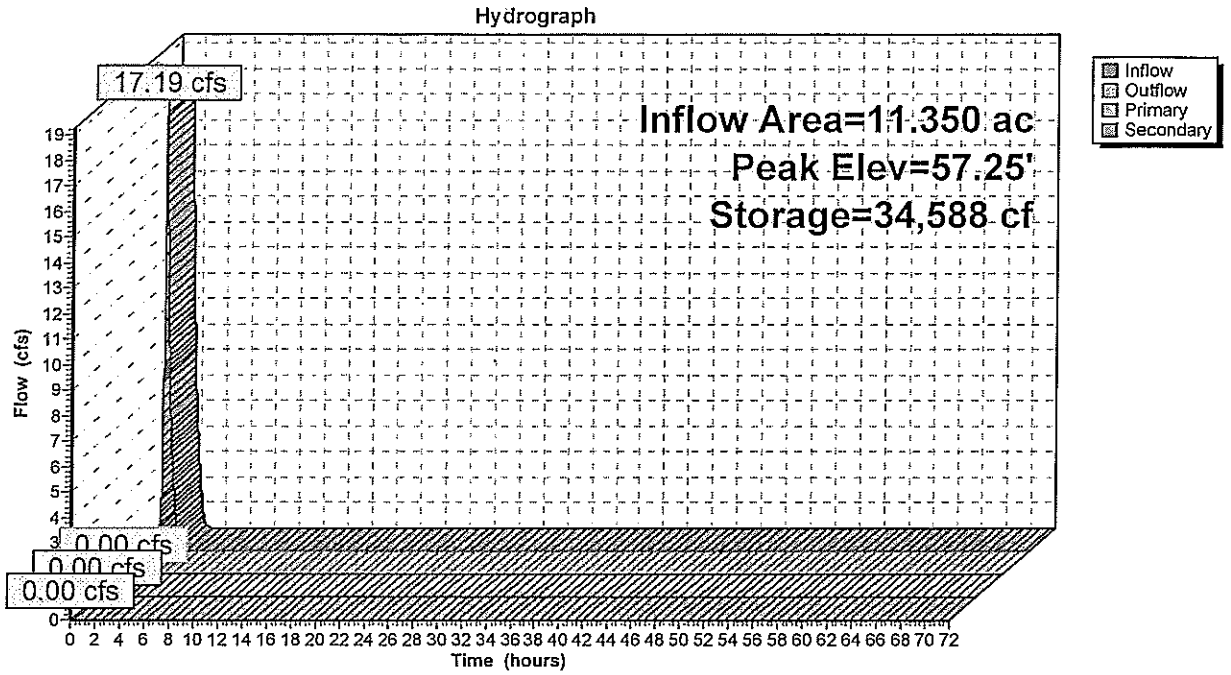
THE ENTIRE WATER QUALITY STORM IS INFILTRATED INTO GROUND, 80% TSS REMOVAL RATE ACHIEVED.

Device	Routing	Invert	Outlet Devices
#1	Primary	56.80'	**15.0" Round Culvert** L= 12.0' RCP, groove end w/headwall, Ke= 0.200 Outlet Invert= 56.68' S= 0.0100 '/' Cc= 0.900 n= 0.013
#2	Device 1	57.30'	**2.5" Vert. Orifice/Grate** C= 0.600
#3	Device 1	60.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	60.30'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' (Free Discharge)
└─**1=Culvert** (Passes 0.00 cfs of 0.04 cfs potential flow)
  ├─**2=Orifice/Grate** (Controls 0.00 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Basin #1



Summary for Pond 2P: Basin #2

Inflow Area = 5.030 ac, 74.35% Impervious, Inflow Depth = 0.77" for Water Quality event
Inflow = 6.98 cfs @ 1.17 hrs, Volume= 0.322 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 52.35' @ 3.10 hrs Surf.Area= 40,292 sf Storage= 14,046 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	179,275 cf	**Basin #2 (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	39,333	0	0
53.00	42,052	40,693	40,693
54.00	44,827	43,440	84,132
55.00	47,558	46,193	130,325
56.00	50,343	48,951	179,275

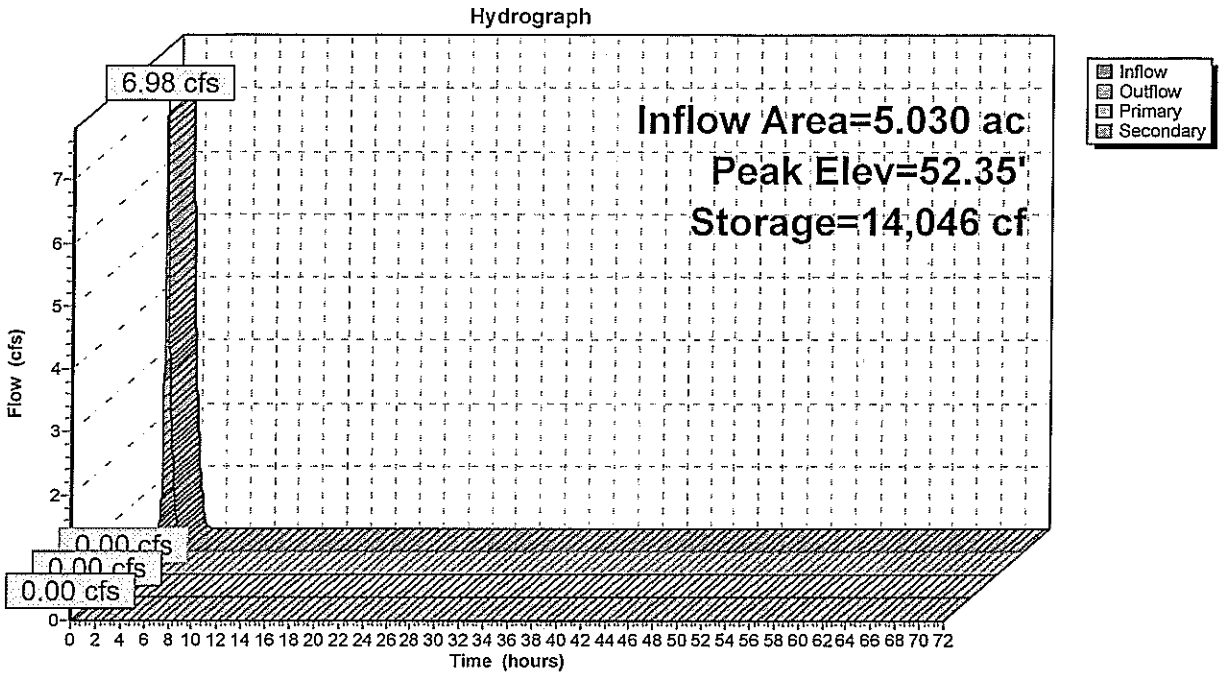
THE ENTIRE WATER QUALITY STORM IS INFILTRATED INTO GROUND, 80% TSS REMOVAL RATE ACHIEVED.

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**15.0" Round Culvert** L= 17.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 50.66' S= 0.0200 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	54.60'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=52.00' (Free Discharge)
└**1=Culvert** (Passes 0.00 cfs of 3.81 cfs potential flow)
  ├**2=Orifice/Grate** (Controls 0.00 cfs)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=52.00' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Basin #2



Summary for Pond 3P: Basin #3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 0.45" for Water Quality event
Inflow = 5.53 cfs @ 1.17 hrs, Volume= 0.255 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.77' @ 3.10 hrs Surf.Area= 42,966 sf Storage= 11,116 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	57.50'	127,089 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

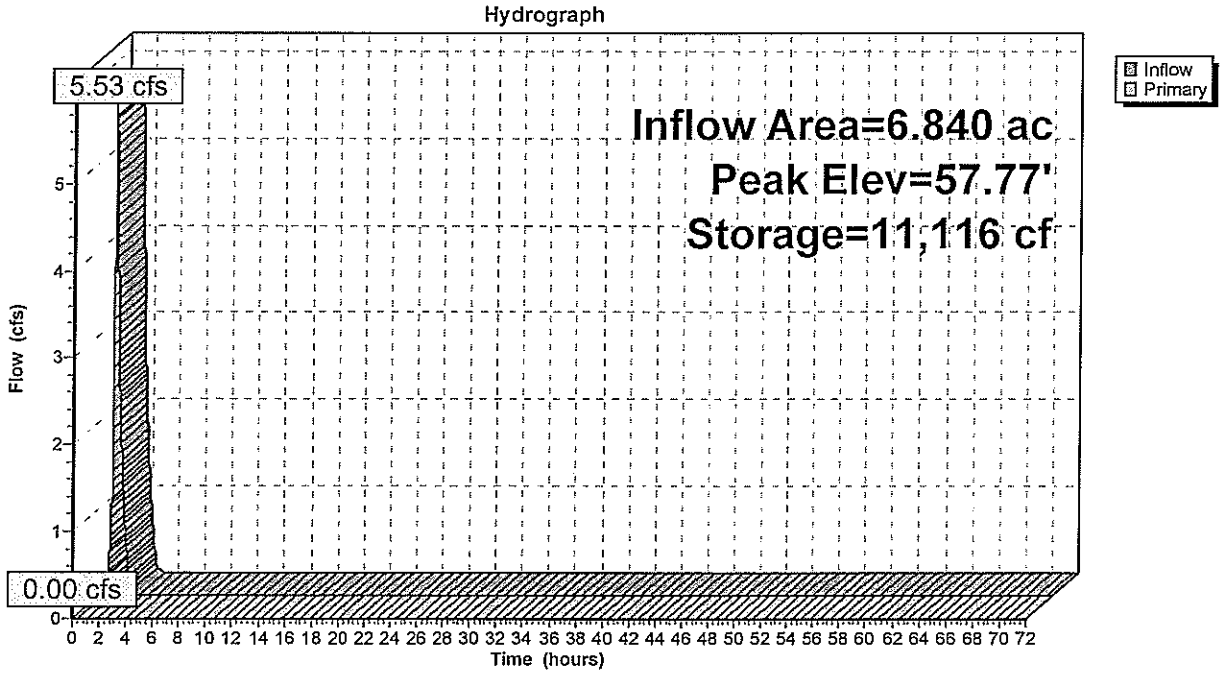
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.50	39,005	0	0
58.00	46,307	21,328	21,328
59.00	53,554	49,931	71,259
60.00	58,107	55,831	127,089

THE ENTIRE WATER QUALITY STORM IS INFILTRATED INTO GROUND, 80% TSS REMOVAL RATE ACHIEVED.

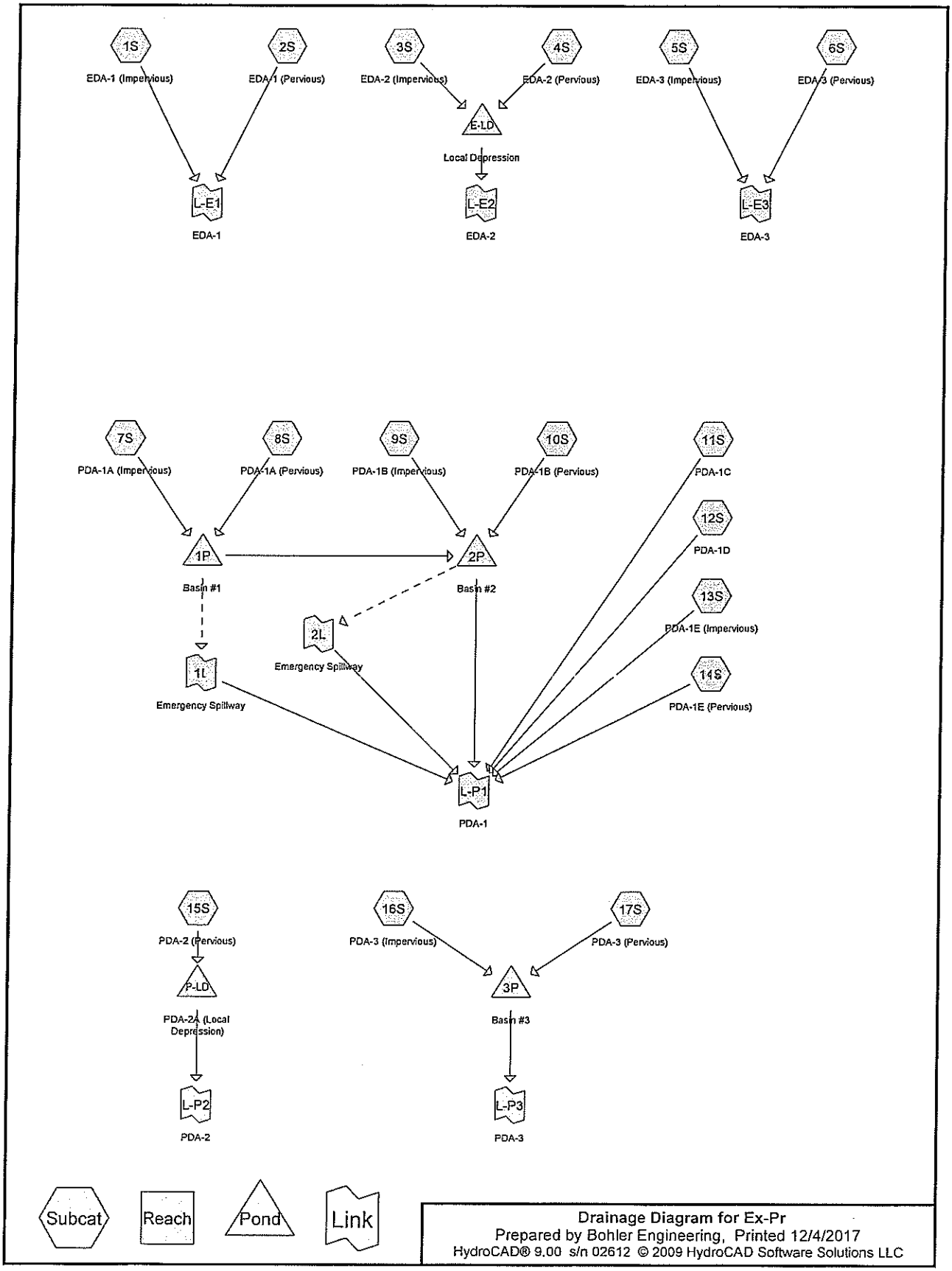
Device	Routing	Invert	Outlet Devices
#1	Primary	59.30'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=57.50' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Basin #3



2-YEAR STORM EVENT



Drainage Diagram for Ex-Pr
Prepared by Bohler Engineering, Printed 12/4/2017
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Summary for Subcatchment 1S: EDA-1 (Impervious)

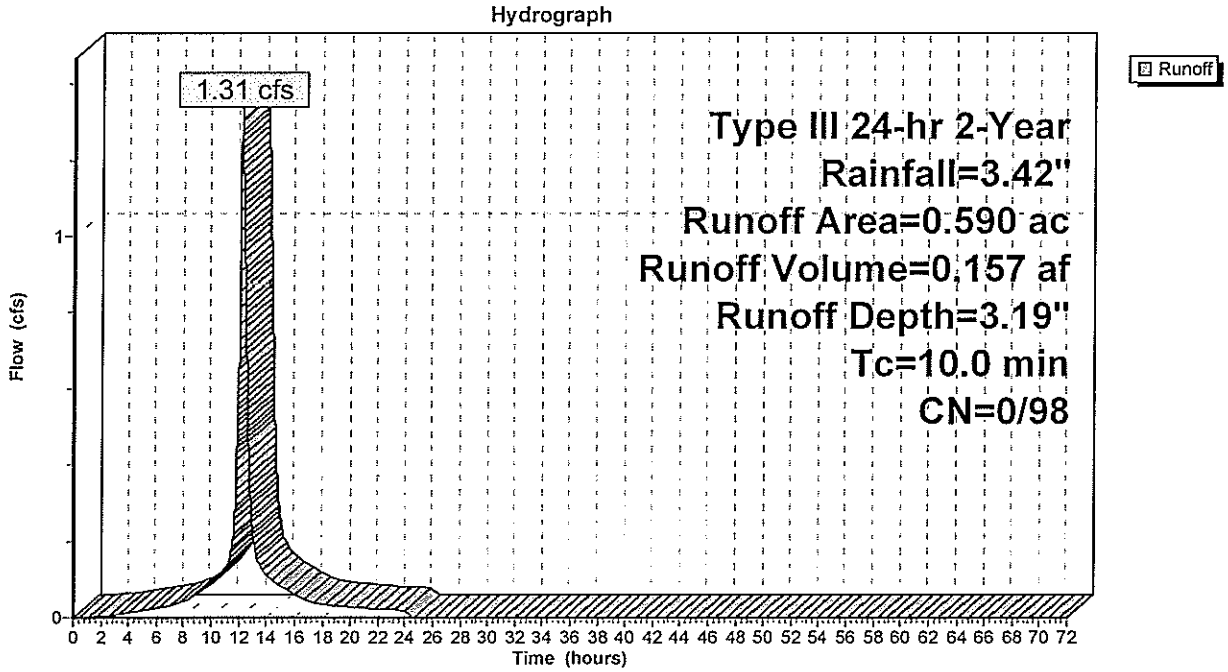
Runoff = 1.31 cfs @ 12.16 hrs, Volume= 0.157 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.590	98	Paved roads w/curbs & sewers, HSG A
0.590	98	100.00% Impervious Area

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

Subcatchment 1S: EDA-1 (Impervious)



Summary for Subcatchment 2S: EDA-1 (Pervious)

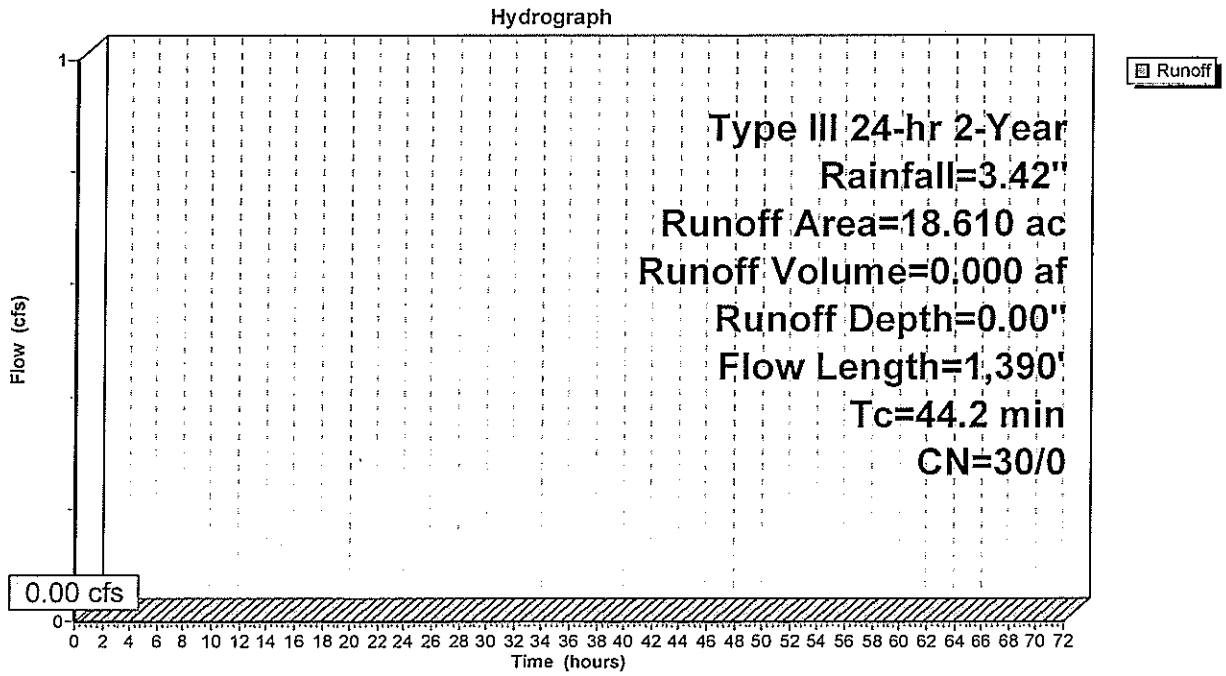
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
18.110	30	Woods, Good, HSG A
0.500	30	Woods, Good, HSG A
18.610	30	Weighted Average
18.610	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.5	90	0.0089	0.06		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
17.7	1,300	0.0058	1.23		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
44.2	1,390	Total			

Subcatchment 2S: EDA-1 (Pervious)



Summary for Subcatchment 3S: EDA-2 (Impervious)

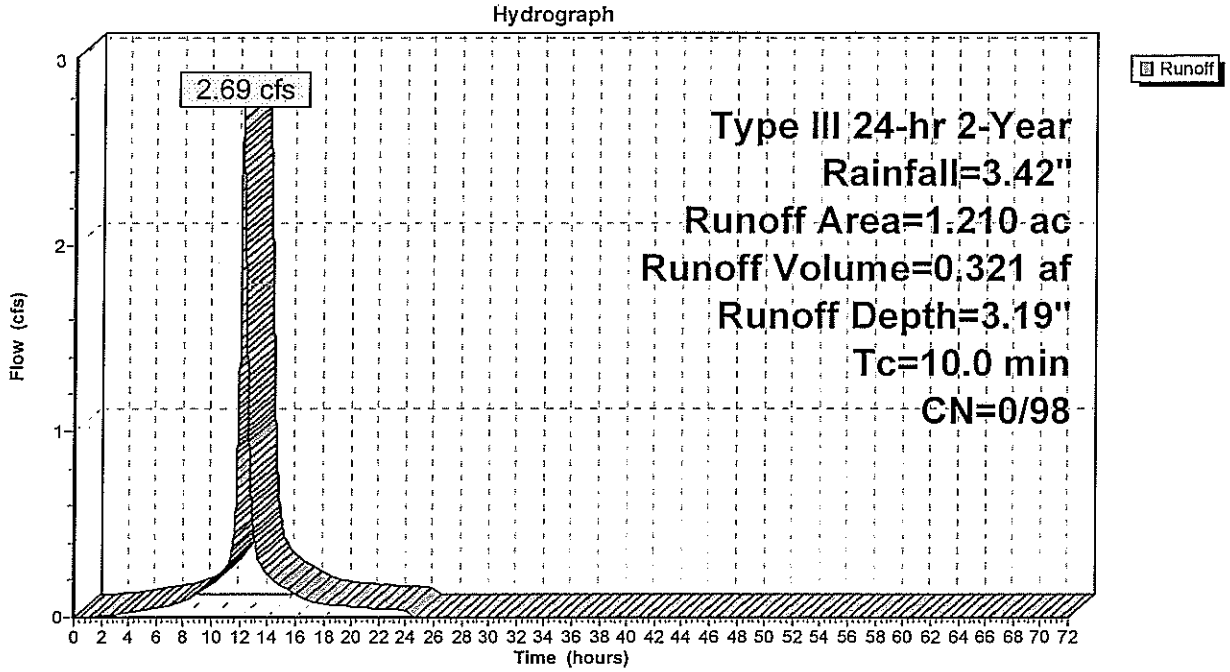
Runoff = 2.69 cfs @ 12.16 hrs, Volume= 0.321 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
1.210	98	Paved parking, HSG A
1.210	98	100.00% Impervious Area

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

Subcatchment 3S: EDA-2 (Impervious)



Summary for Subcatchment 4S: EDA-2 (Pervious)

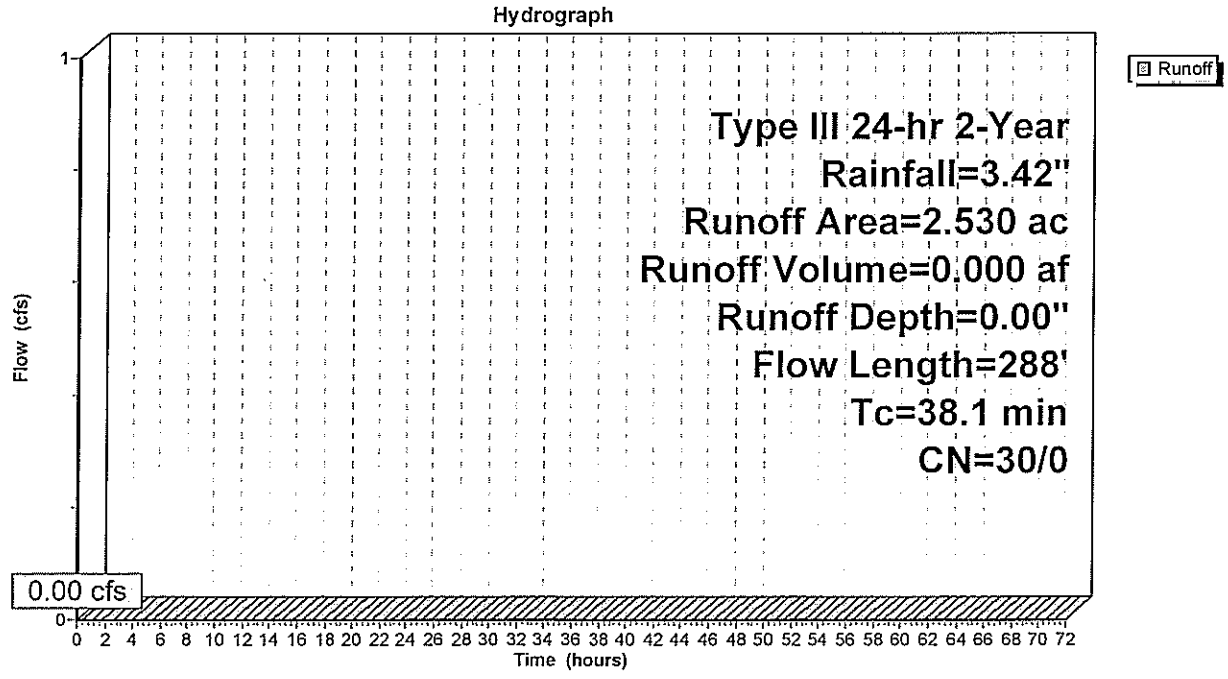
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
1.980	30	Woods, Good, HSG A
0.550	30	Woods, Good, HSG A
2.530	30	Weighted Average
2.530	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.3	150	0.0105	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
0.8	138	0.0290	2.74		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
38.1	288	Total			

Subcatchment 4S: EDA-2 (Pervious)



Summary for Subcatchment 5S: EDA-3 (Impervious)

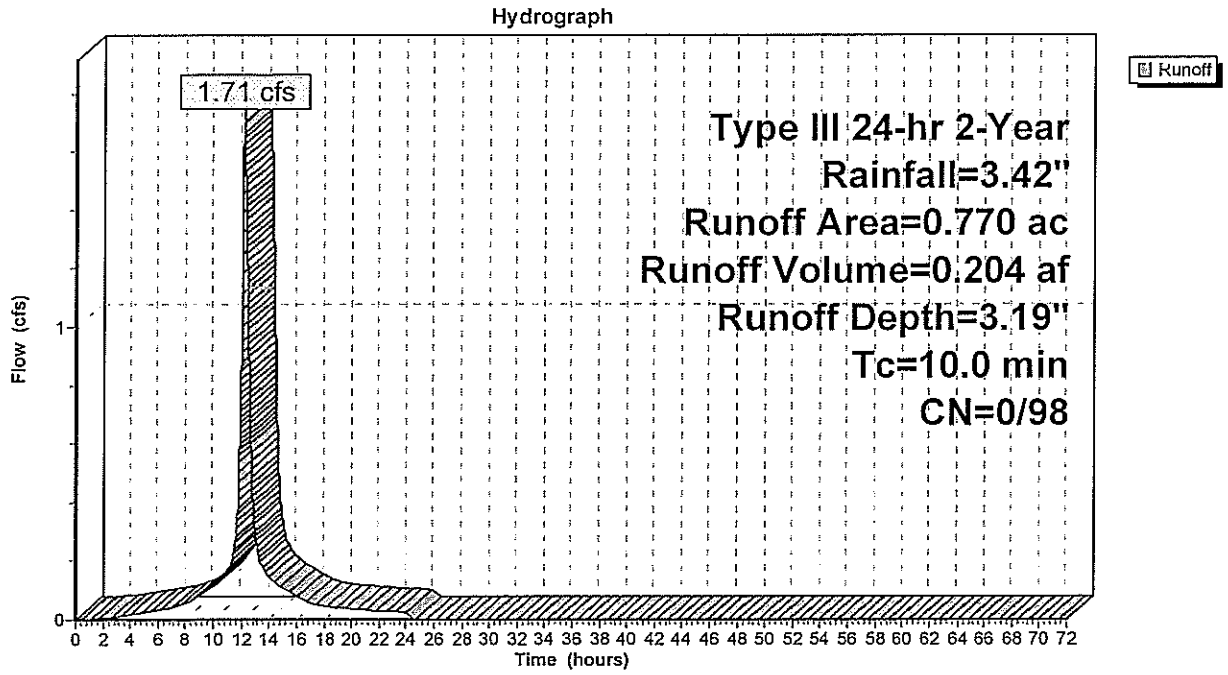
Runoff = 1.71 cfs @ 12.16 hrs, Volume= 0.204 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.770	98	Paved roads w/curbs & sewers, HSG A
0.770	98	100.00% Impervious Area

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

Subcatchment 5S: EDA-3 (Impervious)



Summary for Subcatchment 6S: EDA-3 (Pervious)

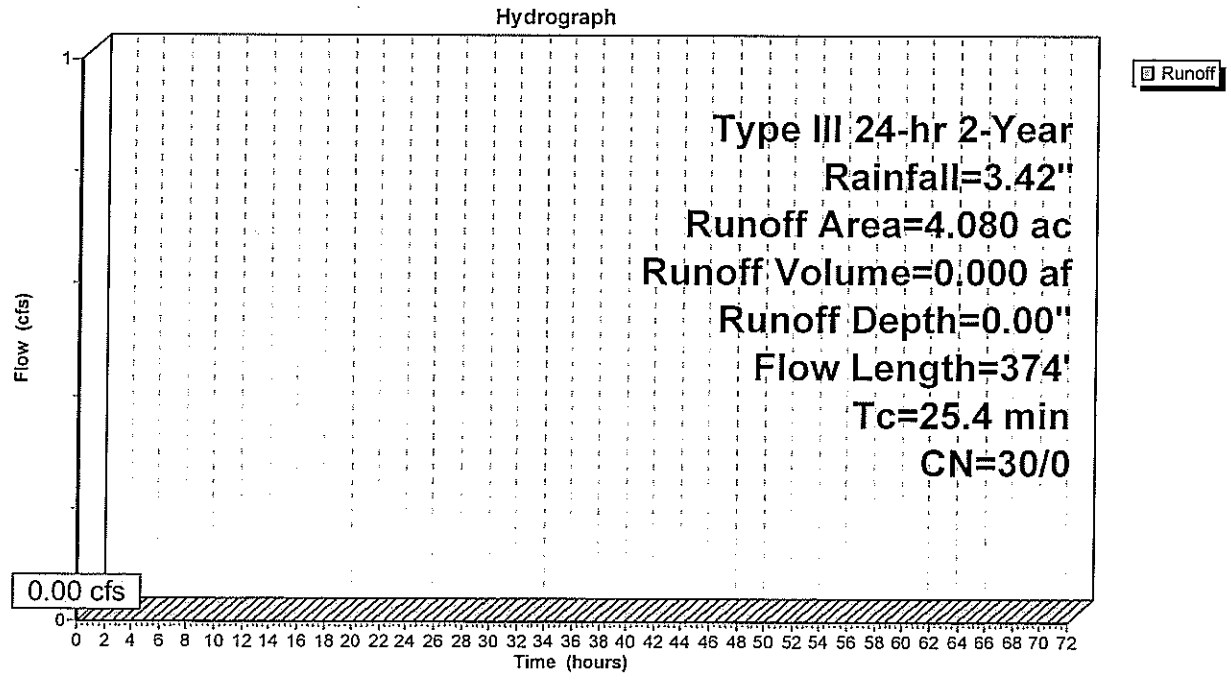
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
2.310	30	Woods, Good, HSG A
1.770	30	Woods, Good, HSG A
4.080	30	Weighted Average
4.080	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	150	0.0390	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
3.3	224	0.0050	1.14		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
25.4	374	Total			

Subcatchment 6S: EDA-3 (Pervious)



Summary for Subcatchment 7S: PDA-1A (Impervious)

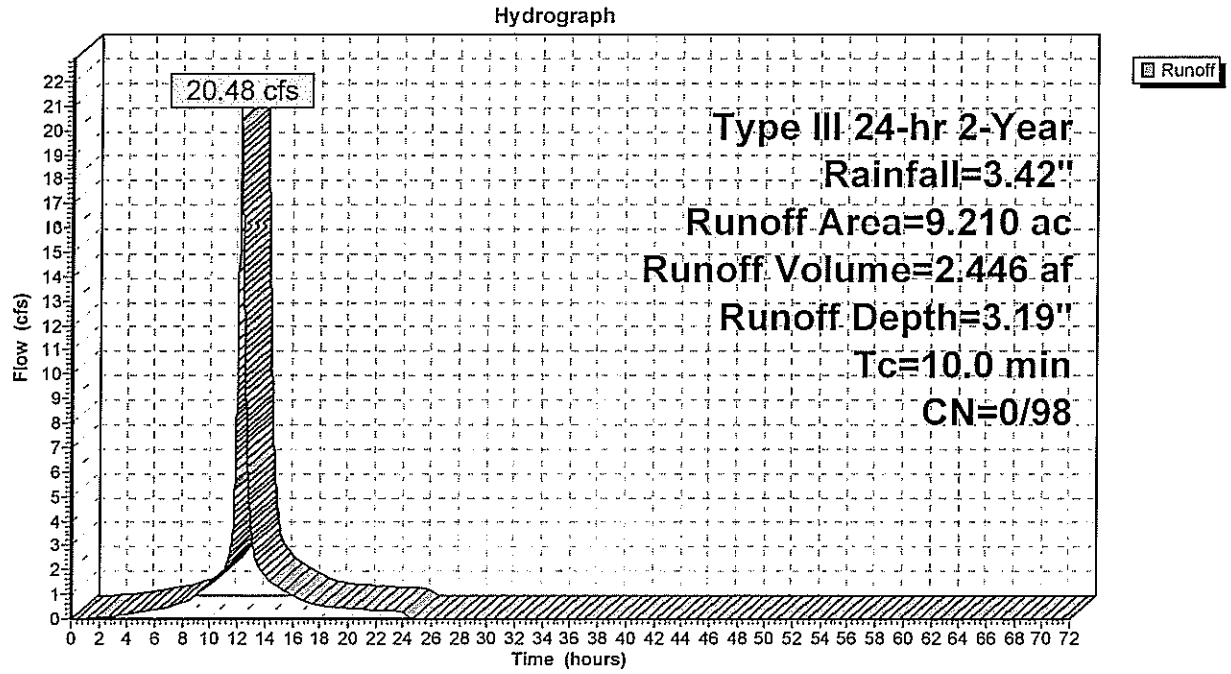
Runoff = 20.48 cfs @ 12.16 hrs, Volume= 2.446 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

	Area (ac)	CN	Description
	6.970	98	Paved parking, HSG A
*	2.240	98	Basin Bottom
	9.210	98	Weighted Average
	9.210	98	100.00% Impervious Area

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

Subcatchment 7S: PDA-1A (Impervious)



Summary for Subcatchment 8S: PDA-1A (Pervious)

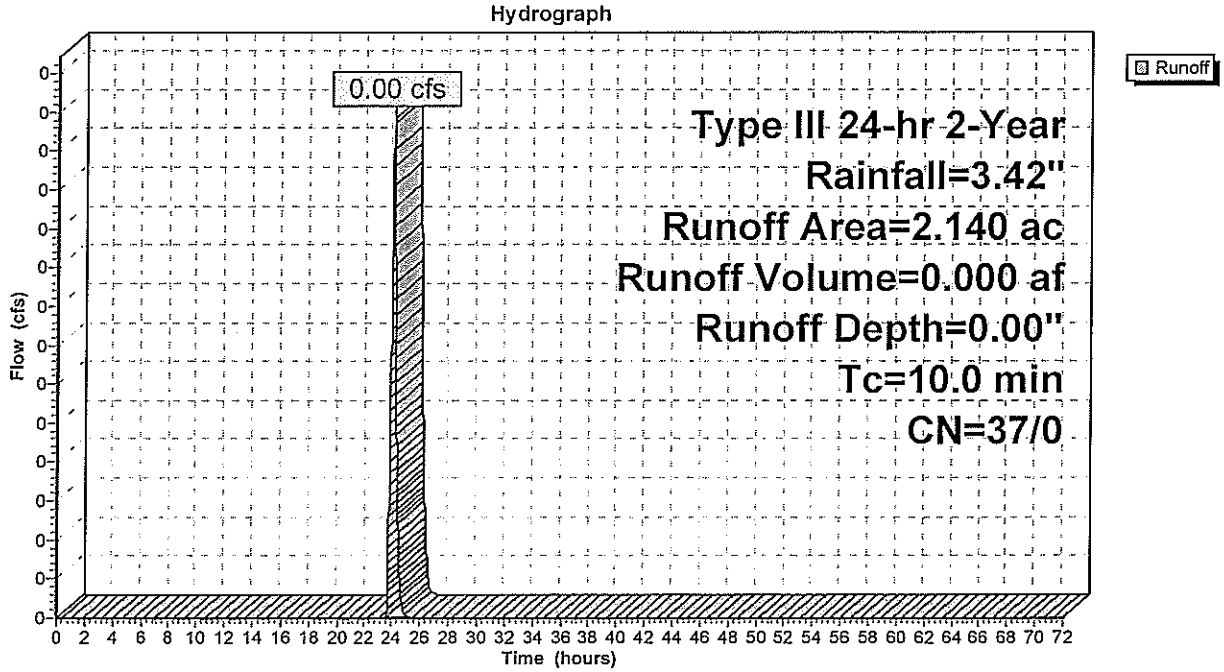
Runoff = 0.00 cfs @ 24.06 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.490	30	Woods, Good, HSG A
1.650	39	>75% Grass cover, Good, HSG A
2.140	37	Weighted Average
2.140	37	100.00% Pervious Area

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

Subcatchment 8S: PDA-1A (Pervious)



Summary for Subcatchment 9S: PDA-1B (Impervious)

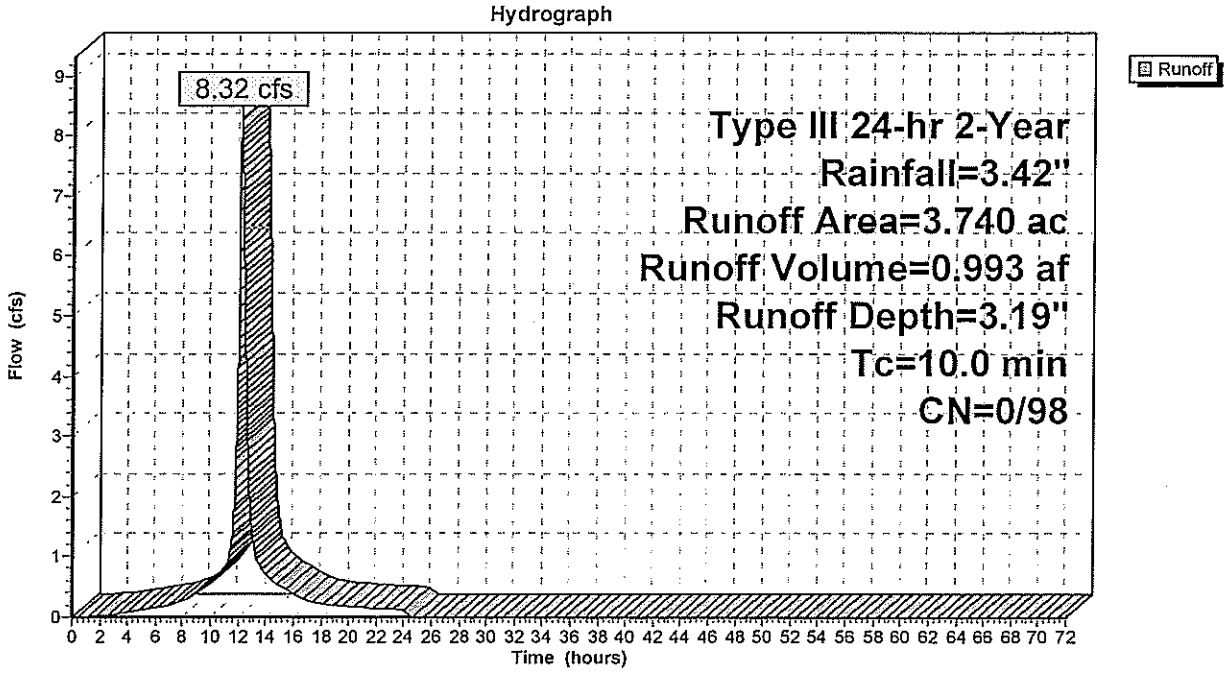
Runoff = 8.32 cfs @ 12.16 hrs, Volume= 0.993 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

	Area (ac)	CN	Description
	2.840	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	3.740	98	Weighted Average
	3.740	98	100.00% Impervious Area

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

Subcatchment 9S: PDA-1B (Impervious)



Summary for Subcatchment 10S: PDA-1B (Pervious)

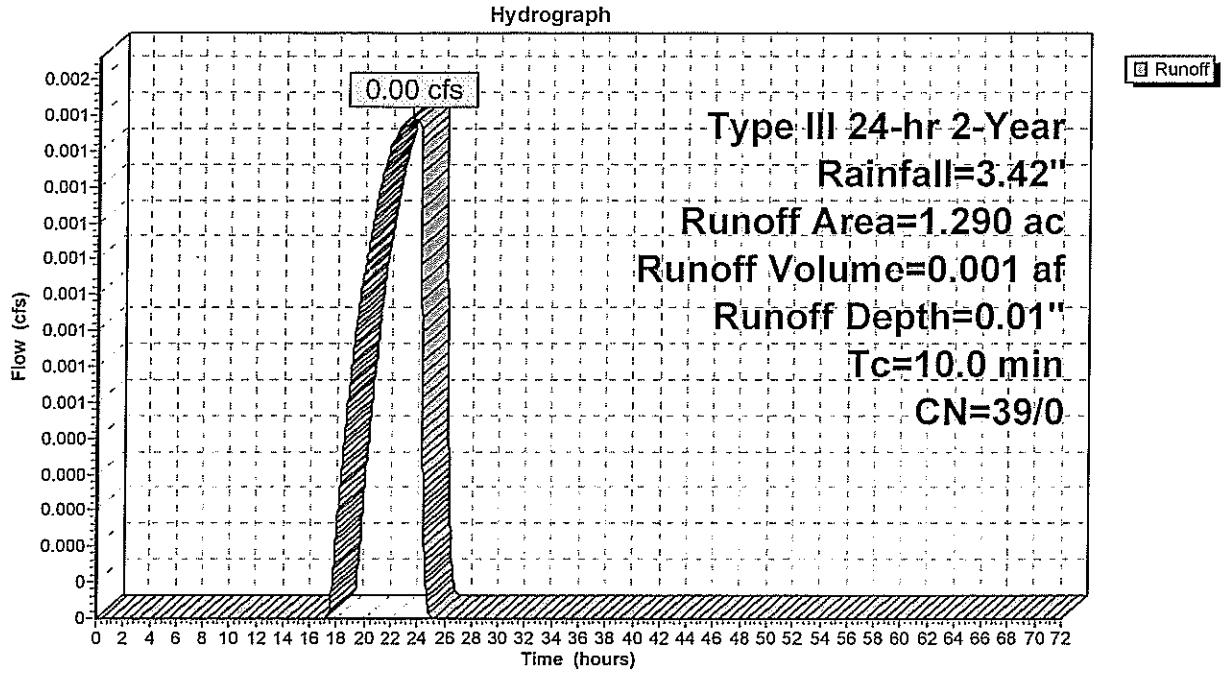
Runoff = 0.00 cfs @ 23.40 hrs, Volume= 0.001 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
1.290	39	100.00% Pervious Area

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

Subcatchment 10S: PDA-1B (Pervious)



Summary for Subcatchment 11S: PDA-1C

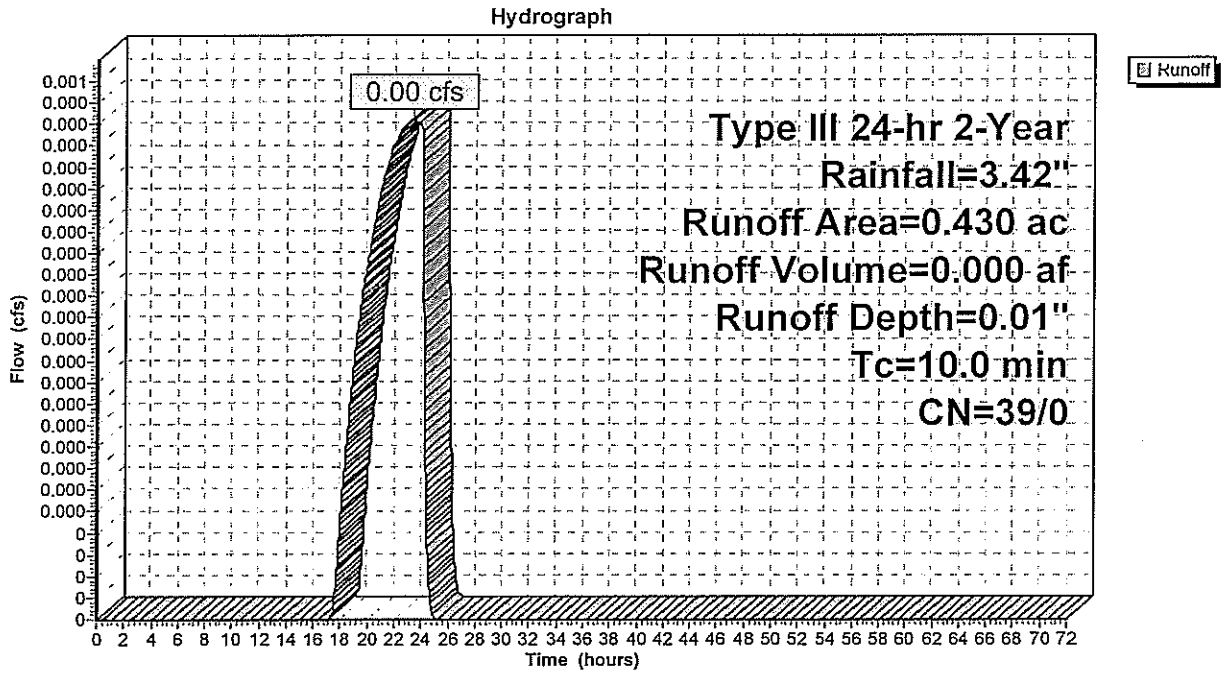
Runoff = 0.00 cfs @ 23.40 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.430	39	>75% Grass cover, Good, HSG A
0.430	39	100.00% Pervious Area

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

Subcatchment 11S: PDA-1C



Summary for Subcatchment 12S: PDA-1D

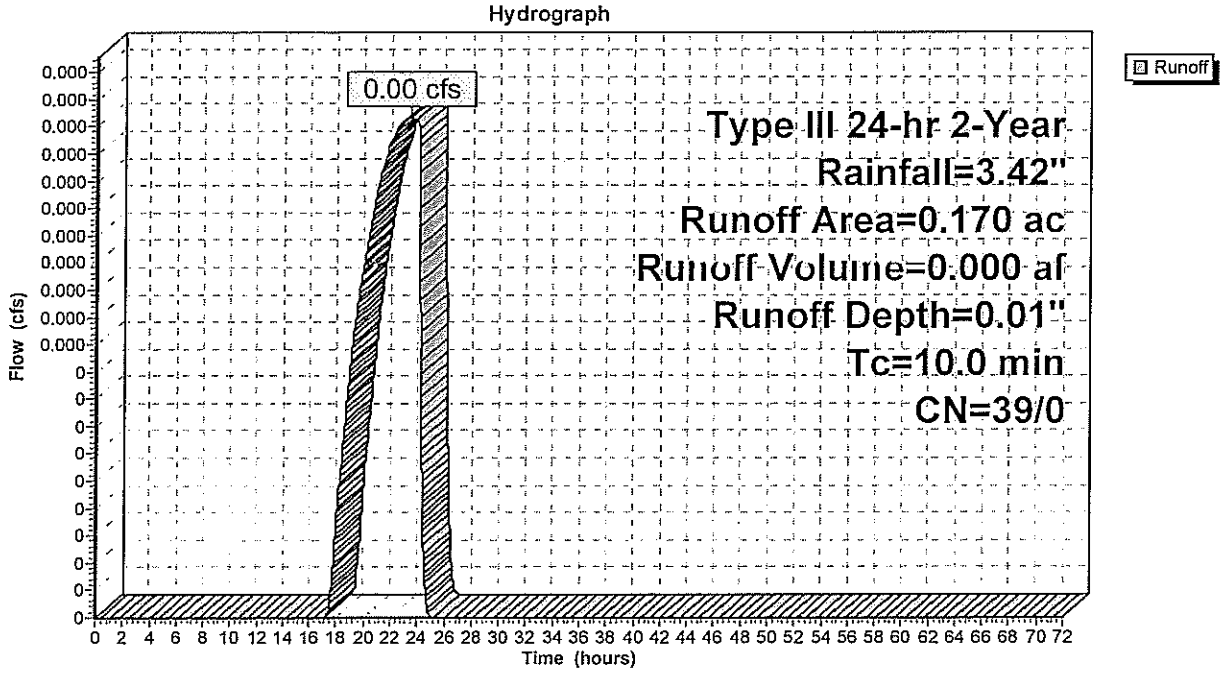
Runoff = 0.00 cfs @ 23.40 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.170	39	>75% Grass cover, Good, HSG A
0.170	39	100.00% Pervious Area

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

Subcatchment 12S: PDA-1D



Summary for Subcatchment 13S: PDA-1E (Impervious)

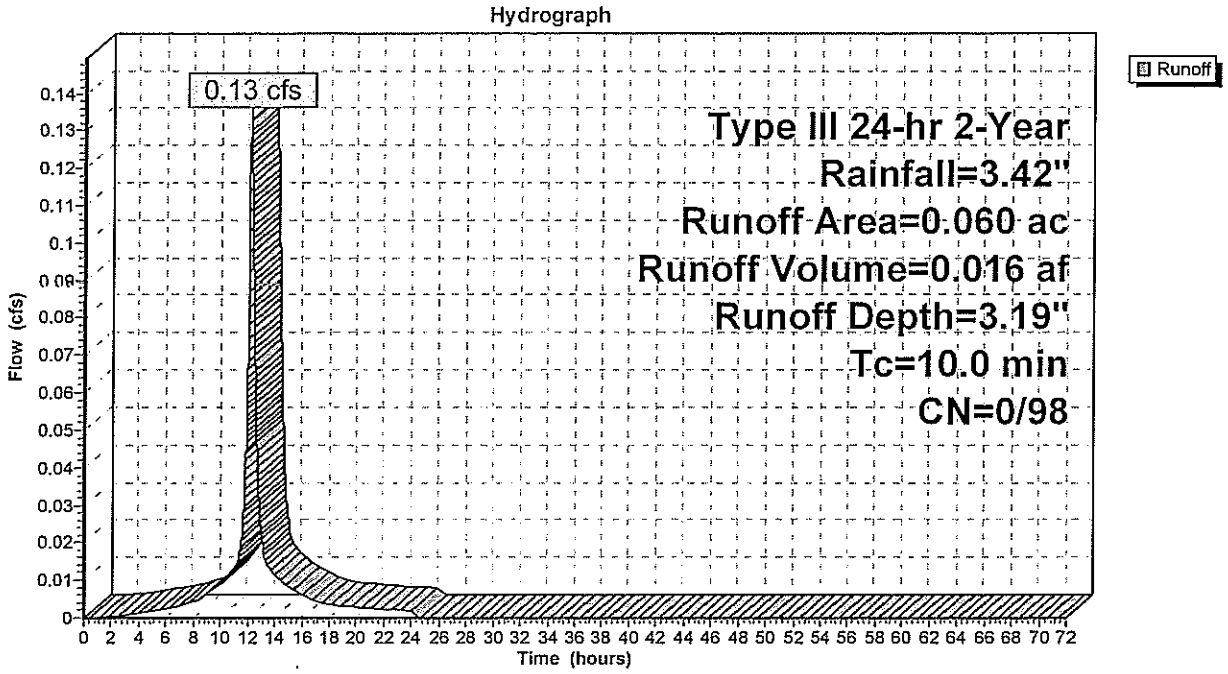
Runoff = 0.13 cfs @ 12.16 hrs, Volume= 0.016 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.060	98	Roofs, HSG A
0.060	98	100.00% Impervious Area

