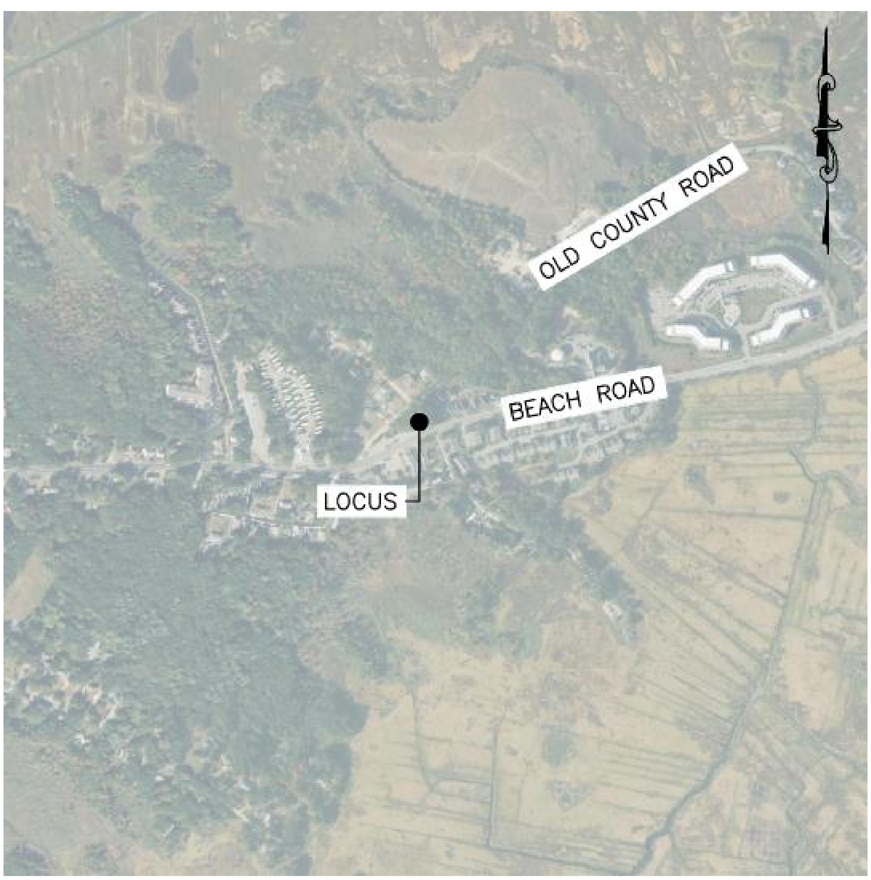
CIVIL DESIGN
Consultants, Inc.
Survey - Design - Permitting - Construction Administration
344 North Main Street
Andover, MA 01810-2611
Tel: (978) 416-0920

# DRAINAGE REPORT

**159 Beach Road**
**Salisbury, Massachusetts**


## OWNER:

**Edward Foote Jr. & Joanne F. Blais**
**123 Central Street**
**Salisbury, MA 01952**

## APPLICANT:

**Larkin Real Estate Group, Inc**
**383 Main Street**
**Medfield, MA 02052**

## SUBMITTED TO:

**Salisbury Planning Board**
**5 Beach Road**
**Salisbury, MA 01952**

## ISSUED:

**June 14, 2022**
**Revised: May 17, 2023**

# DRAINAGE REPORT

# TAB 1

**DRAINAGE REPORT**

159 Beach Road
Salisbury, Massachusetts

## PROJECT DESCRIPTION

The applicant proposes to re-develop 159 Beach Road in Salisbury, MA into a 24-unit residential development, with 5 triplexes, 4 duplexes, and a single-family dwelling. The parcel totals approximately 30,310-SF and contains an existing ice cream stand with paved parking and associated appurtenances. The project consists of construction of 24 units, consisting of 5 triplex dwellings, 4 duplex dwellings, and one single-family dwelling, along with associated infrastructure including driveways, landscaping, drainage facilities, and utilities. Project plans entitled *Site Development Plans for 159 Beach Road*, last revised March 9, 2023, have been prepared by this office and provided for your review. These plans illustrate the proposal in detail including zoning, easements, construction details, and provisions for utilities. Drainage will be collected and routed through best management practices sized to address the MADEP Stormwater Management Standards.

## SITE DESCRIPTION

The total lot area of the project site is approximately 30,310-SF and provides frontage on Beach Road and Old County Road. The site is generally flat, with an elevation ranging between 10-FT and 14-FT across the site.

According to the Natural Resource Conservation Service Soil Survey for Middlesex County, Massachusetts soils on the site are mapped as containing Wareham Loamy Sand and Windsor Loamy Sand, both in Hydrologic Soil Group A.

## SURFACE DRAINAGE

Pre-Development Condition

The pre-development condition consists of two watershed areas contributing to two design points. Design Point #1 (DP-1) receives runoff from drainage area EWA-1 and consists of overland flow to the south towards Beach Road. Design Point #2 (DP-2) receives runoff from drainage area EWA-2 and consists of overland flow to the north and east, towards the abutting properties along Old County Road and Beach Road. Contributing areas to the Design Points are detailed in the following Table 1.

TABLE 1: EXISTING WATERSHED DESIGN POINT DETAILS

| DESIGN POINT | AREA NAME | AREA (SF) | Tc (min.) | CN |
|---|---|---|---|---|
| DP-1 | EWA-1 | 15,898 | 14.4 | 73 |
| DP-2 | EWA-2 | 14,413 | 16.0 | 30 |

Post-Development Condition

The proposed project includes the construction of 5 triplex dwellings, 2 duplex dwellings, and one single-family dwelling. Other components include construction of a new driveways along with landscaping, drainage, utilities, and associated appurtenances. The development is less than one acre, therefore, the system has been designed to meet the requirements of the Town of Salisbury Planning Board Rules and Regulations Section III.c.5 – Drainage.

Drainage will be routed through porous pavement sections and an infiltration trench sized to capture and infiltrate runoff from roofs and driveways for up to and including the 100-year storm event. The drainage design results in all impervious area being captured and treated. This provides a net benefit compared to the existing condition, which had approximately 10,000-SF of untreated impervious area.

The proposed construction results in six watersheds discharging to two Design Points. DP-1 receives flow from PWA-1, which consists of overland flow towards Beach Road. DP-2 receives flow from PWA-2, PWA-3, PWA-4, and PWA-5, all of which consist of overland flow. PWA-3 drains to the proposed infiltration trench which does not overflow. Runoff from PWA-4 and PWA-5 is directed to separate subsurface chamber systems and is treated using Contech hydrodynamic separators prior to infiltration. The design points are summarized in Table 2 below.

TABLE 2: PROPOSED WATERSHED DESIGN POINT DETAILS

| DESIGN POINT | AREA NAME | AREA (SF) | Tc (min.) | CN |
|---|---|---|---|---|
| DP-1 | PWA-1 | 4,463 | 6.0 | 39 |
| DP-2 | PWA-2 | 2,868 | 6.0 | 39 |
| | PWA-3 | 1,799 | 6.0 | 88 |
| | PWA-4 | 8,141 | 6.0 | 85 |
| | PWA-5 | 14,166 | 6.0 | 83 |

Peak Discharge Comparison

As illustrated in the following tables, the impact of the proposed improvements has been mitigated through the use of infiltration trenches and subsurface infiltration chambers for up to and including the 100-year, 24-hour storm event.

Design Point #1

Peak Flow:

| | 2-YR | 10-YR | 25-YR | 50-YR | 100-YR |
|---|---|---|---|---|---|
| | (3.1-IN) | (4.5-IN) | (5.3-IN) | (5.9-IN) | (6.5-IN) |
| | CFS | CFS | CFS | CFS | CFS |
| Pre-Development | 0.3 | 0.6 | 0.8 | 1.0 | 1.1 |
| Post-Development | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Design Point #2