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

Subcatchment 13S: PDA-1E (Impervious)



Summary for Subcatchment 14S: PDA-1E (Pervious)

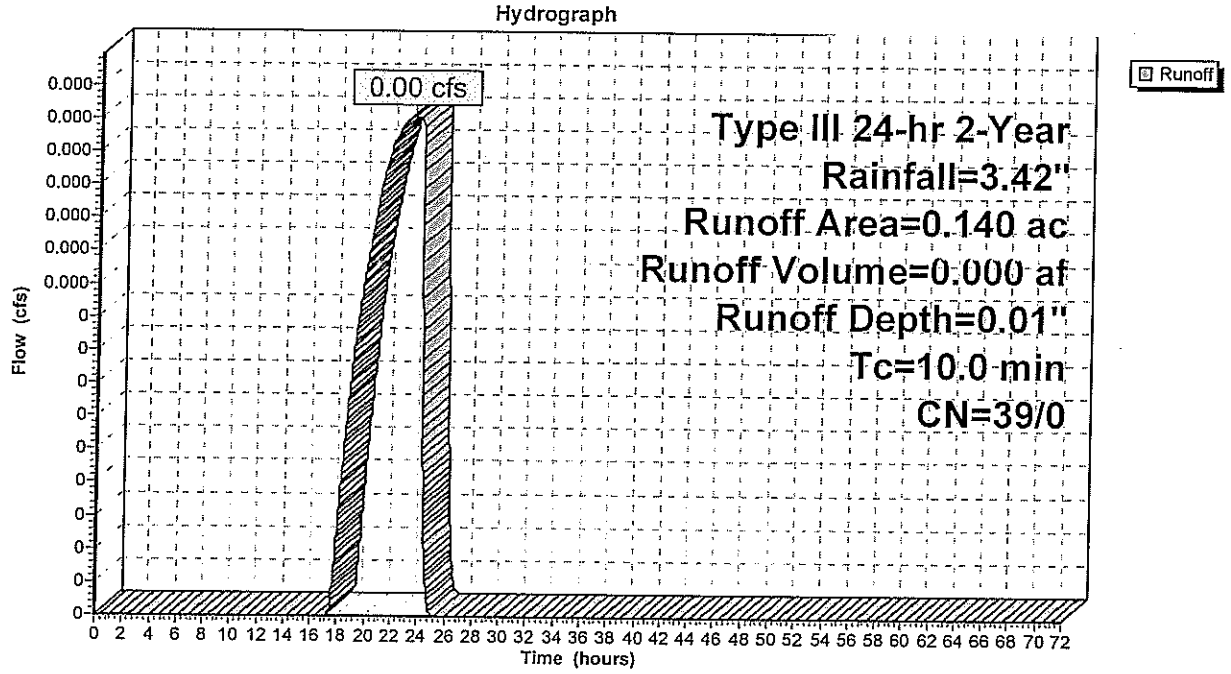
Runoff = 0.00 cfs @ 23.40 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
0.140	39	>75% Grass cover, Good, HSG A
0.140	39	100.00% Pervious Area

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

Subcatchment 14S: PDA-1E (Pervious)



Summary for Subcatchment 15S: PDA-2 (Pervious)

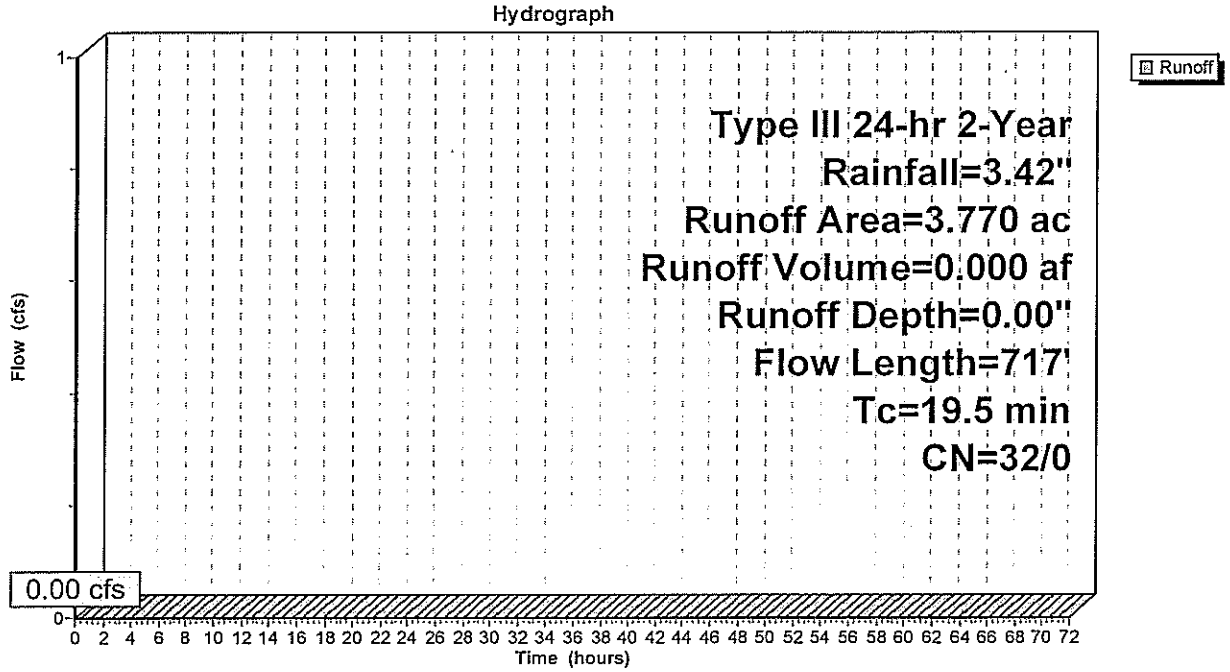
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
3.120	30	Woods, Good, HSG A
0.650	39	>75% Grass cover, Good, HSG A
3.770	32	Weighted Average
3.770	32	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	97	0.0620	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
6.6	620	0.0096	1.58		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
19.5	717	Total			

Subcatchment 15S: PDA-2 (Pervious)



Summary for Subcatchment 16S: PDA-3 (Impervious)

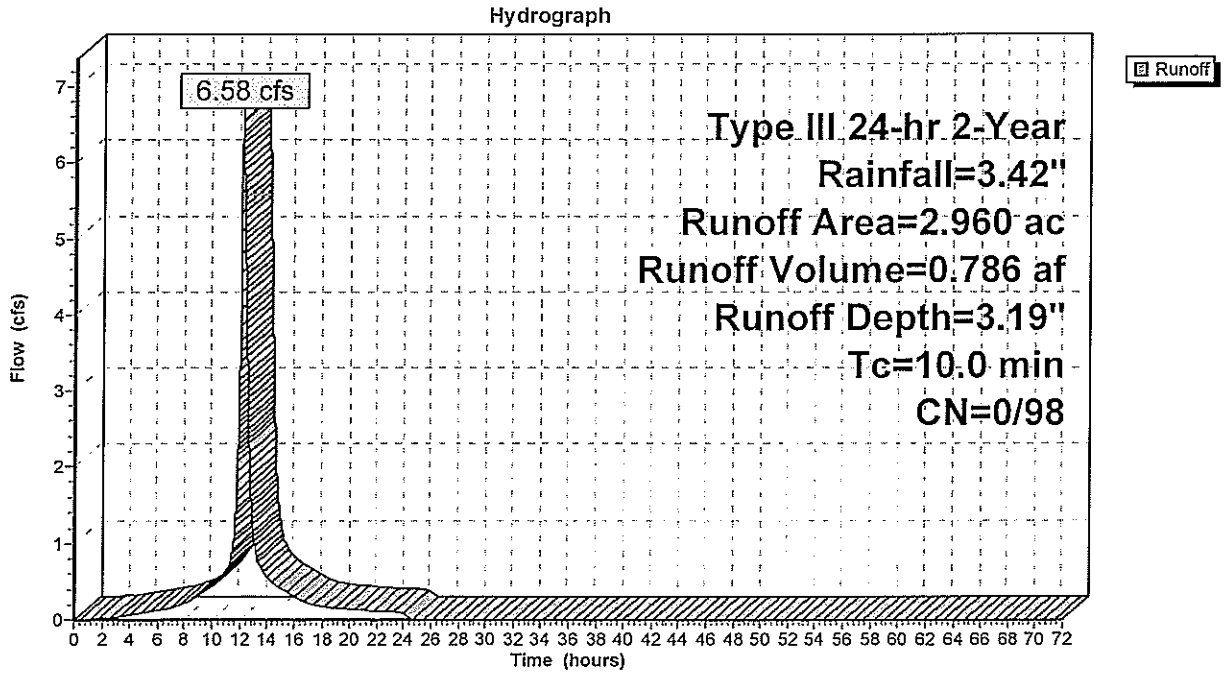
Runoff = 6.58 cfs @ 12.16 hrs, Volume= 0.786 af, Depth= 3.19"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

	Area (ac)	CN	Description
	2.060	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	2.960	98	Weighted Average
	2.960	98	100.00% Impervious Area

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

Subcatchment 16S: PDA-3 (Impervious)



Summary for Subcatchment 17S: PDA-3 (Pervious)

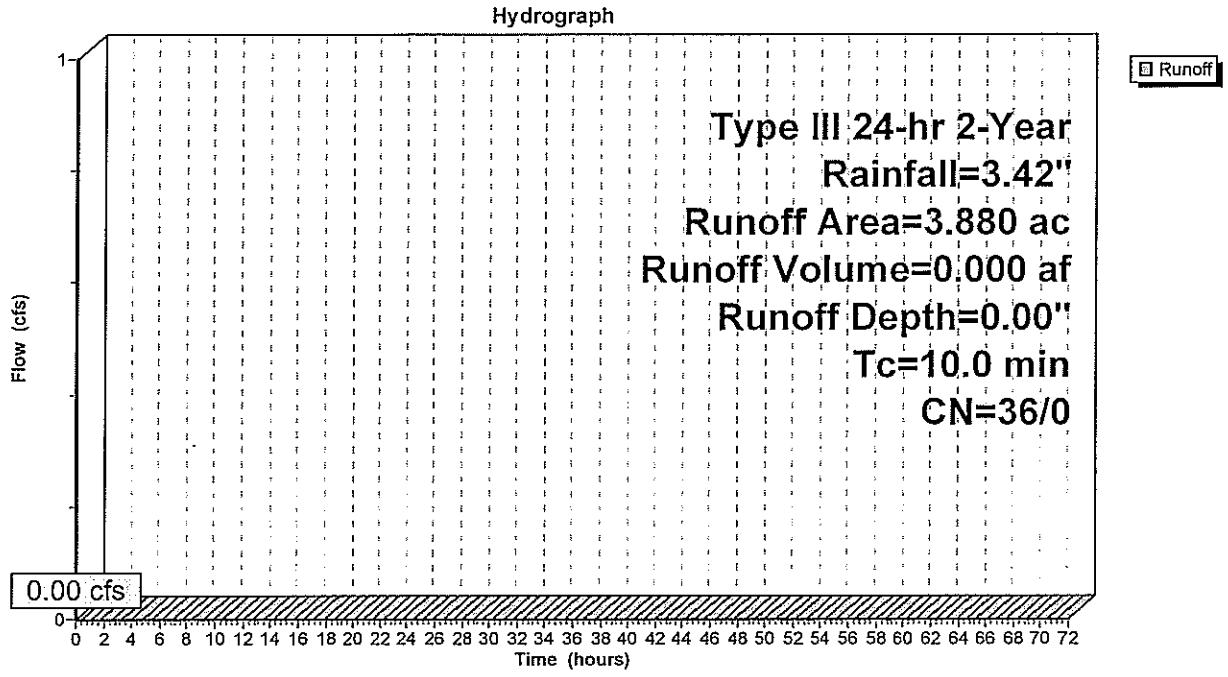
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
2.420	39	>75% Grass cover, Good, HSG A
1.460	30	Woods, Good, HSG A
3.880	36	Weighted Average
3.880	36	100.00% Pervious Area

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

Subcatchment 17S: PDA-3 (Pervious)



Summary for Pond 1P: Basin #1

Inflow Area = 11.350 ac, 81.15% Impervious, Inflow Depth = 2.59" for 2-Year event
Inflow = 20.48 cfs @ 12.16 hrs, Volume= 2.446 af
Outflow = 0.12 cfs @ 24.24 hrs, Volume= 0.525 af, Atten= 99%, Lag= 724.9 min
Primary = 0.12 cfs @ 24.24 hrs, Volume= 0.525 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 57.92' @ 24.24 hrs Surf.Area= 101,797 sf Storage= 101,890 cf

Plug-Flow detention time= 1,963.1 min calculated for 0.525 af (21% of inflow)
Center-of-Mass det. time= 1,727.1 min (2,491.9 - 764.8)

Volume	Invert	Avail.Storage	Storage Description
#1	56.90'	432,566 cf	**Basin #1 (Prismatic)** Listed below (Recalc)

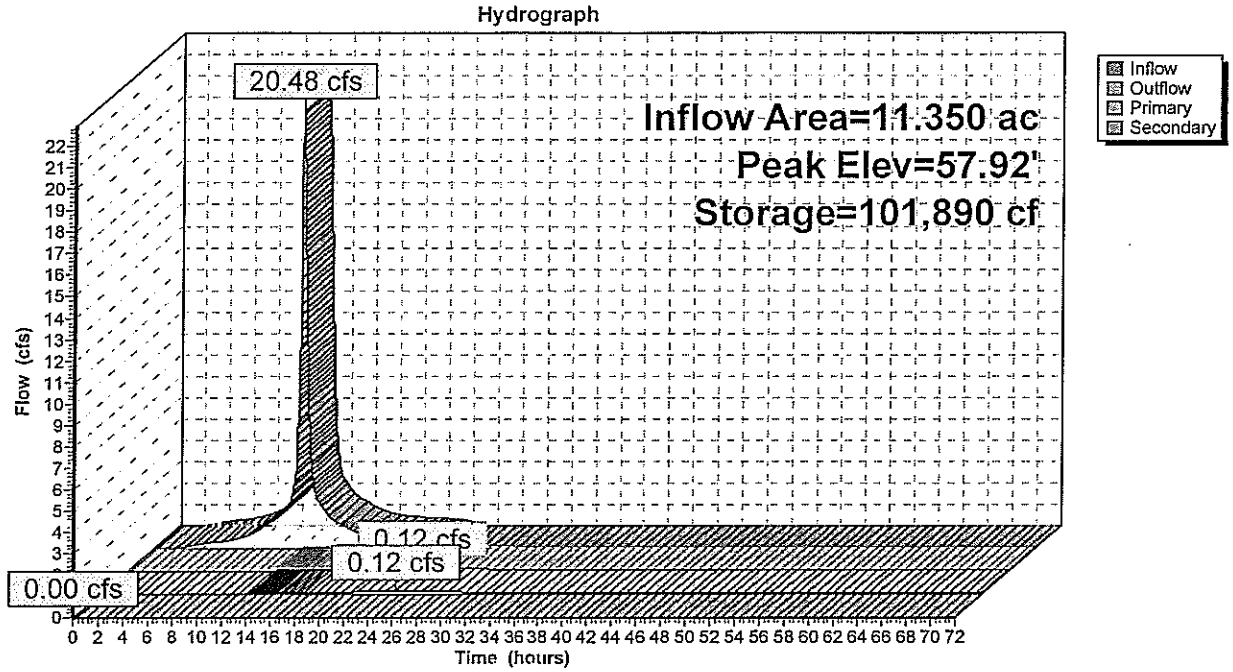
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
56.90	97,675	0	0
57.00	98,767	9,822	9,822
58.00	102,067	100,417	110,239
59.00	105,401	103,734	213,973
60.00	108,770	107,086	321,059
61.00	114,245	111,508	432,566

Device	Routing	Invert	Outlet Devices
#1	Primary	56.80'	**15.0" Round Culvert** L= 12.0' RCP, groove end w/headwall, Ke= 0.200 Outlet Invert= 56.68' S= 0.0100 '/' Cc= 0.900 n= 0.013
#2	Device 1	57.30'	**2.5" Vert. Orifice/Grate** C= 0.600
#3	Device 1	60.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	60.30'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.12 cfs @ 24.24 hrs HW=57.92' TW=52.82' (Dynamic Tailwater)
↑**1=Culvert** (Passes 0.12 cfs of 3.72 cfs potential flow)
↑**2=Orifice/Grate** (Orifice Controls 0.12 cfs @ 3.45 fps)
3=Orifice/Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' TW=0.00' (Dynamic Tailwater)
↑**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Basin #1



Summary for Pond 2P: Basin #2

Inflow Area = 16.380 ac, 79.06% Impervious, Inflow Depth > 1.11" for 2-Year event
Inflow = 8.32 cfs @ 12.16 hrs, Volume= 1.519 af
Outflow = 0.40 cfs @ 16.86 hrs, Volume= 0.898 af, Atten= 95%, Lag= 282.4 min
Primary = 0.40 cfs @ 16.86 hrs, Volume= 0.898 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 52.87' @ 16.86 hrs Surf.Area= 41,686 sf Storage= 35,057 cf

Plug-Flow detention time= 1,353.2 min calculated for 0.898 af (59% of inflow)
Center-of-Mass det. time= 703.3 min (2,065.3 - 1,362.0)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	179,275 cf	**Basin #2 (Prismatic)** Listed below (Recalc)

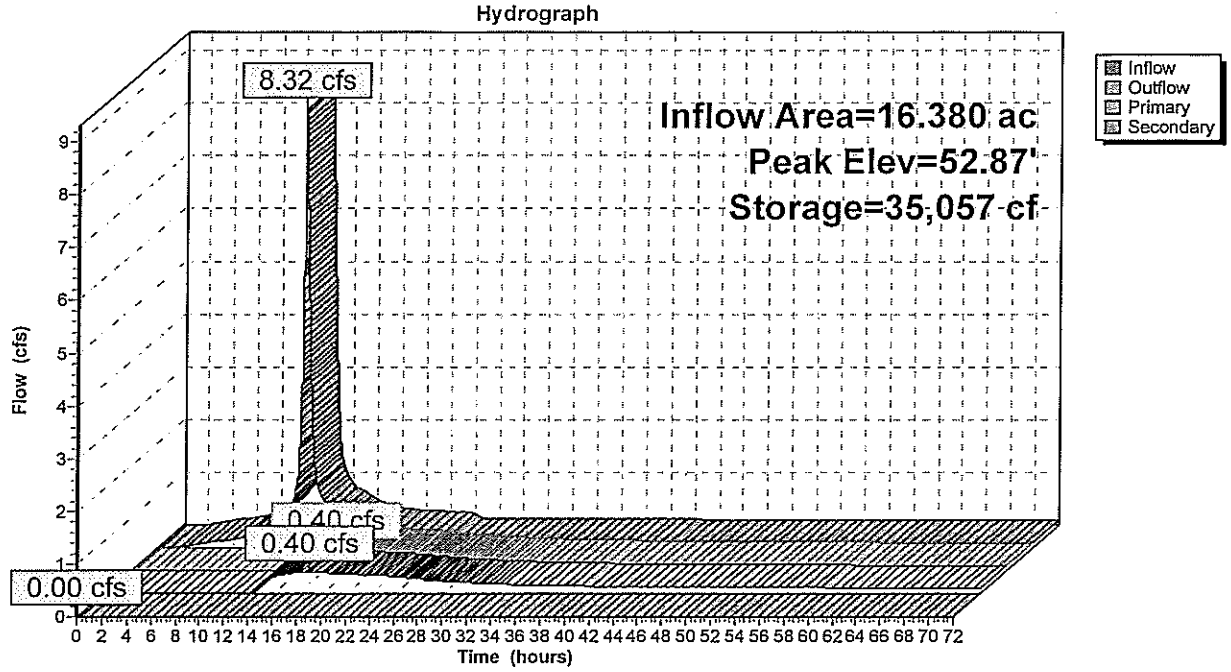
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	39,333	0	0
53.00	42,052	40,693	40,693
54.00	44,827	43,440	84,132
55.00	47,558	46,193	130,325
56.00	50,343	48,951	179,275

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**15.0" Round Culvert** L= 17.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 50.66' S= 0.0200 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	54.60'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.40 cfs @ 16.86 hrs HW=52.87' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.40 cfs of 7.62 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 0.40 cfs @ 2.06 fps)
—**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=52.00' TW=0.00' (Dynamic Tailwater)
↑—**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Basin #2



Summary for Pond 3P: Basin #3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 1.38" for 2-Year event
Inflow = 6.58 cfs @ 12.16 hrs, Volume= 0.786 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 58.27' @ 25.10 hrs Surf.Area= 48,286 sf Storage= 34,241 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

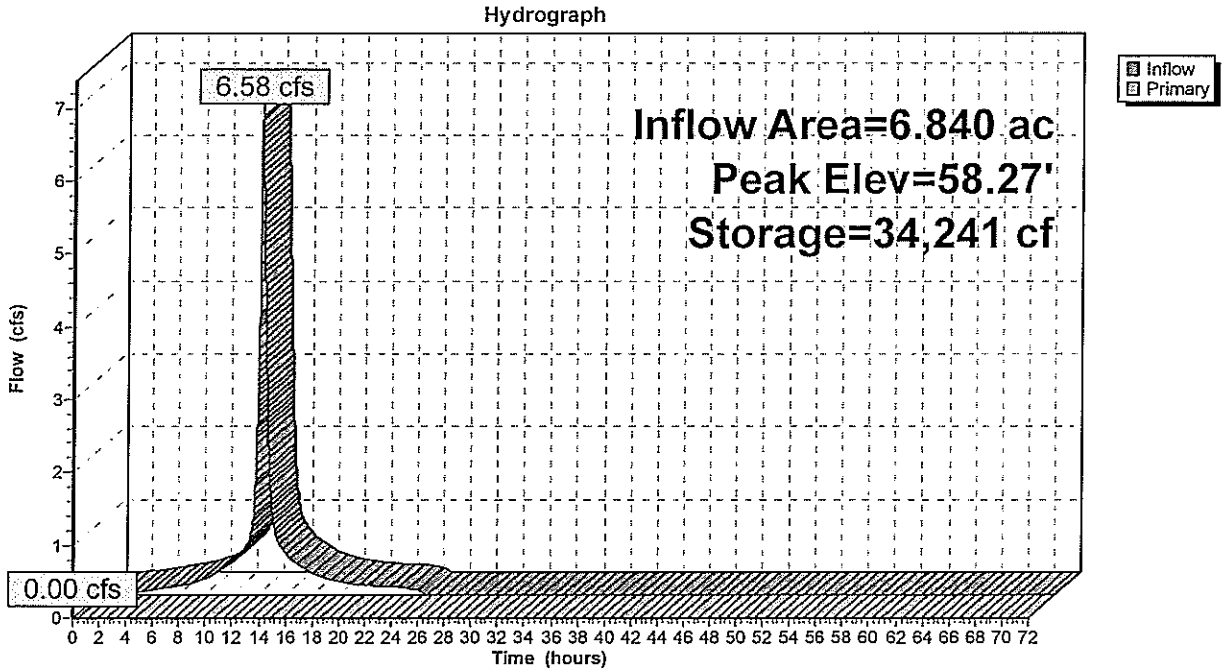
Volume	Invert	Avail.Storage	Storage Description
#1	57.50'	127,089 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.50	39,005	0	0
58.00	46,307	21,328	21,328
59.00	53,554	49,931	71,259
60.00	58,107	55,831	127,089

Device	Routing	Invert	Outlet Devices
#1	Primary	59.30'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=57.50' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Basin #3



Summary for Pond E-LD: Local Depression

Inflow Area = 3.740 ac, 32.35% Impervious, Inflow Depth = 1.03" for 2-Year event
Inflow = 2.69 cfs @ 12.16 hrs, Volume= 0.321 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 56.99' @ 25.10 hrs Surf.Area= 16,940 sf Storage= 13,997 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

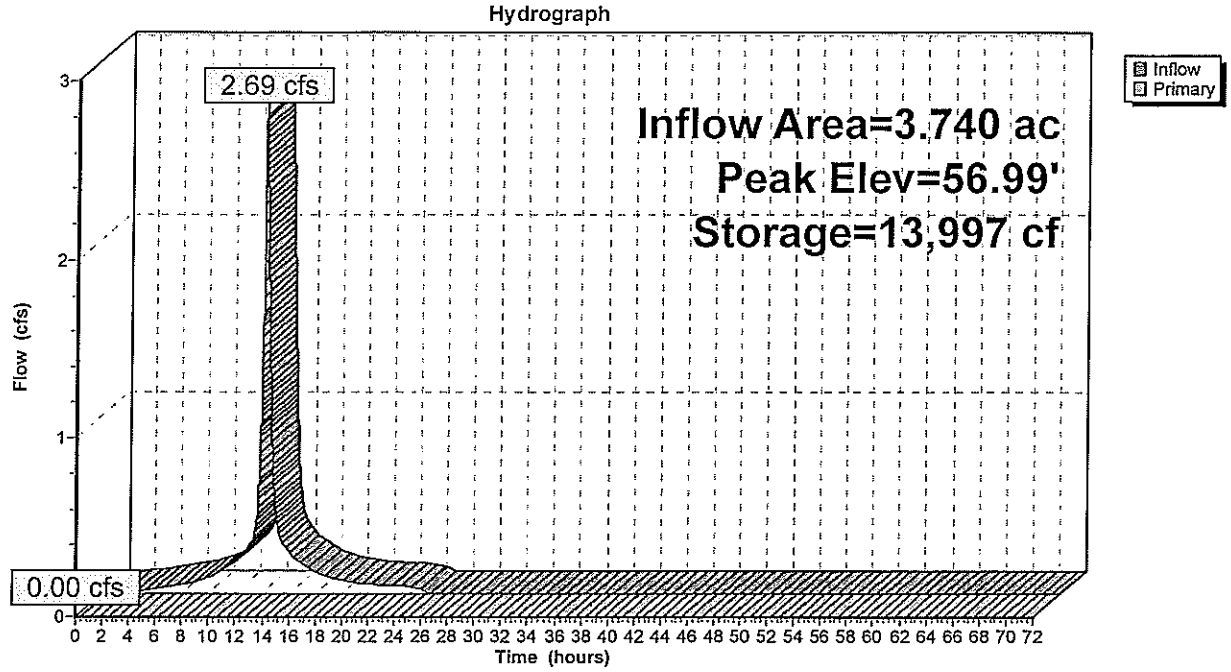
Volume	Invert	Avail.Storage	Storage Description
#1	55.00'	77,509 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
55.00	305	82.0	0	0	305
56.00	6,603	306.0	2,776	2,776	7,224
57.00	17,113	481.0	11,449	14,224	18,191
58.00	29,890	639.0	23,207	37,431	32,284
59.00	51,218	900.0	40,078	77,509	64,258

Device	Routing	Invert	Outlet Devices
#1	Primary	58.79'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=55.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E-LD: Local Depression



Summary for Pond P-LD: PDA-2A (Local Depression)

Inflow Area = 3.770 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 55.00' @ 0.00 hrs Surf.Area= 305 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no inflow)

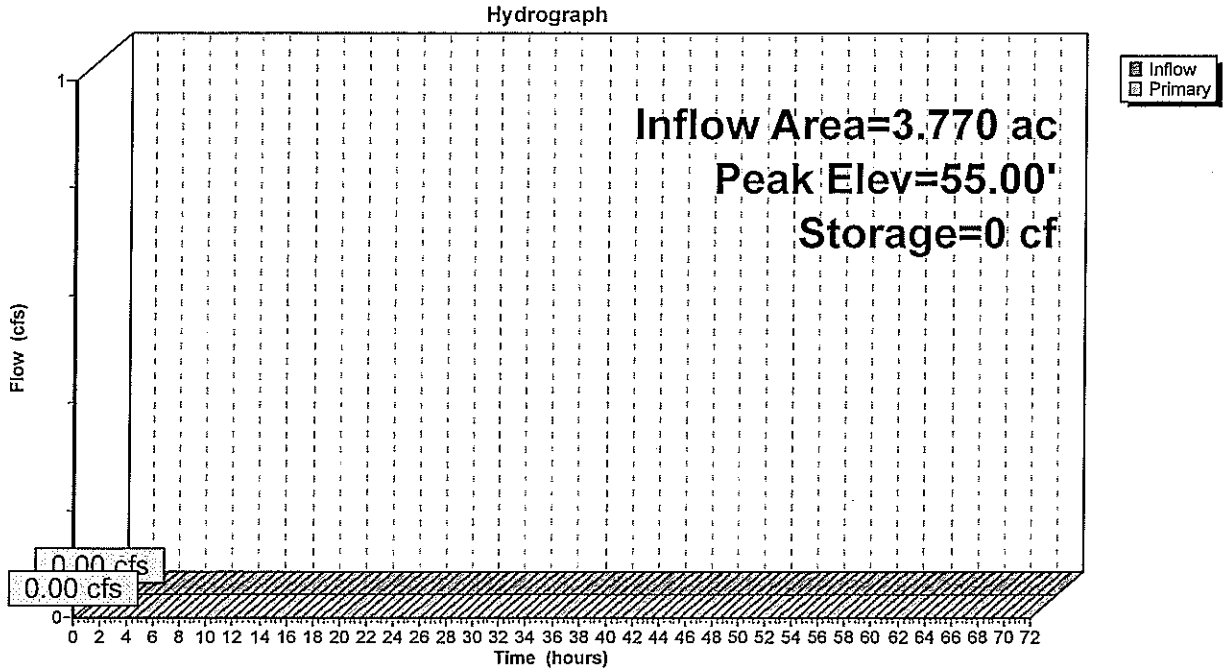
Volume	Invert	Avail.Storage	Storage Description
#1	55.00'	74,341 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
55.00	305	82.0	0	0	305
56.00	6,601	306.0	2,775	2,775	7,224
57.00	17,096	481.0	11,440	14,215	18,191
58.00	29,886	639.0	23,195	37,410	32,284
59.00	44,455	776.0	36,930	74,341	47,727

Device	Routing	Invert	Outlet Devices
#1	Primary	58.79'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=55.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P-LD: PDA-2A (Local Depression)

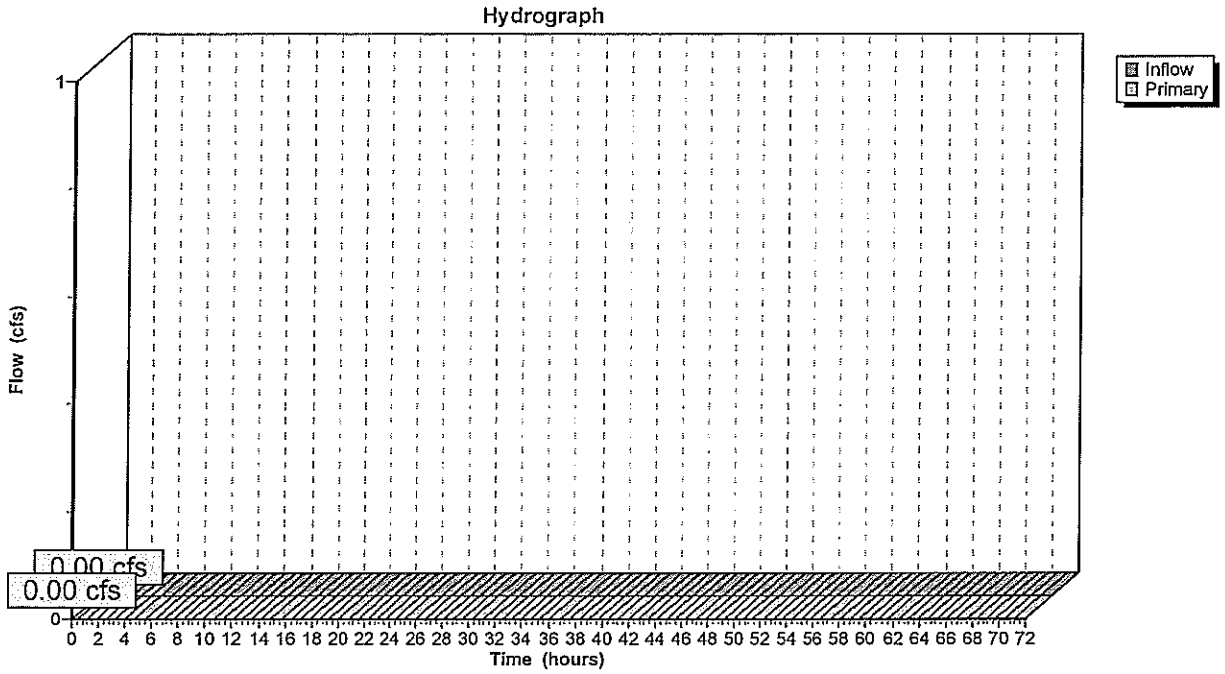


Summary for Link 1L: Emergency Spillway

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Emergency Spillway

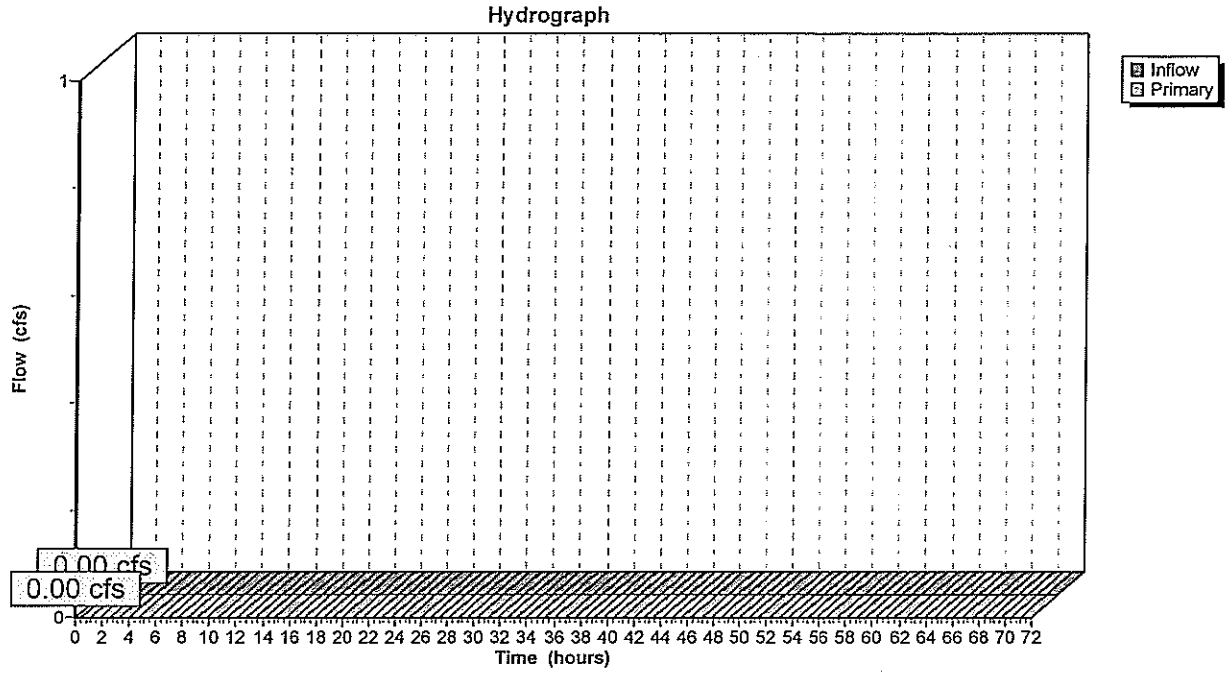


Summary for Link 2L: Emergency Spillway

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Emergency Spillway

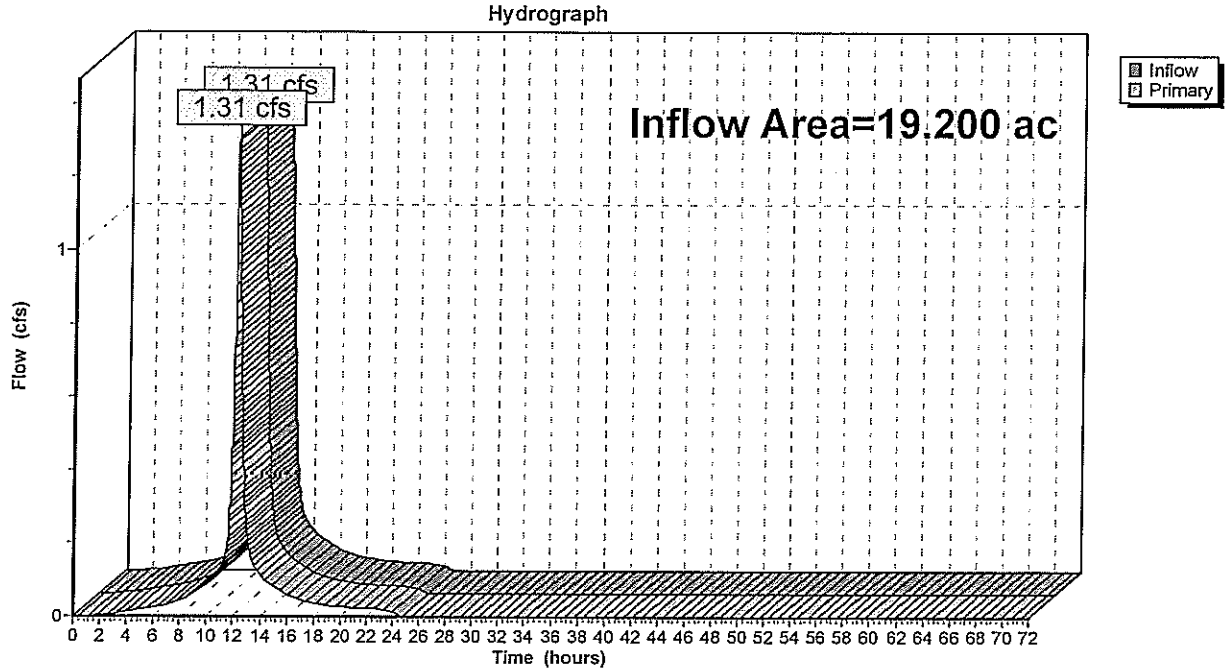


Summary for Link L-E1: EDA-1

Inflow Area = 19.200 ac, 3.07% Impervious, Inflow Depth = 0.10" for 2-Year event
Inflow = 1.31 cfs @ 12.16 hrs, Volume= 0.157 af
Primary = 1.31 cfs @ 12.16 hrs, Volume= 0.157 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E1: EDA-1

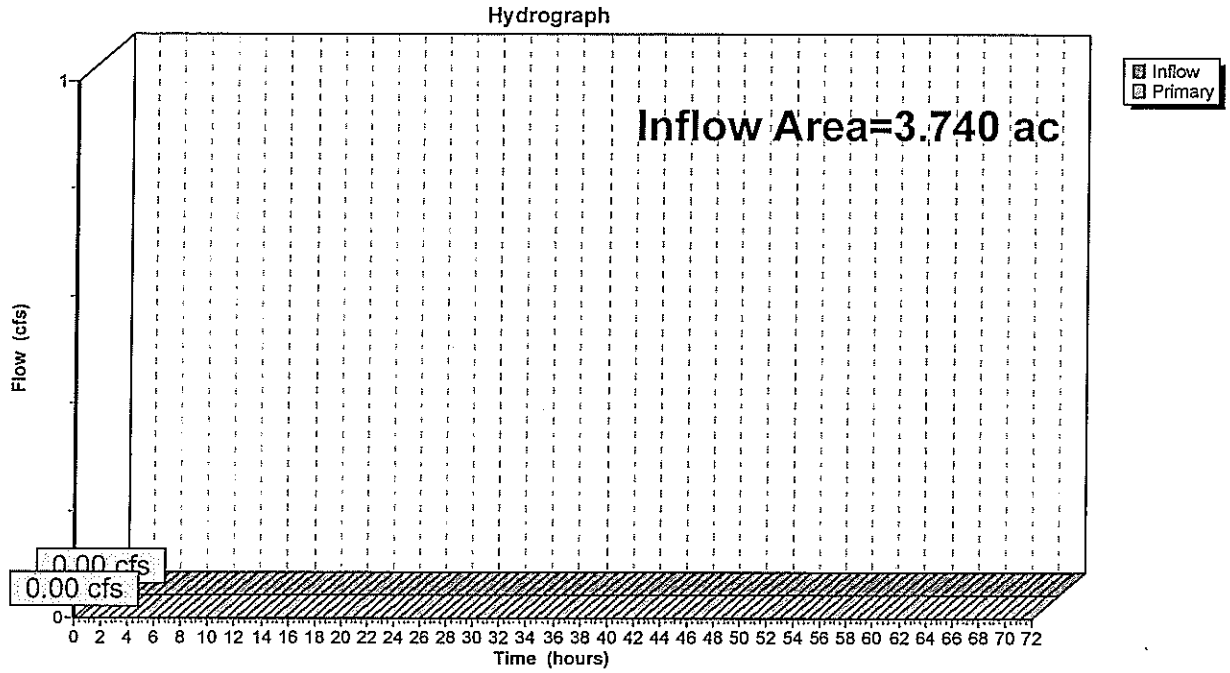


Summary for Link L-E2: EDA-2

Inflow Area = 3.740 ac, 32.35% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E2: EDA-2

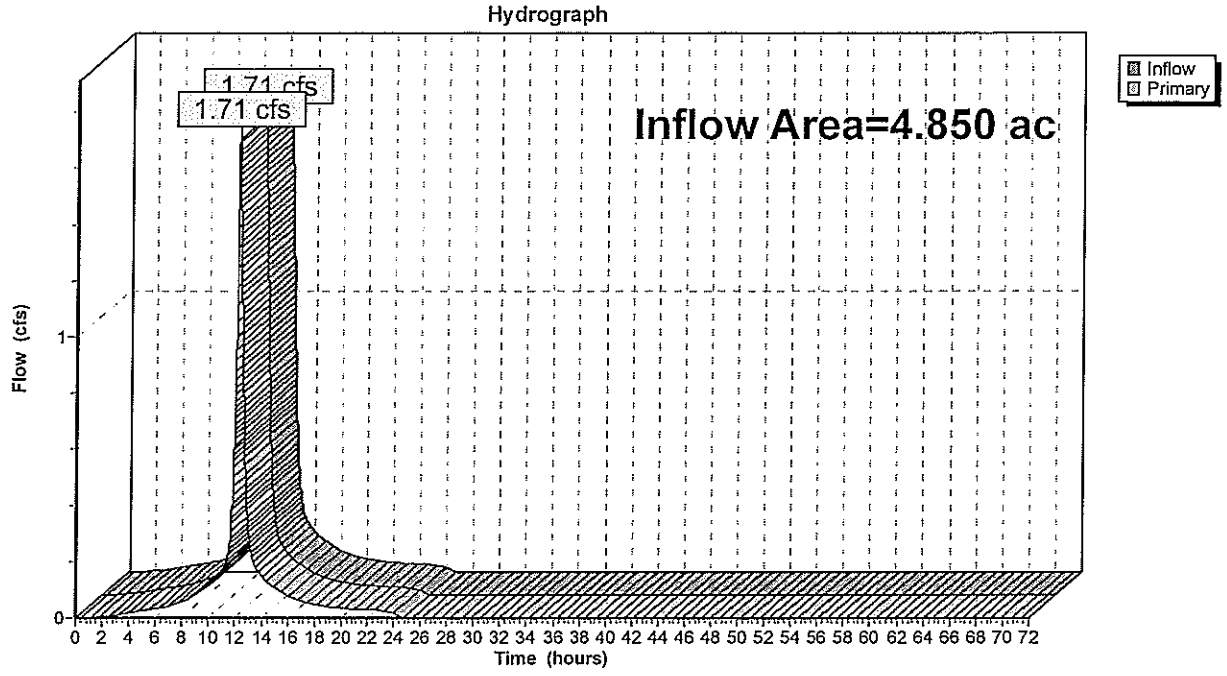


Summary for Link L-E3: EDA-3

Inflow Area = 4.850 ac, 15.88% Impervious, Inflow Depth = 0.51" for 2-Year event
Inflow = 1.71 cfs @ 12.16 hrs, Volume= 0.204 af
Primary = 1.71 cfs @ 12.16 hrs, Volume= 0.204 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E3: EDA-3

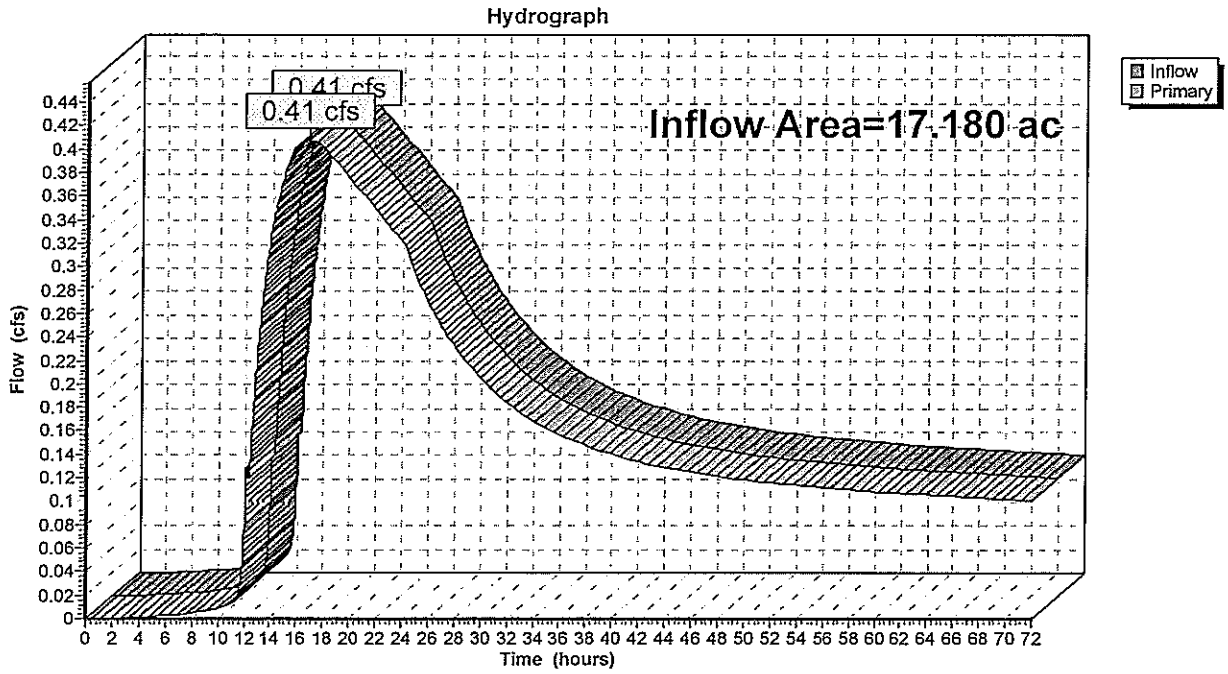


Summary for Link L-P1: PDA-1

Inflow Area = 17.180 ac, 75.73% Impervious, Inflow Depth > 0.64" for 2-Year event
Inflow = 0.41 cfs @ 16.76 hrs, Volume= 0.914 af
Primary = 0.41 cfs @ 16.76 hrs, Volume= 0.914 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P1: PDA-1

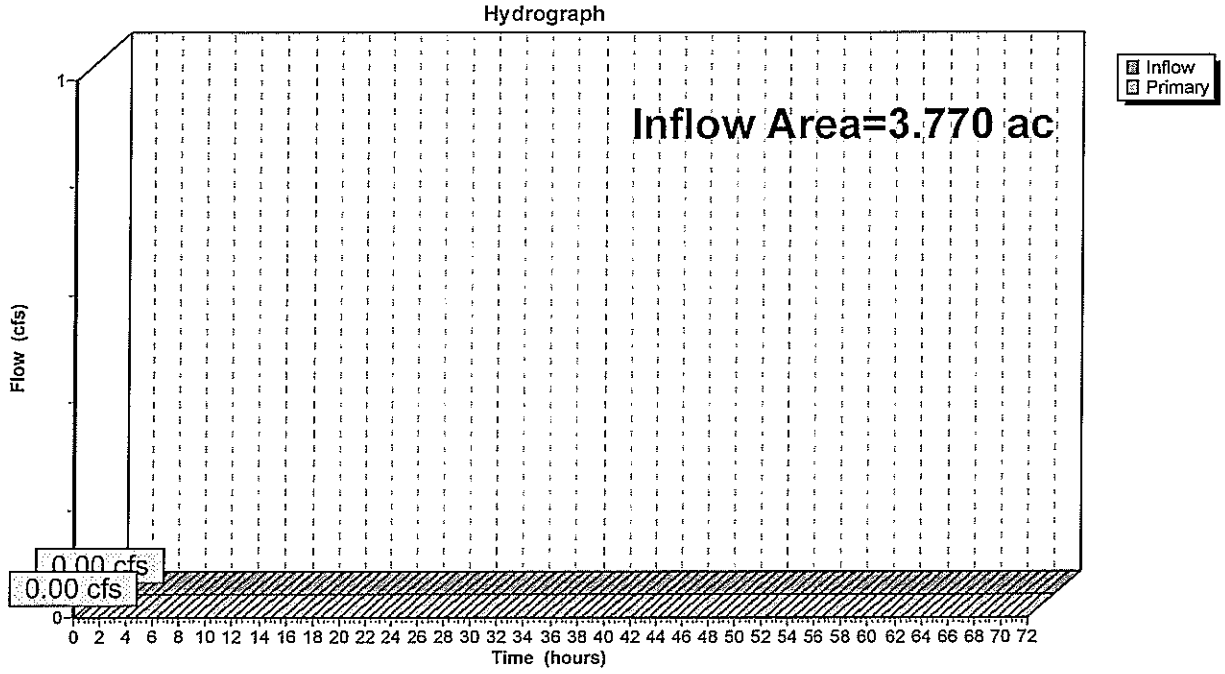


Summary for Link L-P2: PDA-2

Inflow Area = 3.770 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P2: PDA-2