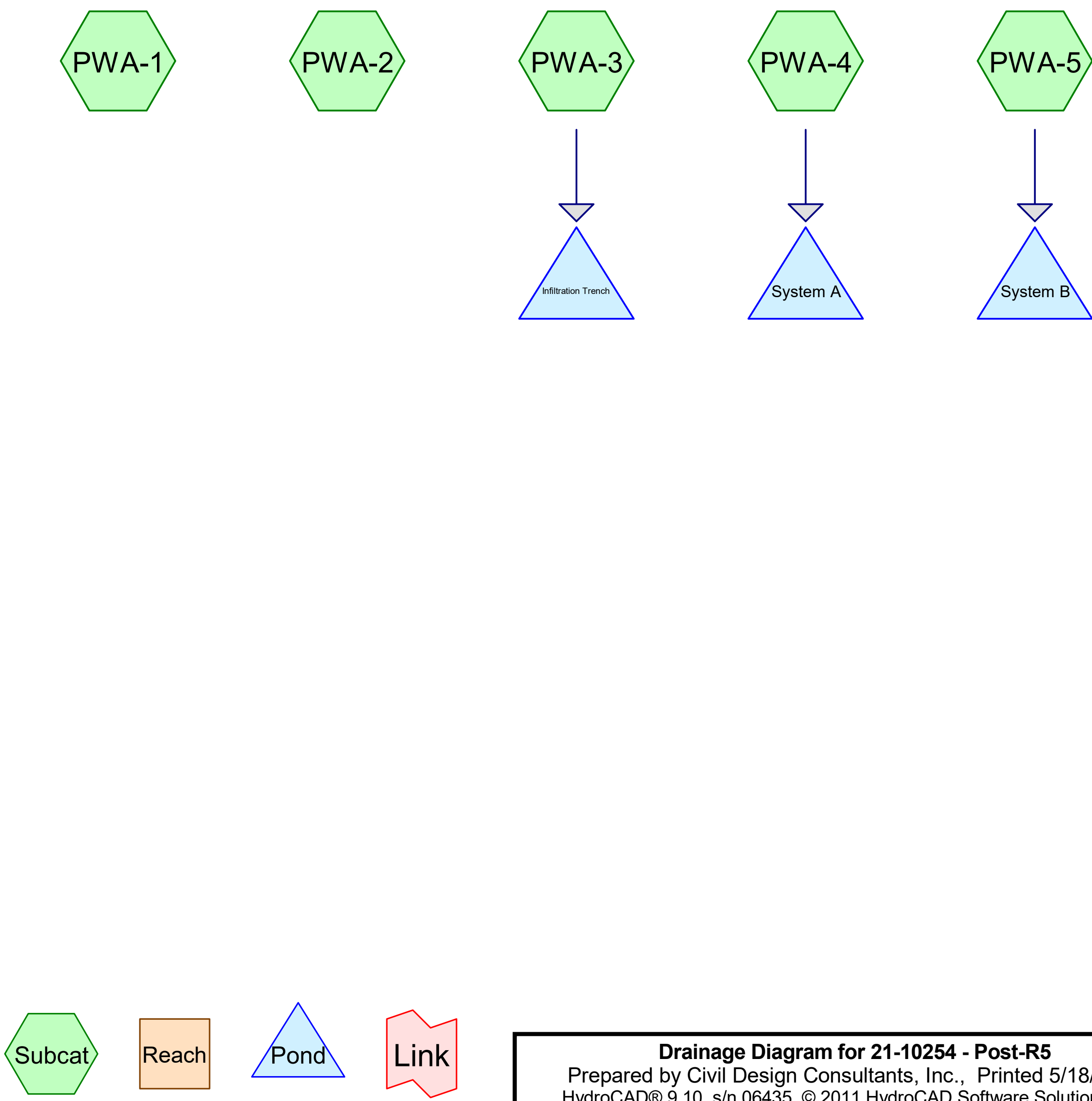
Peak Flow:

| | 2-YR | 10-YR | 25-YR | 50-YR | 100-YR |
|---|---|---|---|---|---|
| | (3.1-IN) | (4.5-IN) | (5.3-IN) | (5.9-IN) | (6.5-IN) |
| | CFS | CFS | CFS | CFS | CFS |
| Pre-Development | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Post-Development | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

## METHODOLOGY

Drainage calculations were performed using the computer program HydroCAD by HydroCAD Software Solutions, LLC based upon Technical Release 20 (TR-20), developed by the NRCS, formerly the Soils Conservation Service. Drainage calculations were prepared for the 2-YR, 10-YR, 25-YR, 50-YR, and 100-YR Type III 24-hour storm events. Rainfall data corresponds with National Weather Service Technical Paper 40 (TP-40) used in Technical Release 55 (TR-55). Curve numbers were generated using the information provided in TR-55 and the SCS Soils Survey.