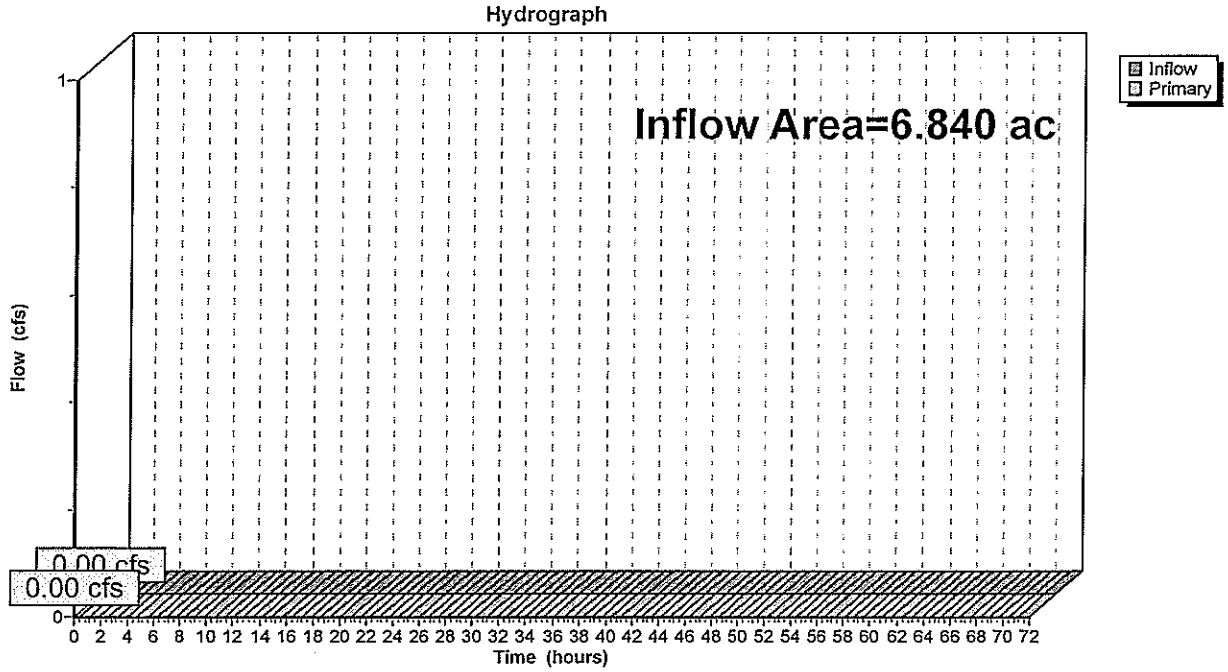


Summary for Link L-P3: PDA-3

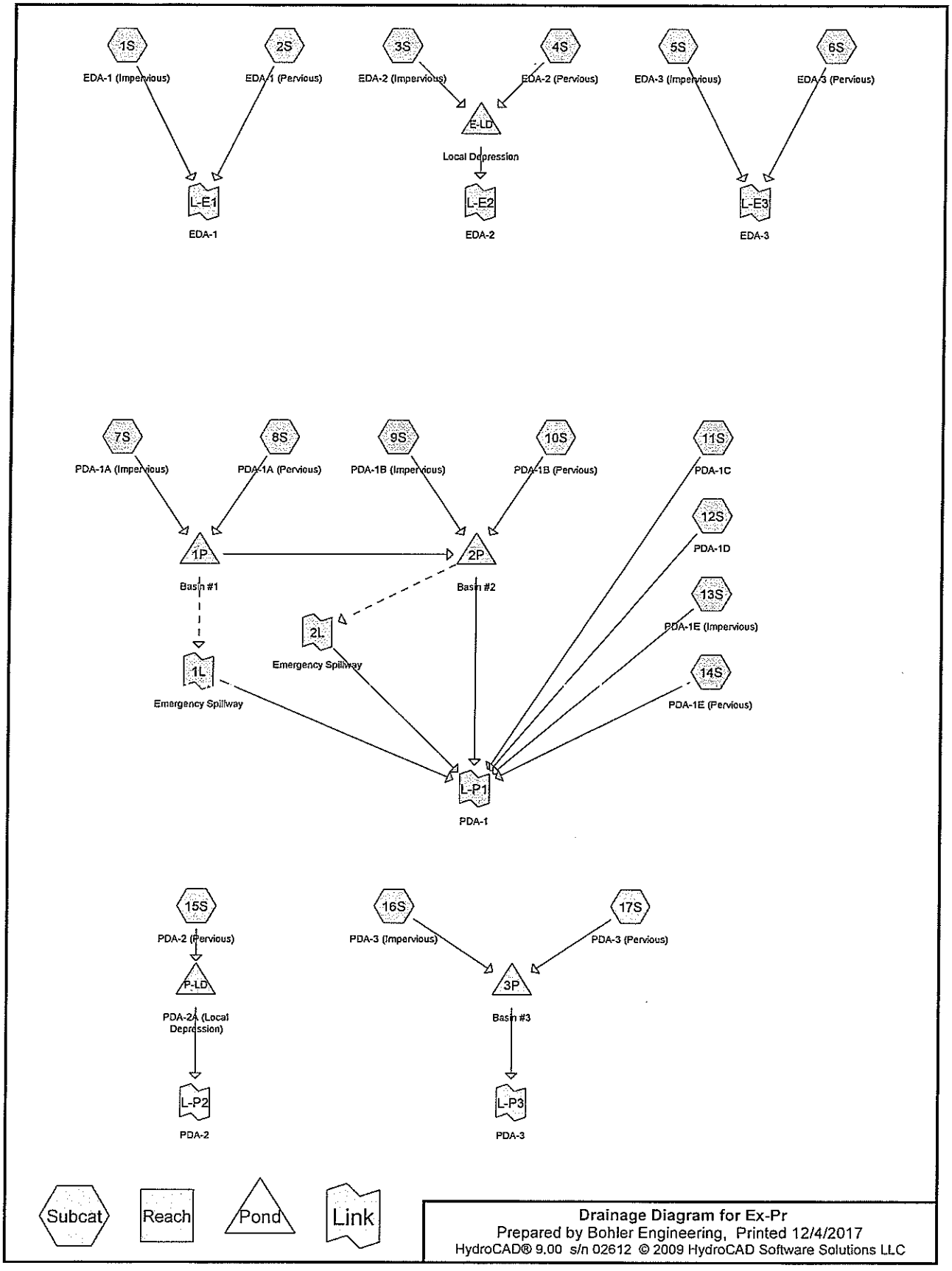
Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 0.00" for 2-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P3: PDA-3



10-YEAR STORM EVENT



Drainage Diagram for Ex-Pr
Prepared by Bohler Engineering, Printed 12/4/2017

Summary for Subcatchment 1S: EDA-1 (Impervious)

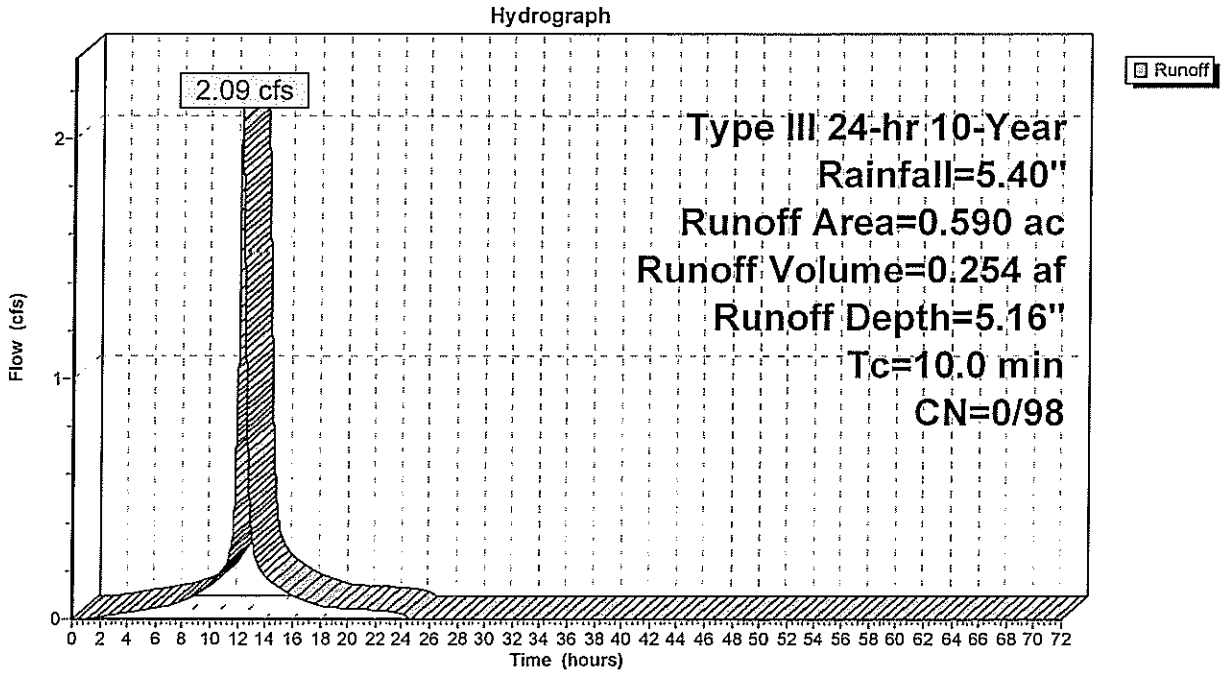
Runoff = 2.09 cfs @ 12.15 hrs, Volume= 0.254 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.590	98	Paved roads w/curbs & sewers, HSG A
0.590	98	100.00% Impervious Area

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

Subcatchment 1S: EDA-1 (Impervious)



Summary for Subcatchment 2S: EDA-1 (Pervious)

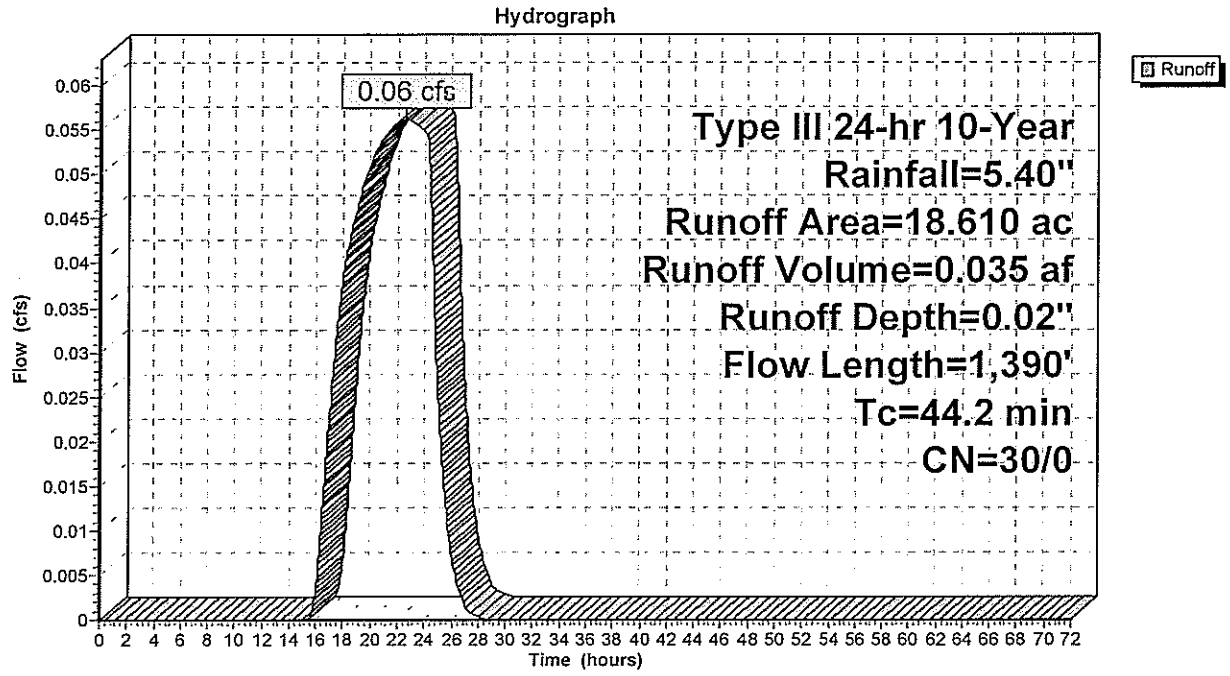
Runoff = 0.06 cfs @ 22.59 hrs, Volume= 0.035 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
18.110	30	Woods, Good, HSG A
0.500	30	Woods, Good, HSG A
18.610	30	Weighted Average
18.610	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.5	90	0.0089	0.06		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
17.7	1,300	0.0058	1.23		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
44.2	1,390	Total			

Subcatchment 2S: EDA-1 (Pervious)



Summary for Subcatchment 3S: EDA-2 (Impervious)

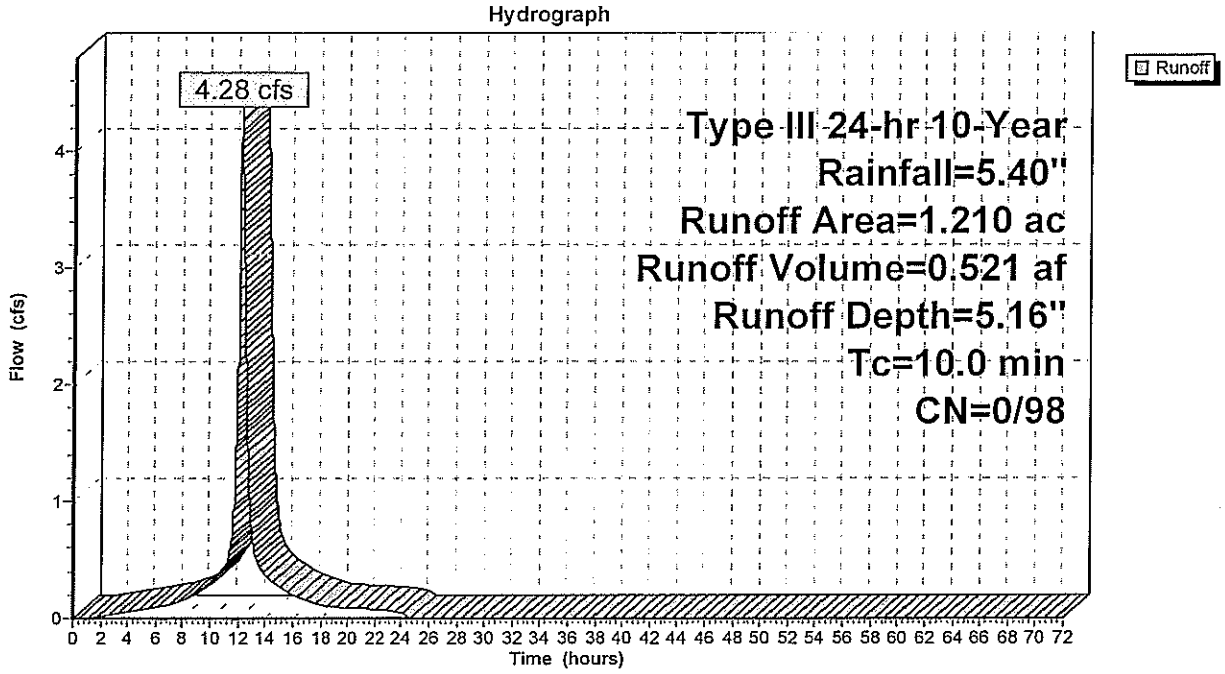
Runoff = 4.28 cfs @ 12.15 hrs, Volume= 0.521 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
1.210	98	Paved parking, HSG A
1.210	98	100.00% Impervious Area

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

Subcatchment 3S: EDA-2 (Impervious)



Summary for Subcatchment 4S: EDA-2 (Pervious)

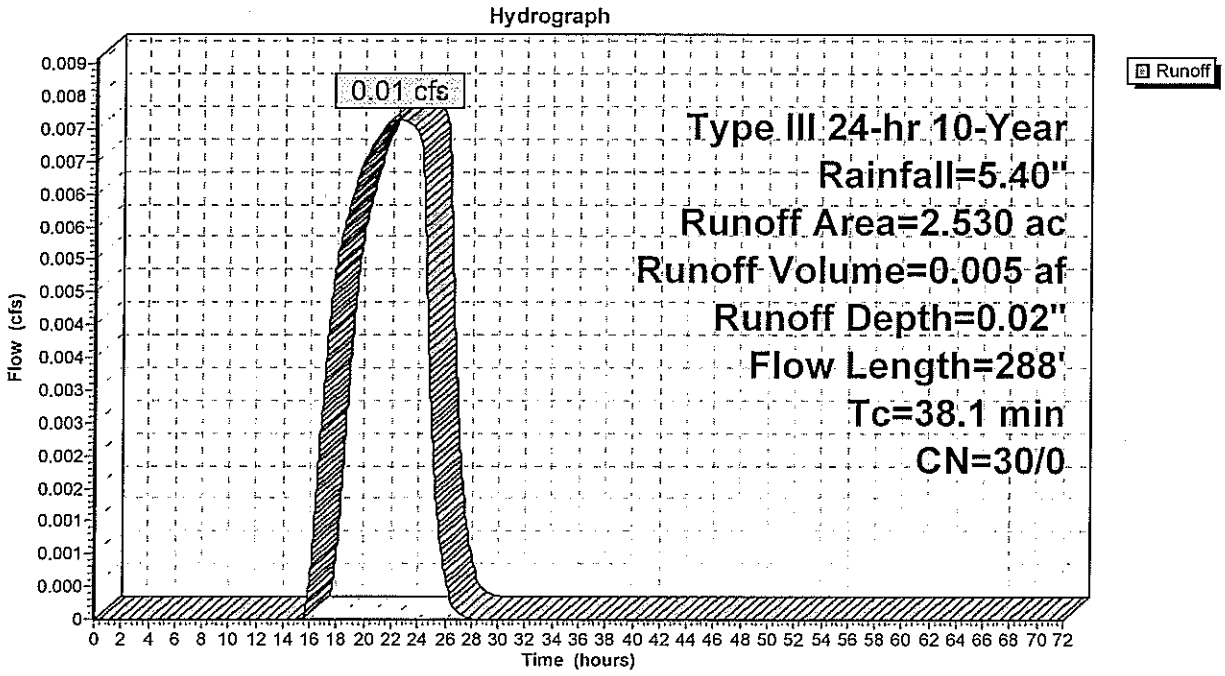
Runoff = 0.01 cfs @ 22.44 hrs, Volume= 0.005 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
1.980	30	Woods, Good, HSG A
0.550	30	Woods, Good, HSG A
2.530	30	Weighted Average
2.530	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.3	150	0.0105	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
0.8	138	0.0290	2.74		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
38.1	288	Total			

Subcatchment 4S: EDA-2 (Pervious)



Summary for Subcatchment 5S: EDA-3 (Impervious)

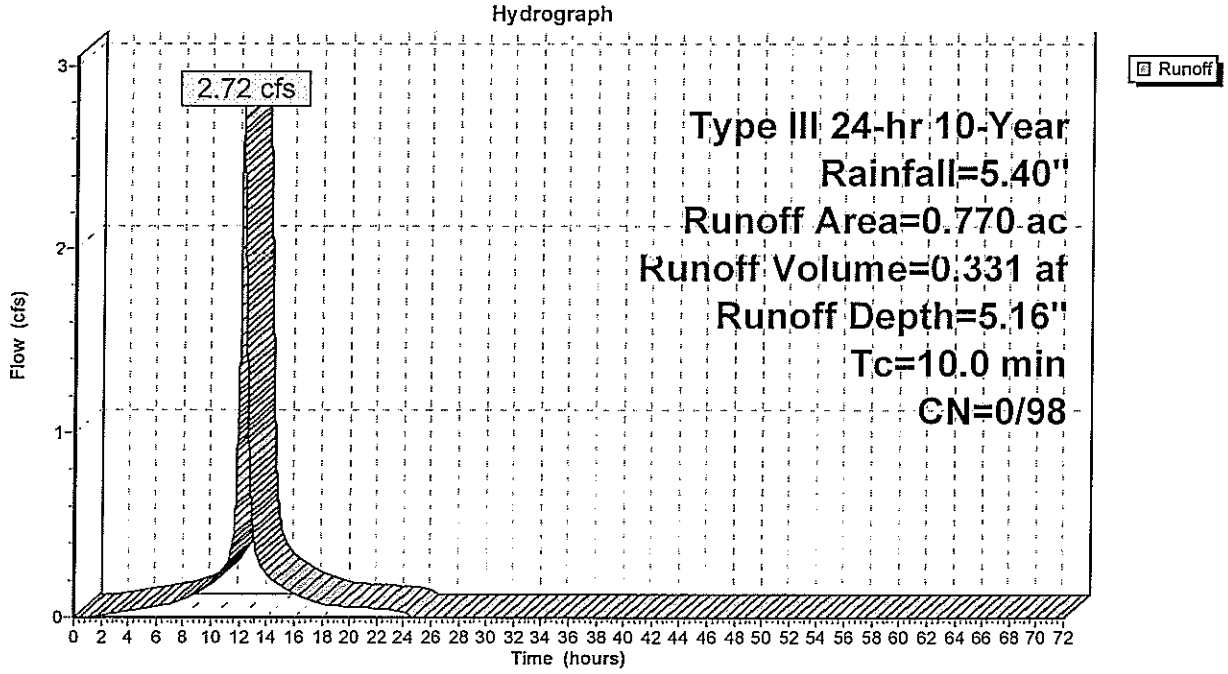
Runoff = 2.72 cfs @ 12.15 hrs, Volume= 0.331 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.770	98	Paved roads w/curbs & sewers, HSG A
0.770	98	100.00% Impervious Area

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

Subcatchment 5S: EDA-3 (Impervious)



Summary for Subcatchment 6S: EDA-3 (Pervious)

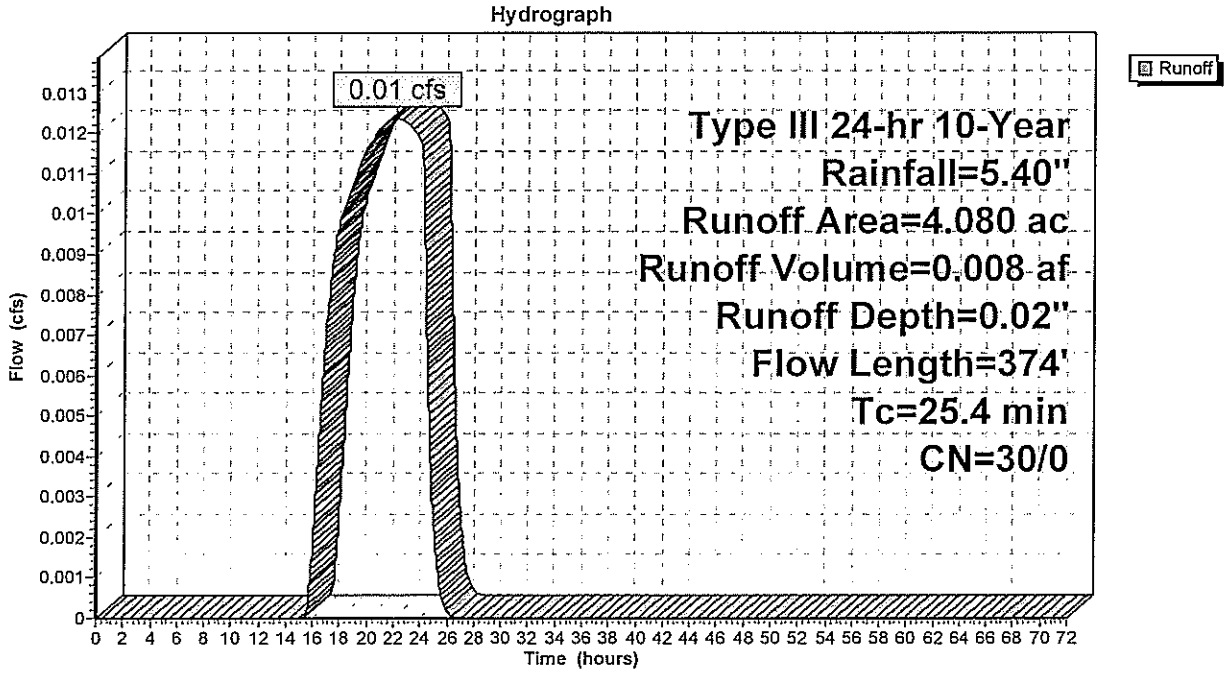
Runoff = 0.01 cfs @ 22.12 hrs, Volume= 0.008 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
2.310	30	Woods, Good, HSG A
1.770	30	Woods, Good, HSG A
4.080	30	Weighted Average
4.080	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	150	0.0390	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
3.3	224	0.0050	1.14		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
25.4	374	Total			

Subcatchment 6S: EDA-3 (Pervious)



Summary for Subcatchment 7S: PDA-1A (Impervious)

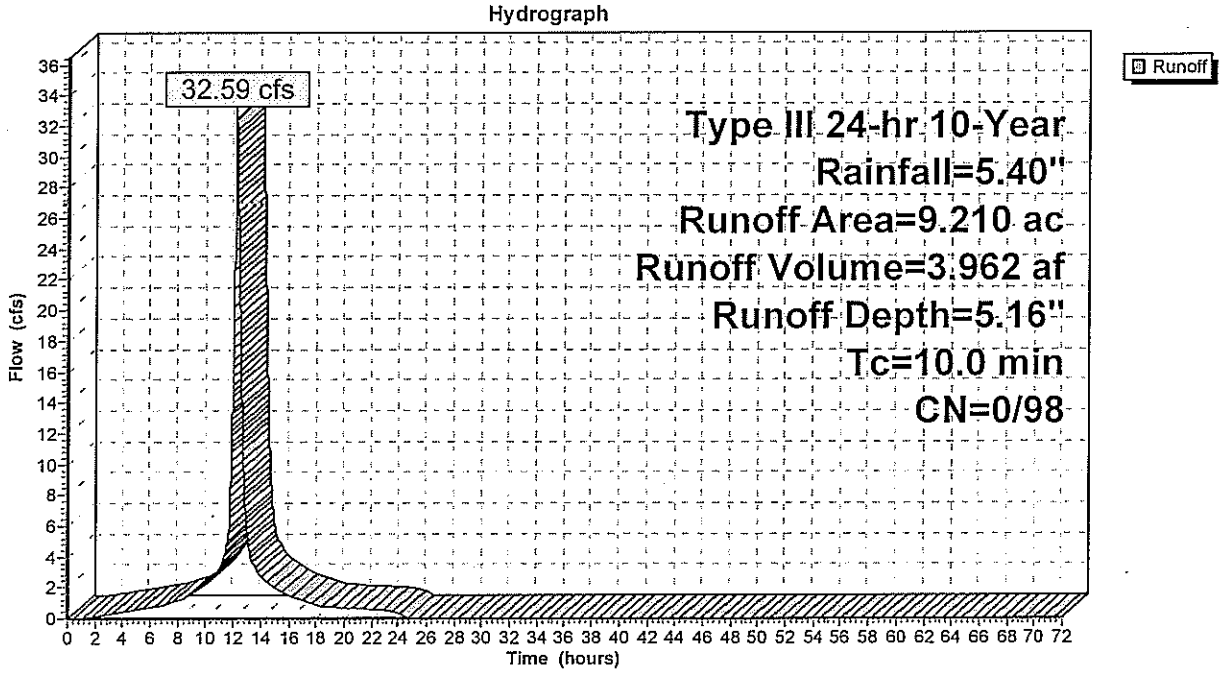
Runoff = 32.59 cfs @ 12.15 hrs, Volume= 3.962 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

	Area (ac)	CN	Description
	6.970	98	Paved parking, HSG A
*	2.240	98	Basin Bottom
	9.210	98	Weighted Average
	9.210	98	100.00% Impervious Area

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

Subcatchment 7S: PDA-1A (Impervious)



Summary for Subcatchment 8S: PDA-1A (Pervious)

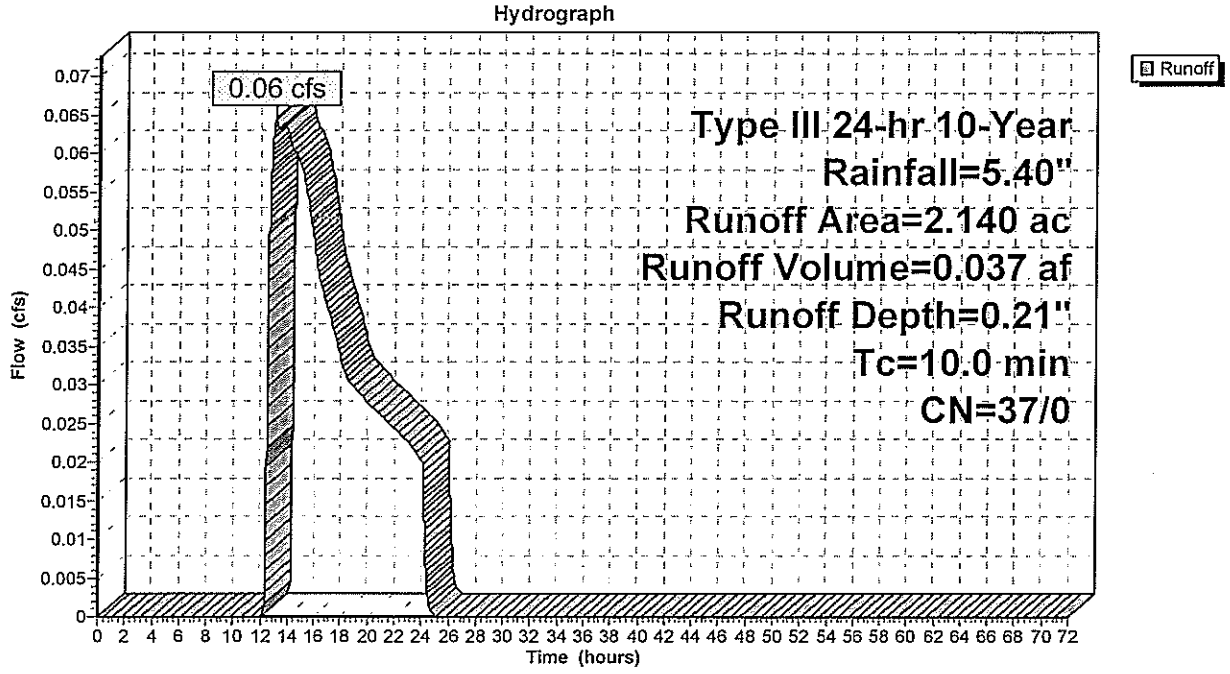
Runoff = 0.06 cfs @ 12.98 hrs, Volume= 0.037 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.490	30	Woods, Good, HSG A
1.650	39	>75% Grass cover, Good, HSG A
2.140	37	Weighted Average
2.140	37	100.00% Pervious Area

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

Subcatchment 8S: PDA-1A (Pervious)



Summary for Subcatchment 9S: PDA-1B (Impervious)

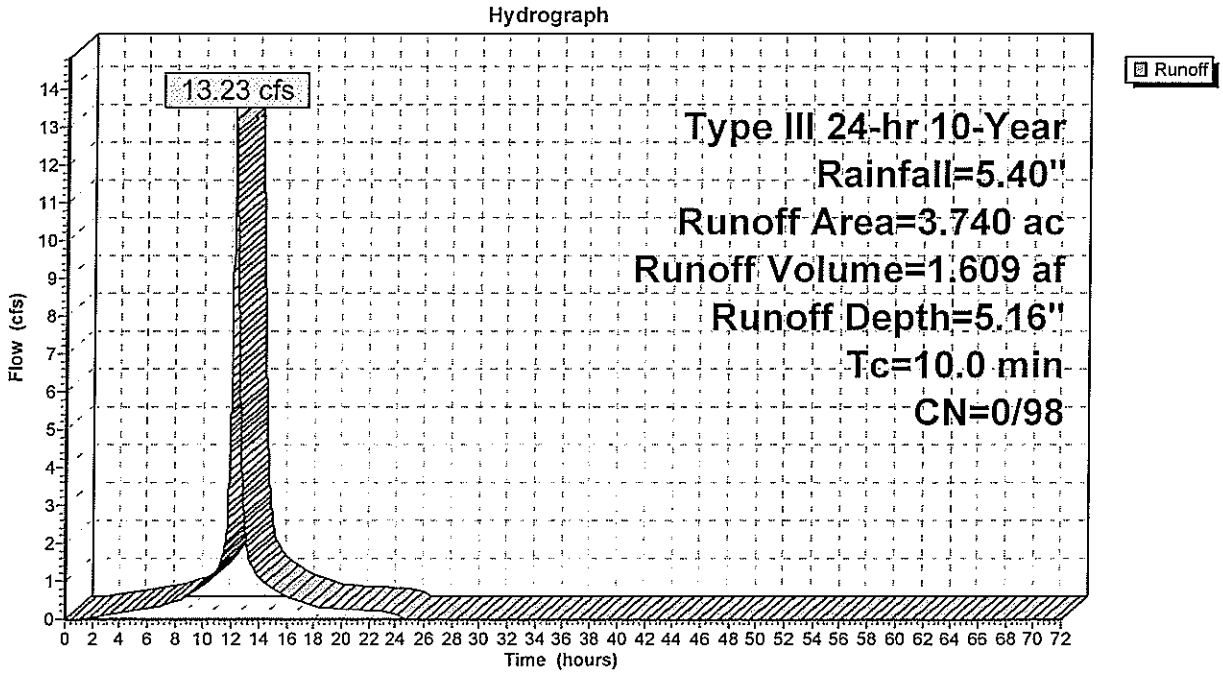
Runoff = 13.23 cfs @ 12.15 hrs, Volume= 1.609 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

	Area (ac)	CN	Description
	2.840	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	3.740	98	Weighted Average
	3.740	98	100.00% Impervious Area

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

Subcatchment 9S: PDA-1B (Impervious)



Summary for Subcatchment 10S: PDA-1B (Pervious)

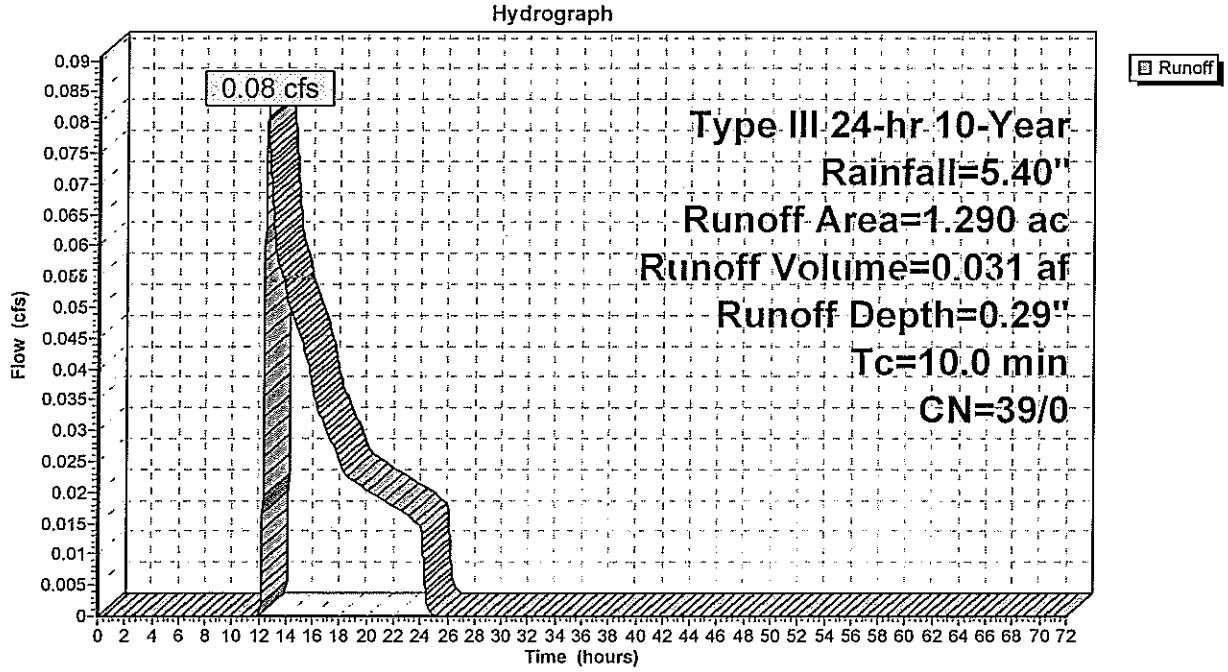
Runoff = 0.08 cfs @ 12.54 hrs, Volume= 0.031 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
1.290	39	100.00% Pervious Area

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

Subcatchment 10S: PDA-1B (Pervious)



Summary for Subcatchment 11S: PDA-1C

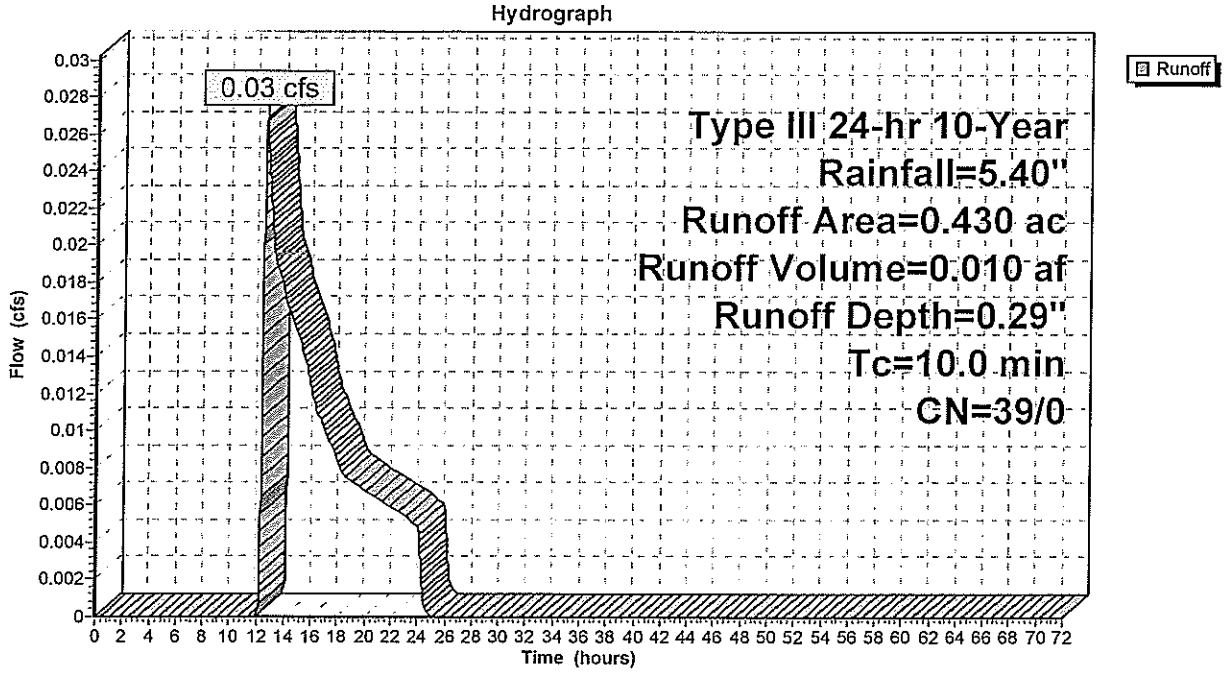
Runoff = 0.03 cfs @ 12.54 hrs, Volume= 0.010 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.430	39	>75% Grass cover, Good, HSG A
0.430	39	100.00% Pervious Area

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

Subcatchment 11S: PDA-1C



Summary for Subcatchment 12S: PDA-1D

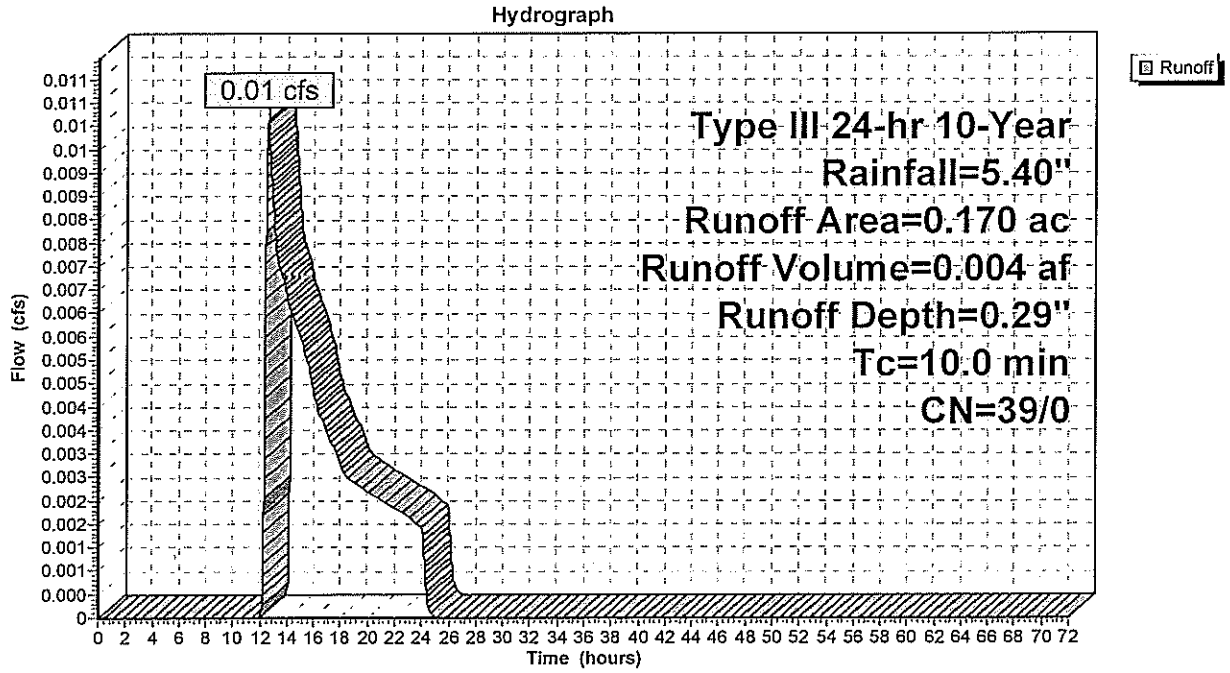
Runoff = 0.01 cfs @ 12.54 hrs, Volume= 0.004 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.170	39	>75% Grass cover, Good, HSG A
0.170	39	100.00% Pervious Area

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

Subcatchment 12S: PDA-1D



Summary for Subcatchment 13S: PDA-1E (Impervious)

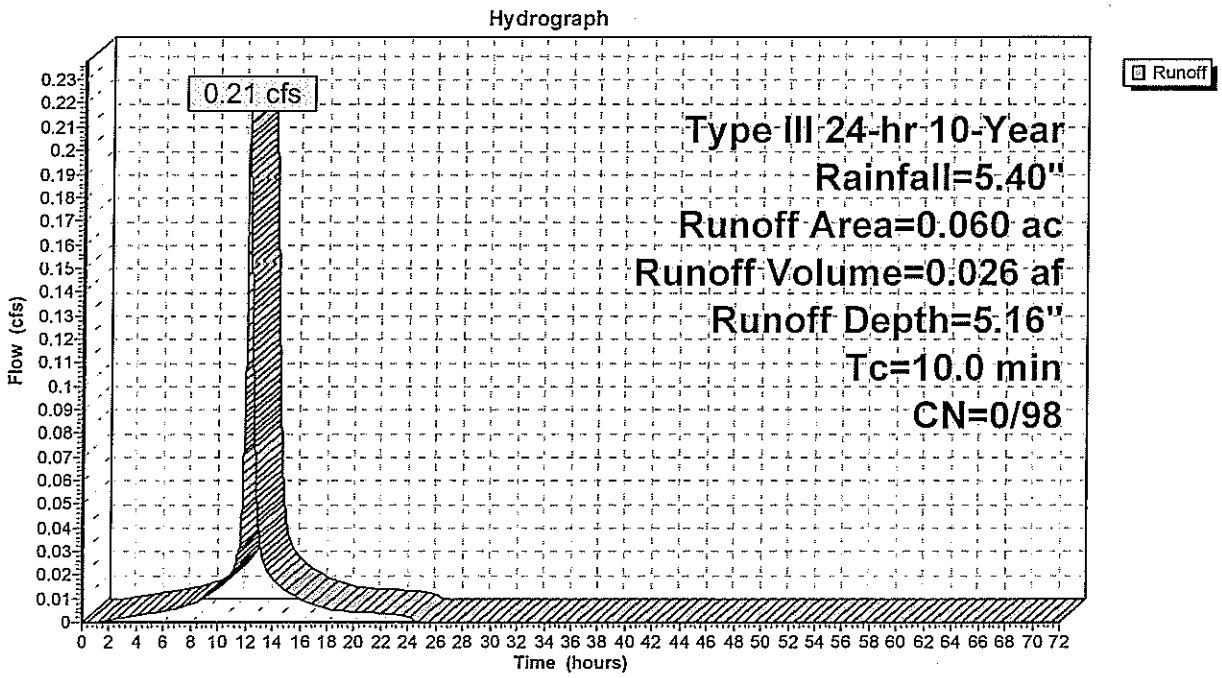
Runoff = 0.21 cfs @ 12.15 hrs, Volume= 0.026 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.060	98	Roofs, HSG A
0.060	98	100.00% Impervious Area

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

Subcatchment 13S: PDA-1E (Impervious)



Summary for Subcatchment 14S: PDA-1E (Pervious)

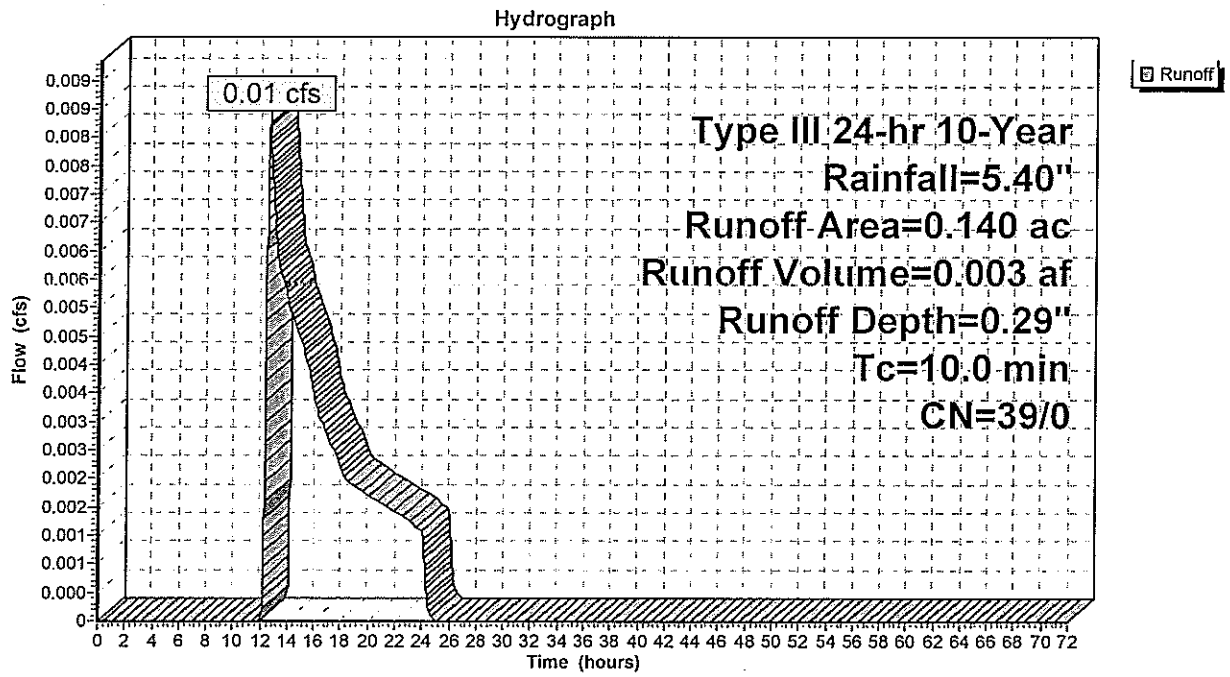
Runoff = 0.01 cfs @ 12.54 hrs, Volume= 0.003 af, Depth= 0.29"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
0.140	39	>75% Grass cover, Good, HSG A
0.140	39	100.00% Pervious Area

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

Subcatchment 14S: PDA-1E (Pervious)



Summary for Subcatchment 15S: PDA-2 (Pervious)

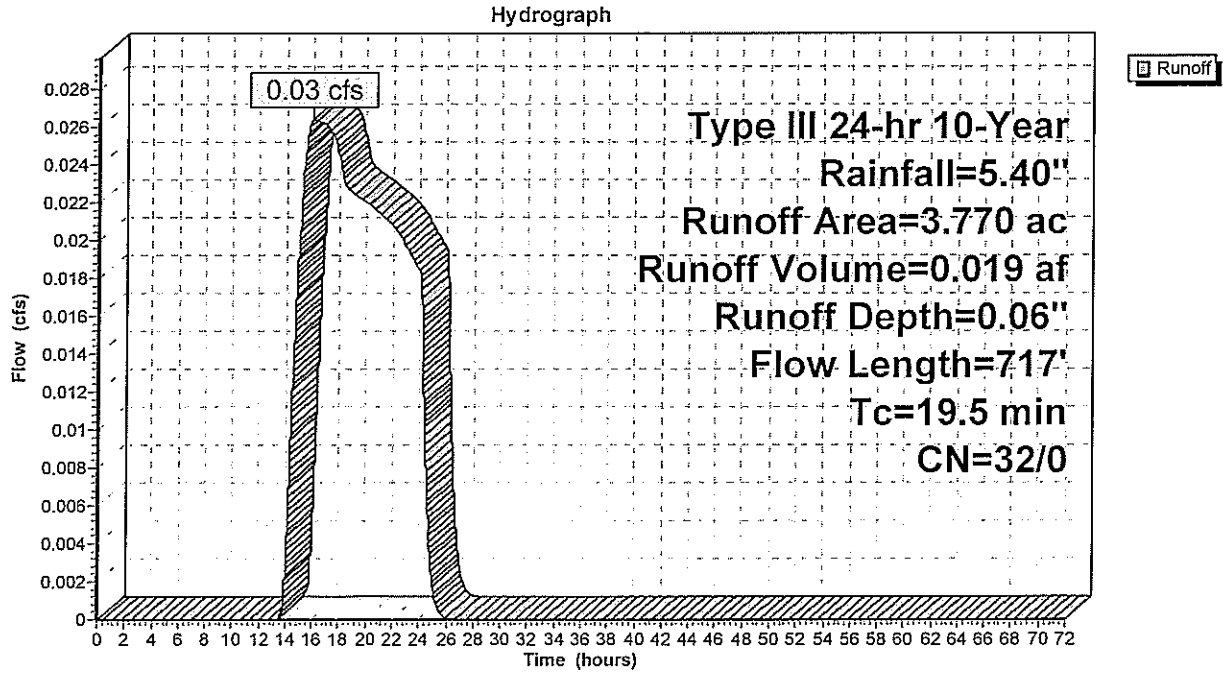
Runoff = 0.03 cfs @ 16.03 hrs, Volume= 0.019 af, Depth= 0.06"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
3.120	30	Woods, Good, HSG A
0.650	39	>75% Grass cover, Good, HSG A
3.770	32	Weighted Average
3.770	32	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	97	0.0620	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
6.6	620	0.0096	1.58		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
19.5	717	Total			

Subcatchment 15S: PDA-2 (Pervious)



Summary for Subcatchment 16S: PDA-3 (Impervious)

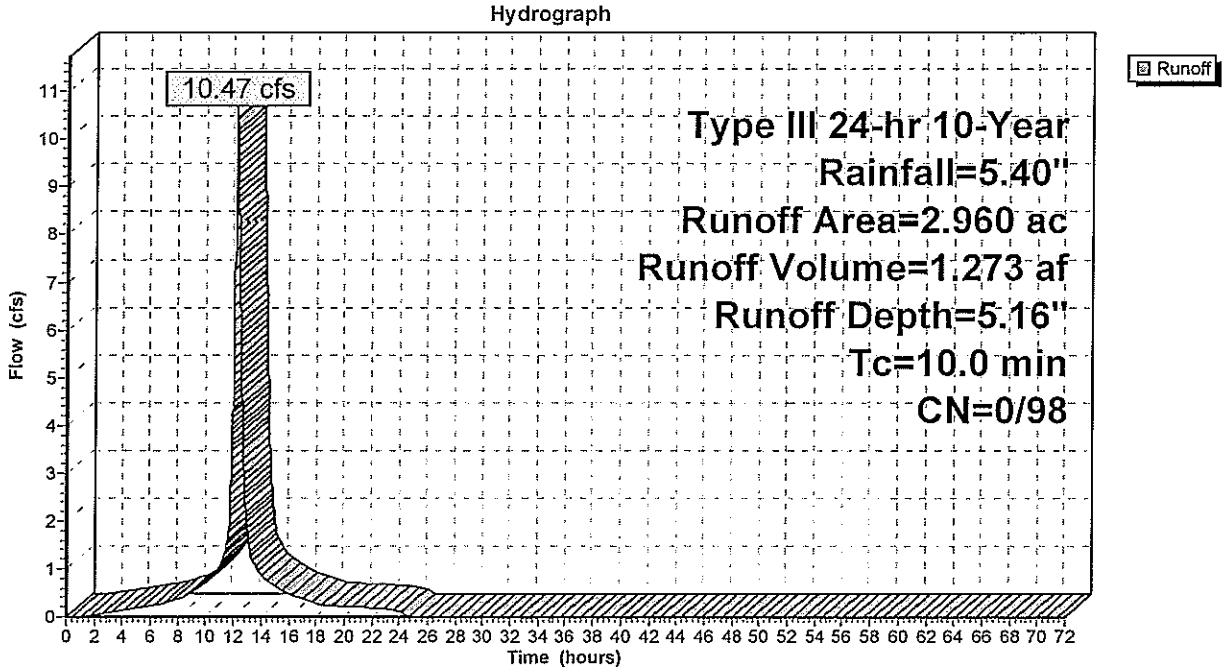
Runoff = 10.47 cfs @ 12.15 hrs, Volume= 1.273 af, Depth= 5.16"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

	Area (ac)	CN	Description
	2.060	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	2.960	98	Weighted Average
	2.960	98	100.00% Impervious Area

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

Subcatchment 16S: PDA-3 (Impervious)



Summary for Subcatchment 17S: PDA-3 (Pervious)

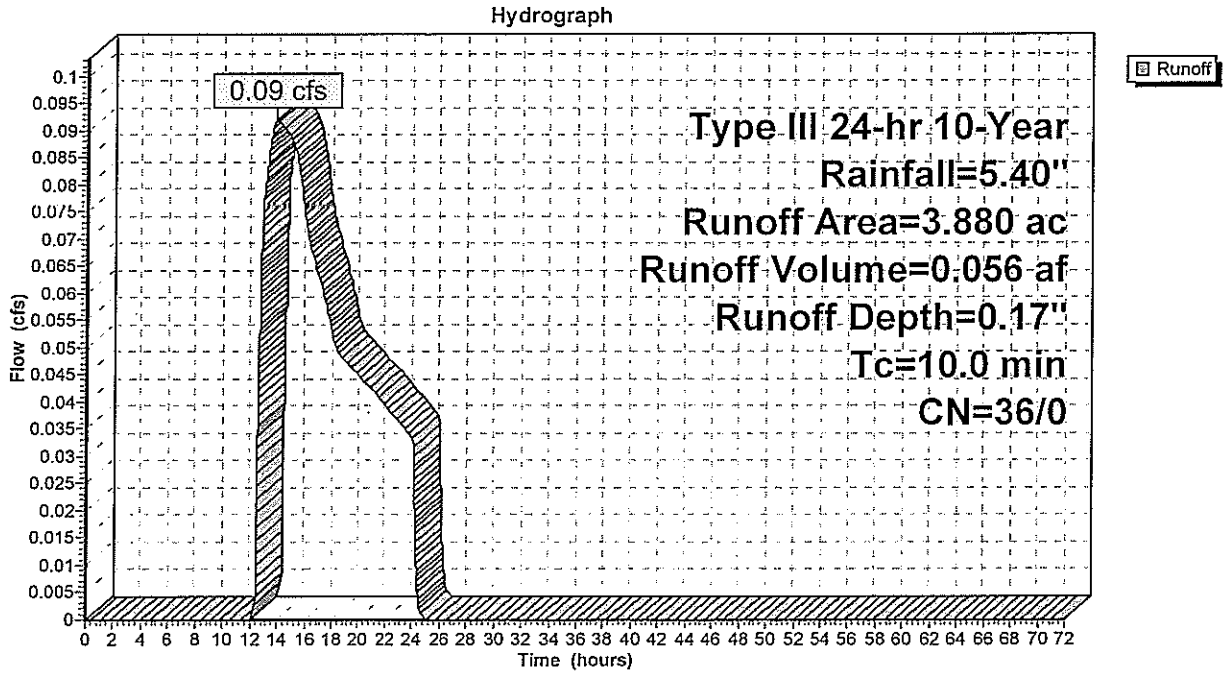
Runoff = 0.09 cfs @ 13.88 hrs, Volume= 0.056 af, Depth= 0.17"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.40"

Area (ac)	CN	Description
2.420	39	>75% Grass cover, Good, HSG A
1.460	30	Woods, Good, HSG A
3.880	36	Weighted Average
3.880	36	100.00% Pervious Area

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

Subcatchment 17S: PDA-3 (Pervious)



Summary for Pond 1P: Basin #1

Inflow Area = 11.350 ac, 81.15% Impervious, Inflow Depth = 4.23" for 10-Year event
Inflow = 32.59 cfs @ 12.15 hrs, Volume= 4.000 af
Outflow = 0.18 cfs @ 24.26 hrs, Volume= 0.814 af, Atten= 99%, Lag= 726.1 min
Primary = 0.18 cfs @ 24.26 hrs, Volume= 0.814 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 58.55' @ 24.26 hrs Surf.Area= 103,903 sf Storage= 166,953 cf

Plug-Flow detention time= 2,006.6 min calculated for 0.814 af (20% of inflow)
Center-of-Mass det. time= 1,742.9 min (2,501.9 - 759.1)

Volume	Invert	Avail.Storage	Storage Description
#1	56.90'	432,566 cf	**Basin #1 (Prismatic)**Listed below (Recalc)

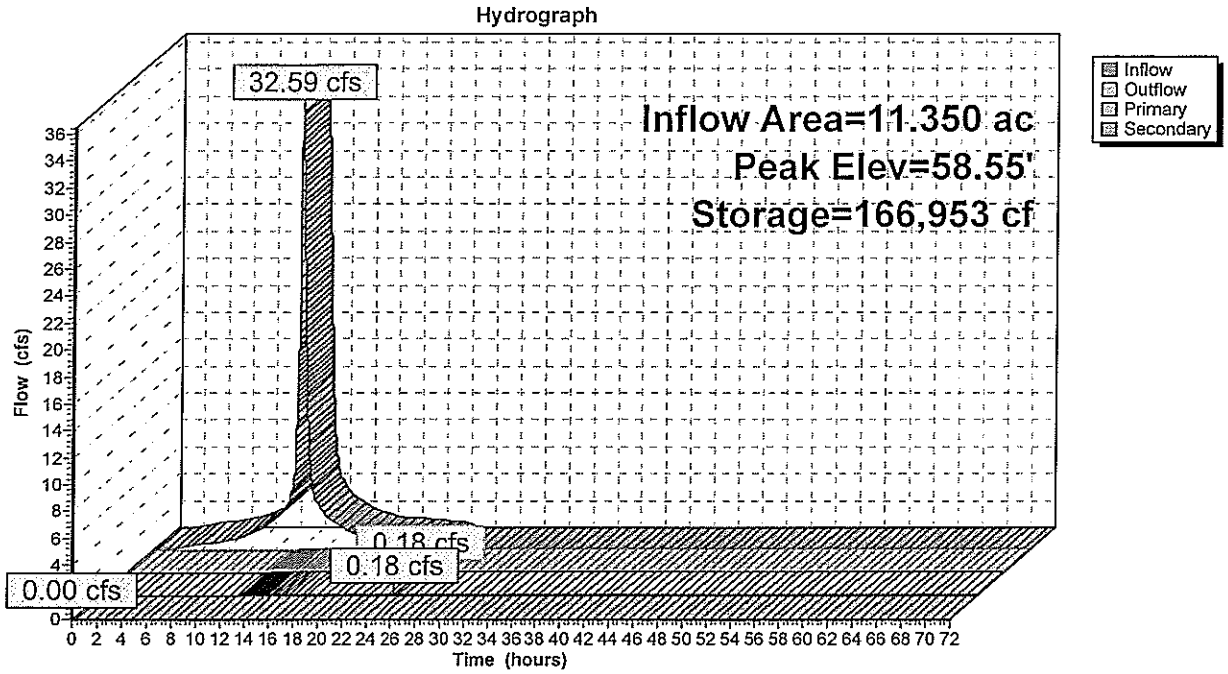
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
56.90	97,675	0	0
57.00	98,767	9,822	9,822
58.00	102,067	100,417	110,239
59.00	105,401	103,734	213,973
60.00	108,770	107,086	321,059
61.00	114,245	111,508	432,566

Device	Routing	Invert	Outlet Devices
#1	Primary	56.80'	**15.0" Round Culvert** L= 12.0' RCP, groove end w/headwall, Ke= 0.200 Outlet Invert= 56.68' S= 0.0100 '/' Cc= 0.900 n= 0.013
#2	Device 1	57.30'	**2.5" Vert. Orifice/Grate** C= 0.600
#3	Device 1	60.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	60.30'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.18 cfs @ 24.26 hrs HW=58.55' TW=52.97' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.18 cfs of 6.38 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.18 cfs @ 5.16 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' TW=0.00' (Dynamic Tailwater)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Basin #1



Summary for Pond 2P: Basin #2

Inflow Area = 16.380 ac, 79.06% Impervious, Inflow Depth > 1.80" for 10-Year event
Inflow = 13.31 cfs @ 12.16 hrs, Volume= 2.454 af
Outflow = 1.07 cfs @ 14.80 hrs, Volume= 1.789 af, Atten= 92%, Lag= 158.7 min
Primary = 1.07 cfs @ 14.80 hrs, Volume= 1.789 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 53.24' @ 14.80 hrs Surf.Area= 42,719 sf Storage= 50,878 cf

Plug-Flow detention time= 1,048.7 min calculated for 1.789 af (73% of inflow)
Center-of-Mass det. time= 497.2 min (1,835.8 - 1,338.6)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	179,275 cf	**Basin #2 (Prismatic)**Listed below (Recalc)

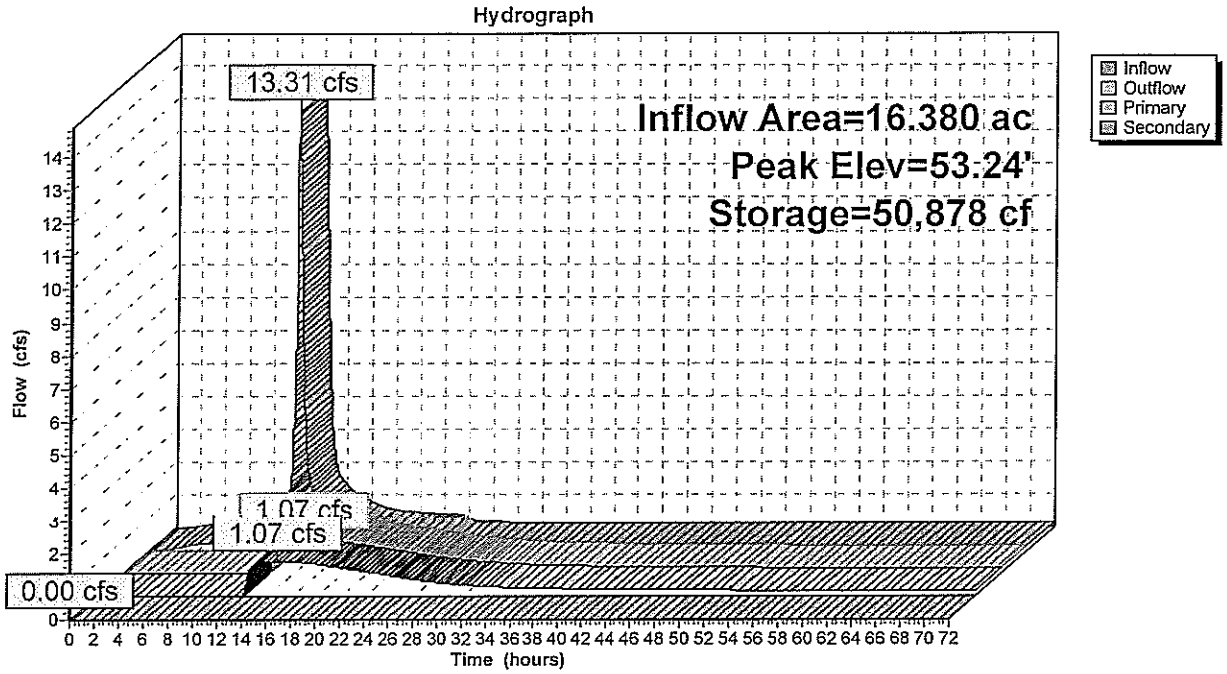
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	39,333	0	0
53.00	42,052	40,693	40,693
54.00	44,827	43,440	84,132
55.00	47,558	46,193	130,325
56.00	50,343	48,951	179,275

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**15.0" Round Culvert** L= 17.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 50.66' S= 0.0200 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	54.60'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.07 cfs @ 14.80 hrs HW=53.24' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 1.07 cfs of 8.99 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 1.07 cfs @ 3.07 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=52.00' TW=0.00' (Dynamic Tailwater)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Basin #2



Summary for Pond 3P: Basin #3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 2.33" for 10-Year event
Inflow = 10.47 cfs @ 12.15 hrs, Volume= 1.329 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 58.75' @ 25.10 hrs Surf.Area= 51,717 sf Storage= 57,913 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

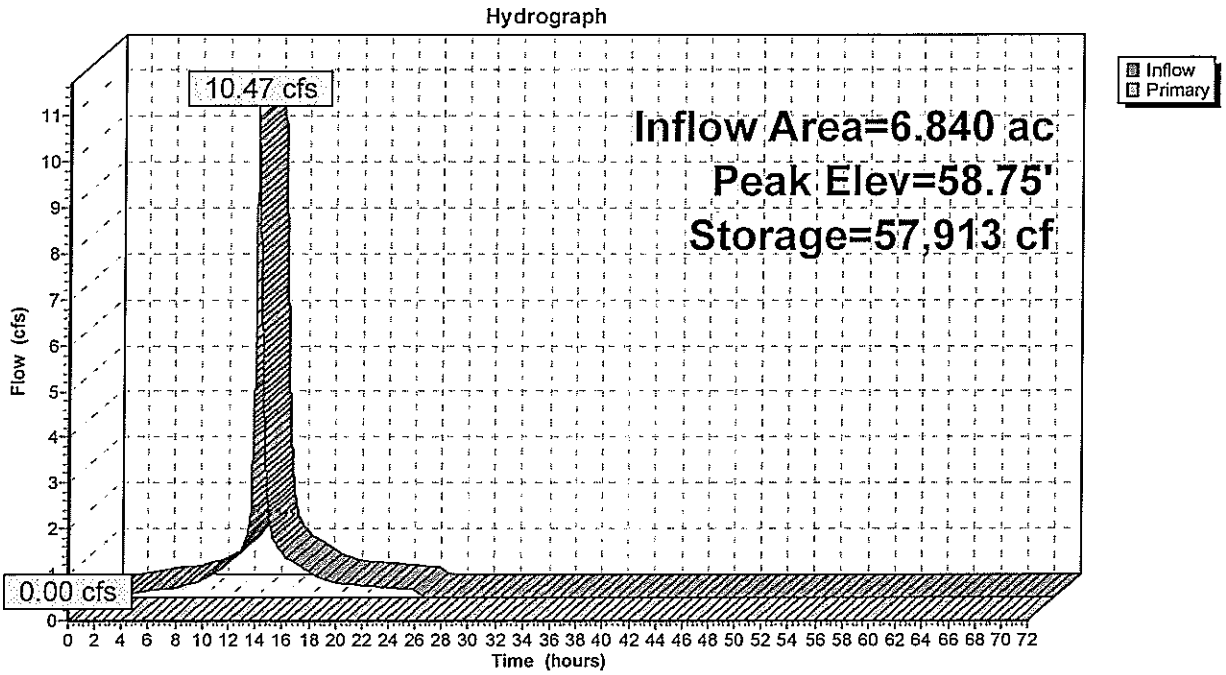
Volume	Invert	Avail.Storage	Storage Description
#1	57.50'	127,089 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.50	39,005	0	0
58.00	46,307	21,328	21,328
59.00	53,554	49,931	71,259
60.00	58,107	55,831	127,089

Device	Routing	Invert	Outlet Devices
#1	Primary	59.30'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=57.50' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Basin #3



Summary for Pond P-LD: PDA-2A (Local Depression)

Inflow Area = 3.770 ac, 0.00% Impervious, Inflow Depth = 0.06" for 10-Year event
Inflow = 0.03 cfs @ 16.03 hrs, Volume= 0.019 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 55.58' @ 26.14 hrs Surf.Area= 2,946 sf Storage= 808 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

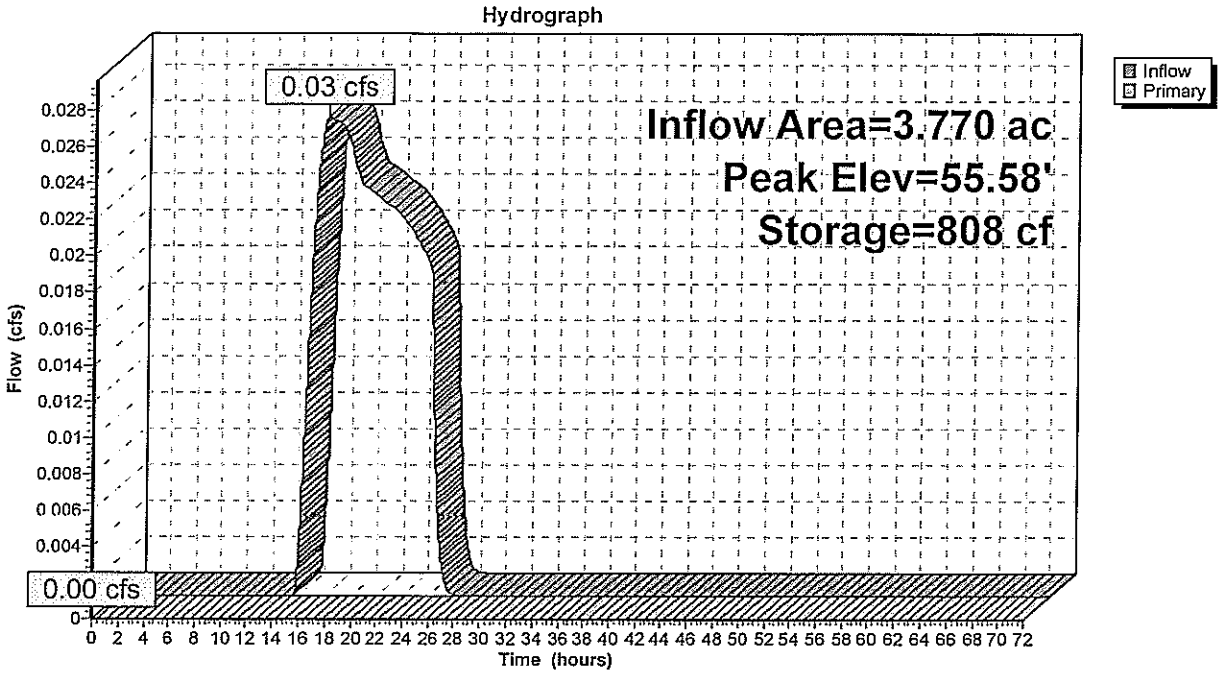
Volume	Invert	Avail.Storage	Storage Description
#1	55.00'	74,341 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
55.00	305	82.0	0	0	305
56.00	6,601	306.0	2,775	2,775	7,224
57.00	17,096	481.0	11,440	14,215	18,191
58.00	29,886	639.0	23,195	37,410	32,284
59.00	44,455	776.0	36,930	74,341	47,727

Device	Routing	Invert	Outlet Devices
#1	Primary	58.79'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=55.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P-LD: PDA-2A (Local Depression)

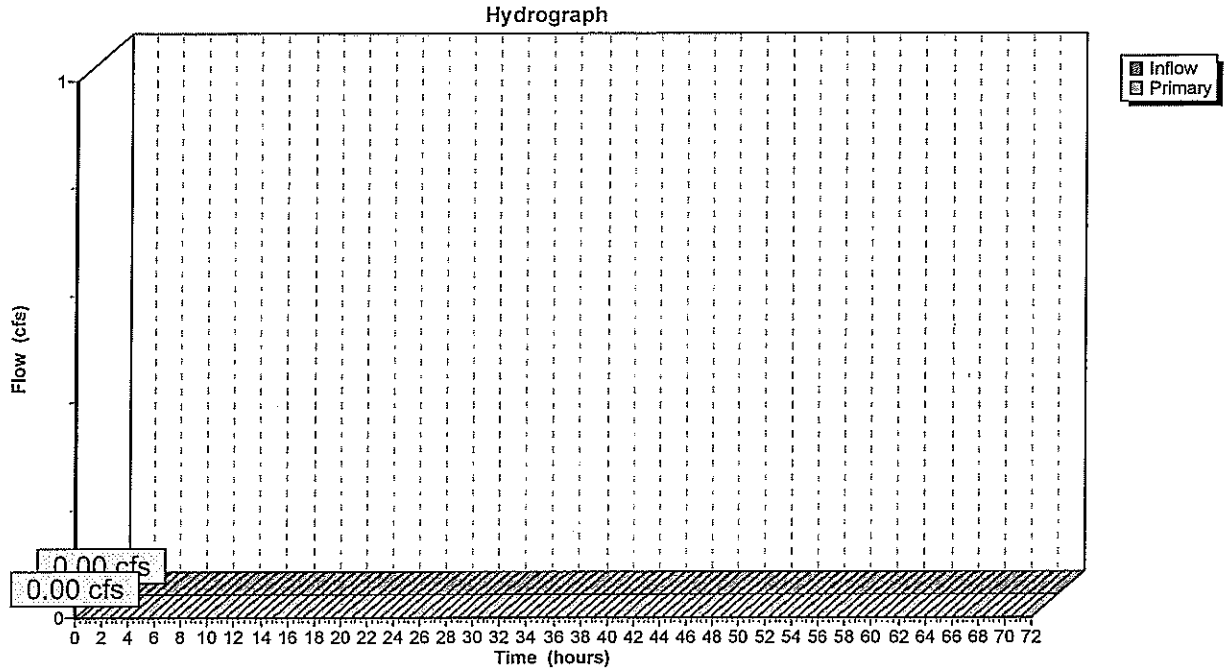


Summary for Link 1L: Emergency Spillway

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Emergency Spillway

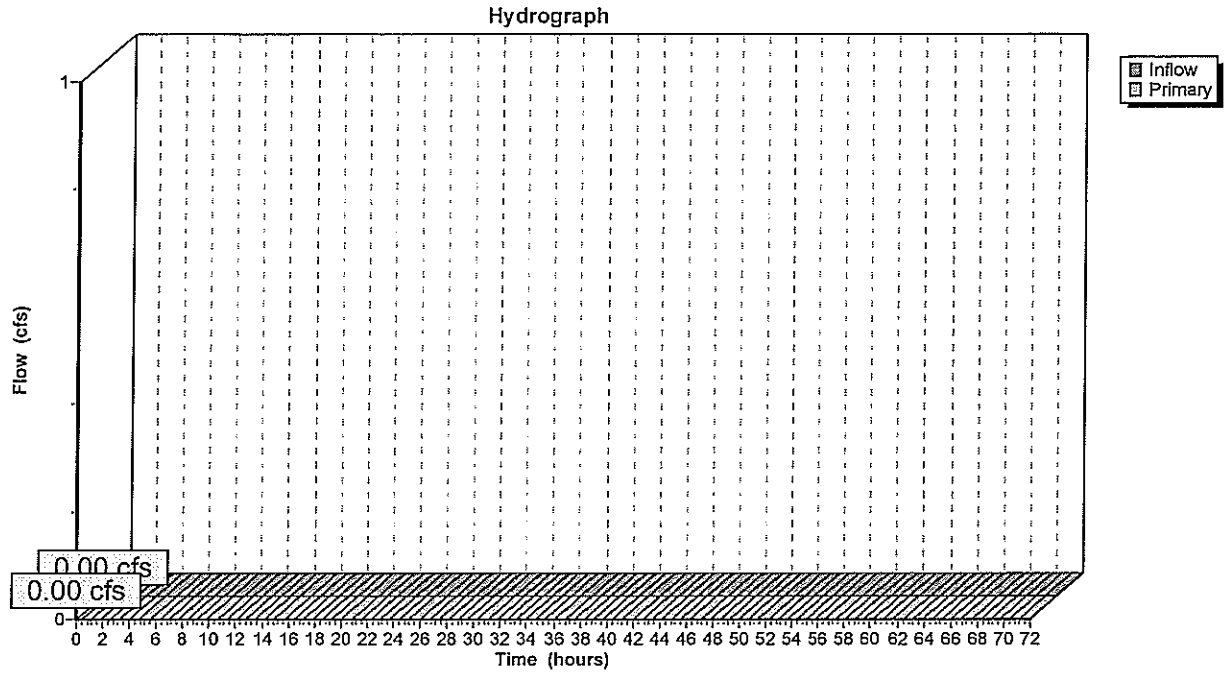


Summary for Link 2L: Emergency Spillway

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Emergency Spillway

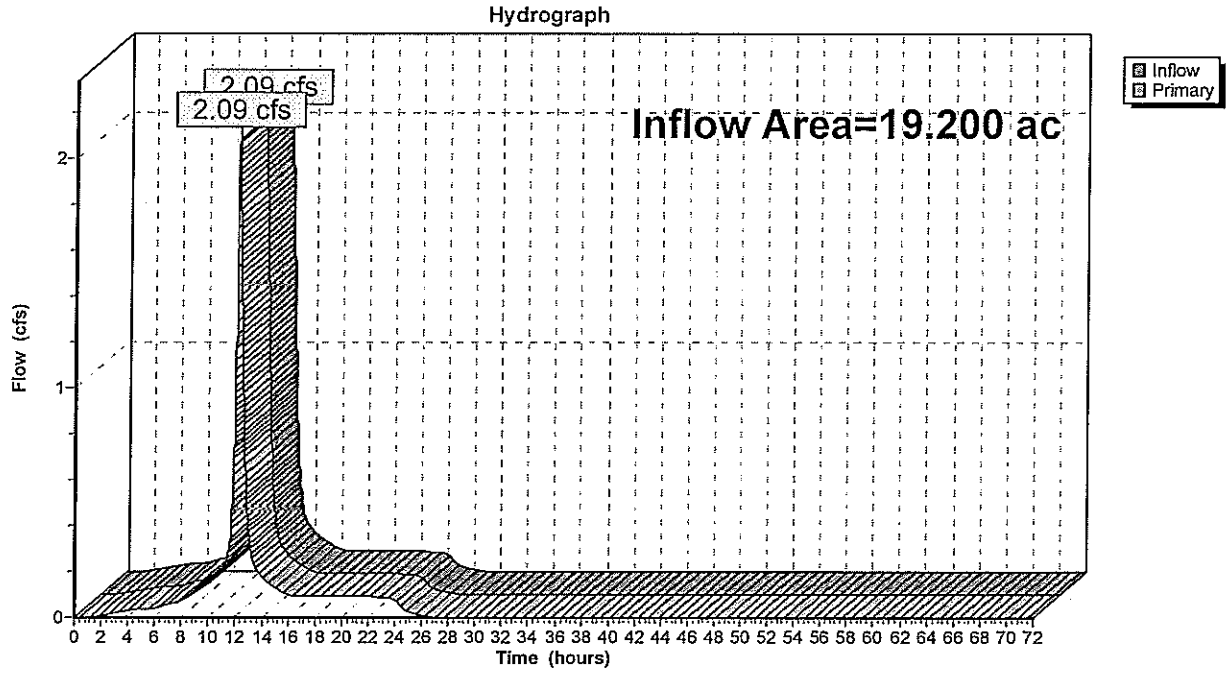


Summary for Link L-E1: EDA-1

Inflow Area = 19.200 ac, 3.07% Impervious, Inflow Depth = 0.18" for 10-Year event
Inflow = 2.09 cfs @ 12.15 hrs, Volume= 0.288 af
Primary = 2.09 cfs @ 12.15 hrs, Volume= 0.288 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E1: EDA-1

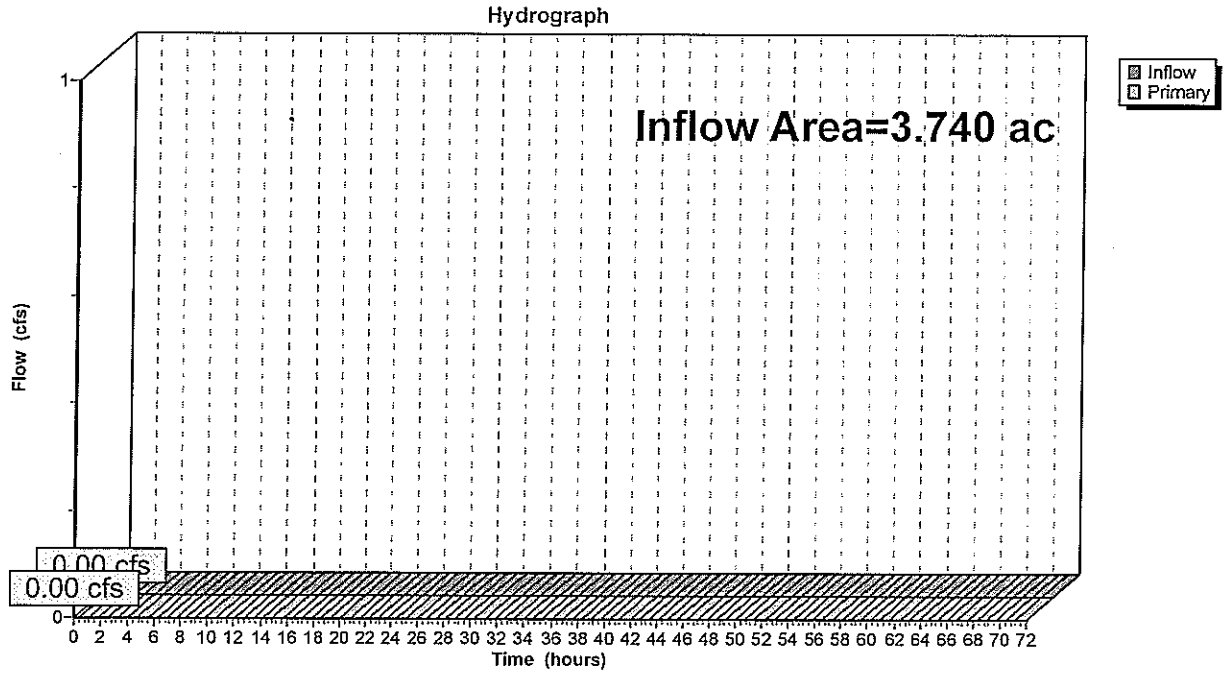


Summary for Link L-E2: EDA-2

Inflow Area = 3.740 ac, 32.35% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E2: EDA-2

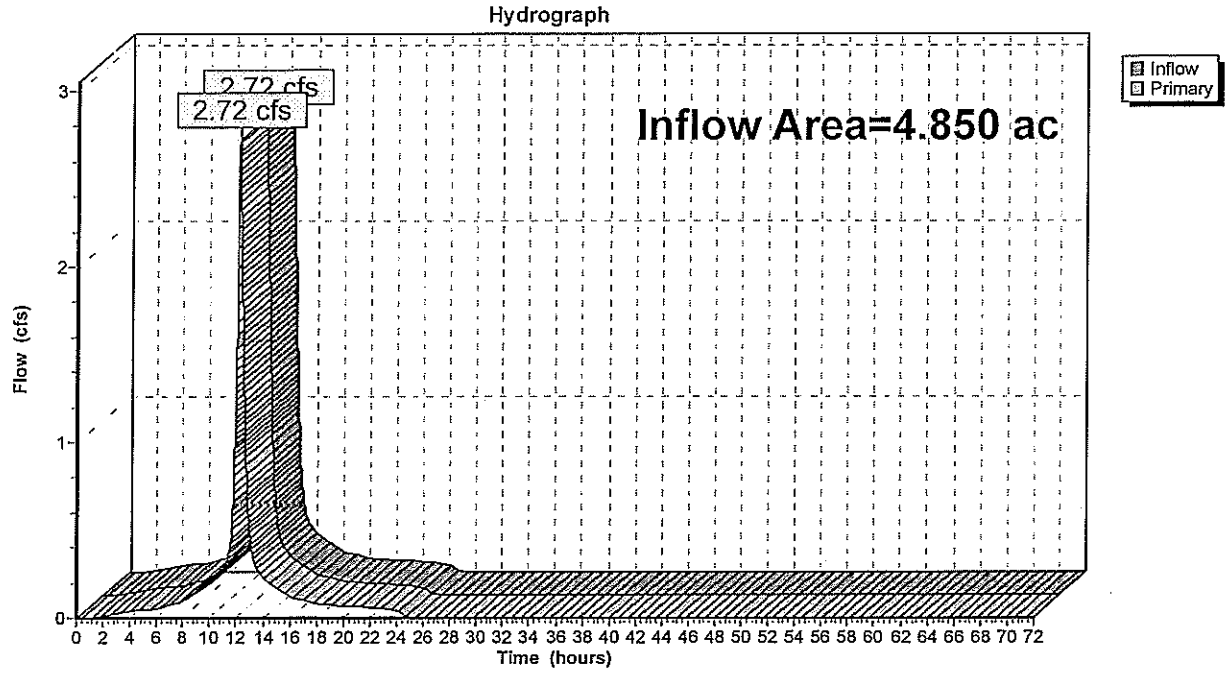


Summary for Link L-E3: EDA-3

Inflow Area = 4.850 ac, 15.88% Impervious, Inflow Depth = 0.84" for 10-Year event
Inflow = 2.72 cfs @ 12.15 hrs, Volume= 0.339 af
Primary = 2.72 cfs @ 12.15 hrs, Volume= 0.339 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E3: EDA-3

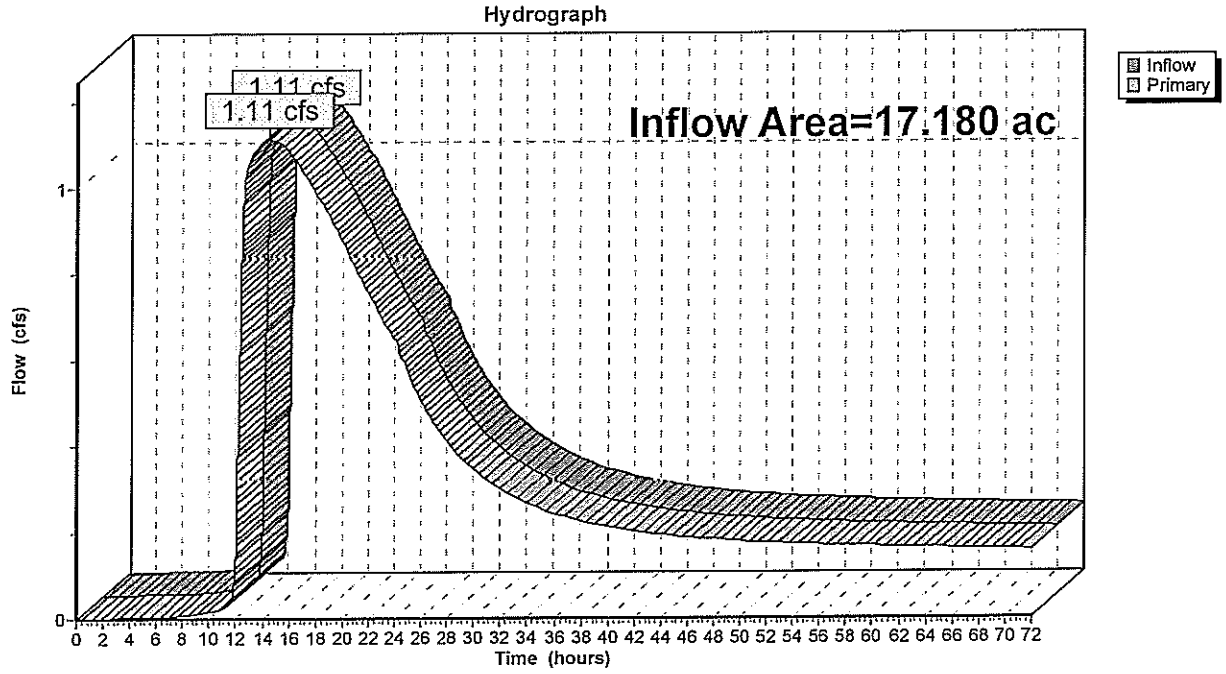


Summary for Link L-P1: PDA-1

Inflow Area = 17.180 ac, 75.73% Impervious, Inflow Depth > 1.28" for 10-Year event
Inflow = 1.11 cfs @ 14.55 hrs, Volume= 1.833 af
Primary = 1.11 cfs @ 14.55 hrs, Volume= 1.833 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P1: PDA-1

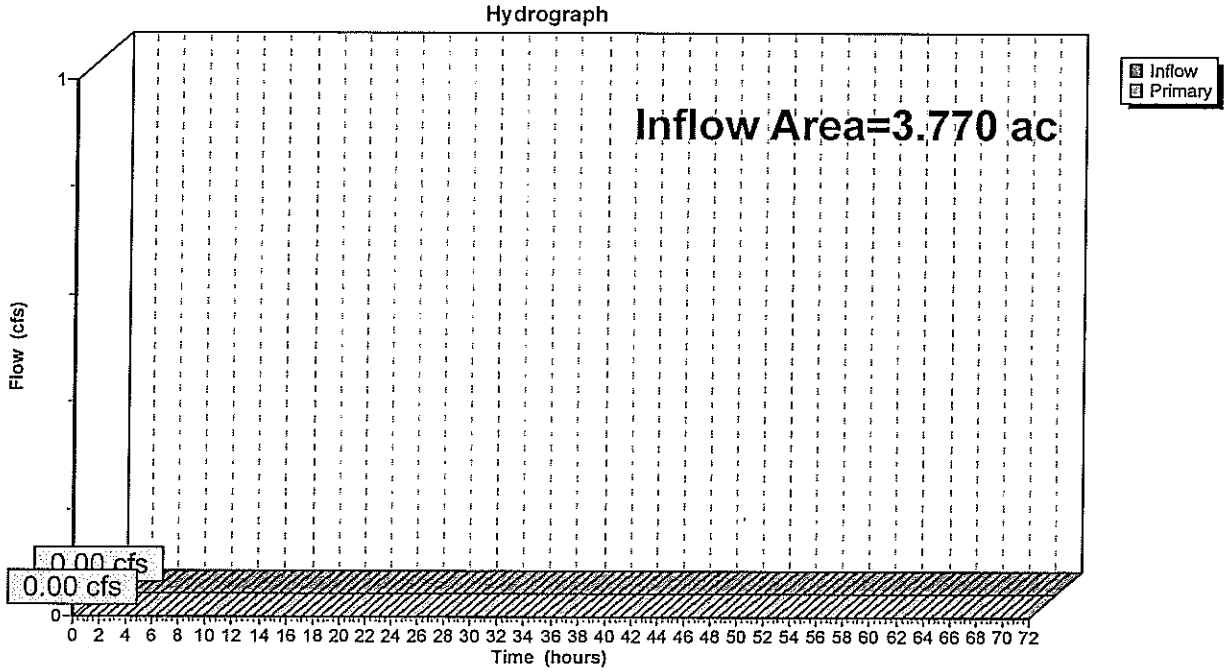


Summary for Link L-P2: PDA-2

Inflow Area = 3.770 ac, 0.00% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P2: PDA-2

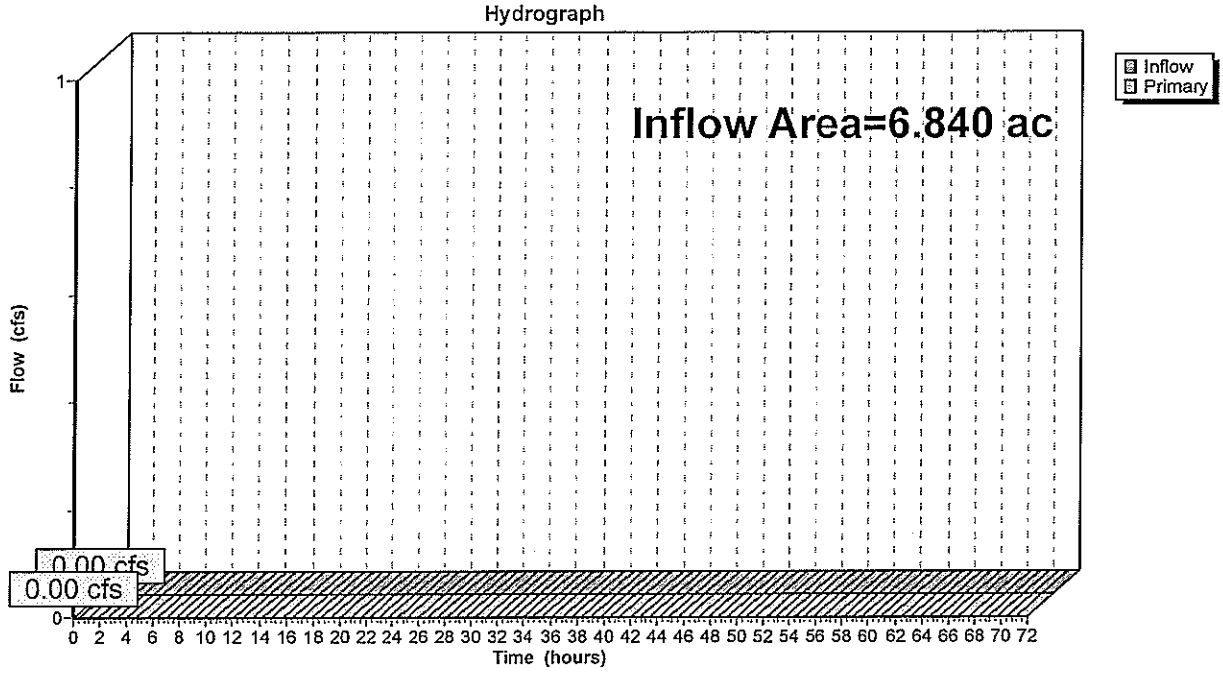


Summary for Link L-P3: PDA-3

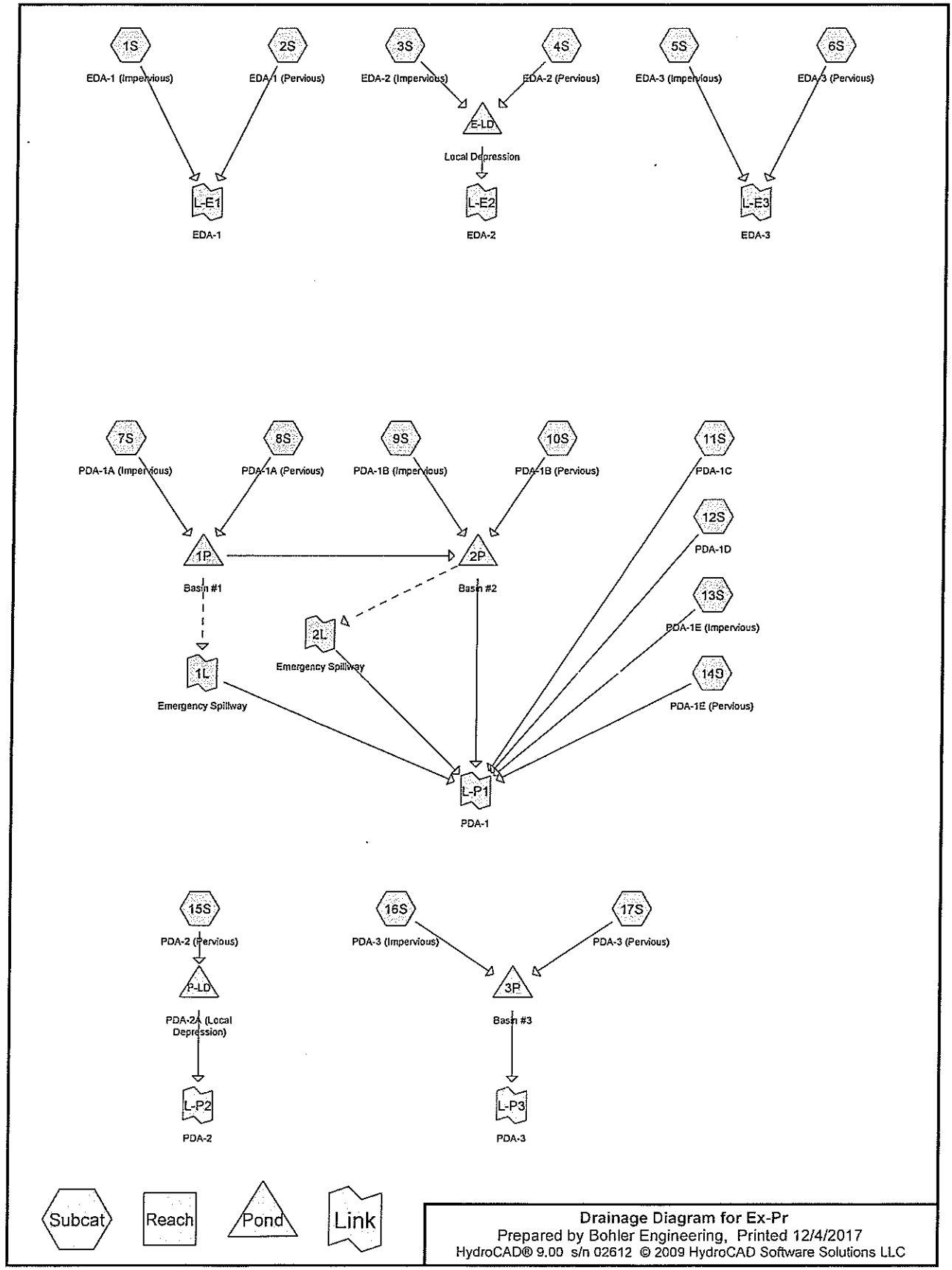
Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 0.00" for 10-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P3: PDA-3



100-YEAR STORM EVENT



Drainage Diagram for Ex-Pr
Prepared by Bohler Engineering, Printed 12/4/2017
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Summary for Subcatchment 1S: EDA-1 (Impervious)

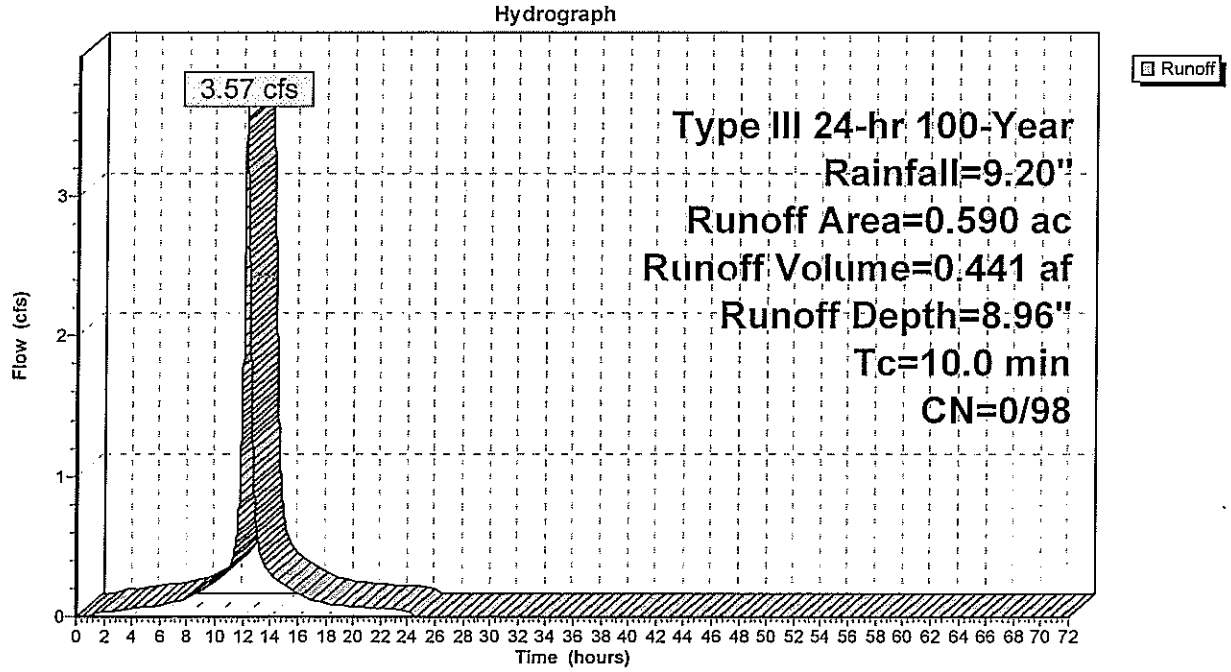
Runoff = 3.57 cfs @ 12.15 hrs, Volume= 0.441 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.590	98	Paved roads w/curbs & sewers, HSG A
0.590	98	100.00% Impervious Area

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

Subcatchment 1S: EDA-1 (Impervious)



Summary for Subcatchment 2S: EDA-1 (Pervious)

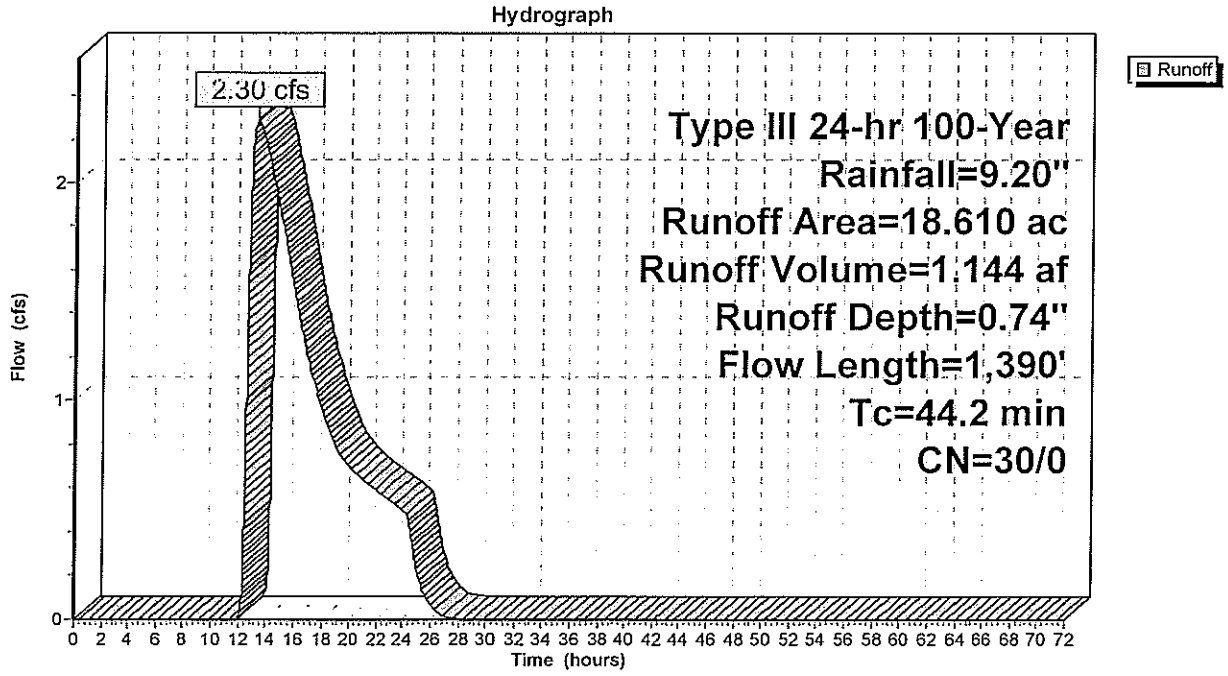
Runoff = 2.30 cfs @ 13.26 hrs, Volume= 1.144 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
18.110	30	Woods, Good, HSG A
0.500	30	Woods, Good, HSG A
18.610	30	Weighted Average
18.610	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
26.5	90	0.0089	0.06		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
17.7	1,300	0.0058	1.23		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
44.2	1,390	Total			

Subcatchment 2S: EDA-1 (Pervious)



Summary for Subcatchment 3S: EDA-2 (Impervious)

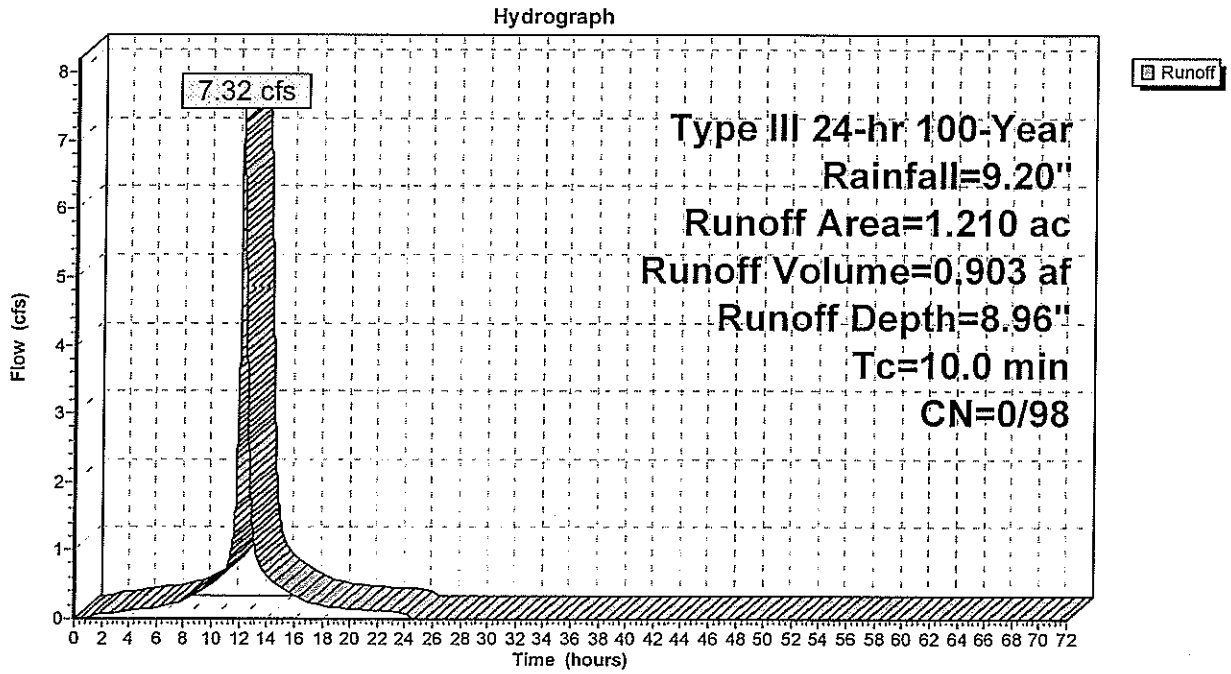
Runoff = 7.32 cfs @ 12.15 hrs, Volume= 0.903 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
1.210	98	Paved parking, HSG A
1.210	98	100.00% Impervious Area

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

Subcatchment 3S: EDA-2 (Impervious)



Summary for Subcatchment 4S: EDA-2 (Pervious)

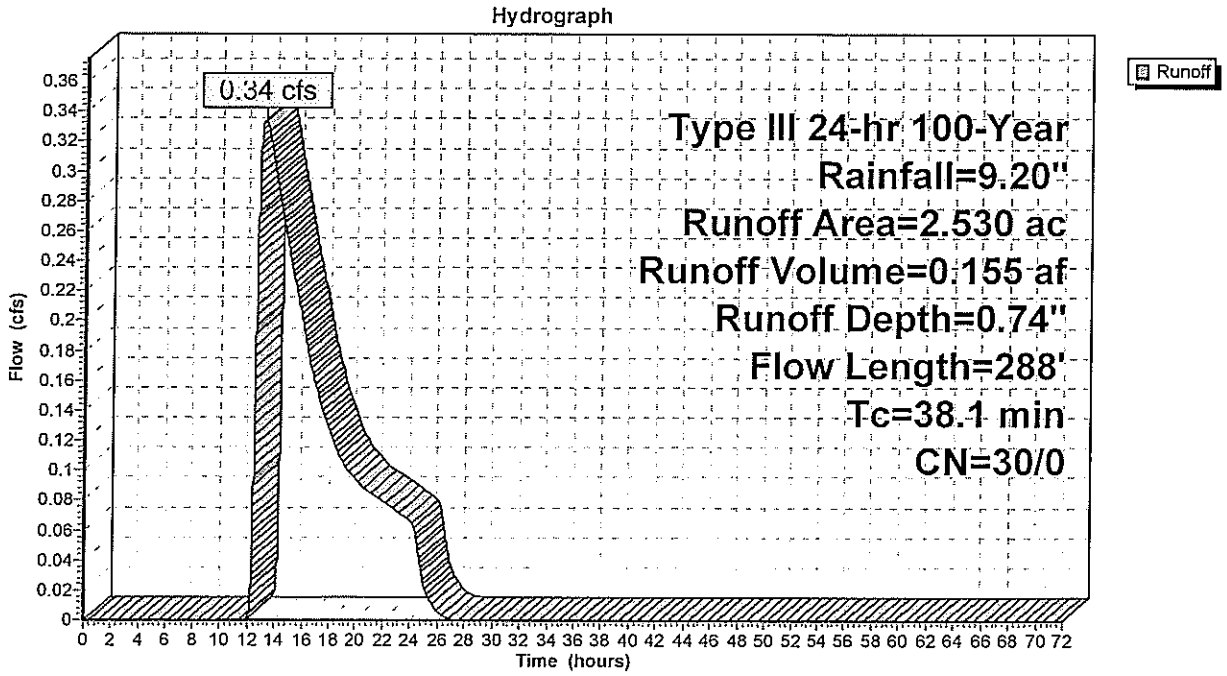
Runoff = 0.34 cfs @ 13.12 hrs, Volume= 0.155 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
1.980	30	Woods, Good, HSG A
0.550	30	Woods, Good, HSG A
2.530	30	Weighted Average
2.530	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
37.3	150	0.0105	0.07		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
0.8	138	0.0290	2.74		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
38.1	288	Total			

Subcatchment 4S: EDA-2 (Pervious)



Summary for Subcatchment 5S: EDA-3 (Impervious)

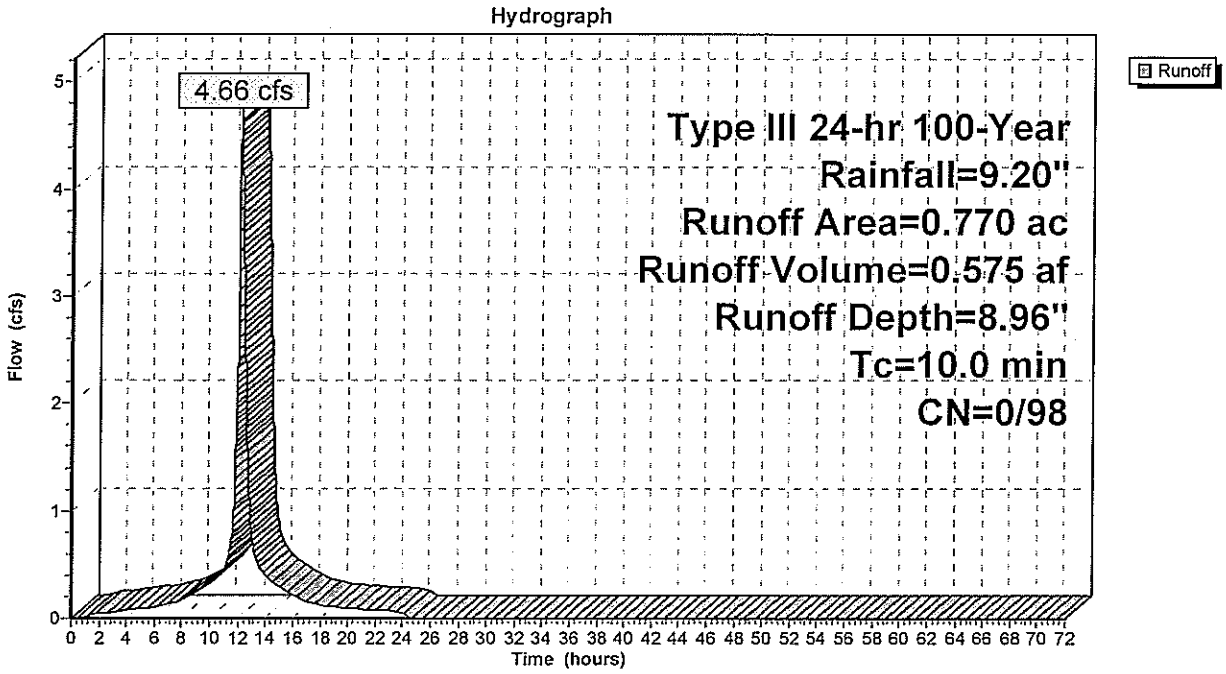
Runoff = 4.66 cfs @ 12.15 hrs, Volume= 0.575 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.770	98	Paved roads w/curbs & sewers, HSG A
0.770	98	100.00% Impervious Area

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

Subcatchment 5S: EDA-3 (Impervious)



Summary for Subcatchment 6S: EDA-3 (Pervious)

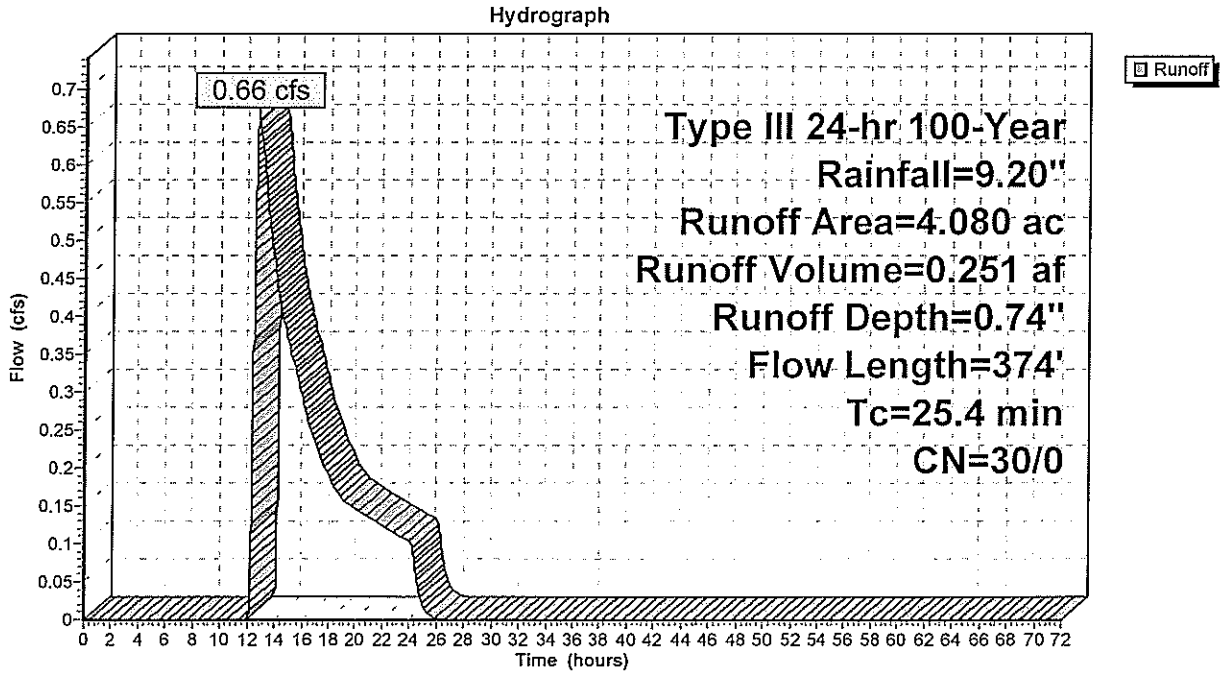
Runoff = 0.66 cfs @ 12.75 hrs, Volume= 0.251 af, Depth= 0.74"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
2.310	30	Woods, Good, HSG A
1.770	30	Woods, Good, HSG A
4.080	30	Weighted Average
4.080	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.1	150	0.0390	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
3.3	224	0.0050	1.14		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
25.4	374	Total			

Subcatchment 6S: EDA-3 (Pervious)



Summary for Subcatchment 7S: PDA-1A (Impervious)

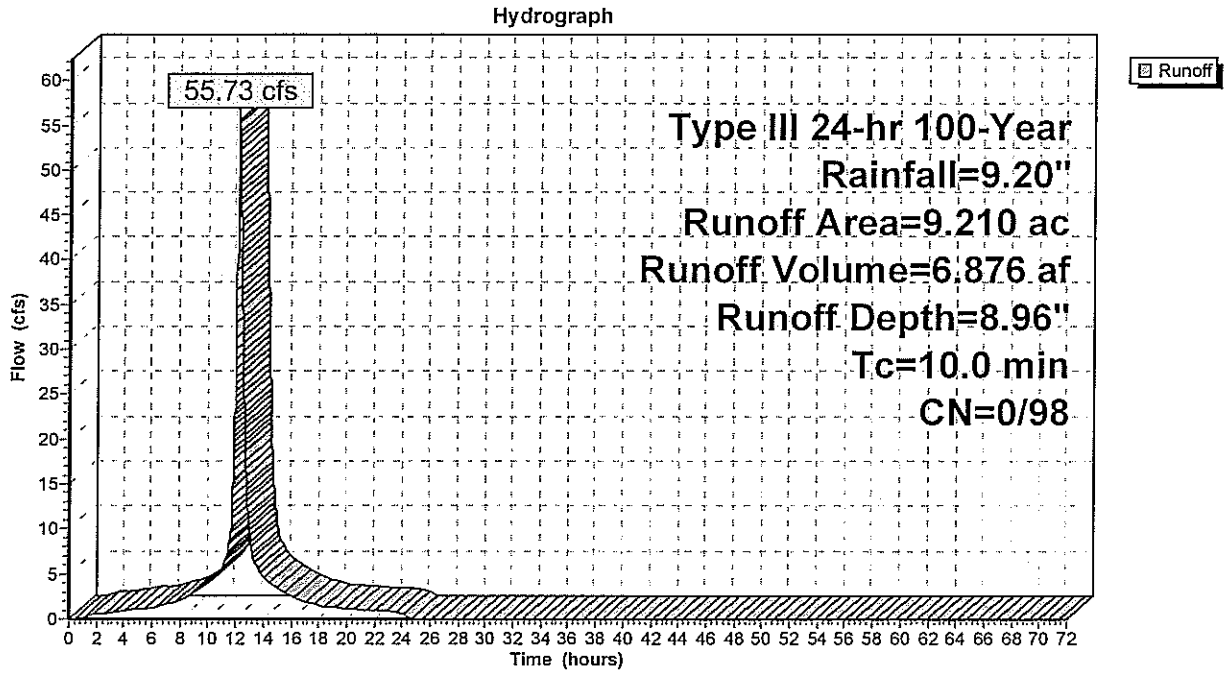
Runoff = 55.73 cfs @ 12.15 hrs, Volume= 6.876 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

	Area (ac)	CN	Description
	6.970	98	Paved parking, HSG A
*	2.240	98	Basin Bottom
	9.210	98	Weighted Average
	9.210	98	100.00% Impervious Area

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

Subcatchment 7S: PDA-1A (Impervious)



Summary for Subcatchment 8S: PDA-1A (Pervious)

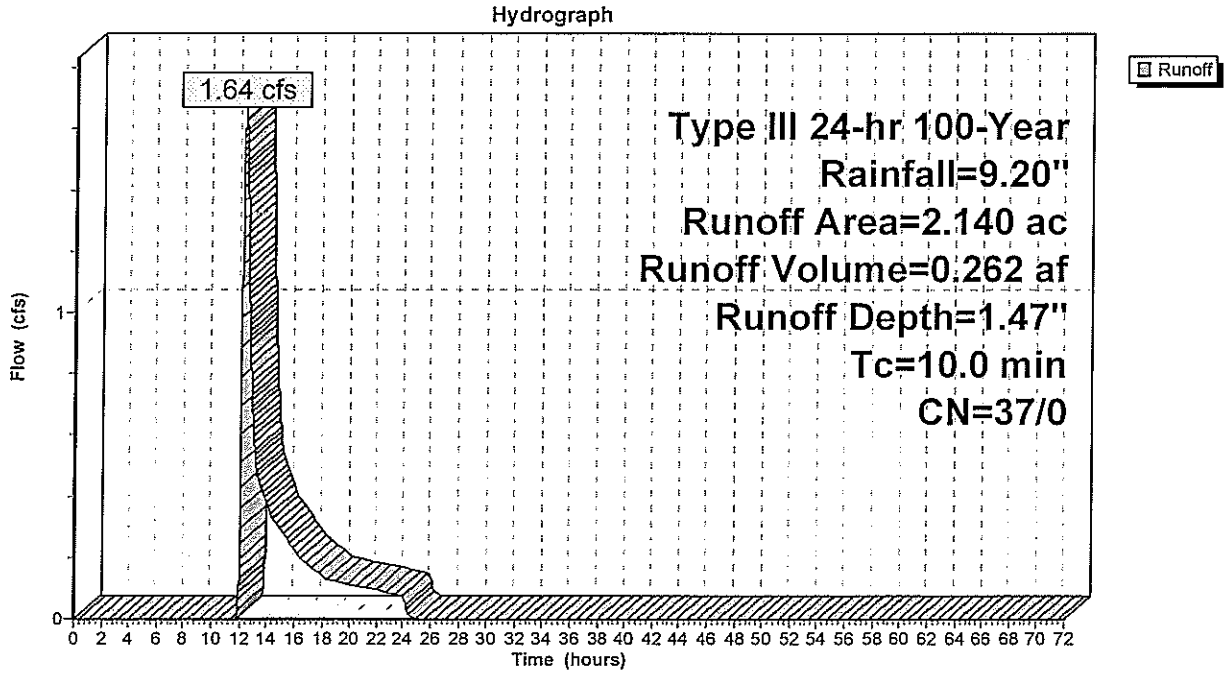
Runoff = 1.64 cfs @ 12.33 hrs, Volume= 0.262 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.490	30	Woods, Good, HSG A
1.650	39	>75% Grass cover, Good, HSG A
2.140	37	Weighted Average
2.140	37	100.00% Pervious Area

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

Subcatchment 8S: PDA-1A (Pervious)



Summary for Subcatchment 9S: PDA-1B (Impervious)

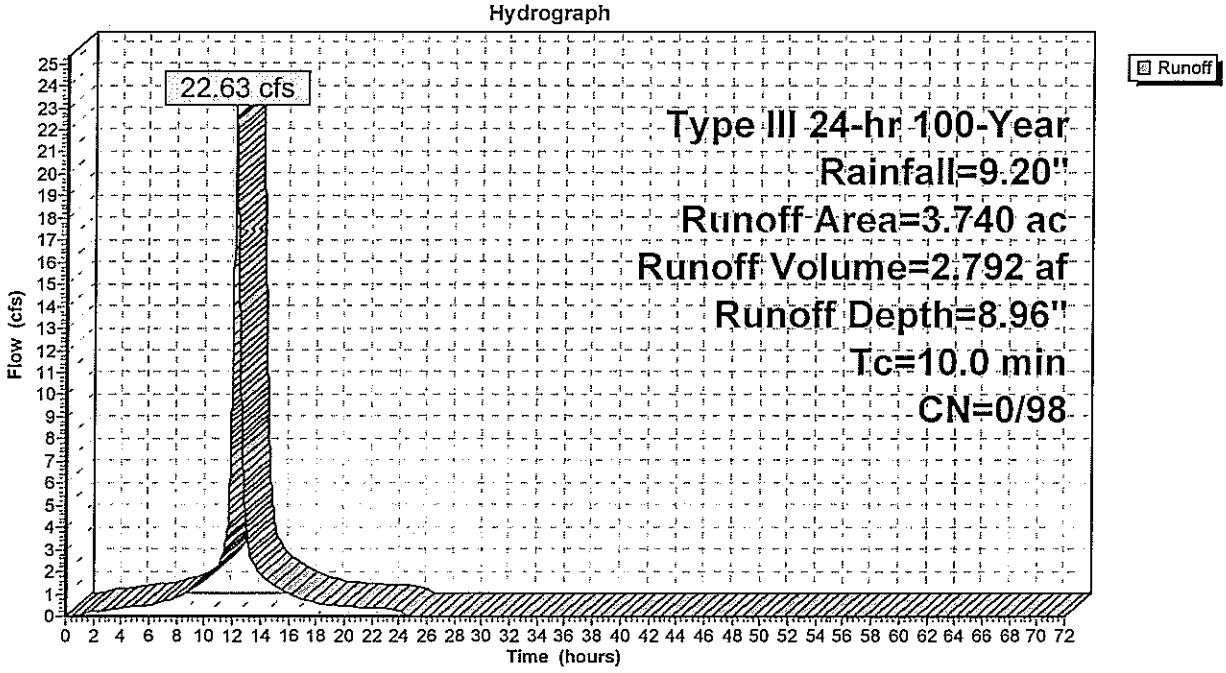
Runoff = 22.63 cfs @ 12.15 hrs, Volume= 2.792 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

	Area (ac)	CN	Description
	2.840	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	3.740	98	Weighted Average
	3.740	98	100.00% Impervious Area

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

Subcatchment 9S: PDA-1B (Impervious)



Summary for Subcatchment 10S: PDA-1B (Pervious)

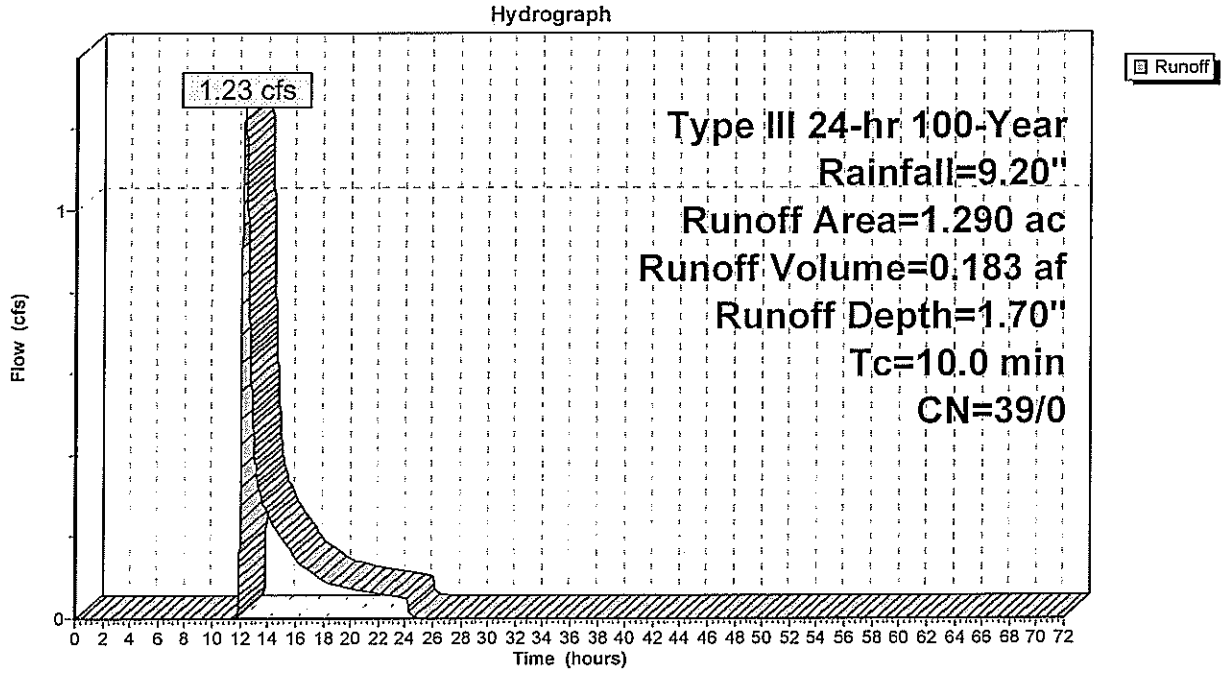
Runoff = 1.23 cfs @ 12.28 hrs, Volume= 0.183 af, Depth= 1.70"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
1.290	39	>75% Grass cover, Good, HSG A
1.290	39	100.00% Pervious Area

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

Subcatchment 10S: PDA-1B (Pervious)



Summary for Subcatchment 11S: PDA-1C

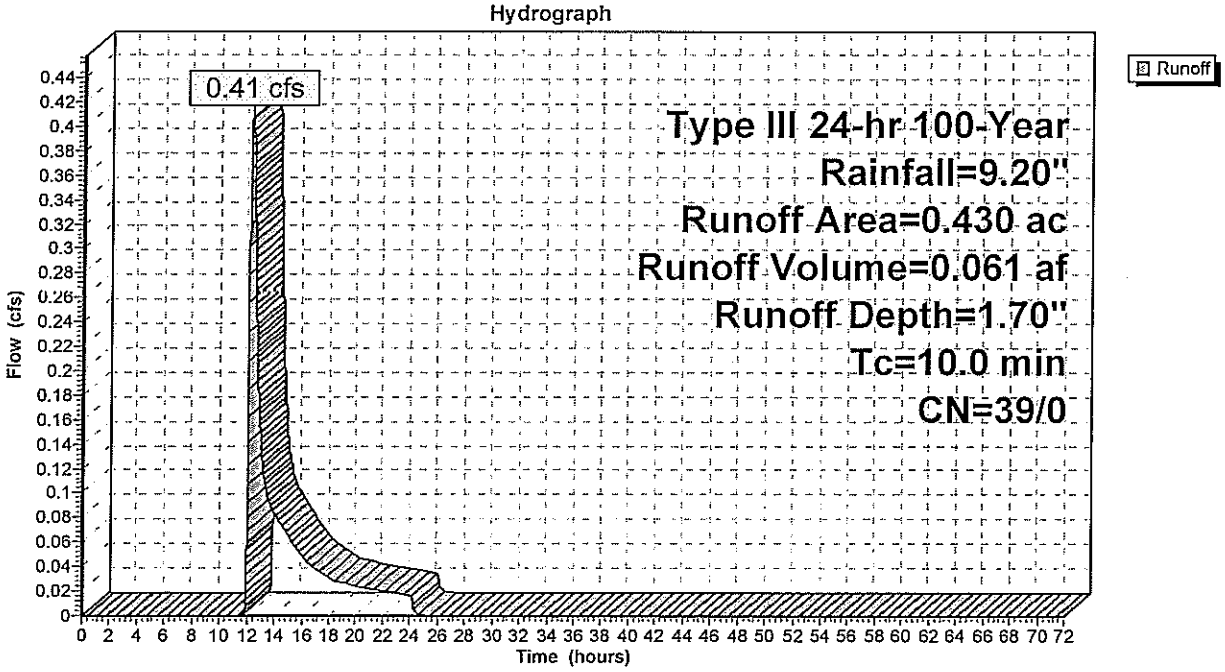
Runoff = 0.41 cfs @ 12.28 hrs, Volume= 0.061 af, Depth= 1.70"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.430	39	>75% Grass cover, Good, HSG A
0.430	39	100.00% Pervious Area

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

Subcatchment 11S: PDA-1C



Summary for Subcatchment 12S: PDA-1D

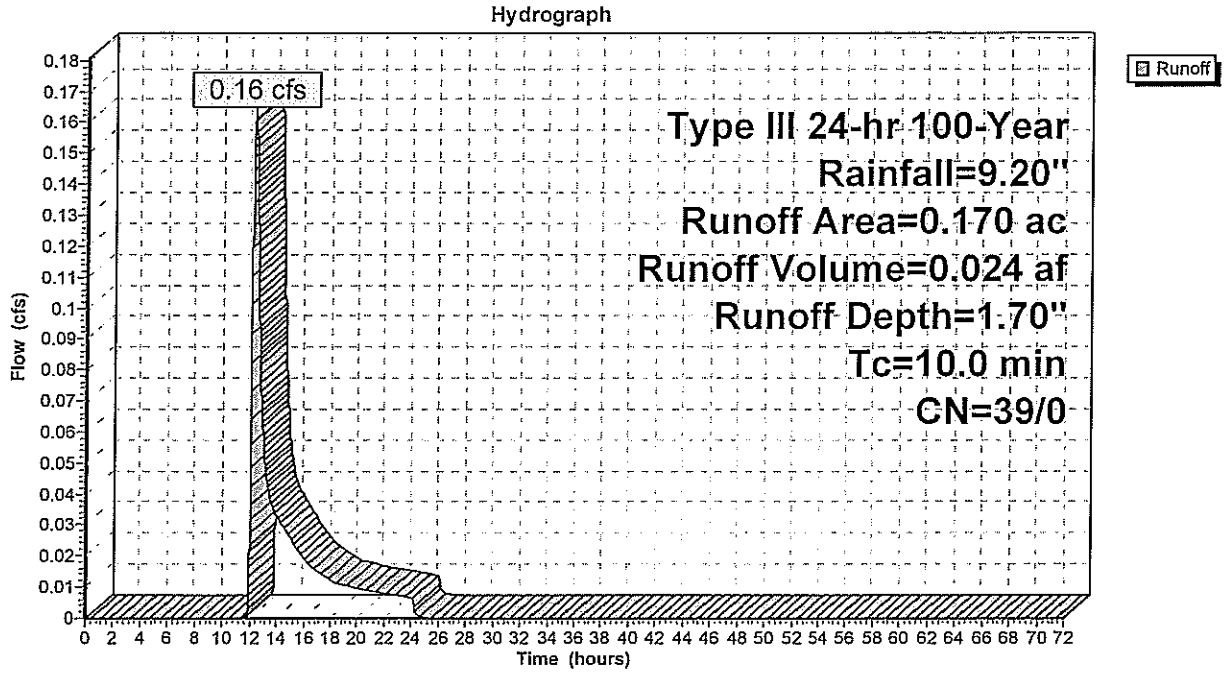
Runoff = 0.16 cfs @ 12.28 hrs, Volume= 0.024 af, Depth= 1.70"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.170	39	>75% Grass cover, Good, HSG A
0.170	39	100.00% Pervious Area

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

Subcatchment 12S: PDA-1D



Summary for Subcatchment 13S: PDA-1E (Impervious)

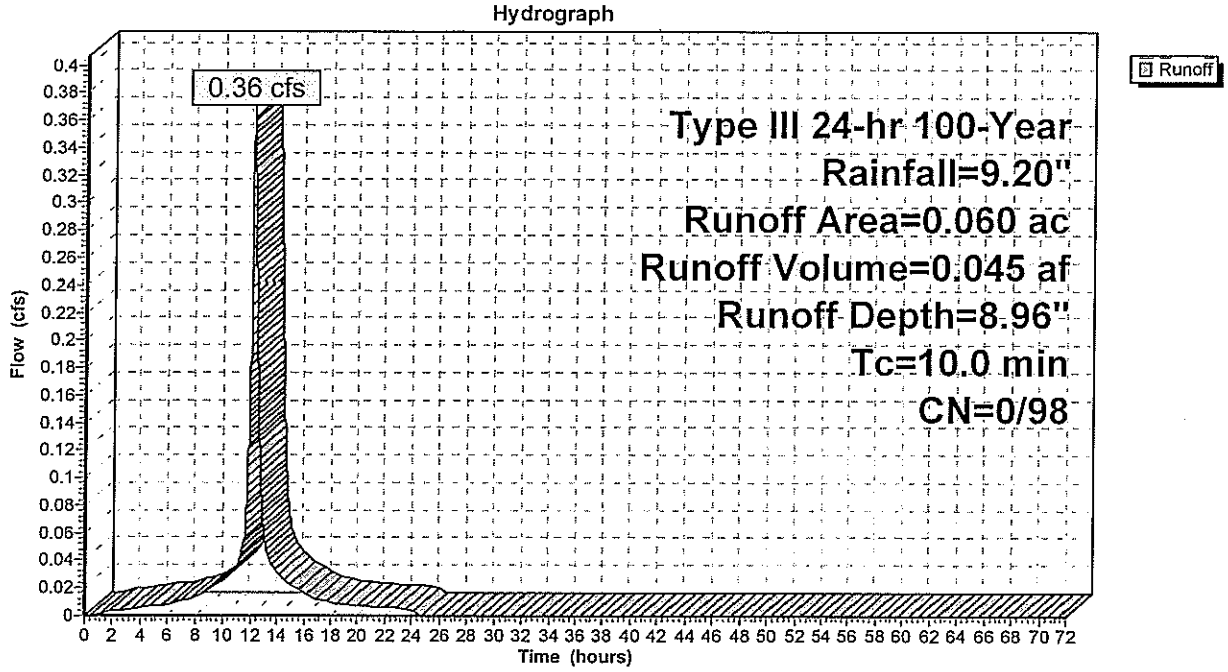
Runoff = 0.36 cfs @ 12.15 hrs, Volume= 0.045 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.060	98	Roofs, HSG A
0.060	98	100.00% Impervious Area

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

Subcatchment 13S: PDA-1E (Impervious)



Summary for Subcatchment 14S: PDA-1E (Pervious)

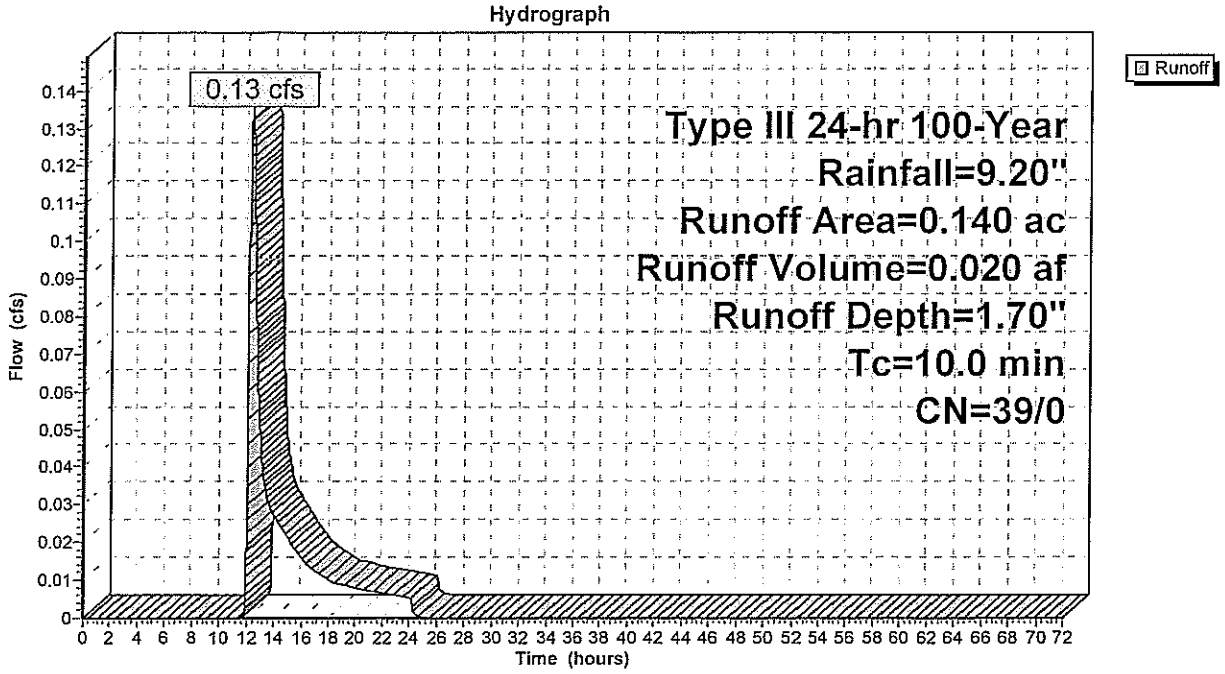
Runoff = 0.13 cfs @ 12.28 hrs, Volume= 0.020 af, Depth= 1.70"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
0.140	39	>75% Grass cover, Good, HSG A
0.140	39	100.00% Pervious Area

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

Subcatchment 14S: PDA-1E (Pervious)



Summary for Subcatchment 15S: PDA-2 (Pervious)

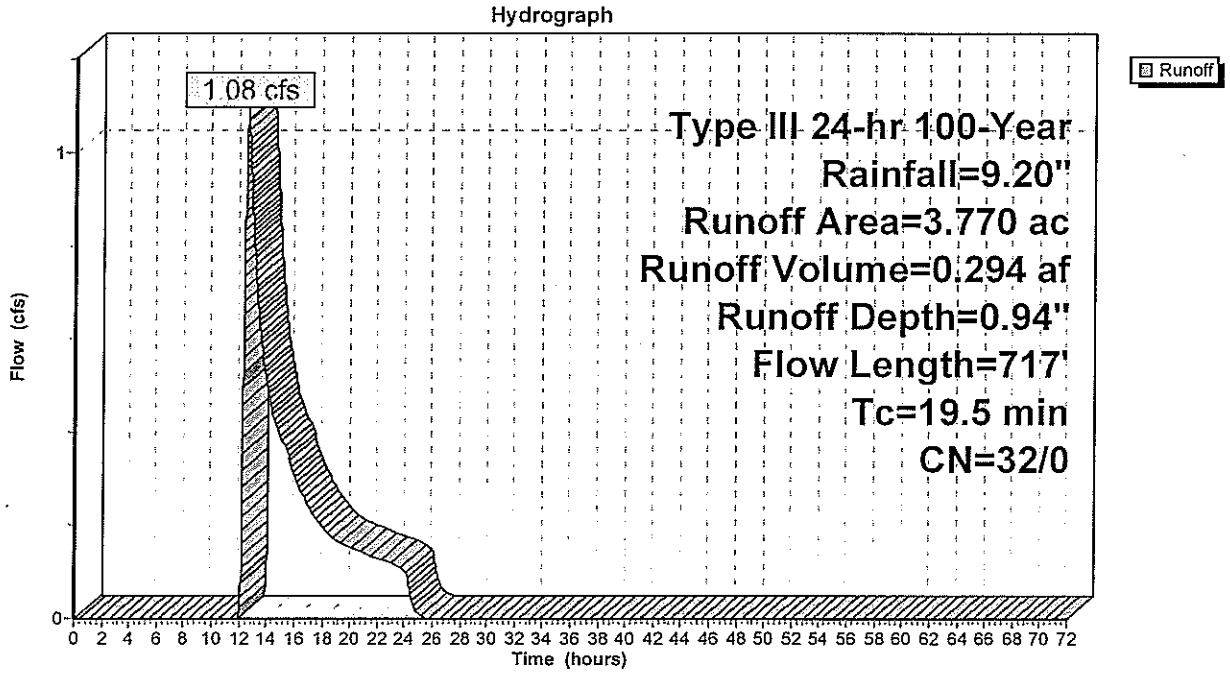
Runoff = 1.08 cfs @ 12.57 hrs, Volume= 0.294 af, Depth= 0.94"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
3.120	30	Woods, Good, HSG A
0.650	39	>75% Grass cover, Good, HSG A
3.770	32	Weighted Average
3.770	32	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	97	0.0620	0.13		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.40"
6.6	620	0.0096	1.58		**Shallow Concentrated Flow, B-C** Unpaved Kv= 16.1 fps
19.5	717	Total			

Subcatchment 15S: PDA-2 (Pervious)



Summary for Subcatchment 16S: PDA-3 (Impervious)

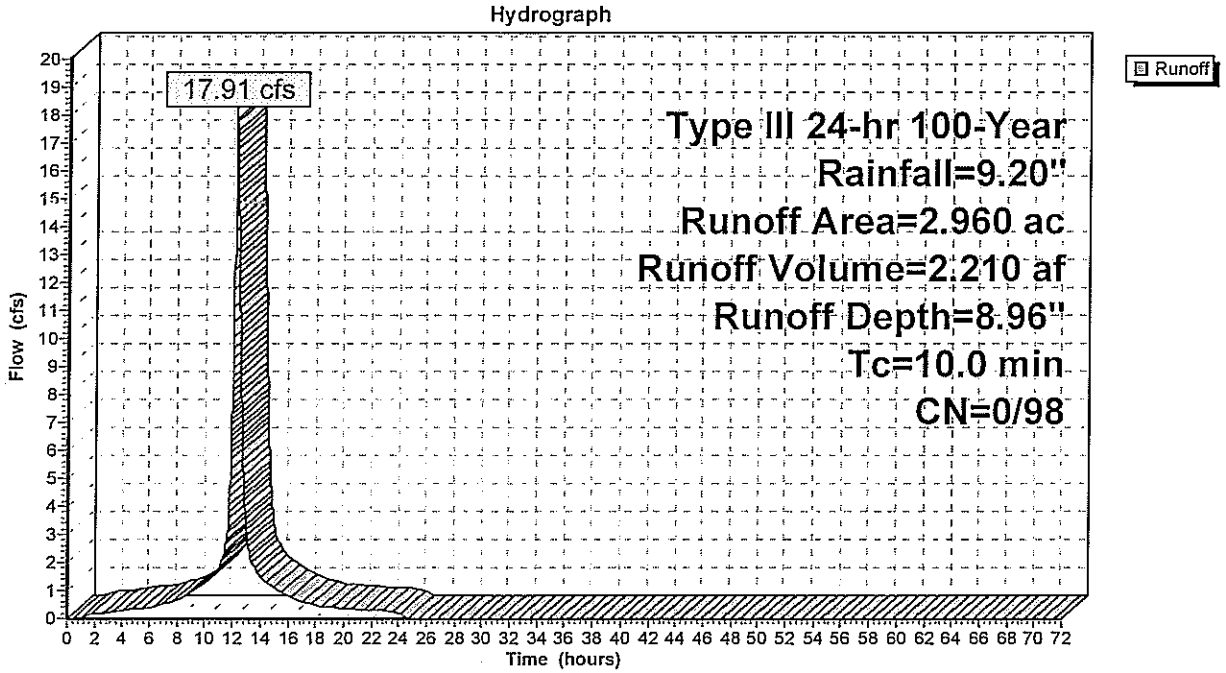
Runoff = 17.91 cfs @ 12.15 hrs, Volume= 2.210 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

	Area (ac)	CN	Description
	2.060	98	Paved parking, HSG A
*	0.900	98	Basin bottom
	2.960	98	Weighted Average
	2.960	98	100.00% Impervious Area

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

Subcatchment 16S: PDA-3 (Impervious)



Summary for Subcatchment 17S: PDA-3 (Pervious)

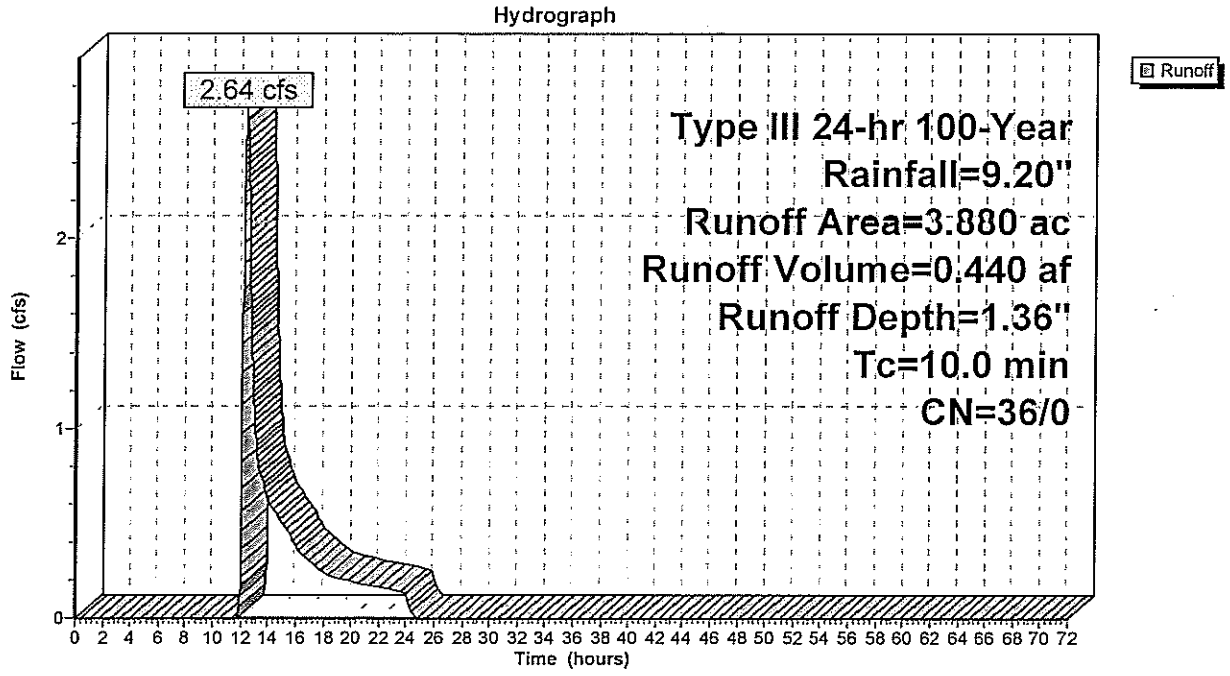
Runoff = 2.64 cfs @ 12.35 hrs, Volume= 0.440 af, Depth= 1.36"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
2.420	39	>75% Grass cover, Good, HSG A
1.460	30	Woods, Good, HSG A
3.880	36	Weighted Average
3.880	36	100.00% Pervious Area

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

Subcatchment 17S: PDA-3 (Pervious)



Summary for Pond 1P: Basin #1

Inflow Area = 11.350 ac, 81.15% Impervious, Inflow Depth = 7.55" for 100-Year event
Inflow = 57.13 cfs @ 12.16 hrs, Volume= 7.139 af
Outflow = 0.25 cfs @ 24.30 hrs, Volume= 1.212 af, Atten= 100%, Lag= 728.4 min
Primary = 0.25 cfs @ 24.30 hrs, Volume= 1.212 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 59.80' @ 24.30 hrs Surf.Area= 108,112 sf Storage= 299,873 cf

Plug-Flow detention time= 2,055.9 min calculated for 1.212 af (17% of inflow)
Center-of-Mass det. time= 1,743.3 min (2,498.8 - 755.5)

Volume	Invert	Avail.Storage	Storage Description
#1	56.90'	432,566 cf	**Basin #1 (Prismatic)** Listed below (Recalc)

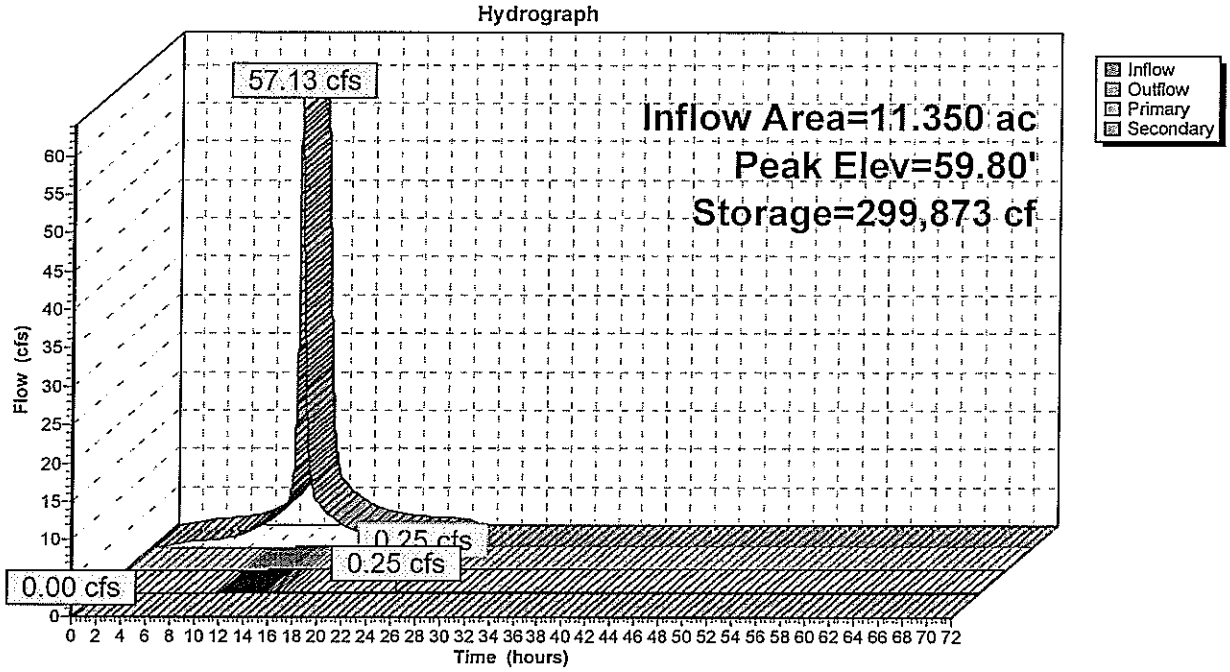
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
56.90	97,675	0	0
57.00	98,767	9,822	9,822
58.00	102,067	100,417	110,239
59.00	105,401	103,734	213,973
60.00	108,770	107,086	321,059
61.00	114,245	111,508	432,566

Device	Routing	Invert	Outlet Devices
#1	Primary	56.80'	**15.0" Round Culvert** L= 12.0' RCP, groove end w/headwall, Ke= 0.200 Outlet Invert= 56.68' S= 0.0100 '/' Cc= 0.900 n= 0.013
#2	Device 1	57.30'	**2.5" Vert. Orifice/Grate** C= 0.600
#3	Device 1	60.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	60.30'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.25 cfs @ 24.30 hrs HW=59.80' TW=53.54' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.25 cfs of 11.08 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.25 cfs @ 7.46 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Basin #1



Summary for Pond 2P: Basin #2

Inflow Area = 16.380 ac, 79.06% Impervious, Inflow Depth > 3.07" for 100-Year event
Inflow = 23.90 cfs @ 12.16 hrs, Volume= 4.187 af
Outflow = 1.91 cfs @ 14.82 hrs, Volume= 3.471 af, Atten= 92%, Lag= 159.6 min
Primary = 1.91 cfs @ 14.82 hrs, Volume= 3.471 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 54.12' @ 14.82 hrs Surf.Area= 45,168 sf Storage= 89,747 cf

Plug-Flow detention time= 883.0 min calculated for 3.471 af (83% of inflow)
Center-of-Mass det. time= 477.6 min (1,740.1 - 1,262.5)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	179,275 cf	**Basin #2 (Prismatic)** Listed below (Recalc)

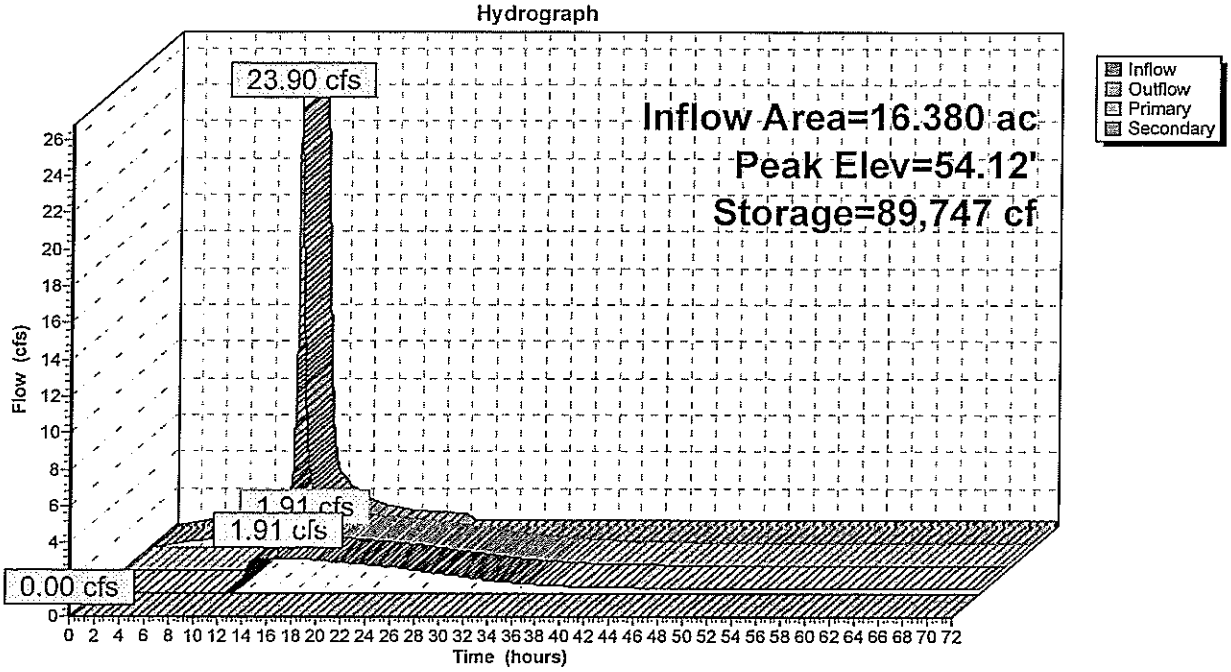
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	39,333	0	0
53.00	42,052	40,693	40,693
54.00	44,827	43,440	84,132
55.00	47,558	46,193	130,325
56.00	50,343	48,951	179,275

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**15.0" Round Culvert** L= 17.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 50.66' S= 0.0200 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	54.60'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.91 cfs @ 14.82 hrs HW=54.12' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.91 cfs of 11.60 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.91 cfs @ 5.47 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=52.00' TW=0.00' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: Basin #2



Summary for Pond 3P: Basin #3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 4.65" for 100-Year event
Inflow = 20.08 cfs @ 12.16 hrs, Volume= 2.650 af
Outflow = 1.37 cfs @ 15.56 hrs, Volume= 0.640 af, Atten= 93%, Lag= 203.6 min
Primary = 1.37 cfs @ 15.56 hrs, Volume= 0.640 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 59.36' @ 15.56 hrs Surf.Area= 55,206 sf Storage= 90,989 cf

Plug-Flow detention time= 594.8 min calculated for 0.640 af (24% of inflow)
Center-of-Mass det. time= 349.8 min (1,127.6 - 777.7)

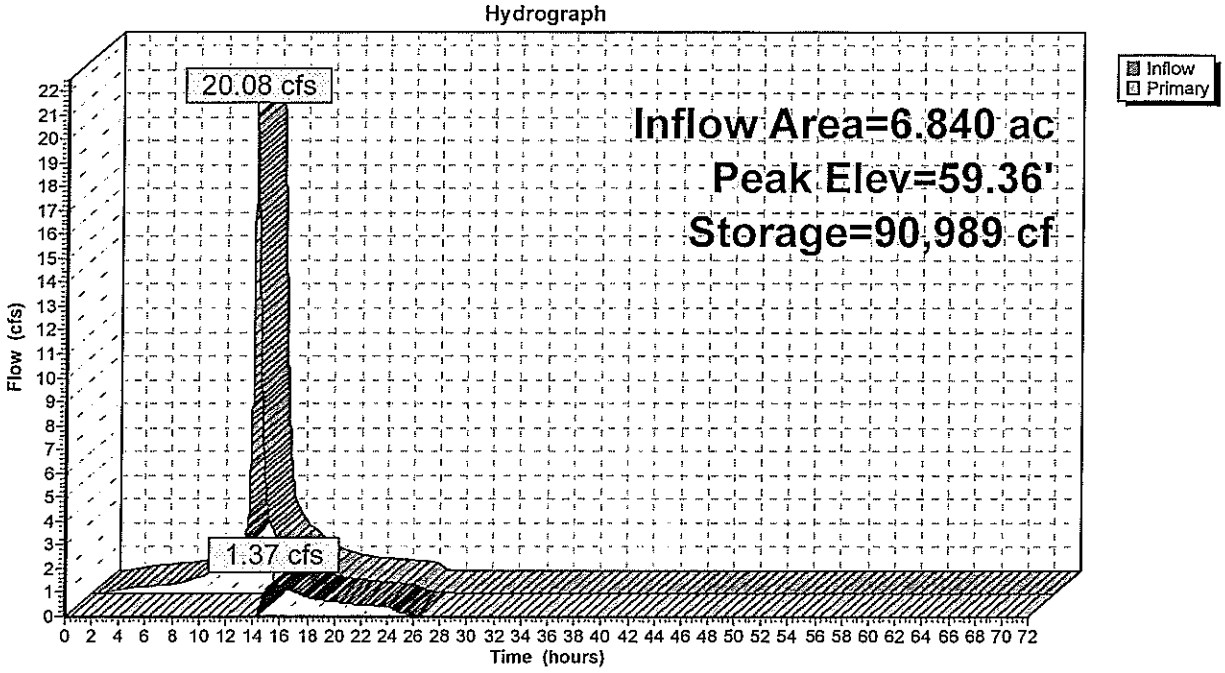
Volume	Invert	Avail.Storage	Storage Description
#1	57.50'	127,089 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.50	39,005	0	0
58.00	46,307	21,328	21,328
59.00	53,554	49,931	71,259
60.00	58,107	55,831	127,089

Device	Routing	Invert	Outlet Devices
#1	Primary	59.30'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.37 cfs @ 15.56 hrs HW=59.36' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Weir Controls 1.37 cfs @ 0.62 fps)

Pond 3P: Basin #3



Summary for Pond E-LD: Local Depression

Inflow Area = 3.740 ac, 32.35% Impervious, Inflow Depth = 3.40" for 100-Year event
Inflow = 7.33 cfs @ 12.15 hrs, Volume= 1.059 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 58.27' @ 28.20 hrs Surf.Area= 35,048 sf Storage= 46,126 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

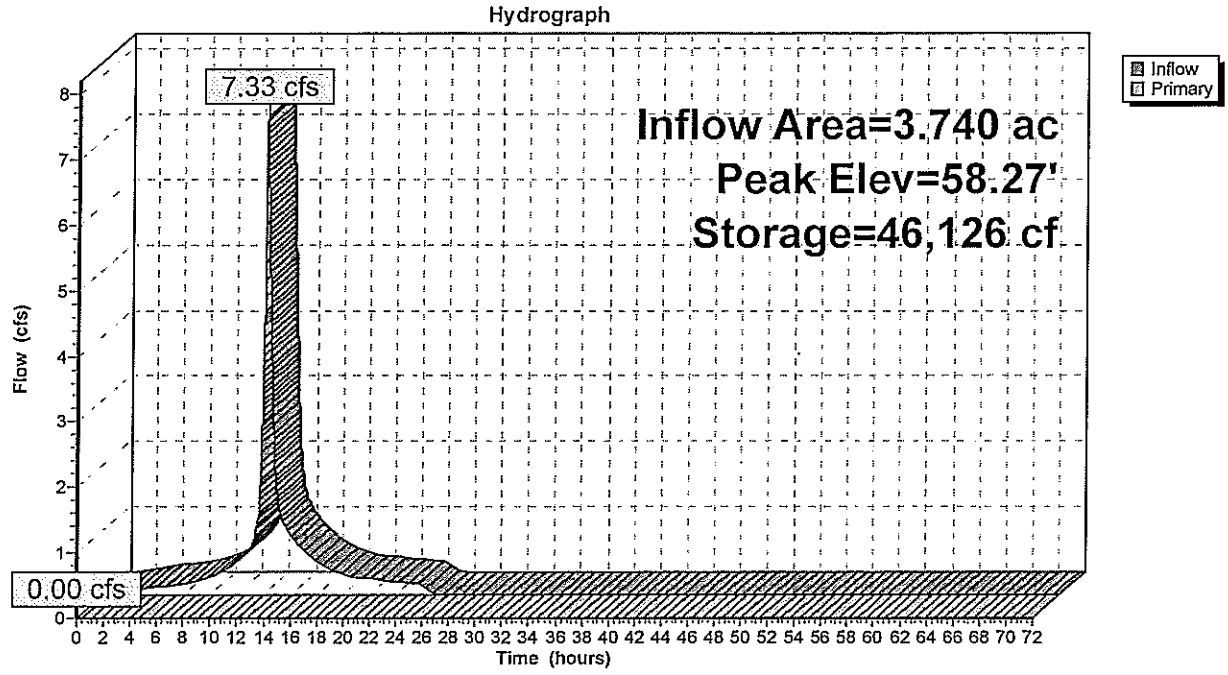
Volume	Invert	Avail.Storage	Storage Description
#1	55.00'	77,509 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
55.00	305	82.0	0	0	305
56.00	6,603	306.0	2,776	2,776	7,224
57.00	17,113	481.0	11,449	14,224	18,191
58.00	29,890	639.0	23,207	37,431	32,284
59.00	51,218	900.0	40,078	77,509	64,258

Device	Routing	Invert	Outlet Devices
#1	Primary	58.79'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=55.00' TW=0.00' (Dynamic Tailwater)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond E-LD: Local Depression



Summary for Pond P-LD: PDA-2A (Local Depression)

Inflow Area = 3.770 ac, 0.00% Impervious, Inflow Depth = 0.94" for 100-Year event
Inflow = 1.08 cfs @ 12.57 hrs, Volume= 0.294 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 56.91' @ 26.14 hrs Surf.Area= 16,006 sf Storage= 12,798 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

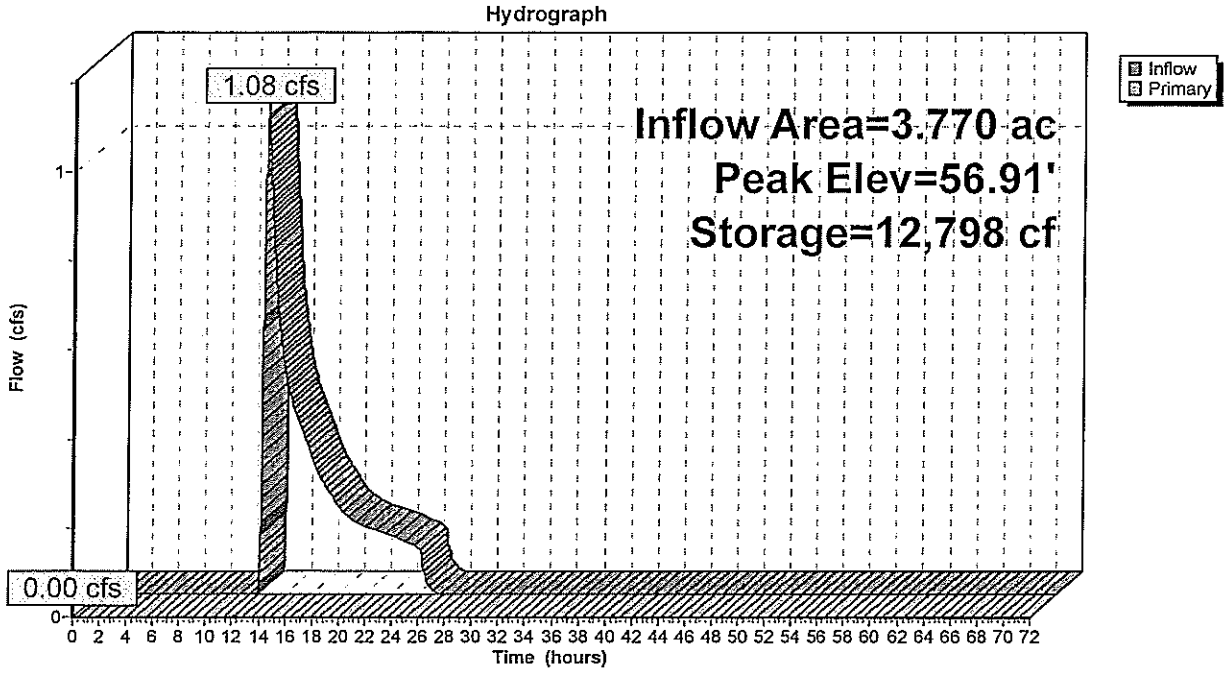
Volume	Invert	Avail.Storage	Storage Description
#1	55.00'	74,341 cf	**Custom Stage Data (Irregular)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
55.00	305	82.0	0	0	305
56.00	6,601	306.0	2,775	2,775	7,224
57.00	17,096	481.0	11,440	14,215	18,191
58.00	29,886	639.0	23,195	37,410	32,284
59.00	44,455	776.0	36,930	74,341	47,727

Device	Routing	Invert	Outlet Devices
#1	Primary	58.79'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=55.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P-LD: PDA-2A (Local Depression)

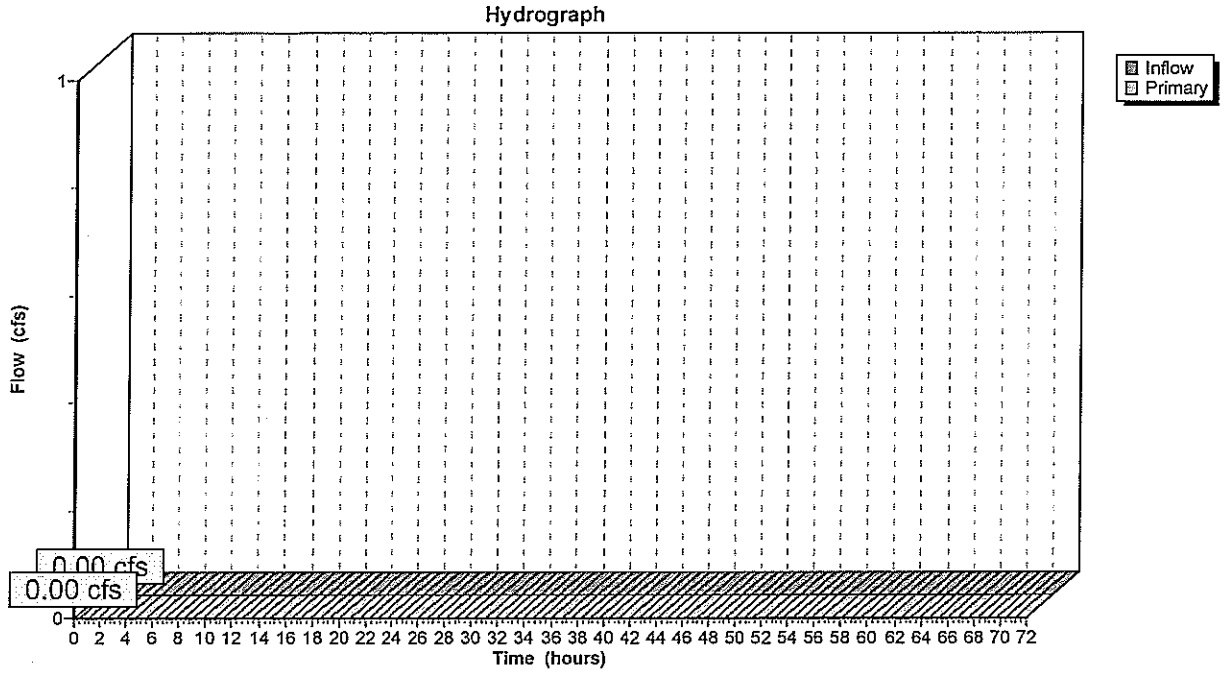


Summary for Link 1L: Emergency Spillway

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 1L: Emergency Spillway

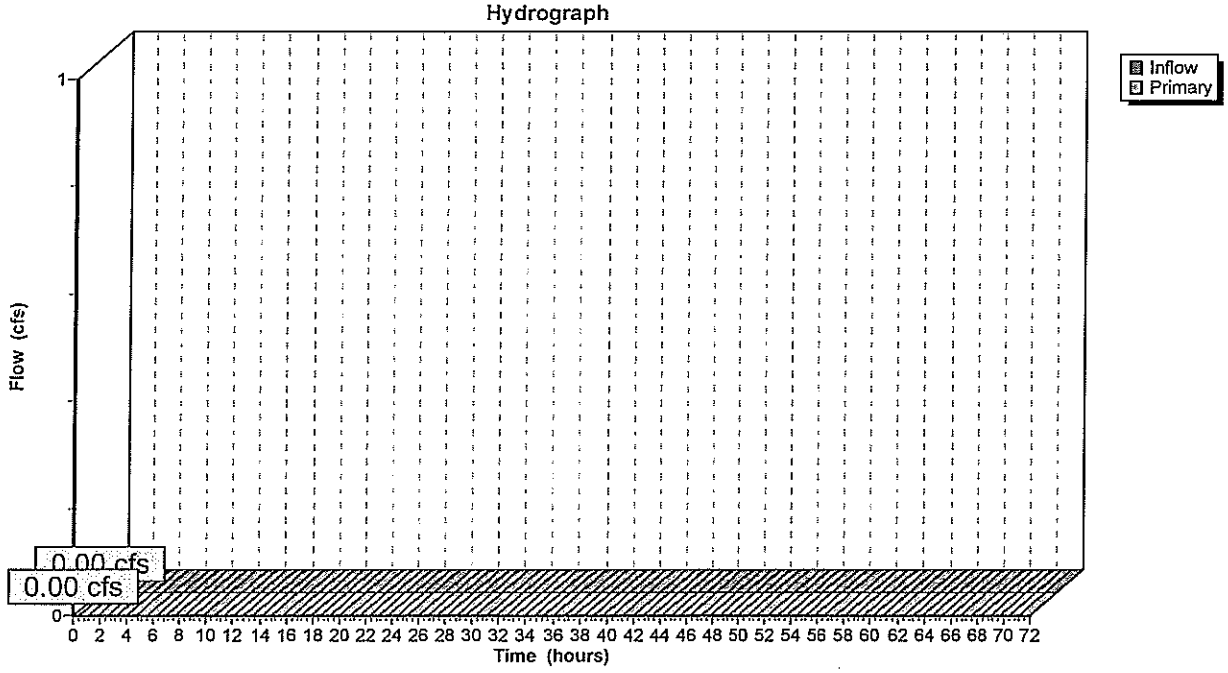


Summary for Link 2L: Emergency Spillway

Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 2L: Emergency Spillway

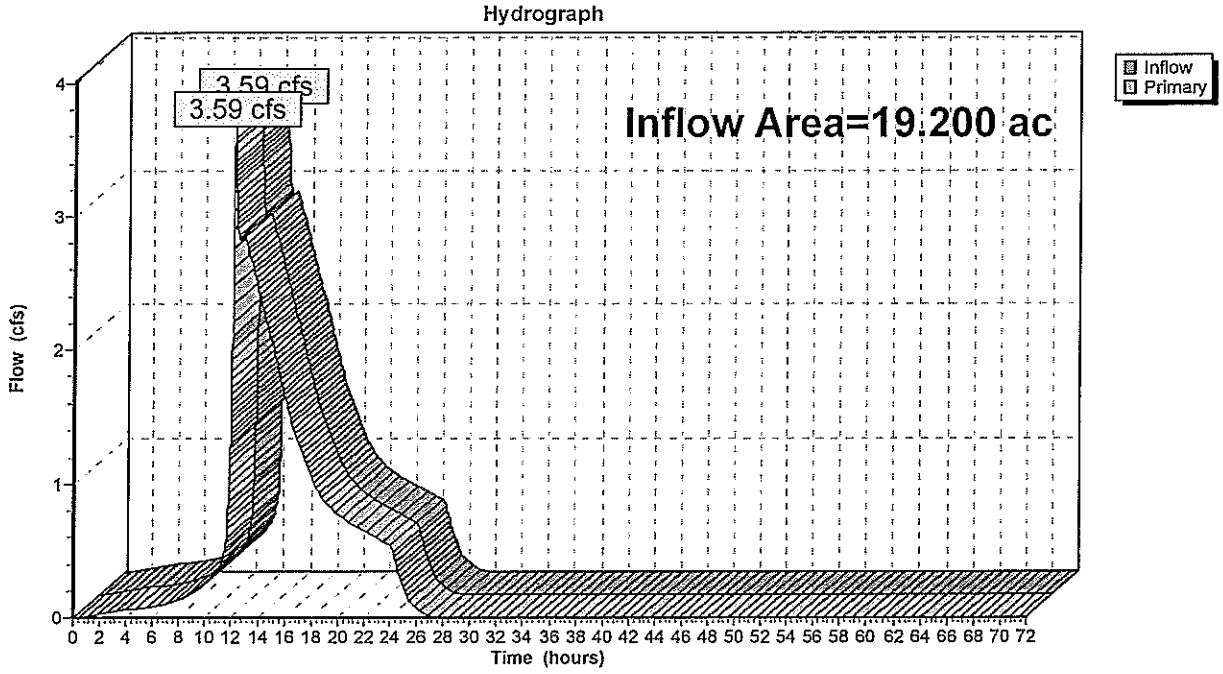


Summary for Link L-E1: EDA-1

Inflow Area = 19.200 ac, 3.07% Impervious, Inflow Depth = 0.99" for 100-Year event
Inflow = 3.59 cfs @ 12.16 hrs, Volume= 1.584 af
Primary = 3.59 cfs @ 12.16 hrs, Volume= 1.584 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E1: EDA-1

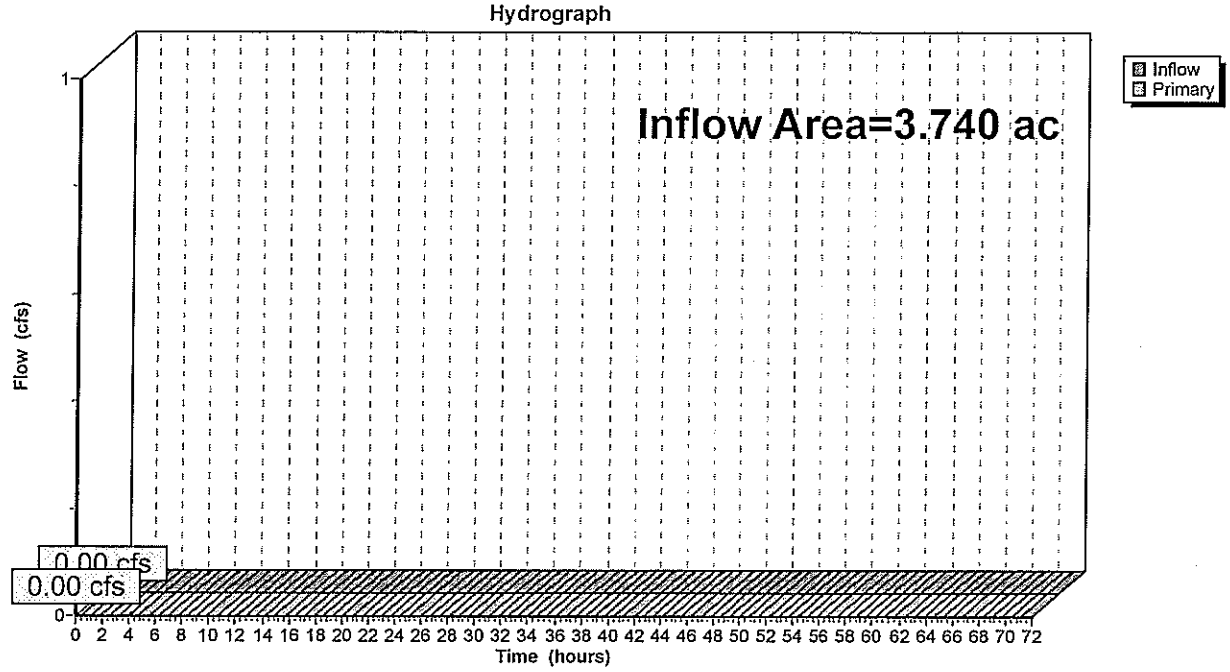


Summary for Link L-E2: EDA-2

Inflow Area = 3.740 ac, 32.35% Impervious, Inflow Depth = 0.00" for 100-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E2: EDA-2

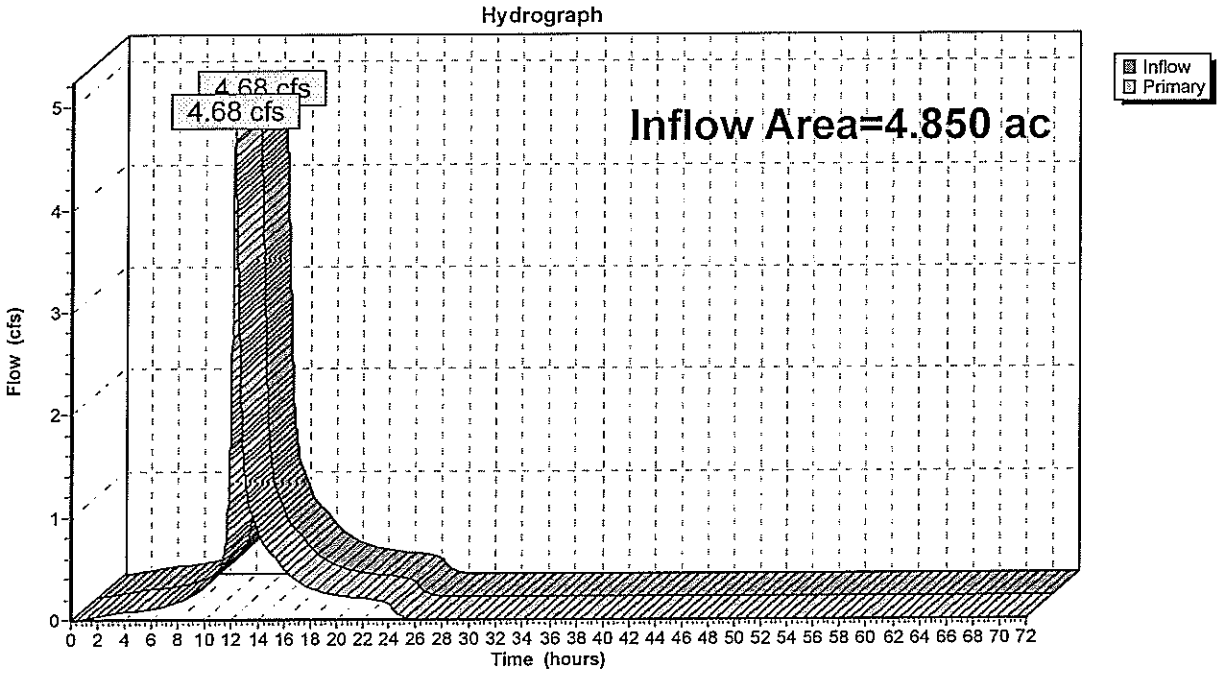


Summary for Link L-E3: EDA-3

Inflow Area = 4.850 ac, 15.88% Impervious, Inflow Depth = 2.04" for 100-Year event
Inflow = 4.68 cfs @ 12.16 hrs, Volume= 0.826 af
Primary = 4.68 cfs @ 12.16 hrs, Volume= 0.826 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-E3: EDA-3

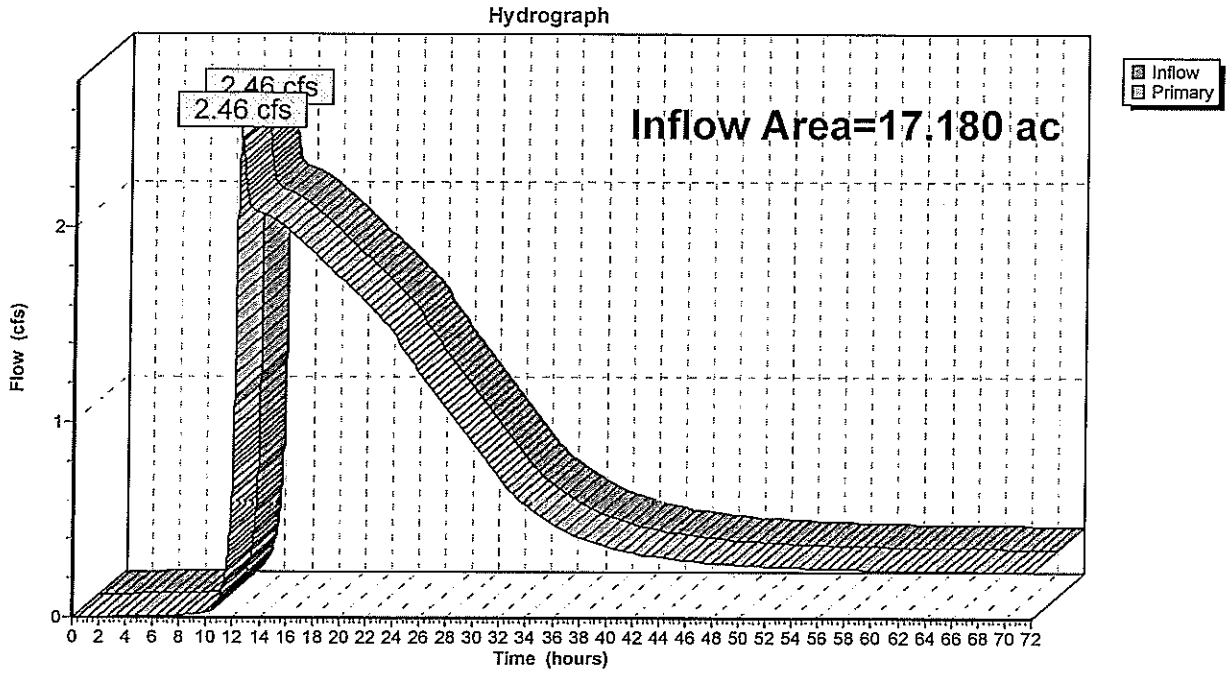


Summary for Link L-P1: PDA-1

Inflow Area = 17.180 ac, 75.73% Impervious, Inflow Depth > 2.53" for 100-Year event
Inflow = 2.46 cfs @ 12.42 hrs, Volume= 3.621 af
Primary = 2.46 cfs @ 12.42 hrs, Volume= 3.621 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P1: PDA-1

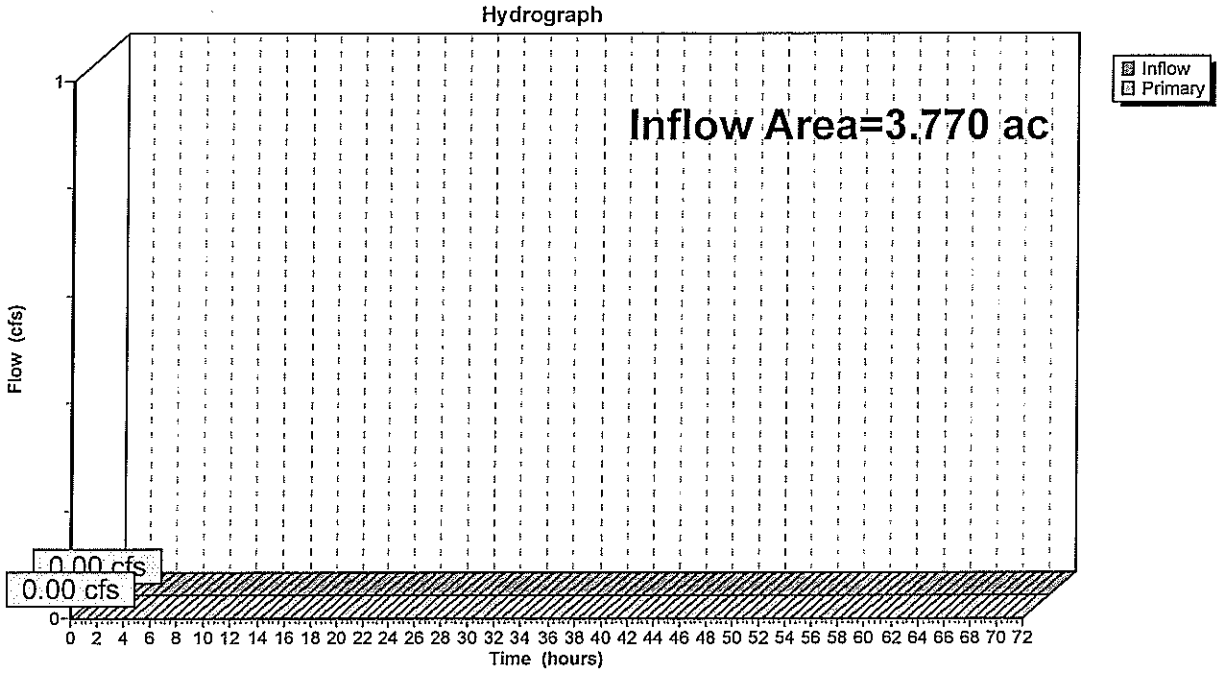


Summary for Link L-P2: PDA-2

Inflow Area = 3.770 ac, 0.00% Impervious, Inflow Depth = 0.00" for 100-Year event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P2: PDA-2

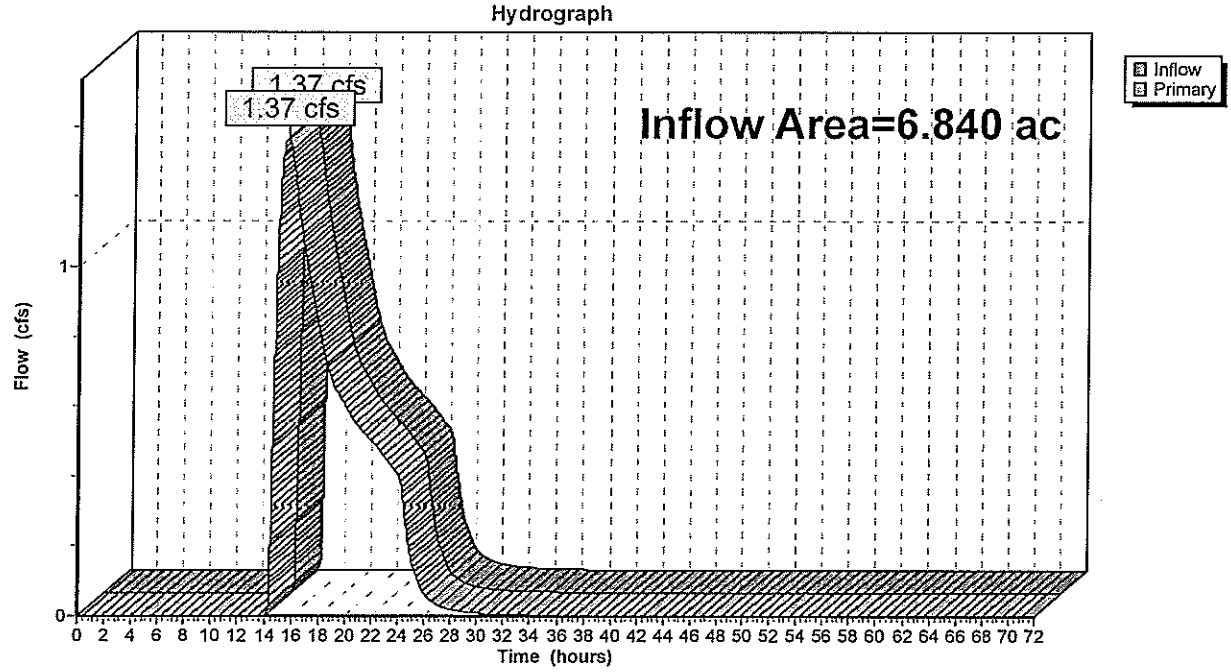


Summary for Link L-P3: PDA-3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 1.12" for 100-Year event
Inflow = 1.37 cfs @ 15.56 hrs, Volume= 0.640 af
Primary = 1.37 cfs @ 15.56 hrs, Volume= 0.640 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link L-P3: PDA-3



B. Design Calculations

- Emergency Spillway Calculations
- Infiltration Rate and Basin Drain Time Calculations
- Recharge Calculations
- Storm Drain Sizing, Curb Cut and Inlet Capacity Check
- Pipe Capacity Check for Underground Basin
- Scour Hole Design
- Township-Specific Requirements Evaluation
- Sediment Basin Design
- Low-Impact Development Checklist

EMERGENCY SPILLWAY CALCULATIONS

Summary for Pond 1P: Basin #1

Inflow Area = 11.350 ac, 81.15% Impervious, Inflow Depth = 7.55" for 100-Year event
Inflow = 57.13 cfs @ 12.16 hrs, Volume= 7.139 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 59.91' @ 25.10 hrs Surf.Area= 108,457 sf Storage= 310,968 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	56.90'	432,566 cf	**Basin #1 (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
56.90	97,675	0	0
57.00	98,767	9,822	9,822
58.00	102,067	100,417	110,239
59.00	105,401	103,734	213,973
60.00	108,770	107,086	321,059
61.00	114,245	111,508	432,566

Device	Routing	Invert	Outlet Devices
#1	Primary	56.80'	**15.0" Round Culvert X 0.00** L= 12.0' RCP, groove end w/headwall, Ke= 0.200 Outlet Invert= 56.68' S= 0.0100 '/' Cc= 0.900 n= 0.013
#2	Device 1	57.30'	**2.5" Vert. Orifice/Grate** C= 0.600
#3	Device 1	60.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	60.30'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)
  ├─**2=Orifice/Grate** (Controls 0.00 cfs)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=56.90' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

BASIN #1 EMERGENCY SPILLWAY CHECK FOR 10-YEAR STORM EVENT

Summary for Pond 1P: Basin #1

Inflow Area = 11.350 ac, 81.15% Impervious, Inflow Depth = 4.23" for 10-Year event
Inflow = 32.59 cfs @ 12.15 hrs, Volume= 4.000 af
Outflow = 25.21 cfs @ 12.34 hrs, Volume= 4.000 af, Atten= 23%, Lag= 11.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 25.21 cfs @ 12.34 hrs, Volume= 4.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 60.30' Surf.Area= 110,413 sf Storage= 353,936 cf
Peak Elev= 60.52' @ 12.34 hrs Surf.Area= 111,600 sf Storage= 378,012 cf (24,076 cf above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= 31.1 min (790.1 - 759.1)

Volume	Invert	Avail.Storage	Storage Description
#1	56.90'	432,566 cf	**Basin #1 (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
56.90	97,675	0	0
57.00	98,767	9,822	9,822
58.00	102,067	100,417	110,239
59.00	105,401	103,734	213,973
60.00	108,770	107,086	321,059
61.00	114,245	111,508	432,566

Device	Routing	Invert	Outlet Devices
#1	Primary	56.80'	**15.0" Round Culvert X 0.00** L= 12.0' RCP, groove end w/headwall, Ke= 0.200 Outlet Invert= 56.68' S= 0.0100 '/' Cc= 0.900 n= 0.013
#2	Device 1	57.30'	**2.5" Vert. Orifice/Grate** C= 0.600
#3	Device 1	60.00'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	60.30'	**100.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=60.30' (Free Discharge)
↑—**1=Culvert** (Controls 0.00 cfs)
↑—**2=Orifice/Grate** (Passes < 0.28 cfs potential flow)
—**3=Orifice/Grate** (Passes < 6.45 cfs potential flow)

Secondary OutFlow Max=25.21 cfs @ 12.34 hrs HW=60.52' (Free Discharge)
↑—**4=Broad-Crested Rectangular Weir** (Weir Controls 25.21 cfs @ 1.16 fps)

Summary for Pond 2P: Basin #2

Inflow Area = 5.030 ac, 74.35% Impervious, Inflow Depth = 7.10" for 100-Year event
Inflow = 23.75 cfs @ 12.16 hrs, Volume= 2.975 af
Outflow = 0.84 cfs @ 17.25 hrs, Volume= 0.415 af, Atten= 96%, Lag= 305.5 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 0.84 cfs @ 17.25 hrs, Volume= 0.415 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 54.65' @ 17.25 hrs Surf.Area= 46,589 sf Storage= 113,627 cf

Plug-Flow detention time= 794.5 min calculated for 0.415 af (14% of inflow)
Center-of-Mass det. time= 447.9 min (1,206.9 - 759.0)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	179,275 cf	**Basin #2 (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	39,333	0	0
53.00	42,052	40,693	40,693
54.00	44,827	43,440	84,132
55.00	47,558	46,193	130,325
56.00	50,343	48,951	179,275

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**15.0" Round Culvert X 0.00** L= 17.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 50.66' S= 0.0200 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	54.60'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=52.00' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
  └**2=Orifice/Grate** (Controls 0.00 cfs)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.84 cfs @ 17.25 hrs HW=54.65' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 0.84 cfs @ 0.53 fps)

Summary for Pond 2P: Basin #2

Inflow Area = 5.030 ac, 74.35% Impervious, Inflow Depth = 3.91" for 10-Year event
Inflow = 13.23 cfs @ 12.15 hrs, Volume= 1.640 af
Outflow = 9.86 cfs @ 12.36 hrs, Volume= 1.640 af, Atten= 26%, Lag= 12.4 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 9.86 cfs @ 12.36 hrs, Volume= 1.640 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 54.60' Surf.Area= 46,466 sf Storage= 111,520 cf
Peak Elev= 54.83' @ 12.36 hrs Surf.Area= 47,102 sf Storage= 122,427 cf (10,907 cf above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= 35.8 min (796.9 - 761.1)

Volume	Invert	Avail.Storage	Storage Description
#1	52.00'	179,275 cf	**Basin #2 (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
52.00	39,333	0	0
53.00	42,052	40,693	40,693
54.00	44,827	43,440	84,132
55.00	47,558	46,193	130,325
56.00	50,343	48,951	179,275

Device	Routing	Invert	Outlet Devices
#1	Primary	51.00'	**15.0" Round Culvert X 0.00** L= 17.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 50.66' S= 0.0200 '/' Cc= 0.900 n= 0.013
#2	Device 1	52.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.20'	**36.0" x 36.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	54.60'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=54.60' (Free Discharge)
└**1=Culvert** (Controls 0.00 cfs)
  ├**2=Orifice/Grate** (Passes < 2.23 cfs potential flow)
  └**3=Orifice/Grate** (Passes < 9.93 cfs potential flow)

Secondary OutFlow Max=9.86 cfs @ 12.36 hrs HW=54.83' (Free Discharge)
└**4=Broad-Crested Rectangular Weir** (Weir Controls 9.86 cfs @ 1.21 fps)

BASIN #3 EMERGENCY SPILLWAY CHECK FOR 100-YEAR STORM EVENT

Summary for Pond 3P: Basin #3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 4.65" for 100-Year event
Inflow = 20.08 cfs @ 12.16 hrs, Volume= 2.650 af
Outflow = 1.37 cfs @ 15.56 hrs, Volume= 0.640 af, Atten= 93%, Lag= 203.6 min
Primary = 1.37 cfs @ 15.56 hrs, Volume= 0.640 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 59.36' @ 15.56 hrs Surf.Area= 55,206 sf Storage= 90,989 cf

Plug-Flow detention time= 594.8 min calculated for 0.640 af (24% of inflow)
Center-of-Mass det. time= 349.8 min (1,127.6 - 777.7)

Volume	Invert	Avail.Storage	Storage Description
#1	57.50'	127,089 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.50	39,005	0	0
58.00	46,307	21,328	21,328
59.00	53,554	49,931	71,259
60.00	58,107	55,831	127,089

Device	Routing	Invert	Outlet Devices
#1	Primary	59.30'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=1.37 cfs @ 15.56 hrs HW=59.36' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 1.37 cfs @ 0.62 fps)

BASIN #3 EMERGENCY SPILLWAY CHECK FOR 10-YEAR STORM EVENT

Summary for Pond 3P: Basin #3

Inflow Area = 6.840 ac, 43.27% Impervious, Inflow Depth = 2.33" for 10-Year event
Inflow = 10.47 cfs @ 12.15 hrs, Volume= 1.329 af
Outflow = 7.14 cfs @ 12.41 hrs, Volume= 1.329 af, Atten= 32%, Lag= 15.1 min
Primary = 7.14 cfs @ 12.41 hrs, Volume= 1.329 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Starting Elev= 59.30' Surf.Area= 54,920 sf Storage= 87,530 cf
Peak Elev= 59.49' @ 12.41 hrs Surf.Area= 55,778 sf Storage= 97,966 cf (10,437 cf above start)

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= 46.2 min (814.7 - 768.5)

Volume	Invert	Avail.Storage	Storage Description
#1	57.50'	127,089 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
57.50	39,005	0	0
58.00	46,307	21,328	21,328
59.00	53,554	49,931	71,259
60.00	58,107	55,831	127,089

Device	Routing	Invert	Outlet Devices
#1	Primary	59.30'	**35.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=7.14 cfs @ 12.41 hrs HW=59.49' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 7.14 cfs @ 1.08 fps)

INFILTRATION RATE AND BASIN DRAIN TIME CALCULATIONS

Infiltration Rate and Basin Drain Time Calculation

Per Darcy's Law Q= K*I*A

K= the hydraulic conductivity of soil in feet per second (fps)
K = tested permeability rate in (inch/hour) / (factor of safety * 12 * 3600)
I = the hydraulic gradient (minimum = 1)
A = The area of infiltration in square feet (sf)
Factor of Safety used = 3

For Basin #1

The minimum tested permeability rate is 4.7 inch/hour

K = 3.63E-05 ft/s
$I_{(min)}$= 1
A = 97,675 sf

Q = 3.54 cfs

The total basin storage upto to elevation of 60.30' is 353,936 cf
It would take about 353,936/(3.54 x 3600) = 27.8 hours to drain the entire basin volume via infiltration only.
(This approach is conservative as any discharge from outlet structure is ignored.)

For Basin #2

the minimum tested permeability rate is 11.8 inch/hour

K = 9.10E-05 ft/s
$I_{(min)}$= 1
A = 39,333 sf

Q = 3.58 cfs

The total basin storage upto to elevation of 54.60' is 111,520 cf
It would take about 111,520/(3.58 x 3600) = 8.7 hours to drain the entire basin volume via infiltration only.
(This approach is conservative as any discharge from outlet structure is ignored.)

For Basin #3

the minimum tested permeability rate is 20 inch/hour

K = 1.54E-04 ft/s
$I_{(min)}$= 1
A = 39,005 sf

Q = 6.02 cfs

The total basin storage upto to elevation of 59.30' is 87,530 cf
It would take about 87,530/(6.02 x 3600) = 4.0 hours to drain the entire basin volume via infiltration only.

RECHARGE CALCULATIONS

Toms River is not listed in the table, Manchester Twp. is used.

New Jersey Groundwater Recharge Spreadsheet Version 2.0 November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
OCEAN CO., MANCHESTER TWP	47.8	1.53

Project Name:	Grunin
Description:	Toms River, NJ
Analysis Date:	12/04/17

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	2.6	Impervious areas	Lakewood	0.0	-
2	2.8	Open space	Lakewood	17.2	174,434
3	22.4	Woods	Lakewood	16.7	1,359,407
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
Total =	27.8			Total Annual Recharge (in)	otal Annual Recharge (cu-ft)
				16.2	1,533,840

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	11.9	Impervious areas	Lakewood	0.0	-
2	10.8	Open space	Lakewood	17.2	672,815
3	5.1	Woods	Lakewood	16.7	309,508
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
Total =	27.8			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
Annual Recharge Requirements Calculation ↓				9.7	982,323
% of Pre-Developed Annual Recharge to Preserve =			100%	Total Impervious Area (sq.ft)	518,364
Post-Development Annual Recharge Deficit=			*551,517*	(cubic feet)	

Recharge Efficiency Parameters Calculations (area averages)

RWC=	2.65	(in)	DRWC=	0.89	(in)
ERWC =	0.62	(in)	EDRWC=	0.21	(in)

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

Areas within EDA-1, EDA-2 and EDA-3 were calculated under the existing condition, similarly areas within PDA-1, PDA-2 and PDA-3 were calculated under the proposed condition.

This is the annual recharge deficit for the proposed development.

Project Name	Description	Analysis Date	BMP or LID Type
Grunin	Toms River, NJ	12/04/17	

Recharge BMP Input Parameters

Parameter	Symbol	Value	Unit
BMP Area	ABMP	97675.0	sq.ft
BMP Effective Depth, this is the cesign variable	dBMP	1.2	in
Upper ieve: of the BMP surface (negative if above ground)	dBMPu	12.0	in
Depth of lower surface of BMP, must be>=dBMPu	dEXC	48.0	in
Post-development Land Segment Location of BMP , Input Zero if Location is distributed or undetermined	SegBMP	2	unitless

Root Zone Water capacity Calculated Parameters

Parameter	Symbol	Value	Unit
Empty Portion of RWC under Post-D Natural Recharge	ERWC	0.48	in
ERWC Modified to consider dEXC	EDRWC	0.00	in
Empty Portion of RWC under Infilt. BMP	RERWC	0.00	in

Recharge Design Parameters

Parameter	Symbol	Value	Unit
Inches of Runoff to capture	Qdesign	0.38	in
Inches of Rainfall to capture	Pdesign	0.48	in
Recharge Provided Avg. over Imp. Area		20.3	in
Runoff Captured Avg. over Imp. Area		20.3	in

BMP Calculated Size Parameters

ABMP/Aimp	Aratio	0.30	unitless
BMP Volume	VBMP	10,079	cu.ft

Parameters from Annual Recharge Worksheet

Post-D Deficit Recharge (or desired recharge volume)	Vdef	551,517	cu.ft
Post-D Impervious Area (or target Impervious Area)	Aimp	326,700	sq.ft
Root Zone Water Capacity	RWC	2.05	in
RWC Modified to consider dEXC	DRWC	0.00	in
Climatic Factor	C-factor	1.53	no units
Average Annual P	Pavg	47.8	in
Recharge Requirement over Imp. Area	dr	12.8	in

System Performance Calculated Parameters

Annual BMP Recharge Volume		551,517	cu.ft
Avg BMP Recharge Efficiency		100.0%	Represents % Infiltration Recharged
%Rainfall became Runoff		78.3%	%
%Runoff Infiltrated		54.1%	%
%Runoff Recharged		34.1%	%
%Rainfall Recharged		26.7%	%

CALCULATION CHECK MESSAGES

Volume Balance-> OK
dBMP Check---> OK
dEXC Check---> OK
BMP Location---> OK

OTHER NOTES

Pdesign is accurate only after BMP dimensions are updated to make rech volume= deficit volume. The portion of BMP infiltration prior to filling and the area occupied by BMP are ignored in these calculations. Results are sensetive to dBMP, make sure dBMP selected is small enough for BMP to empty in less than 3 days. For land Segment Location of BMP if you select "Impervious areas" RWC will be minimal but not zero as determined by the soil type and a shallow root zone for this Land Cover allowing consideration of lateral flow and other losses.

How to solve for different recharge volumes: By default the spreadsheet assigns the values of total deficit recharge volume "Vdef" and total proposed impervious area "Aimp" from the "Annual Recharge" sheet to "Vdef" and "Aimp" on this page. This allows solution for a single BMP to handle the entire recharge requirement assuming the runoff from entire impervious area is available to the BMP.
To solve for a smaller BMP or a LID-IMP to recharge only part of the recharge requirement, set Vdef to your target value and Aimp to impervious area directly connected to your infiltration facility and then solve for ABMP or dBMP. To go back to the default configuration clik the "Default Vdef & Aimp" button.

The proposed Basin #1 is sufficient to satisfy the groundwater recharge requirement for the entire site, the calculated required depth is only 1.2 inch, while proposed Basin #1 has a recharge depth about 57.30-56.90 = 0.4' or 4.8 inches. OK

STORM DRAIN SIZING, CURB CUT CALCULATIONS

BOHLER
ENGINEERING

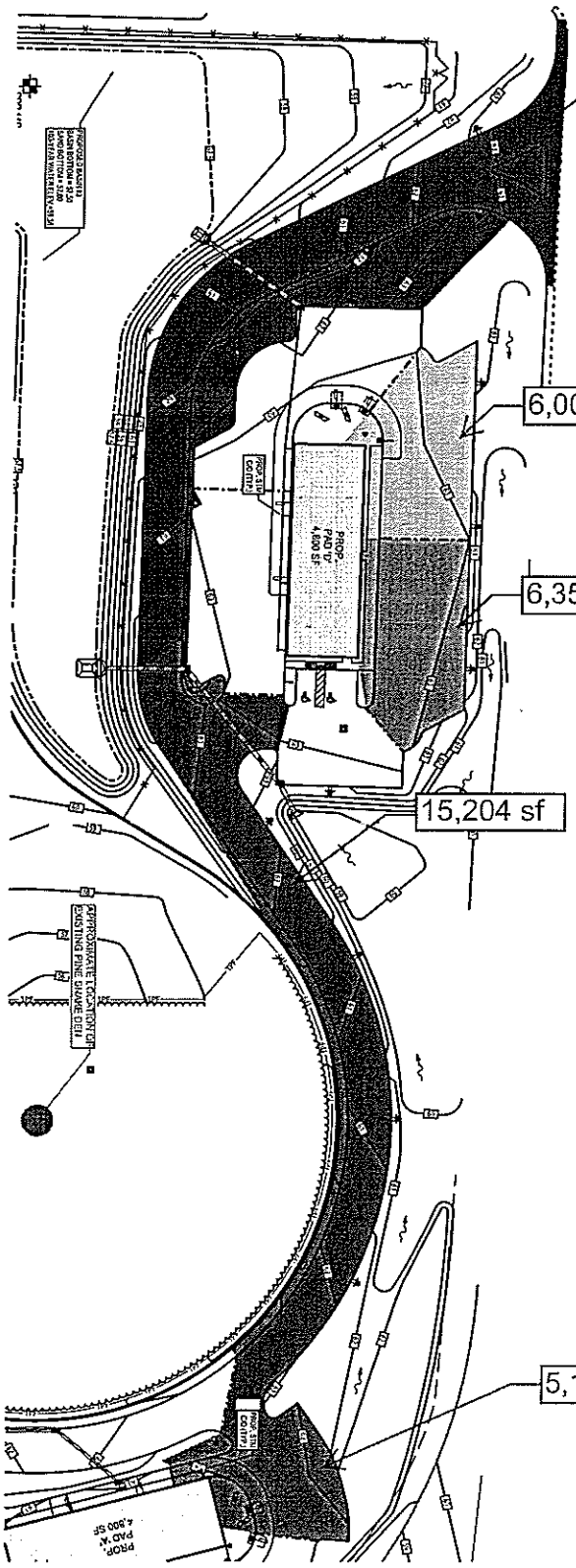
Stormwater Collection System Calculations

Project: Grunin Properties - Proposed Retail Development
Job #: JM170508
Location: Toms River/Manchester
Design Storm: 25 year

Computed By: AJH
Checked By: JZ
Date: 12/5/2017

NOTES:
1) Design method used is Rational Method
2) "B1" denotes existing structure.
2) Refer to Weighted Runoff Coefficient table for calculation of incremental areas and C values

PIPE SECTION		SUBCATCHMENT AREA	INCREMENTAL		CUMULATIVE	TIME OF CONCENTRATION			I	PEAK RUNOFF		PIPING INPUT			PIPING DATA		
FROM	TO	Area (Acres)	"C"	A x C Ac	A x C (acres)	Tc to Inlet (min)	Tc in Pipe (min.)	Final Tc (min)	(In/Hr)	Q to Inlet (CFS)	Q cum. for Pipe (CFS)	Dia. (In)	Length (Ft)	Man. "n"	Slope (%)	Pipe Capacity (cfs)	Pipe Velocity (fps)
Drainage System																	
B1	B2	0.00 Ac.	0.99	0.00	0.00	10.00	0.01	10.00	6.60	0.00	0.00	15	12	0.013	8.10	18.38	14.98
B2	B3	0.21 Ac.	0.86	0.18	0.18	10.00	0.51	10.01	6.60	1.19	1.19	15	139	0.013	0.75	5.59	4.56
B3	B4	0.14 Ac.	0.84	0.12	0.30	10.00	0.60	10.52	6.50	0.78	1.95	15	164	0.013	0.75	5.59	4.56
B4	B5	0.23 Ac.	0.89	0.20	0.50	10.00	0.63	11.12	6.40	1.28	3.20	15	171	0.013	0.75	5.59	4.56
B-RD	B5	1.19 Ac.	0.99	1.17	1.17	10.00	0.10	10.00	6.60	7.72	7.72	18	37	0.013	1.00	10.50	5.94
B5	B6	0.21 Ac.	0.94	0.20	1.87	10.00	0.07	11.75	6.30	1.26	11.78	18	32	0.013	1.50	12.86	7.28
B7	B8	0.50 Ac.	0.60	0.30	0.30	10.00	0.58	10.00	6.60	1.98	1.98	15	115	0.013	0.40	4.08	3.33
B8	B9	0.24 Ac.	0.77	0.18	0.48	10.00	0.53	10.58	6.50	1.17	3.12	15	105	0.013	0.40	4.08	3.33
B9	B10	0.37 Ac.	0.55	0.20	0.68	10.00	0.18	11.11	6.40	1.28	4.35	18	41	0.013	0.40	6.64	3.76
B10	B11	0.13 Ac.	0.93	0.12	0.80	10.00	0.57	11.29	6.40	0.77	5.12	18	128	0.013	0.40	6.64	3.76
B11	B12	0.07 Ac.	0.99	0.07	0.87	10.00	0.10	11.86	6.30	0.44	5.48	18	23	0.013	0.40	6.64	3.76
C1	C2	1.54 Ac.	0.65	1.00	1.00	10.00	0.06	10.00	6.60	6.60	6.60	18	18	0.013	0.75	9.09	5.15
C2	C3	0.10 Ac.	0.94	0.09	1.09	10.00	0.28	10.06	6.60	0.59	7.19	18	85	0.013	0.75	9.09	5.15
C3	C4	0.15 Ac.	0.99	0.15	1.24	10.00	0.15	10.34	6.60	0.99	8.18	18	46	0.013	0.75	9.09	5.15
C-RD	C5	0.11 Ac.	0.99	0.11	0.11	10.00	0.29	10.00	6.60	0.73	0.73	8	79	0.010	1.00	1.57	4.50
C5	C6	0.17 Ac.	0.93	0.16	0.27	10.00	0.35	10.29	6.60	1.06	1.78	15	64	0.013	0.33	3.71	3.02



The maximum drainage area is 20,324 sf
5' wide curb cut is proposed, the depth of flow is about 3.6 inches, and velocity is 1.90 fps.

BOHLER ENGINEERING
35 Technology Drive, Warren, NJ 07059
(908) 668-8300

Date: 12/4/2017
Project: Toms River, NJ
Project No: JM170508

Calculated By: JZ
Checked By: GD

Curb Cut Calculations

Curb Cut # 1

Design Parameters:

Total Drainage Area Tributary to Curb Cut, A ..... 20,324 sf or 0.47 ac
- Impervious Area ..... 13,801 sf or 0.32 ac
- Pervious Area ..... 6,523 sf or 0.15 ac

Weighted C Value 0.78
- Impervious Area using, C = 0.99
- Pervious Area using, C = 0.35

25-year Rainfall Intensity, *I* ..... 7.70 in/hr
(assumes Time in Concentration = 6 minutes)

Curb Width, *b* ..... 5.00 ft

Curb Height, *h* ..... 6.00 in or 0.50 ft

Flow Rate Calculations:

Peak Runoff Rate, $Q = C \times I \times A$ = 2.82 cfs

Using the Kindsvater-Carter Rectangular Weir Equation:

Flow Rate for a Suppressed Weir, $Q = 2/3\ C_e\ (2g)^{0.5}\ b\ d^{3/2}$

Where:
Rectangular Weir Coefficient, C_e = 0.65
Gravity, g = 32.174 ft^2/s

Therefore:

Depth of Flow, $d = \left(\frac{3Q}{2bC_e\sqrt{2g}}\right)^{\frac{2}{3}}$ ..... 0.30 ft or 3.57 in

Velocity, $V = \left(\frac{Q}{2.3(L+1.8W)}\right)^{\frac{2}{3}}$ ..... 1.90 fps < 2fps [OK FOR GRASS]

Gabion Dimensions:

Per the *Standards for Soil Erosion and Sediment Control in New Jersey* dated July 1999, Table 23-1:Gabion dimensions:

Table 23-1 Gabion Dimensions	
Gabion Thickness (ft)	Maximum Velocity (fps)
1/2	6
3/4	11
1	14

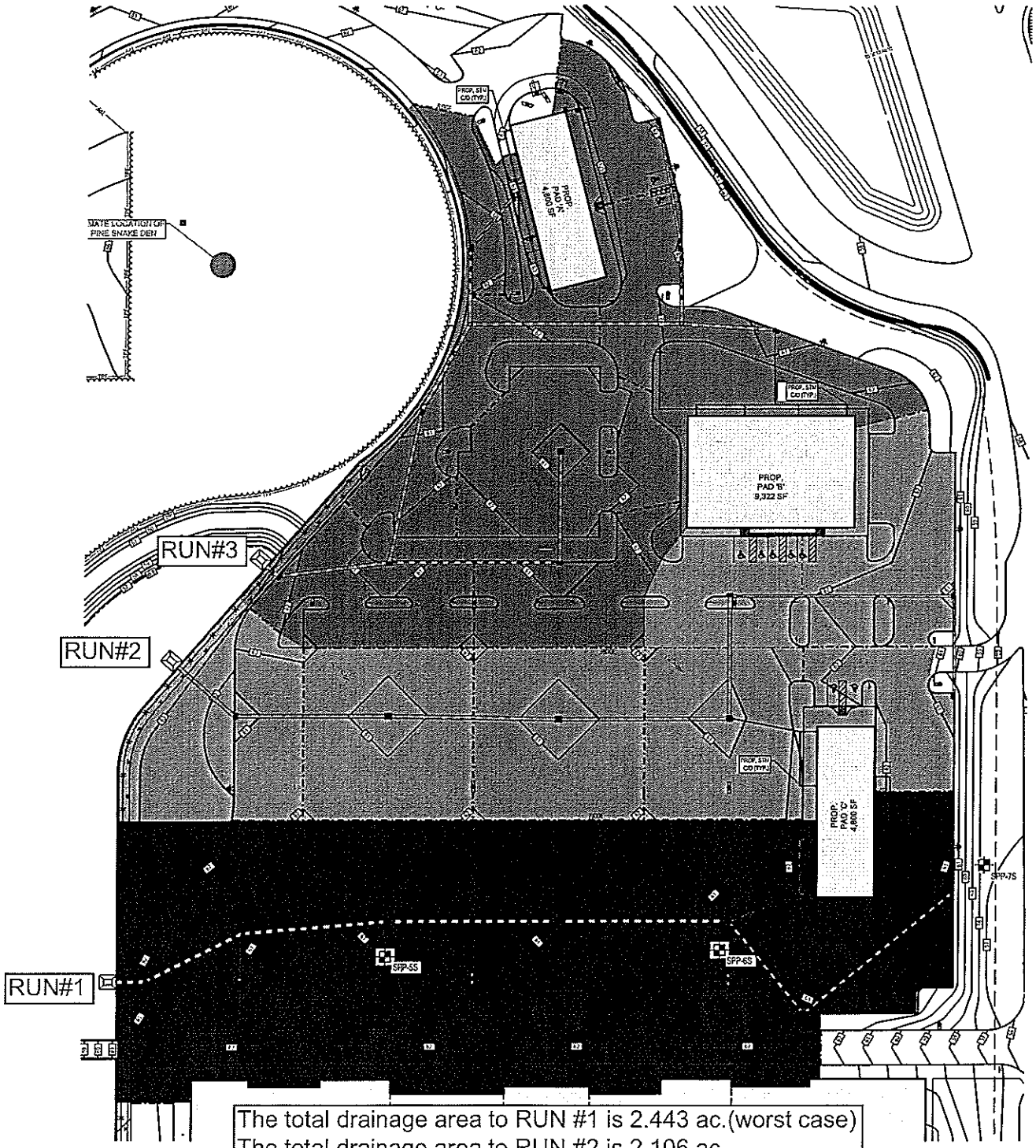
<—— USE THIS SIZE

Therefore, use a 6" thick PVC gabion mattress with geotextile fabric for added stability of stormwater runoff.

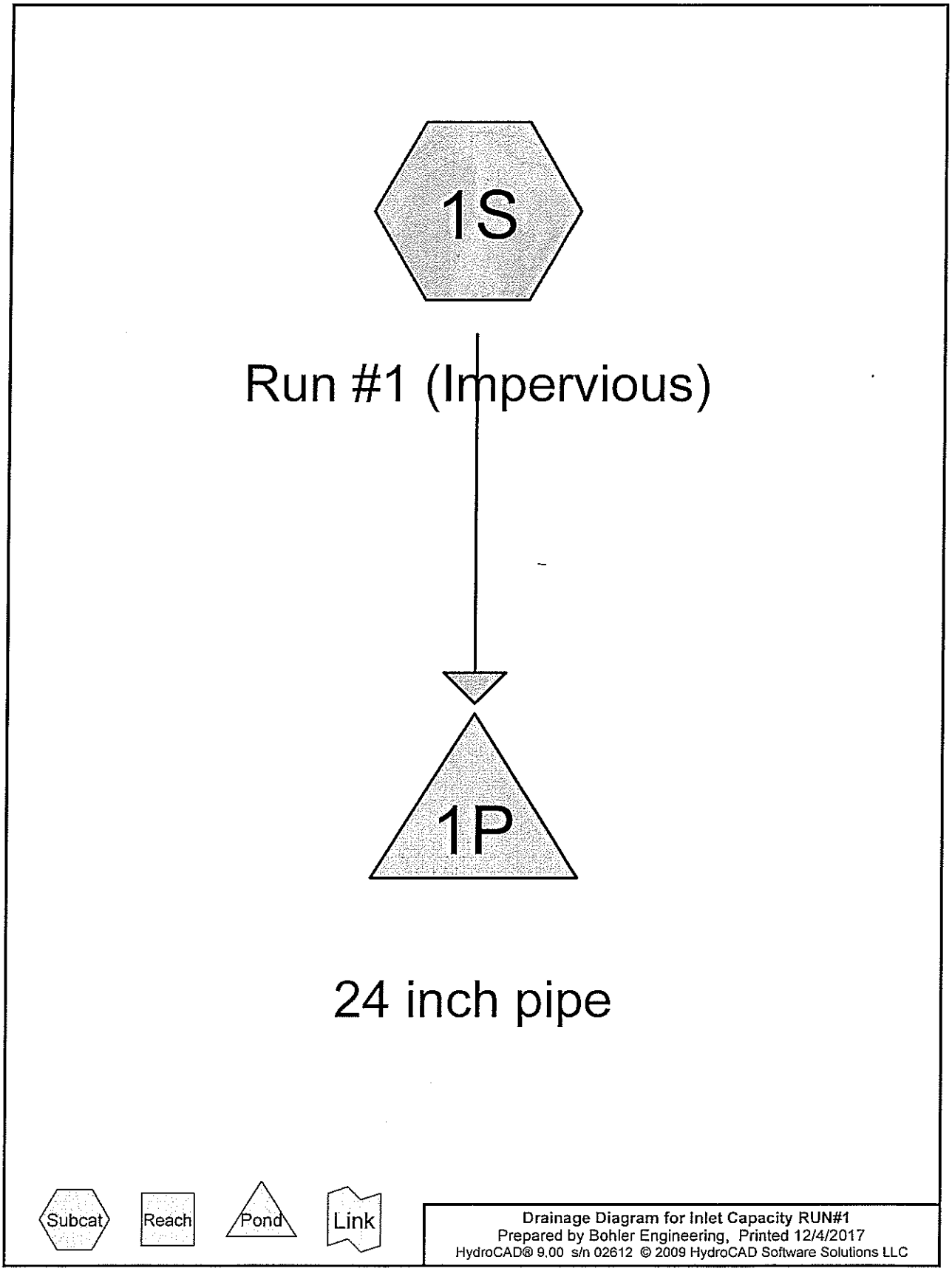
NOTES:
1. The design storm shall be the same as that required for riprap, riprap size and location, filter, and quality criteria shall be as outlined below.
2. The design water velocity does not exceed that given in table 23-1.
3. The manning's "n" value used for gabions shall be 0.025.
4. The wire mesh structures are not exposed to abrasion from sand and gravel transported by moving water.
5. Plastic coated wire shall be used.
6. All wire mesh structures placed against the bottom of the channel shall be underlain by geotextile or a gravel filter designed according to the limits outlined in Table 23-1.
7. The rock used to fill basket structures shall be 4" to 7" angular, block-shaped rock. For wire mesh "mattress" structures, 3" to 4" stone may be used provided the mesh opening is small enough to contain the stone. Smaller stone will provide more stone layers " in the mattress where larger stone would not sufficiently fill the structure's void space.

PIPE CAPACITY CHECK FOR UNDERGROUND BASIN

Pipe Capacity Check
for Underground Basin



The total drainage area to RUN #1 is 2.443 ac.(worst case)
The total drainage area to RUN #2 is 2.106 ac.
The total drainage area to RUN #3 is 2.185 ac.
The pipe capacity for RUN #1 is checked.



Drainage Diagram for Inlet Capacity RUN#1
Prepared by Bohler Engineering, Printed 12/4/2017
HydroCAD® 9.00 s/n 02612 © 2009 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: Run #1 (Impervious)

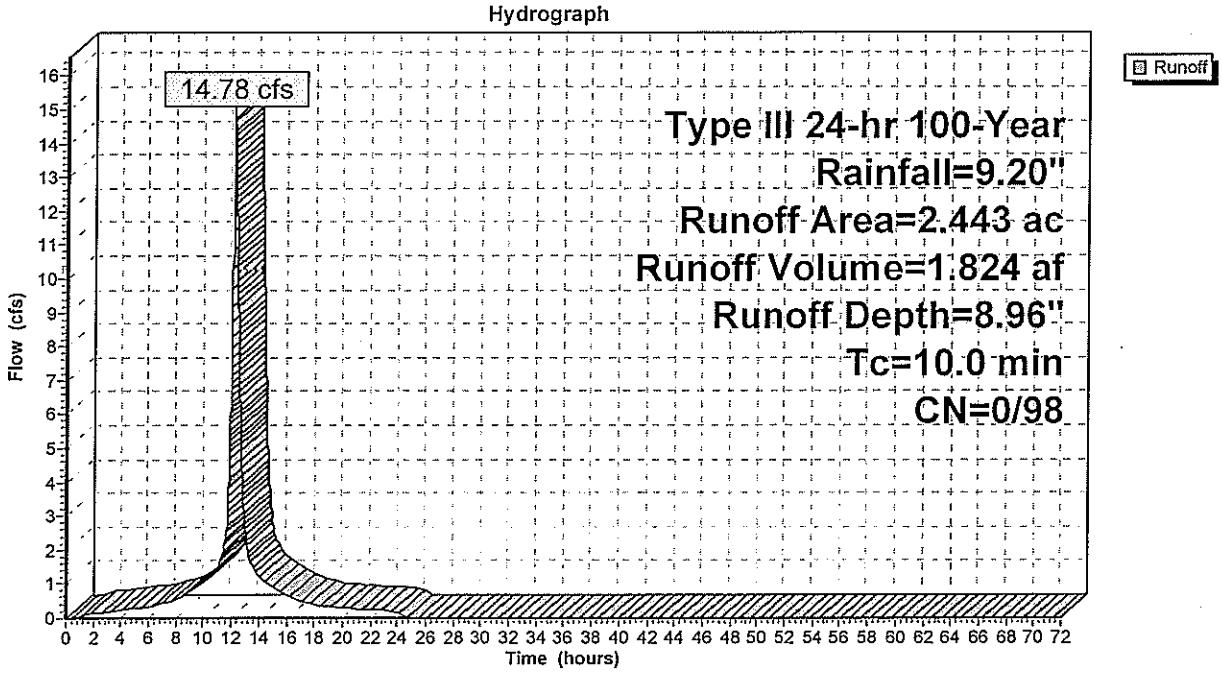
Runoff = 14.78 cfs @ 12.15 hrs, Volume= 1.824 af, Depth= 8.96"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=9.20"

Area (ac)	CN	Description
2.443	98	Paved parking, HSG A
2.443	98	100.00% Impervious Area

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

Subcatchment 1S: Run #1 (Impervious)



Summary for Pond 1P: 24 inch pipe

Inflow Area = 2.443 ac,100.00% Impervious, Inflow Depth = 8.96" for 100-Year event
Inflow = 14.78 cfs @ 12.15 hrs, Volume= 1.824 af
Outflow = 14.78 cfs @ 12.16 hrs, Volume= 1.788 af, Atten= 0%, Lag= 0.1 min
Primary = 14.78 cfs @ 12.16 hrs, Volume= 1.788 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 59.97' @ 12.16 hrs Surf.Area= 70 sf Storage= 1,593 cf

Plug-Flow detention time= 24.7 min calculated for 1.788 af (98% of inflow)
Center-of-Mass det. time= 11.9 min (761.2 - 749.4)

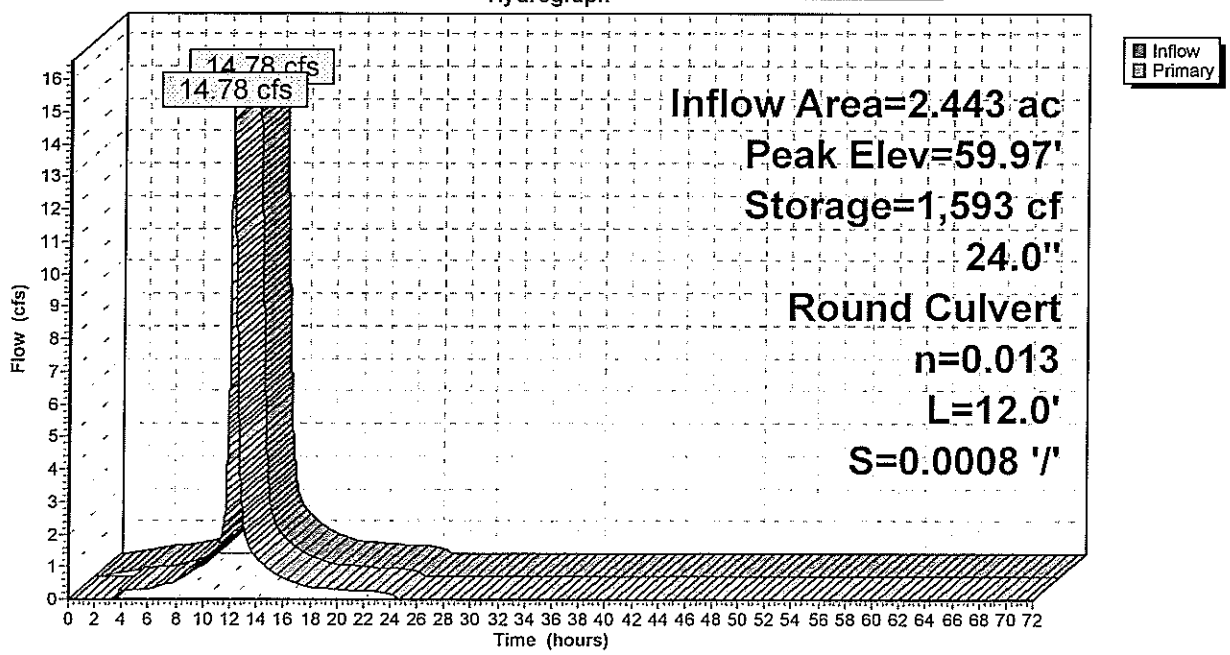
WATER ELEVATION IS BELOW GRATE ELEVATION

Volume	Invert	Avail.Storage	Storage Description
#1	56.91'	1,385 cf	**24.0" D x 441.0'L Pipe Storage S= 0.0010 '/'**
#2	57.00'	245 cf	**4.00'W x 3.50'L x 3.50'H Prismatoid** x 5
		1,630 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	56.91'	**24.0" Round Culvert** L= 12.0' RCP, groove end projecting, Ke= 0.200 Outlet Invert= 56.90' S= 0.0008 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=14.78 cfs @ 12.16 hrs HW=59.97' TW=59.36' (Fixed TW Elev= 59.36')
↑—**1=Culvert** (Inlet Controls 14.78 cfs @ 4.70 fps)

50-YEAR WATER ELEVATION IN BASIN #1 IS USED FOR TAIL WATER



SCOUR HOLE DESIGN

BOHLER ENGINEERING

35 Technology Drive, Warren, NJ 07059
(908) 668-8300

Date: 12/5/2017
Project: Grunin
Project No: JM170508

Calculated By: AJH
Checked By: JZ

Conduit Outlet Protection Calculations

Scour Hole # 3

Design Parameters:

Design Storm Flow for 25 Year, Q	15.96 cfs
Vertical Dimension of Outlet Pipe, D_o	24 in
Horizontal Dimension of Outlet Pipe, W_o	24 in
Tailwater Depth, TW[1]	0.40 ft
Scour Hole Depth, y (1/2 D_o or D_o)	12 in

Apron Dimension Calculations:

Minimum Bottom Width, $W_1 = 2W_o$	W_1 = 4.00 ft
Minimum Bottom Length, $L_1 = 3D_o$	L_1 = 6.00 ft
Minimum Top Width *(max side slope of 3:1)*, W_2	W_2 =10.00 ft
Minimum Top Length *(max side slope of 3:1)*, L_2	L_2 =12.00 ft

Scour holes #1 and #2 both receive less flow than #3 and have the same outlet pipe size, so the dimensions for scour hole #3 are used.

Rip Rap Stone Size Calculations:

Unit Dicharge, $q = Q/D_o$ = 7.98 cfs per foot

- **Case I:** $y = 1/2\ D_o$

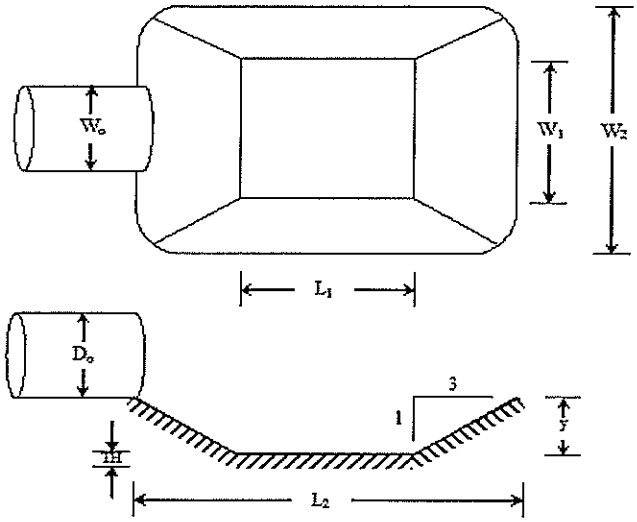
  Median Stone, $d_{50} = \frac{0.0125\ q^{1.33}}{TW}$ = 5.94 in Therefore, use $d50$ = 6 in

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric ..... TH = 12 in

- **Case II:** $y = D_o$

  Median Stone, $d_{50} = \frac{0.0082\ q^{1.33}}{TW}$ =

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric .....



Notes:

1. The side slopes shall be 3:1 or flatter.
2. The bottom grade shall be 0.0% (level).
3. There shall be no overfall at the end of the apron or at the end of the culvert.
4. Fifty (50) percent by weight of the rip-rap mixture shall be smaller than the median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size. The rip-rap shall be reasonably well graded.
5. The thickness of the rip-rap apron may be two (2) times the median stone diameter provided that the apron is constructed on a bedding of four (4) inches of 3/4 inch clean stone on approved filter fabric material.
6. Rip-rap and filter fabric shall meet the standards of the governing Soil Conservation District as well as the requirements of the local municipality.
7. Where the scour hole is to be placed within an existing or proposed waterway:
   a. The scour hole sidewalls should be eliminated to maintain a smooth hydraulic line along the waterway bottom to avoid inviting turbulent flow from a sudden depression in the waterway.
   b. If the flow in the waterway is greater than the flow from the proposed outlet, the rip-rap used to construct the scour hole should be sized based on the greater flow value according to the standard rip-rap.

Footnote:

1. Tailwater depth shall be the 2 year storm if discharging into a detention basin or areas where tailwater cannot be computed, use $TW = 0.2D_o$.

BOHLER ENGINEERING

Date: 12/5/2017
Project: Grunin
Project No: JM170508

35 Technology Drive, Warren, NJ 07059
(908) 668-8300

Calculated By: AJH
Checked By: JZ

Conduit Outlet Protection Calculations

Scour Hole # 5

Design Parameters:

Design Storm Flow for 25 Year, Q	11.78 cfs
Vertical Dimension of Outlet Pipe, D_o	18 in
Horizontal Dimension of Outlet Pipe, W_o	18 in
Tailwater Depth, TW[1]	0.30 ft
Scour Hole Depth, y (1/2 D_o or D_o)	9 in

Apron Dimension Calculations:

Minimum Bottom Width, $W_1 = 2W_o$	W_1 = 3.00 ft
Minimum Bottom Length, $L_1 = 3D_o$	L_1 = 4.50 ft
Minimum Top Width *(max side slope of 3:1)*, W_2	W_2 = 7.50 ft
Minimum Top Length *(max side slope of 3:1)*, L_2	L_2 = 9.00 ft

Rip Rap Stone Size Calculations:

Unit Dicharge, $q = Q/D_o$ = 7.85 cfs per foot

- **Case I:** $y = 1/2\ D_o$

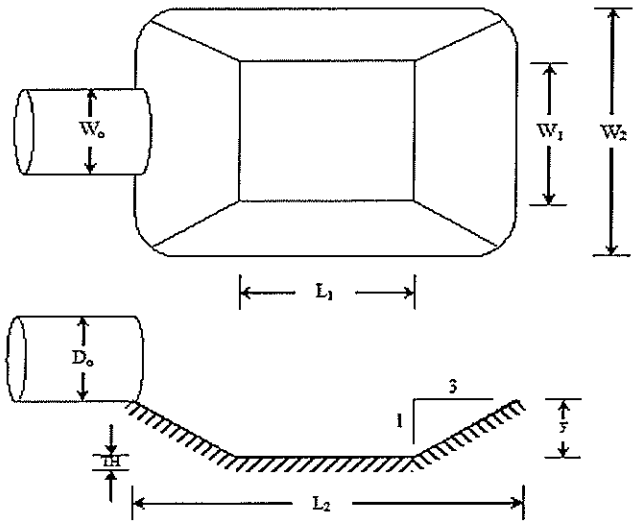
  Median Stone, $d_{50} = \frac{0.0125\ q^{1.33}}{TW}$ = 7.75 in Therefore, use $d50$ = 8 in

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric ..... TH = 16 in

- **Case II:** $y = D_o$

  Median Stone, $d_{50} = \frac{0.0082\ q^{1.33}}{TW}$ =

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric .....



Notes:

1. The side slopes shall be 3:1 or flatter.
2. The bottom grade shall be 0.0% (level).
3. There shall be no overfall at the end of the apron or at the end of the culvert.
4. Fifty (50) percent by weight of the rip-rap mixture shall be smaller than the median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size. The rip-rap shall be reasonably well graded.
5. The thickness of the rip-rap apron may be two (2) times the median stone diameter provided that the apron is constructed on a bedding of four (4) inches of 3/4 inch clean stone on approved filter fabric material.
6. Rip-rap and filter fabric shall meet the standards of the governing Soil Conservation District as well as the requirements of the local municipality.
7. Where the scour hole is to be placed within an existing or proposed waterway:
   a. The scour hole sidewalls should be eliminated to maintain a smooth hydraulic line along the waterway bottom to avoid inviting turbulent flow from a sudden depression in the waterway.
   b. If the flow in the waterway is greater than the flow from the proposed outlet, the rip-rap used to construct the scour hole should be sized based on the greater flow value according to the standard rip-rap.

Footnote:

1. Tailwater depth shall be the 2 year storm if discharging into a detention basin or areas where tailwater cannot be computed, use $TW = 0.2D_o$.

BOHLER ENGINEERING

35 Technology Drive, Warren, NJ 07059
(908) 668-8300

Date: 12/5/2017
Project: Grunin
Project No: JM170508

Calculated By: AJH
Checked By: JZ

Conduit Outlet Protection Calculations

Scour Hole # 7

Design Parameters:

Design Storm Flow for 25 Year, Q	8.18 cfs
Vertical Dimension of Outlet Pipe, D_o	18 in
Horizontal Dimension of Outlet Pipe, W_o	18 in
Tailwater Depth, TW[1]	0.30 ft
Scour Hole Depth, y (1/2 D_o or D_o)	9 in

Apron Dimension Calculations:

Minimum Bottom Width, $W_1 = 2W_o$	W_1 = 3.00 ft
Minimum Bottom Length, $L_1 = 3D_o$	L_1 = 4.50 ft
Minimum Top Width *(max side slope of 3:1)*, W_2	W_2 = 7.50 ft
Minimum Top Length *(max side slope of 3:1)*, L_2	L_2 = 9.00 ft

Scour holes #4 and #6 both receive less flow than #7 and have the same outlet pipe size, so the dimensions for scour hole #7 are used.

Rip Rap Stone Size Calculations:

Unit Dicharge, $q = Q/D_o$ = 5.45 cfs per foot

- **Case I:** $y = 1/2\ D_o$

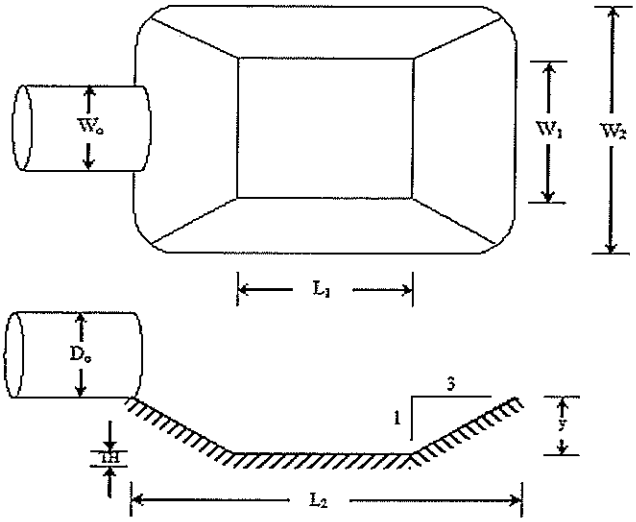
  Median Stone, $d_{50} = \frac{0.0125\ q^{1.33}}{TW}$ = 4.77 in Therefore, use $d50$ = 6 in

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric ..... TH = 12 in

- **Case II:** $y = D_o$

  Median Stone, $d_{50} = \frac{0.0082\ q^{1.33}}{TW}$ =

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric .....



Notes:

1. The side slopes shall be 3:1 or flatter.
2. The bottom grade shall be 0.0% (level).
3. There shall be no overfall at the end of the apron or at the end of the culvert.
4. Fifty (50) percent by weight of the rip-rap mixture shall be smaller than the median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size. The rip-rap shall be reasonably well graded.
5. The thickness of the rip-rap apron may be two (2) times the median stone diameter provided that the apron is constructed on a bedding of four (4) inches of 3/4 inch clean stone on approved filter fabric material.
6. Rip-rap and filter fabric shall meet the standards of the governing Soil Conservation District as well as the requirements of the local municipality.
7. Where the scour hole is to be placed within an existing or proposed waterway:
   a. The scour hole sidewalls should be eliminated to maintain a smooth hydraulic line along the waterway bottom to avoid inviting turbulent flow from a sudden depression in the waterway.
   b. If the flow in the waterway is greater than the flow from the proposed outlet, the rip-rap used to construct the scour hole should be sized based on the greater flow value according to the standard rip-rap.

Footnote:

1. Tailwater depth shall be the 2 year storm if discharging into a detention basin or areas where tailwater cannot be computed, use $TW = 0.2D_o$.

BOHLER
ENGINEERING

35 Technology Drive, Warren, NJ 07059
(908) 668-8300

Date: 12/5/2017
Project: Grunin
Project No: JM170508

Calculated By: AJH
Checked By: JZ

Conduit Outlet Protection Calculations

Scour Hole # 8

Design Parameters:

Design Storm Flow for 25 Year, Q	1.78 cfs
Vertical Dimension of Outlet Pipe, D_o	15 in
Horizontal Dimension of Outlet Pipe, W_o	15 in
Tailwater Depth, TW[1]	0.25 ft
Scour Hole Depth, y (1/2 D_o or D_o)	8 in

Apron Dimension Calculations:

Minimum Bottom Width, $W_1 = 2W_o$	W_1 = 2.50 ft
Minimum Bottom Length, $L_1 = 3D_o$	L_1 = 3.75 ft
Minimum Top Width *(max side slope of 3:1)*, W_2	W_2 = 6.25 ft
Minimum Top Length *(max side slope of 3:1)*, L_2	L_2 = 7.50 ft

Rip Rap Stone Size Calculations:

Unit Dicharge, $q = Q/D_o$ = 1.42 cfs per foot

- **Case I:** $y = 1/2\ D_o$

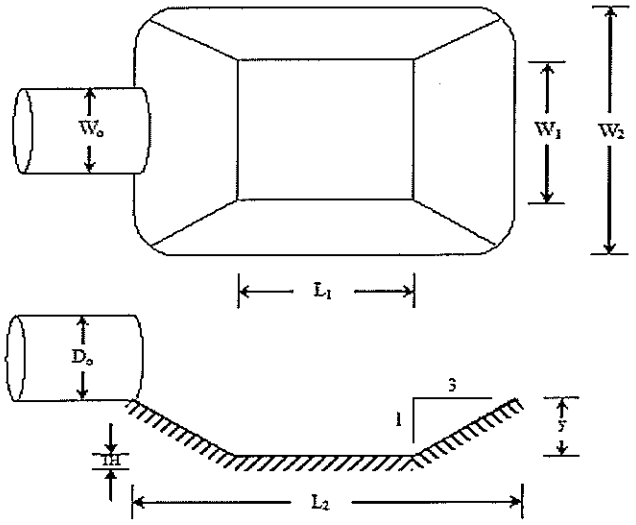
  Median Stone, $d_{50} = \frac{0.0125\ q^{1.33}}{TW}$ = 0.96 in Therefore, use $d50$ = 6 in

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric TH = 12 in

- **Case II:** $y = D_o$

  Median Stone, $d_{50} = \frac{0.0082\ q^{1.33}}{TW}$ =

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric



Notes:

1. The side slopes shall be 3:1 or flatter.
2. The bottom grade shall be 0.0% (level).
3. There shall be no overfall at the end of the apron or at the end of the culvert.
4. Fifty (50) percent by weight of the rip-rap mixture shall be smaller than the median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size. The rip-rap shall be reasonably well graded.
5. The thickness of the rip-rap apron may be two (2) times the median stone diameter provided that the apron is constructed on a bedding of four (4) inches of 3/4 inch clean stone on approved filter fabric material.
6. Rip-rap and filter fabric shall meet the standards of the governing Soil Conservation District as well as the requirements of the local municipality.
7. Where the scour hole is to be placed within an existing or proposed waterway:
   a. The scour hole sidewalls should be eliminated to maintain a smooth hydraulic line along the waterway bottom to avoid inviting turbulent flow from a sudden depression in the waterway.
   b. If the flow in the waterway is greater than the flow from the proposed outlet, the rip-rap used to construct the scour hole should be sized based on the greater flow value according to the standard rip-rap.

Footnote:

1. Tailwater depth shall be the 2 year storm if discharging into a detention basin or areas where tailwater cannot be computed, use $TW = 0.2D_o$.

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(908) 668-8300

Date: 12/5/2017
Project: Grunin
Project No: JM170508

Calculated By: AJH
Checked By: JZ

Conduit Outlet Protection Calculations

Scour Hole # 9

Design Parameters:

Design Storm Flow for 25 Year, Q	3.63 cfs
Vertical Dimension of Outlet Pipe, D_o	10 in
Horizontal Dimension of Outlet Pipe, W_o	10 in
Tailwater Depth, TW[1]	0.60 ft
Scour Hole Depth, y (1/2 D_o or D_o)	5 in

Apron Dimension Calculations:

Minimum Bottom Width, $W_1 = 2W_o$	W_1 = 1.67 ft
Minimum Bottom Length, $L_1 = 3D_o$	L_1 = 2.50 ft
Minimum Top Width *(max side slope of 3:1)*, W_2	W_2 = 4.17 ft
Minimum Top Length *(max side slope of 3:1)*, L_2	L_2 = 5.00 ft

Rip Rap Stone Size Calculations:

Unit Dicharge, $q = Q/D_o$ = 4.36 cfs per foot

- **Case I:** $y = 1/2\ D_o$

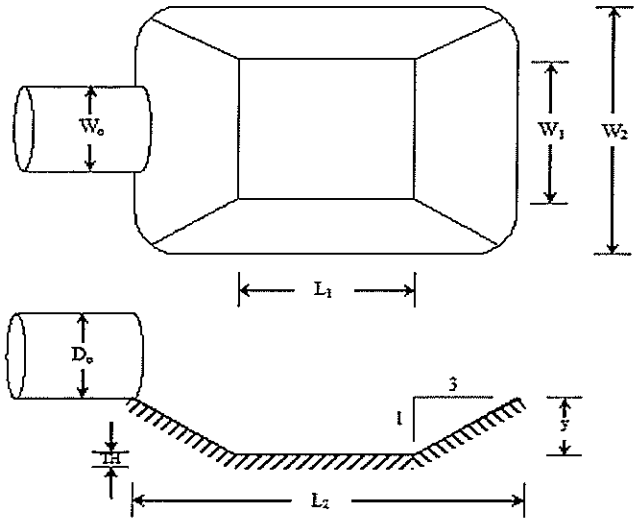
  Median Stone, $d_{50} = \frac{0.0125\ q^{1.33}}{TW}$ = 1.77 in Therefore, use $d50$ = 6 in

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric ..... TH = 12 in

- **Case II:** $y = D_o$

  Median Stone, $d_{50} = \frac{0.0082\ q^{1.33}}{TW}$ =

  Apron Thickness, $TH = 2 \times d_{50}$ with filter fabric .....



Notes:

1. The side slopes shall be 3:1 or flatter.
2. The bottom grade shall be 0.0% (level).
3. There shall be no overfall at the end of the apron or at the end of the culvert.
4. Fifty (50) percent by weight of the rip-rap mixture shall be smaller than the median size stone designated as d_{50}. The largest stone size in the mixture shall be 1.5 times the d_{50} size. The rip-rap shall be reasonably well graded.
5. The thickness of the rip-rap apron may be two (2) times the median stone diameter provided that the apron is constructed on a bedding of four (4) inches of 3/4 inch clean stone on approved filter fabric material.
6. Rip-rap and filter fabric shall meet the standards of the governing Soil Conservation District as well as the requirements of the local municipality.
7. Where the scour hole is to be placed within an existing or proposed waterway:
   a. The scour hole sidewalls should be eliminated to maintain a smooth hydraulic line along the waterway bottom to avoid inviting turbulent flow from a sudden depression in the waterway.
   b. If the flow in the waterway is greater than the flow from the proposed outlet, the rip-rap used to construct the scour hole should be sized based on the greater flow value according to the standard rip-rap.

Footnote:

1. Tailwater depth shall be the 2 year storm if discharging into a detention basin or areas where tailwater cannot be computed, use $TW = 0.2D_o$.

TOWNSHIP-SPECIFIC REQUIREMENTS EVALUATION

There are several requirements for the detention and retention facilities design per Toms River and Manchester Township ordinance.

Per Township of Manchester:

- Only one half (0.5) of the area devoted to the detention or retention facilities shall be considered non-impervious.
  - In this design, the 50% of the basin Area is considered as impervious area (with a CN number of 98)

SATISFIED

- Retention facilities shall be required to provide one hundred (100%) percent storage capacity for the fifty (50) year storm.
  - In this design, all basins are designed so that the 100-year storm event can be managed.

SATISFIED

Per Township of Toms River:

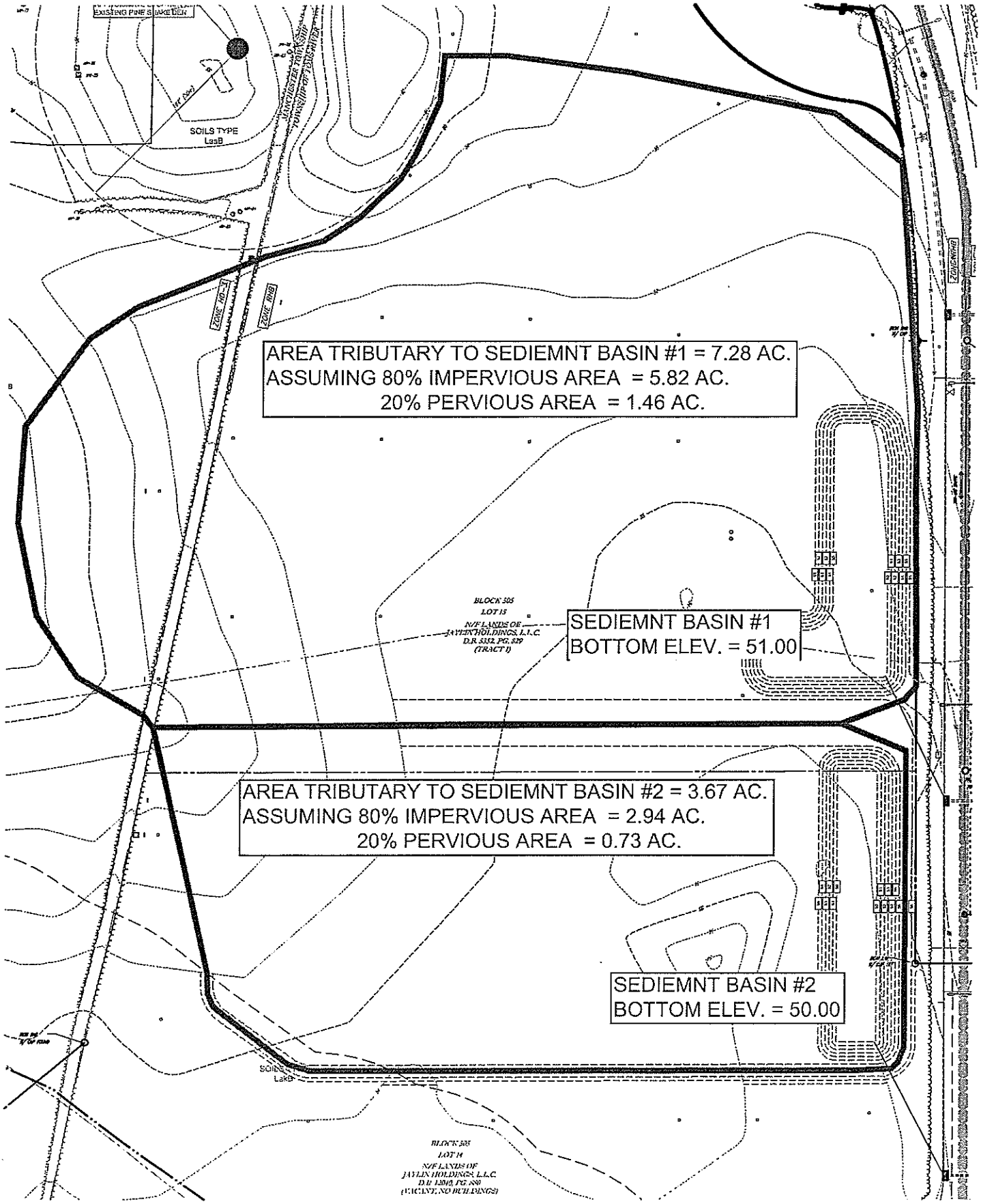
- For detention facilities, the design storm frequency shall be 24 hours storm with return period not less than 50 years for the tributary area not exceeding 50 acres.
  - In this design, the tributary drainage area to any of the basin is less than 50 acres, and all stormwater management basins are designed with Type III 24-hr storm up to the 100-year storm event.

SATISFIED

- For retention facilities, the required capacity must be doubled.
  - In this design, there is no retention facilities proposed in the Township of Toms River.

SATISFIED

SEDIMENT BASIN DESIGN


AREA TRIBUTARY TO SEDIEMNT BASIN #1 = 7.28 AC.
ASSUMING 80% IMPERVIOUS AREA = 5.82 AC.
20% PERVIOUS AREA = 1.46 AC.
SEDIEMNT BASIN #1
BOTTOM ELEV. = 51.00
AREA TRIBUTARY TO SEDIEMNT BASIN #2 = 3.67 AC.
ASSUMING 80% IMPERVIOUS AREA = 2.94 AC.
20% PERVIOUS AREA = 0.73 AC.
SEDIEMNT BASIN #2
BOTTOM ELEV. = 50.00
SOILS TYPE
LasB
BLOCK 505
LOT 15
N/F LANDS OF
JAYLIN HOLDINGS, L.L.C.
D.B. 5352, PG. 329
(TRACT I)
BLOCK 505
LOT 14
N/F LANDS OF
JAYLIN HOLDINGS, L.L.C.
D.B. 13040, PG. 880
(VACANT, NO BUILDINGS)

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ENGINEERING

35 Technology Drive, Warren, NJ 07059
(908) 668-8300

Date: 11/22/2017
Project: TOMES RIVER
Project No: JM170508

Calculated By: JZ
Checked By: GD

Sediment Storage Capacity Calculations

Sediment Basin # 1

TRAP EFFICIENCY METHOD:

Sediment type:		Sand (Type A)
Trap efficiency value:		80%
Curve used:	(see Curve 26-1)	Median Grained Curve
Ratio of capacity to annual inflow (C/I):	(see Curve 26-1)	0.0600
Average annual surface runoff (R):	(see Figure 26-1)	25.0 in
Watershed area (A):		7.28 Ac.
Avergae annual surface runoff, $I = \frac{R \times A}{12}$ =		15.17 Ac ft
Total capacity, C = I × C/I =		0.91 Ac ft

SEDIMENT STORAGE CAPACITY METHOD:

1. DETEMINE VOLUME FOR SEDIMENT STORAGE USING METHOD 2

a. Determine drainage area, DA, and average annual erosion, A:

Drainage area, (DA):		7.28 Ac.
Land use type:		Construction areas
Average annual erosion, (A):		50.0 ton/ac/yr
(DA) × (A) =		364 tons/yr

b. Determine delivery rate, DR:

Watershed area (A):		0.01 sq mi
Sediment delivery ratio:	(refer to Curve 26-2)	Sandy
DR =	(refer to Curve 26-2)	37%

c. Determine sediment density, γ:

Soil texture:	(refer to Table 26-1)	Sand, aerated
γ =		92.5 lbs/cf

d. Determine the minimum volume for sediment storage for the planned life of the structure:

V = (DA) (A) (DR) (TE) (1/γ) (2,000 lbs/ton) (1/43,560 sf/ac) = 0.053 Ac ft

2. Determine the minimum volume for temporary floodway storage:

2-year, 24 hour Rainfall intensity:		3.3 inches
Soil type:		Lakewood
Soil group:		A
CN:		92
Volume 2-yr design storm:	56,528 CF	1.298 Ac ft
Total volume required (including sediment):		1.351 Ac ft

DETERMINE THE LARGER VOLUME OF THE TWO METHODS:

TOTAL VOLUME REQUIRED:				1.351 Ac ft or 58,830 CF

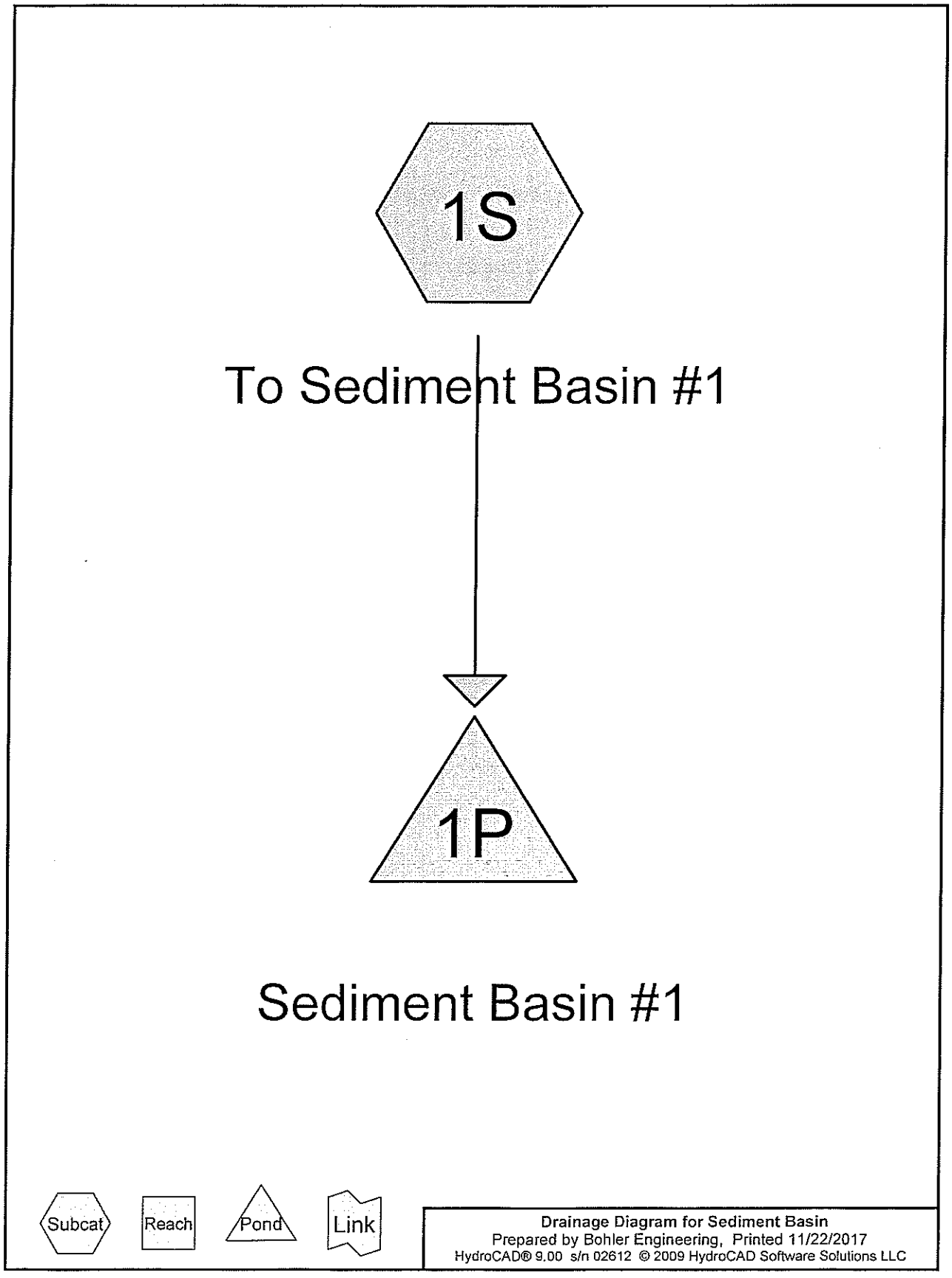
DEWATERING:

Trap efficiency value:			50%
Curve:		(refer to Curve 26-1)	Median Grained Curve
Ratio of capacity to annual inflow, (C/I):		(refer to Curve 26-1)	0.0135
Average annual surface runoff, (R):		(refer to Figure 26-1)	25.0 in
Watershed area, (A):			7.28 Ac.
Avergae annual surface runoff, $I = \frac{R \times A}{12}$ =			15.17 Ac ft
Total capacity, C = I × C/I =			0.20 Ac ft or 8,919 CF

SEDIMENT BASIN BOTTOM ELEVATION:					51.00
ELEVATION OF SEDIMENT STORAGE:					53.00
THE TOTAL VOLUME FROM	51.00	to	53.00 :		0.68 Ac ft
				or	29,713 CF
ELEVATION OF EMERGENCY SPILLWAY:					55.50
THE TOTAL VOLUME FROM	53.00	to	55.50 :		1.10 Ac ft
				or	48,076 CF
TOTAL VOLUME OF THE SEDIMENTAL BASIN					1.79 Ac ft
				or	77,789 CF
ELEVATION OF 4" DEWATERING ORFICE:					**53.00**
ELEVATION TOP OF RISER:					**54.50**

SEDIMENT BASIN # 1

ELEVATION	AREA (SF)	INCR. VOL. (CF)	TOTAL VOLUME (CF)
51	12993		
52	14842	13918	13918
53	16749	15796	29713
54	18711	17730	47443
55	20731	19721	67164
56	22806	21769	88933


1S
To Sediment Basin #1
1P
Sediment Basin #1
Subcat
Reach
Pond
Link
Drainage Diagram for Sediment Basin
Prepared by Bohler Engineering, Printed 11/22/2017
HydroCAD® 9.00 s/n 02612 © 2009 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: To Sediment Basin #1

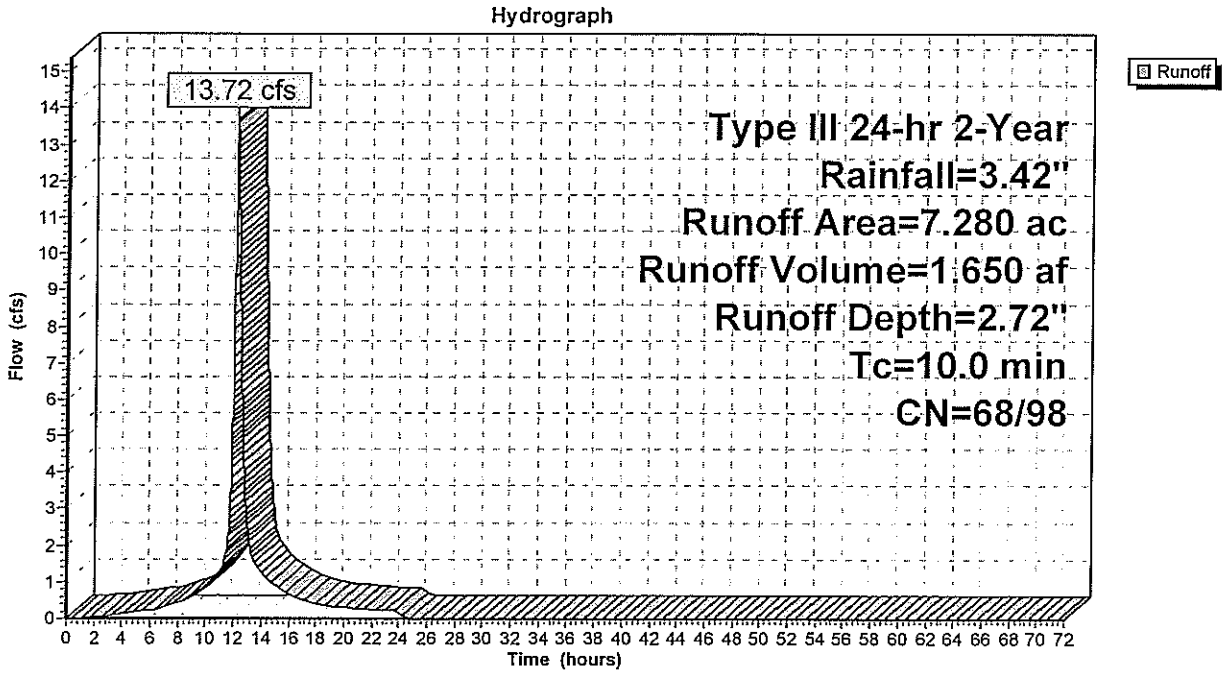
Runoff = 13.72 cfs @ 12.16 hrs, Volume= 1.650 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
5.820	98	Paved parking, HSG A
1.460	68	<50% Grass cover, Poor, HSG A
7.280	92	Weighted Average
1.460	68	20.05% Pervious Area
5.820	98	79.95% Impervious Area

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

Subcatchment 1S: To Sediment Basin #1



Summary for Pond 1P: Sediment Basin #1

Inflow Area = 7.280 ac, 79.95% Impervious, Inflow Depth = 2.72" for 2-Year event
Inflow = 13.72 cfs @ 12.16 hrs, Volume= 1.650 af
Outflow = 0.48 cfs @ 17.22 hrs, Volume= 0.947 af, Atten= 96%, Lag= 303.6 min
Primary = 0.48 cfs @ 17.22 hrs, Volume= 0.947 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 54.47' @ 17.22 hrs Surf.Area= 19,667 sf Storage= 56,528 cf

Plug-Flow detention time= 953.3 min calculated for 0.947 af (57% of inflow)
Center-of-Mass det. time= 837.7 min (1,610.3 - 772.6)

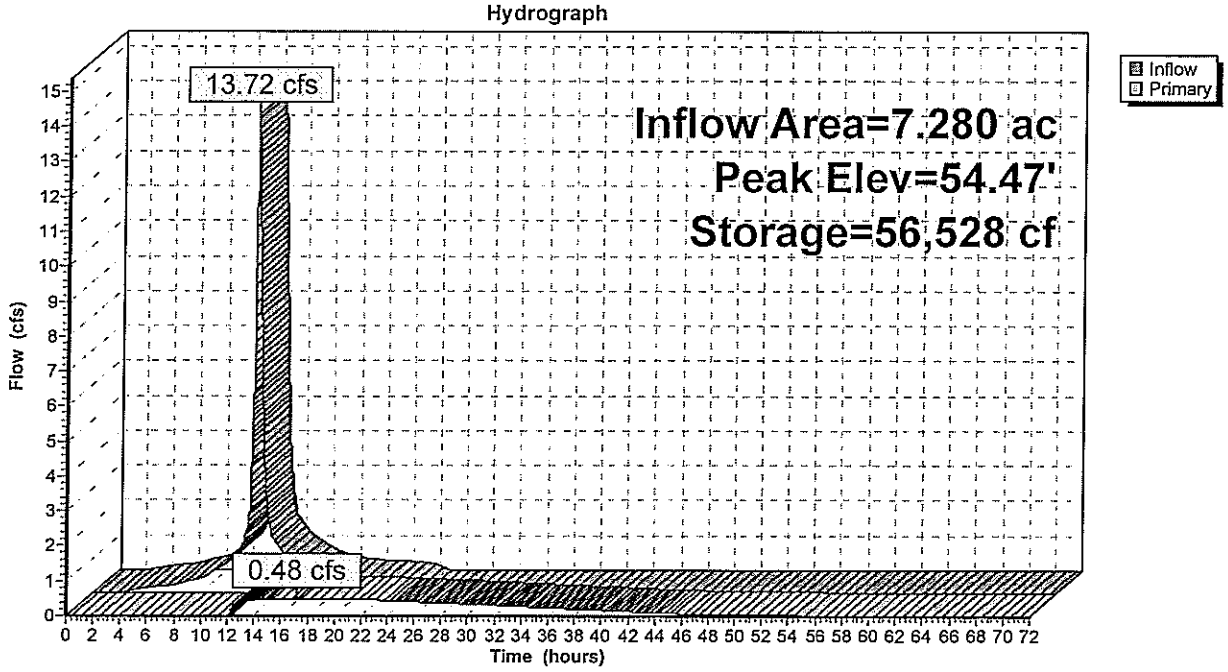
Volume	Invert	Avail.Storage	Storage Description
#1	51.00'	88,933 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
51.00	12,993	0	0
52.00	14,842	13,918	13,918
53.00	16,749	15,796	29,713
54.00	18,711	17,730	47,443
55.00	20,731	19,721	67,164
56.00	22,806	21,769	88,933

Device	Routing	Invert	Outlet Devices
#1	Primary	52.00'	**15.0" Round Culvert** L= 110.0' CMP, projecting, no headwall, Ke= 0.900 Outlet Invert= 51.60' S= 0.0036 '/' Cc= 0.900 n= 0.011
#2	Device 1	53.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.50'	**15.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.48 cfs @ 17.22 hrs HW=54.47' (Free Discharge)
↑—**1=Culvert** (Passes 0.48 cfs of 6.34 cfs potential flow)
↑—**2=Orifice/Grate** (Orifice Controls 0.48 cfs @ 5.50 fps)
—**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 1P: Sediment Basin #1



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(908) 668-8300

Date: 11/22/2017
Project: TOMES RIVER
Project No: JM170508

Calculated By: JZ
Checked By: GD

Sediment Storage Capacity Calculations

Sediment Basin # 2

TRAP EFFICIENCY METHOD:

Sediment type:		Sand (Type A)
Trap efficiency value:		80%
Curve used:	(see Curve 26-1)	Median Grained Curve
Ratio of capacity to annual inflow (C/I):	(see Curve 26-1)	0.0600
Average annual surface runoff (R):	(see Figure 26-1)	25.0 in
Watershed area (A):		3.67 Ac.
Avergae annual surface runoff, $I = \frac{R \times A}{12}$ =		7.65 Ac ft
Total capacity, C = I × C/I =		0.46 Ac ft

SEDIMENT STORAGE CAPACITY METHOD:

1. DETEMINE VOLUME FOR SEDIMENT STORAGE USING METHOD 2

a. Determine drainage area, DA, and average annual erosion, A:

Drainage area, (DA):		3.67 Ac.
Land use type:		Construction areas
Average annual erosion, (A):		50.0 ton/ac/yr
(DA) × (A) =		184 tons/yr

b. Determine delivery rate, DR:

Watershed area (A):		0.01 sq mi
Sediment delivery ratio:	(refer to Curve 26-2)	Sandy
DR =	(refer to Curve 26-2)	40%

c. Determine sediment density, γ:

Soil texture:	(refer to Table 26-1)	Sand, aerated
γ =		92.5 lbs/cf

d. Determine the minimum volume for sediment storage for the planned life of the structure:

V = (DA) (A) (DR) (TE) (1/γ) (2,000 lbs/ton) (1/43,560 sf/ac) = 0.029 Ac ft

2. Determine the minimum volume for temporary floodway storage:

2-year, 24 hour Rainfall intensity:	Ocean County	3.3 inches
Soil type:		Lakewood
Soil group:		A
CN:		92
Volume 2-yr design storm:	24,632 CF	0.565 Ac ft
Total volume required (including sediment):		0.595 Ac ft

DETERMINE THE LARGER VOLUME OF THE TWO METHODS:

TOTAL VOLUME REQUIRED: 0.595 Ac ft or 25,910 CF

DEWATERING:

Trap efficiency value:		50%
Curve:	(refer to Curve 26-1)	Median Grained Curve
Ratio of capacity to annual inflow, (C/I):	(refer to Curve 26-1)	0.0135
Average annual surface runoff, (R):	(refer to Figure 26-1)	25.0 in
Watershed area, (A):		3.67 Ac.
Avergae annual surface runoff, $I = \frac{R \times A}{12}$ =		7.65 Ac ft
Total capacity, C = I × C/I =		0.10 Ac ft or 4,496 CF

SEDIMENT BASIN BOTTOM ELEVATION: 50.00

ELEVATION OF SEDIMENT STORAGE: 51.00

THE TOTAL VOLUME FROM 50.00 to 51.00 : 0.40 Ac ft or 17,293 CF

ELEVATION OF EMERGENCY SPILLWAY: 55.50

THE TOTAL VOLUME FROM 51.00 to 55.50 : 1.06 Ac ft or 46,205 CF

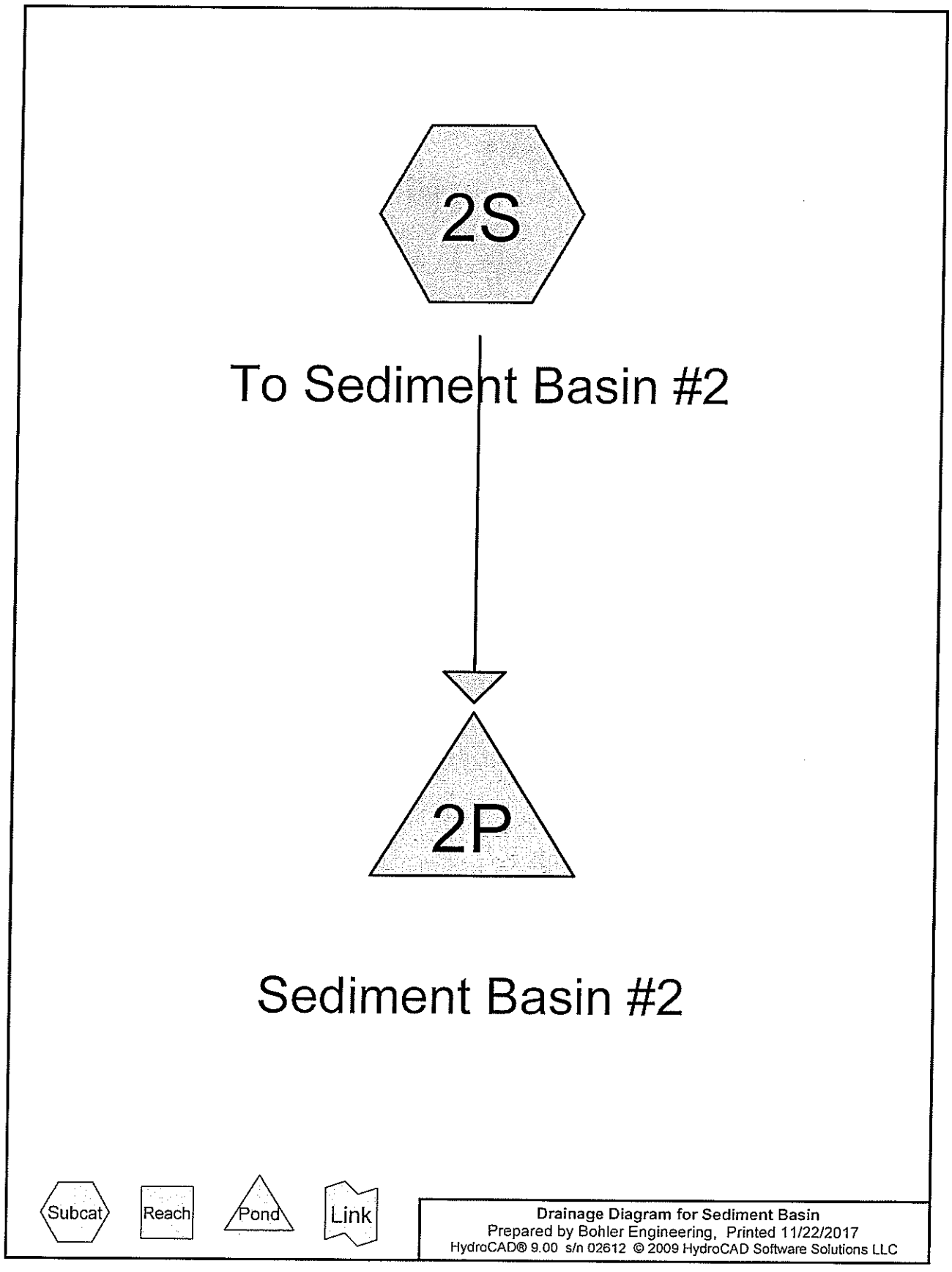
TOTAL VOLUME OF THE SEDIMENTAL BASIN 1.46 Ac ft or **63,498 CF**

ELEVATION OF 4" DEWATERING ORFICE: **51.00**

ELEVATION TOP OF RISER: **54.50**

SEDIMENT BASIN # 2

ELEVATION	AREA (SF)	INCR. VOL. (CF)	TOTAL VOLUME (CF)
50	7087		
51	8633	7860	7860
52	10233	9433	17293
53	11889	11061	28354
54	13601	12745	41099
55	15370	14486	55585
56	17196	16283	71868


2S
To Sediment Basin #2
2P
Sediment Basin #2
Subcat
Reach
Pond
Link
Drainage Diagram for Sediment Basin
Prepared by Bohler Engineering, Printed 11/22/2017
HydroCAD® 9.00 s/n 02612 © 2009 HydroCAD Software Solutions LLC

Summary for Subcatchment 2S: To Sediment Basin #2

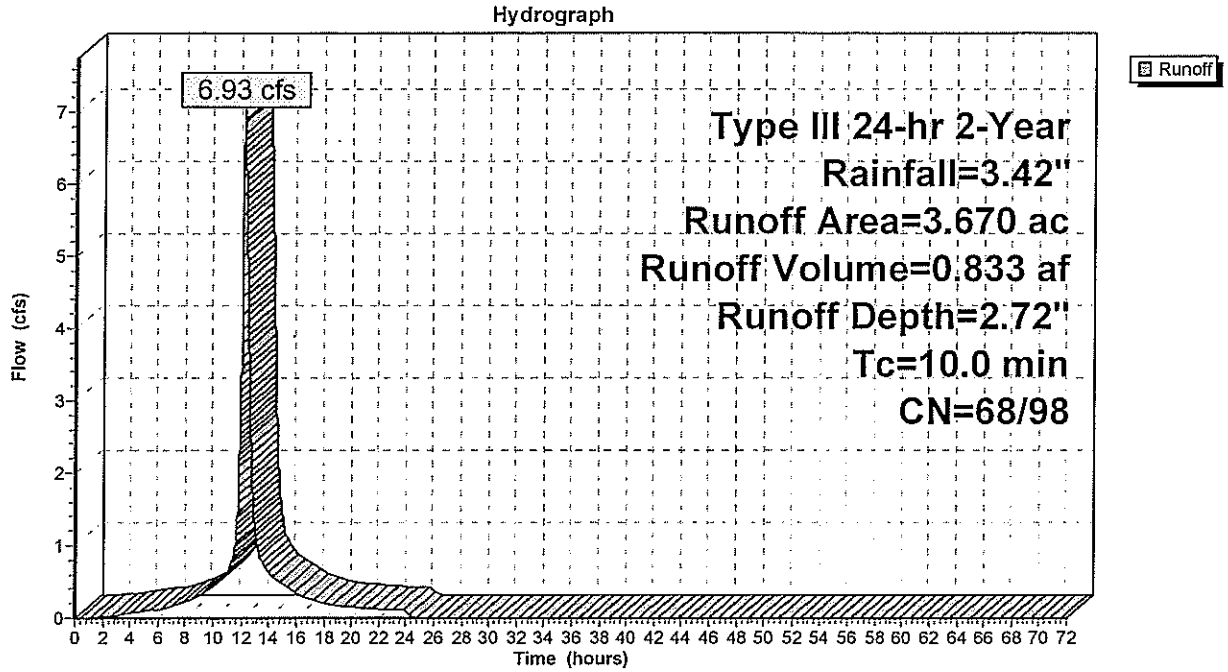
Runoff = 6.93 cfs @ 12.16 hrs, Volume= 0.833 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=Delmarva, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.42"

Area (ac)	CN	Description
2.940	98	Paved parking, HSG A
0.730	68	<50% Grass cover, Poor, HSG A
3.670	92	Weighted Average
0.730	68	19.89% Pervious Area
2.940	98	80.11% Impervious Area

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

Subcatchment 2S: To Sediment Basin #2



Summary for Pond 2P: Sediment Basin #2

Inflow Area = 3.670 ac, 80.11% Impervious, Inflow Depth = 2.72" for 2-Year event
Inflow = 6.93 cfs @ 12.16 hrs, Volume= 0.833 af
Outflow = 0.52 cfs @ 14.56 hrs, Volume= 0.648 af, Atten= 93%, Lag= 144.1 min
Primary = 0.52 cfs @ 14.56 hrs, Volume= 0.648 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 52.68' @ 14.56 hrs Surf.Area= 11,359 sf Storage= 24,632 cf

Plug-Flow detention time= 586.8 min calculated for 0.648 af (78% of inflow)
Center-of-Mass det. time= 504.5 min (1,277.0 - 772.5)

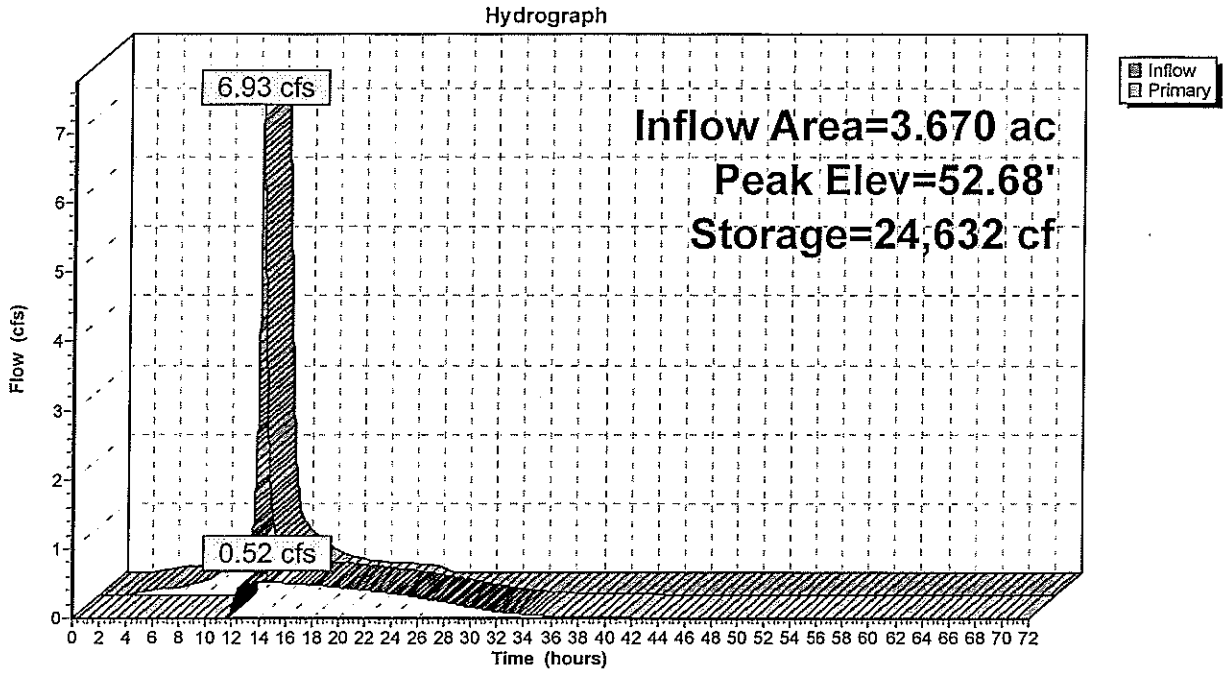
Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	71,868 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
50.00	7,087	0	0
51.00	8,633	7,860	7,860
52.00	10,233	9,433	17,293
53.00	11,889	11,061	28,354
54.00	13,601	12,745	41,099
55.00	15,370	14,486	55,585
56.00	17,196	16,283	71,868

Device	Routing	Invert	Outlet Devices
#1	Primary	50.00'	**15.0" Round Culvert** L= 122.0' CMP, projecting, no headwall, Ke= 0.900 Outlet Invert= 49.51' S= 0.0040 '/' Cc= 0.900 n= 0.011
#2	Device 1	51.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	54.50'	**15.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.52 cfs @ 14.56 hrs HW=52.68' (Free Discharge)
└**1=Culvert** (Passes 0.52 cfs of 6.69 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.52 cfs @ 5.92 fps)
  └**3=Orifice/Grate** (Controls 0.00 cfs)

Pond 2P: Sediment Basin #2



LOW-IMPACT DEVELOPMENT CHECKLIST

APPENDIX A

Low Impact Development Checklist

A checklist for identifying nonstructural stormwater management strategies incorporated into proposed land development

According to the NJDEP Stormwater Management Rules at N.J.A.C. 7:8, the groundwater recharge, stormwater quality, and stormwater quantity standards established by the Rules for major land development projects must be met by incorporating nine specific nonstructural stormwater management strategies into the project's design to the maximum extent practicable.

To accomplish this, the Rules require an applicant seeking land development approval from a regulatory board or agency to identify those nonstructural strategies that have been incorporated into the project's design. In addition, if an applicant contends that it is not feasible to incorporate any of the specific strategies into the project's design, particularly for engineering, environmental, or safety reasons, the Rules further require that the applicant provide a basis for that contention.

This checklist has been prepared to assist applicants, site designers, and regulatory boards and agencies in ensuring that the nonstructural stormwater management requirements of the Rules are met. It provides an applicant with a means to identify both the nonstructural strategies incorporated into the development's design and the specific low impact development BMPs (LID-BMPs) that have been used to do so. It can also help an applicant explain the engineering, environmental, and/or safety reasons that a specific nonstructural strategy could not be incorporated into the development's design.

The checklist can also assist municipalities and other land development review agencies in the development of specific requirements for both nonstructural strategies and LID-BMPs in zoning and/or land use ordinances and regulations. As such, where requirements consistent with the Rules have been adopted, they may supersede this checklist.

Finally, the checklist can be used during a pre-design meeting between an applicant and pertinent review personnel to discuss local nonstructural strategies and LID-BMPs requirements in order to optimize the development's nonstructural stormwater management design.

Since this checklist is intended to promote the use of nonstructural stormwater management strategies and provide guidance in their incorporation in land development projects, municipalities are permitted to revise it as necessary to meet the goals and objectives of their specific stormwater management program and plan within the limits of N.J.A.C. 7:8.

Low Impact Development Checklist

A checklist for identifying nonstructural stormwater management strategies incorporated into proposed land development

Municipality: Township of Manchester and Township of Toms River

County: Ocean Date: November 2017

Review board or agency: Toms River Township, Manchester Township, Ocean County, NJDOT, Ocean County SCD, and NJDEP

Proposed land development name: Proposed Retail Development

Lot(s): Manchester (2,3,4,5, & 9)
Toms River (14 & 15)

Block(s): Manchester (44)
Toms River (505)

Project or application number: TBD

Applicant's name: Jaylin Holdings, LLC c/o Grunin Properties

Applicant's address: Dove Esplanade Bldg #1, 1027 Hooper Avenue, Toms River, NJ 08753

Telephone: (732) 341-5800 Fax: (732) 505-8018

Email address: grunin1@verizon.net

Designer's name: Bohler Engineering (D.F. Wisotsky, P.E.)

Designer's address: 305 Fellowship Road, Suite 210, Mount Laurel, NJ 08054

Telephone: (856) 930-4000 Fax: (856) 930 4001

Email address: dwisotsky@bohlereng.com

Part 1: Description of Nonstructural Approach to Site Design

In narrative form, provide an overall description of the nonstructural stormwater management approach and strategies incorporated into the proposed site's design. Attach additional pages as necessary. Details of each nonstructural strategy are provided in Part 3 below.

The site has been designed to minimize the site disturbance, maintain existing natural features, and minimize impervious coverage, while providing a safe site with appropriate traffic protection measures. In environmentally sensitive portions of the site, retaining walls have been incorporated into the design to limit the disturbance on-site. The stormwater drainage system utilizes curb cuts, where appropriate, to eliminate the need for stormwater piping whenever possible. In addition, the stormwater drainage system proposes three (3) stormwater management basins rather than one (1) centralized basin. Silt fencing, tree protection fencing, and inlet protection devices have been proposed. The limit of disturbance will be clearly defined and maintained during construction. Contractors are instructed to minimize and strictly regulate construction areas, access roads, material and equipment storage areas. In addition, light weight, rubber tired construction equipment will be used whenever possible, with movements limited to a few repetitive routes. To minimize the site's impact on the preserved portions of the site during operation, trash compactors will be utilized to ensure commercial by-products be stored or transported in a confined manner. In addition, trash cans will be provided at all store entrance locations, as these areas are anticipated to experience high pedestrian traffic. Trash can collection will also be provided on a daily basis, as described within the site Operations and Maintenance Manual. Curbed catch basin grates will also be N-eco type, and trash racks will be provided at outlet structures to reduce the opening areas entering and exiting the stormwater drainage system. Lastly, the proposed snake barrier and chain link fence, which separate the developed portion of the site and the preserved portion, will act as a litter fence, to prevent litter from blowing off the site, if any. These measures listed above will provide preventative source control to ensure that the larger pollutants do not do not make their way into the stormwater drainage system.

Part 2: Review of Local Stormwater Management Regulations

Title and date of stormwater management regulations used in development design:

StormwaterManagementRegulationsN.J.A.C.7:8,dated06/20/16andN.J.BestManagementPractices,dated04/04, last revised 9/17

Do regulations include nonstructural requirements? Yes: ✓ No: _____

If yes, briefly describe: As specified in N.J.A.C. 7:8-5.3b. Including minimizing impervious surface, maximize protection of natural drainage features and vegetation, using swales to disconnect impervious area, and increasing time of concentration.

List LID-BMPs prohibited by local regulations: N/A

Pre-design meeting held? Yes: ✓ Date: Several - See Below No: _____

Meeting held with: Meetings were held on several dates including 3/19/08, 4/21/08, 7/10/08, 11/18/08 & 7/2/09 with members of the project team and various members of the NJDEP to discuss the proposed design. Recently the layout was revised to further reduce impervious cover by approximately 1.90 acres.

Pre-design site walk held? Yes: ✓ Date: Several - See Below No: _____

Site walk held with: Site visits were held on several dates including 06/07/09, 06/18/09, 06/26/09, 08/05/09 and 08/24/09 with members of the project team to observe existing site conditions in preparation for the proposed design. Recently the layout was revised to reduce impervious cover by approximately 1.90 acres.

Other agencies with stormwater review jurisdiction:

Name: Township of Toms River, Township of Manchester, and Ocean County

Required approval: Site Plan Approval

Name: Ocean County Soil Conservation District

Required approval: Soil Erosion and Sediment Control Certification

Name: NJDOT

Required approval: Major Access Permit

Part 3: Nonstructural Strategies and LID-BMPs in Design

3.1 Vegetation and Landscaping

Effective management of both existing and proposed site vegetation can reduce a development's adverse impacts on groundwater recharges and runoff quality and quantity. This section of the checklist helps identify the vegetation and landscaping strategies and nonstructural LID-BMPs that have been incorporated into the proposed development's design to help maintain existing recharge rates and/or minimize or prevent increases in runoff quantity and pollutant loading.

A. Has an inventory of existing site vegetation been performed? Yes: ✓ No: _____

If yes, was this inventory a factor in the site's layout and design? Yes: ✓ No: _____

B. Does the site design utilize any of the following nonstructural LID-BMPs?

Preservation of natural areas? Yes: ✓ No: _____ If yes, specify % of site: 70.0%

Native ground cover? Yes: ✓ No: _____ If yes, specify % of site: 13.3%

Vegetated buffers? Yes: ✓ No: _____ If yes, specify % of site: 12.5%

C. Do the land development regulations require these nonstructural LID-BMPs?

Preservation of natural areas? Yes: _____ No: ✓ If yes, specify % of site: _____

Native ground cover? Yes: _____ No: ✓ If yes, specify % of site: _____

Vegetated buffers? Yes: _____ No: ✓ If yes, specify % of site: _____

D. If vegetated filter strips or buffers are utilized, specify their functions:

Reduce runoff volume increases through lower runoff coefficient: Yes: _____ No: ✓

Reduce runoff pollutant loads through runoff treatment: Yes: _____ No: ✓

Maintain groundwater recharge by preserving natural areas: Yes: _____ No: ✓

3.2 Minimize Land Disturbance

Minimizing land disturbance is a nonstructural LID-BMP that can be applied during both the development's construction and post-construction phases. This section of the checklist helps identify those land disturbance strategies and nonstructural LID-BMPs that have been incorporated into the proposed development's design to minimize land disturbance and the resultant change in the site's hydrologic character.

A. Have inventories of existing site soils and slopes been performed? Yes: ✓ No: _____

If yes, were these inventories factors in the site's layout and design? Yes: ✓ No: _____

B. Does the development's design utilize any of the following nonstructural LID-BMPs?

Restrict permanent site disturbance by land owners? Yes: ✓ No: _____

If yes, how: Approximately 21.7 acres have been preserved for the Northern Pine Snake found on-site. In addition, a 4' high snake barrier has been provided around the perimeter of the preservation area on-site.

Restrict temporary site disturbance during construction? Yes: ✓ No: _____

If yes, how: Silt fence will be installed prior to construction activities to define the proposed limit of disturbance.

Consider soils and slopes in selecting disturbance limits? Yes: ✓ No: _____

If yes, how: Approximately 46.4 acres of the 73.4 acre development has been preserved per direction received at our pre-design meetings with the NJDEP, and development has been limited to those areas outside of this boundary. In addition, with exception of wetlands areas, the site consists of only Group A soils with the majority of slopes within the range of 1%-5%.

C. Specify percentage of site to be cleared: 31.3% Regraded: 36.8%

D. Specify percentage of cleared areas done so for buildings: 4.1%

For driveways and parking: 9.4% For roadways: 0.0%

E. What design criteria and/or site changes would be required to reduce the percentages in C and D above?

The site has been designed to minimize the land area to be cleared by this application, with retaining wall provided as necessary. The current plans propose parking which meets the minimum number of spaces required by the Applicant of the building for safe and efficient operation. In order to provide additional reduction in site clearing and impervious coverage, the size or number of parking spaces would have to be reduced, which will make it impractical to build on this site after preserving over 46 acres of undisturbed area for pine snake habitat.

F. Specify site's hydrologic soil group (HSG) percentages:

HSG A: 66.8% HSG B: _____ HSG C: _____ HSG D: 33.2%

G. Specify percentage of each HSG that will be permanently disturbed:

HSG A: 55.0% HSG B: _____ HSG C: _____ HSG D: 0.0%

H. Locating site disturbance within areas with less permeable soils (HSG C and D) and minimizing disturbance within areas with greater permeable soils (HSG A and B) can help maintain groundwater recharge rates and reduce runoff volume increases. In light of the HSG percentages in F and G above, what other practical measures if any can be taken to achieve this?

Approximately 46.4 acres of the 73.4 acre development has been preserved per direction received at our pre-design meetings with the NJDEP and development has been limited to those areas outside of this boundary. In addition, with the exception of wetlands areas classified as HSG D, majority of the site consists of only Group A soils.

I. Does the site include Karst topography? Yes: _____ No: ✓

If yes, discuss measures taken to limit Karst impacts:

3.3 Impervious Area Management

New impervious surfaces at a development site can have the greatest adverse effect on groundwater recharge and stormwater quality and quantity. This section of the checklist helps identify those nonstructural strategies and LID-BMPs that have been incorporated into a proposed development's design to comprehensively manage the extent and impacts of new impervious surfaces.

A. Specify impervious cover at site: Existing: 2.0% Proposed: 15.4%

B. Specify maximum site impervious coverage allowed by regulations: 65% (Manchester) Not Specified (Toms River)

C. Compare proposed street cartway widths with those required by regulations:

N/A - Commercial Development

Type of Street	Proposed Cartway Width (feet)	Required Cartway Width (feet)
Residential access – low intensity		
Residential access – medium intensity		
Residential access – high intensity with parking		
Residential access – high intensity without parking		
Neighborhood		
Minor collector – low intensity without parking		
Minor collector – with one parking lane		
Minor collector – with two parking lanes		
Minor collector – without parking		
Major collector		

D. Compare proposed parking space dimensions with those required by regulations:

Proposed: 10' x 20' Manchester
9' x 18' Toms River

Regulations: 10' x 20' Manchester
9' x 18' Toms River

E. Compare proposed number of parking spaces with those required by regulations:

Proposed: 606 Regulations: 582

F. Specify percentage of total site impervious cover created by buildings: 4.2%

By driveways and parking: 11.1% By roadways: 0.0%

G. What design criteria and/or site changes would be required to reduce the percentages in F above?

The site has been designed considering the allowable impervious coverage on-site and the Applicant's design requirements for safe and efficient operation based upon their experience throughout New Jersey.

H. Specify percentage of total impervious area that will be unconnected:

Total site: 0% Buildings: 0% Driveways and parking: 7.4% Roads: 0%

Minimal impervious areas have been unconnected because the proposed snake barrier separating the proposed and preserved portions of the site will not allow sheetflow runoff from the impervious areas to the pervious areas.

I. Specify percentage of total impervious area that will be porous:

Total site: 0% Buildings: 0% Driveways and parking: 0% Roads: 0%

J. Specify percentage of total building roof area that will be vegetated: 0%

K. Specify percentage of total parking area located beneath buildings: 0%

No parking has been proposed beneath the building because the Seasonal High Groundwater on-site limits the depth of excavation and the maximum building height specified by the township restricts the height of the building.

L. Specify percentage of total parking located within multi-level parking deck: 0%

3.4 Time of Concentration Modifications

Decreasing a site's time of concentration (Tc) can lead directly to increased site runoff rates which, in turn, can create new and/or aggravate existing erosion and flooding problems downstream. This section of the checklist helps identify those nonstructural strategies and LID-BMPs that have been incorporated into the proposed development's design to effectively minimize such Tc decreases.

When reviewing Tc modification strategies, it is important to remember that a drainage area's Tc should reflect the general conditions throughout the area. As a result, Tc modifications must generally be applied throughout a drainage area, not just along a specific Tc route.

A. Specify percentage of site's total stormwater conveyance system length that will be:

Storm sewer: 81.0% Vegetated swale: 4.7% Natural channel: 0.0%

Stormwater management facility: 14.3% Other: 0.0%

Note: the total length of the stormwater conveyance system should be measured from the site's downstream property line to the downstream limit of sheet flow at the system's headwaters.

B. What design criteria and/or site changes would be required to reduce the storm sewer percentages and increase the vegetated swale and natural channel percentages in A above?

The stormwater drainage system on-site proposes three (3) small basins, rather than one (1) centralized basin. Incorporating additional vegetated swales in the stormwater drainage system would eliminate some of the stormwater basins on-site, reduce the amount of proposed landscape, which was designed in accordance with the applicable ordinance (Manchester/TomsRiver), and require additional disturbance. In addition, the minimal slopes and overall grade change are not conducive to swale design, and space is further limited due to the proposed snake barrier required by the NJDEP ordinance (toms River and/or Manchester)

C. In conveyance system subareas that have overland or sheet flow over impervious surfaces or turf grass, what practical and effective site changes can be made to:

Decrease overland flow slope: All areas of the site have been designed to minimize slopes on-site. Within impervious areas, the curbline has been designed at 1% slope, and other areas to 1.5%. Decreasing slopes further may create potential ponding issues, which may negatively impact site safety.

Increase overland flow roughness: The developed portion of the site will experience minimal overland flow. Those areas that do experience overland flow have been planted in accordance with applicable landscaping.

3.5 Preventative Source Controls

The most effective way to address water quality concerns is by pollution prevention. This section of the checklist helps identify those nonstructural strategies and LID-BMPs that have been incorporated into the proposed development's design to reduce the exposure of pollutants to prevent their release into the stormwater runoff.

A. Trash Receptacles

Specify the number of trash receptacles provided: 8

Specify the spacing between the trash receptacles: 1 per tenant

Compare trash receptacles proposed with those required by regulations:

Proposed: 8 Regulations: Not Specified

B. Pet Waste Stations

Specify the number of pet waste stations provided: 0

Specify the spacing between the pet waste stations: N/A

Compare pet waste stations proposed with those required by regulations:

Proposed: 0 Regulations: Not Specified

C. Inlets, Trash Racks, and Other Devices that Prevent Discharge of Large Trash and Debris

Specify percentage of total inlets that comply with the NJPDES storm drain inlet criteria: 100%

D. Maintenance

Specify the frequency of the following maintenance activities:

Street sweeping: Proposed: Once a month Regulations: Not Specified

Litter collection: Proposed: Once a day Regulations: Not Specified

Identify other stormwater management measures on the site that prevent discharge of large trash and debris:

The proposed snake barrier and chain-link fence provided along the perimeter of the preserved portion of the site will also act as a litter fence to contain debris within the maintained portion of the property.

E. Prevention and Containment of Spills

Identify locations where pollutants are located on the site, and the features that prevent these pollutants from being exposed to stormwater runoff:

Pollutant: N/A Location: N/A

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: N/A Location: N/A

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: N/A Location: N/A

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: N/A Location: N/A

Feature utilized to prevent pollutant exposure, harmful accumulation, or contain spills:

Pollutant: N/A Location: N/A

Part 4: Compliance with Nonstructural Requirements of NJDEP Stormwater Management Rules

1. Based upon the checklist responses above, indicate which nonstructural strategies have been incorporated into the proposed development's design in accordance with N.J.A.C. 7:8-5.3(b):

No.	Nonstructural Strategy	Yes	No
1.	Protect areas that provide water quality benefits or areas particularly susceptible to erosion and sediment loss.	✓	
2.	Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces.	✓	
3.	Maximize the protection of natural drainage features and vegetation.	✓	
4.	Minimize the decrease in the pre-construction time of concentration.	✓	
5.	Minimize land disturbance including clearing and grading.	✓	
6.	Minimize soil compaction.	✓	
7.	Provide low maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides.	✓	
8.	Provide vegetated open-channel conveyance systems discharge into and through stable vegetated areas.	✓	
9.	Provide preventative source controls.	✓	

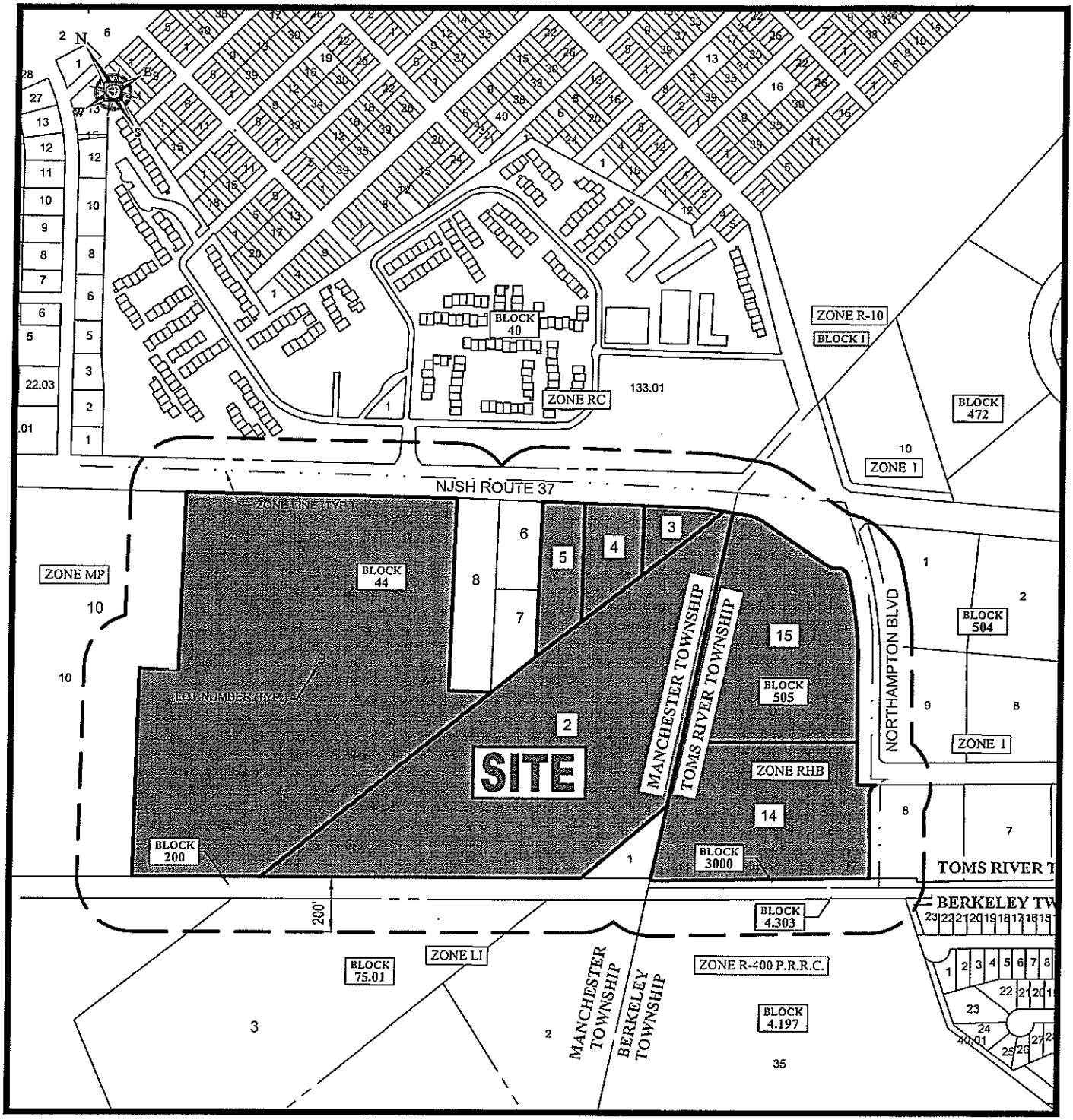
2. For those strategies that have not been incorporated into the proposed development's design, provide engineering, environmental, and/or safety reasons. Attached additional pages as necessary.

The stormwater drainage system on-site proposes three (3) small basins, rather than one (1) centralized basin. Incorporating additional vegetated swales in the stormwater drainage system would eliminate some of the stormwater basins on-site, reduce the amount of proposed landscape, which was designed in accordance with the applicable ordinance (Manchester/Toms River), and require additional disturbance. In addition, the minimal slopes and overall grade change are not conducive to swale design.

C. Maps & Documentation

- Location Map
- USGS & HUC14 Location Map
- Soil Map
- Drainage Area Maps
  - Existing Drainage Area Map
  - Proposed Drainage Area Map

LOCATION MAP

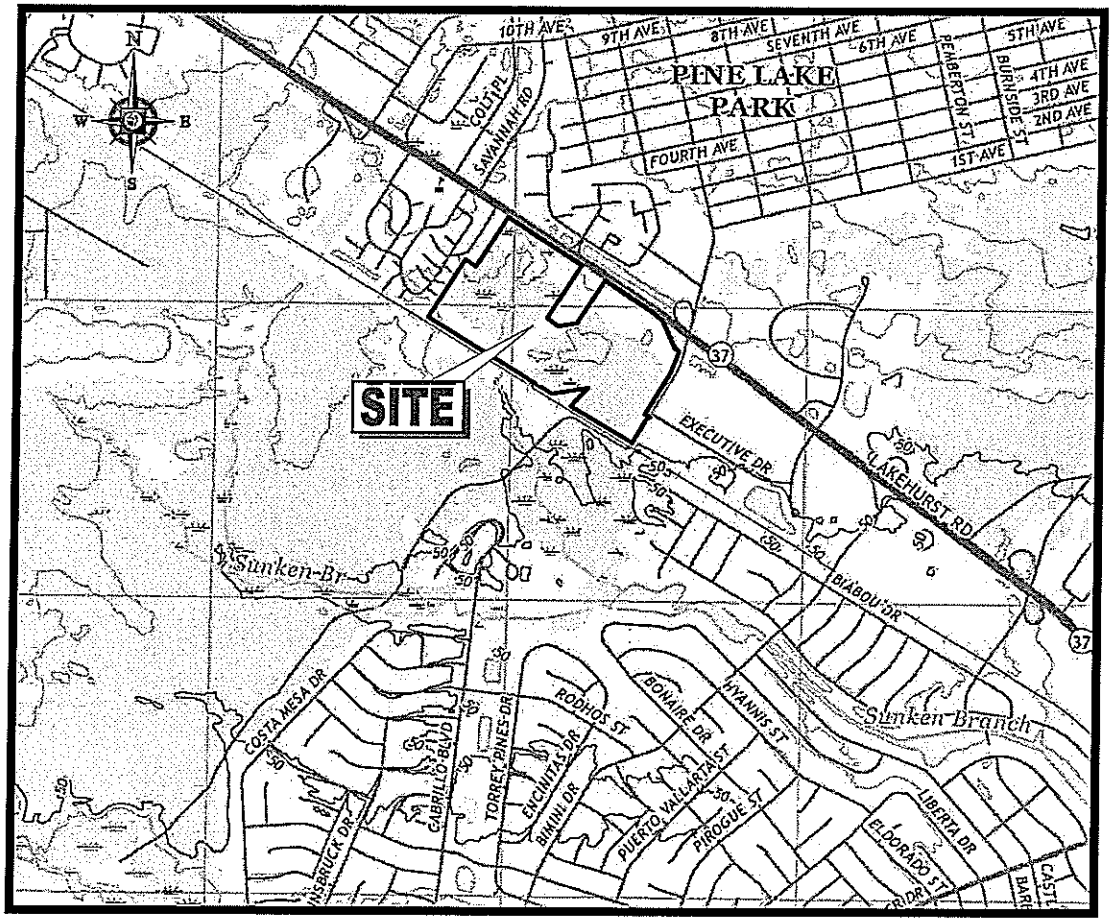


LOCATION MAP

SCALE: 1" = 500'

SOURCE: GIS PARCEL DATA MAPS

USGS & HUC14 LOCATION MAP



USGS MAP

SCALE: 1" = 2,000'

SOURCE: USGS KESWICK GROVE QUADRANGLE

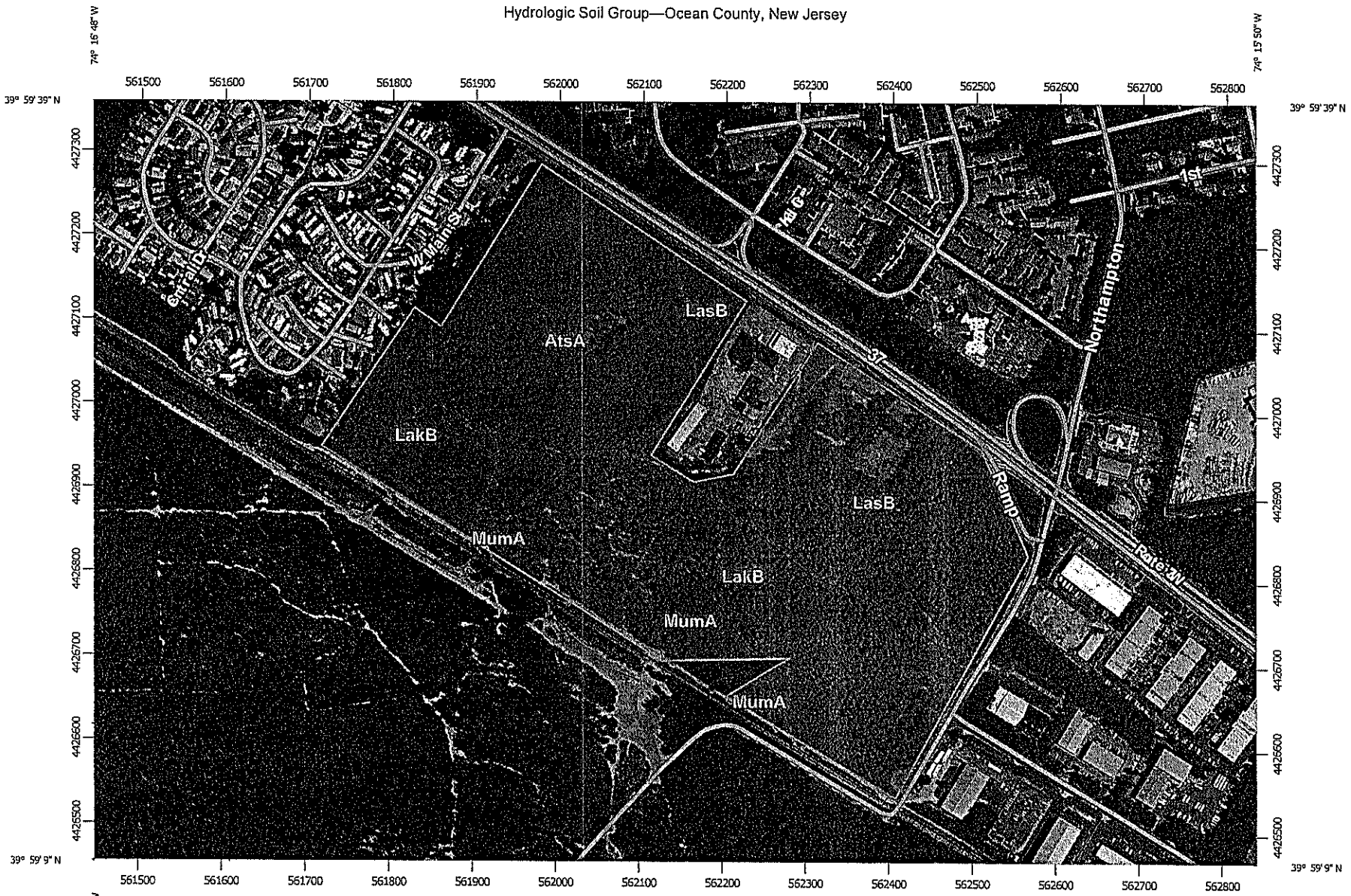
NJ-GeoWeb — nidep department of environmental protection

Report of Sub-Watershed HUC 14

Attribute	Value
HYDROLOGIC UNIT CODE (14 DIGIT)	02040301080050
WATERSHED MANAGEMENT AREA NO.	13
WATERSHED MANAGEMENT AREA NAME	Barnegat Bay
WATER REGION NO.	3
WATER REGION NAME	Atlantic Coast
SUB-WATERSHED ID	13GA05
SUB-WATERSHED NAME	Wrangel Brook (below Michaels Branch)
WATERSHED ID	13GA
WATERSHED NAME	Toms River (below Oak Ridge Parkway)
Acres	5,932.67266959992
Huc12	020403010304

SOIL MAP

Hydrologic Soil Group—Ocean County, New Jersey



MAP LEGEND

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

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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: Ocean County, New Jersey
Survey Area Data: Version 13, Sep 17, 2015

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

Date(s) aerial images were photographed: Aug 8, 2014—Sep 2, 2014

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.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Ocean County, New Jersey (NJ029)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AtsA	Atsion sand, 0 to 2 percent slopes	A/D	20.3	28.0%
LakB	Lakehurst sand, 0 to 5 percent slopes	A	27.9	38.6%
LasB	Lakewood sand, 0 to 5 percent slopes	A	20.8	28.8%
MumA	Mullica sandy loam, 0 to 2 percent slopes	A/D	3.3	4.6%
Totals for Area of Interest			72.4	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

DRAINAGE AREA MAPS