# TAB 2




**Drainage Diagram for 21-10254 - Post-R5**
Prepared by Civil Design Consultants, Inc., Printed 5/18/2023
HydroCAD® 9.10 s/n 06435 © 2011 HydroCAD Software Solutions LLC

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PWA-1:** Runoff Area=4,463 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39 Runoff=0.0 cfs 0 cf

**Subcatchment PWA-2:** Runoff Area=2,868 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39 Runoff=0.0 cfs 0 cf

**Subcatchment PWA-3:** Runoff Area=1,799 sf 83.10% Impervious Runoff Depth=1.91"
Tc=6.0 min CN=88 Runoff=0.1 cfs 286 cf

**Subcatchment PWA-4:** Runoff Area=8,141 sf 78.69% Impervious Runoff Depth=1.67"
Tc=6.0 min CN=85 Runoff=0.4 cfs 1,135 cf

**Subcatchment PWA-5:** Runoff Area=14,166 sf 74.40% Impervious Runoff Depth=1.53"
Tc=6.0 min CN=83 Runoff=0.6 cfs 1,803 cf

**Pond Infiltration Trench:** Peak Elev=10.45' Storage=46 cf Inflow=0.1 cfs 286 cf
Outflow=0.0 cfs 286 cf

**Pond System A:** Peak Elev=10.26' Storage=194 cf Inflow=0.4 cfs 1,135 cf
Outflow=0.1 cfs 1,135 cf

**Pond System B:** Peak Elev=8.11' Storage=326 cf Inflow=0.6 cfs 1,803 cf
Outflow=0.2 cfs 1,803 cf

**Total Runoff Area = 31,437 sf Runoff Volume = 3,224 cf Average Runoff Depth = 1.23"**
**41.34% Pervious = 12,996 sf 58.66% Impervious = 18,441 sf**

## Summary for Subcatchment PWA-1:

[45] Hint: Runoff=Zero

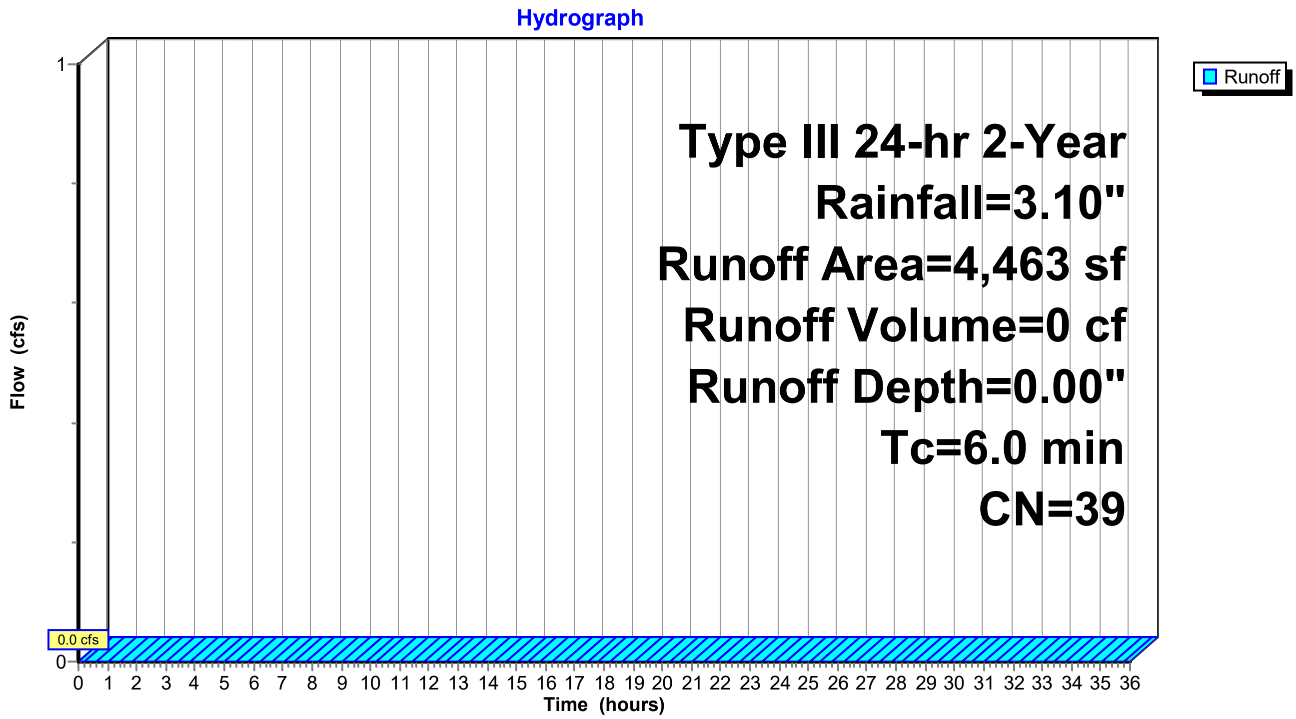
Runoff = 0.0 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 4,463 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 4,463 | 39 | Weighted Average |
| 4,463 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-1:



## Summary for Subcatchment PWA-2:

[45] Hint: Runoff=Zero

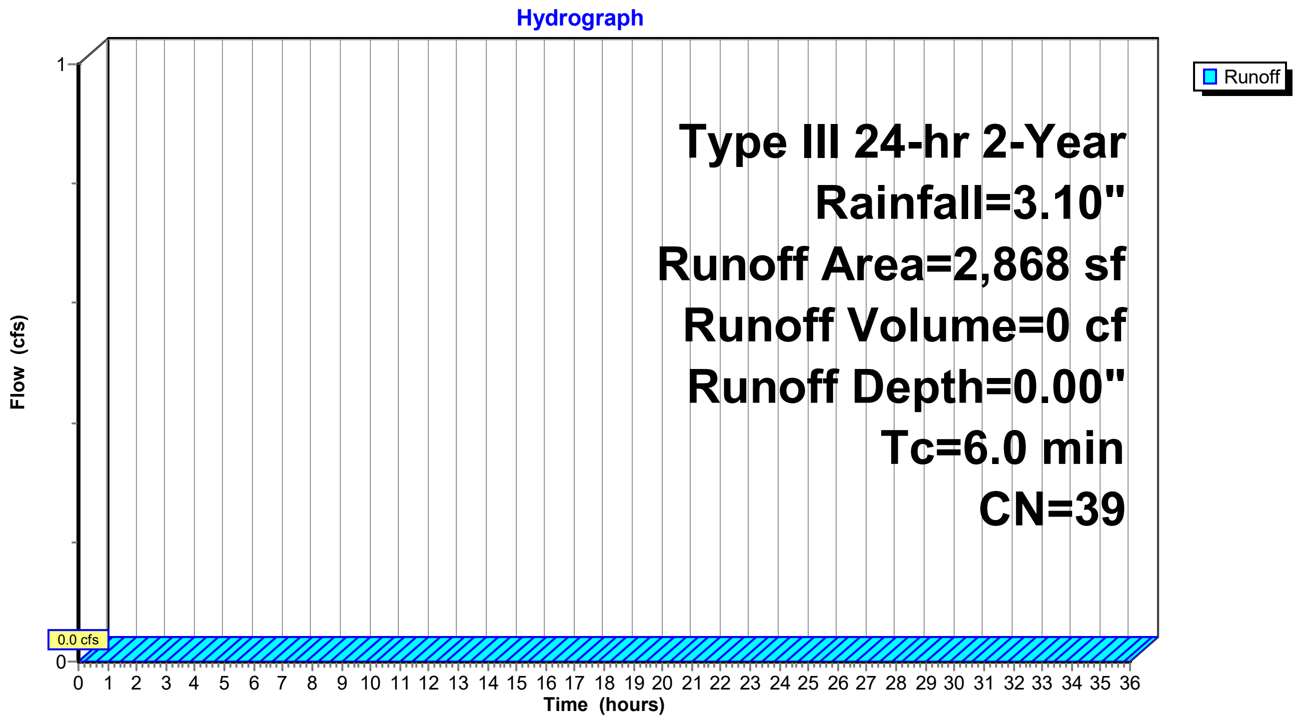
Runoff = 0.0 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 2,868 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 2,868 | 39 | Weighted Average |
| 2,868 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-2:



## Summary for Subcatchment PWA-3:

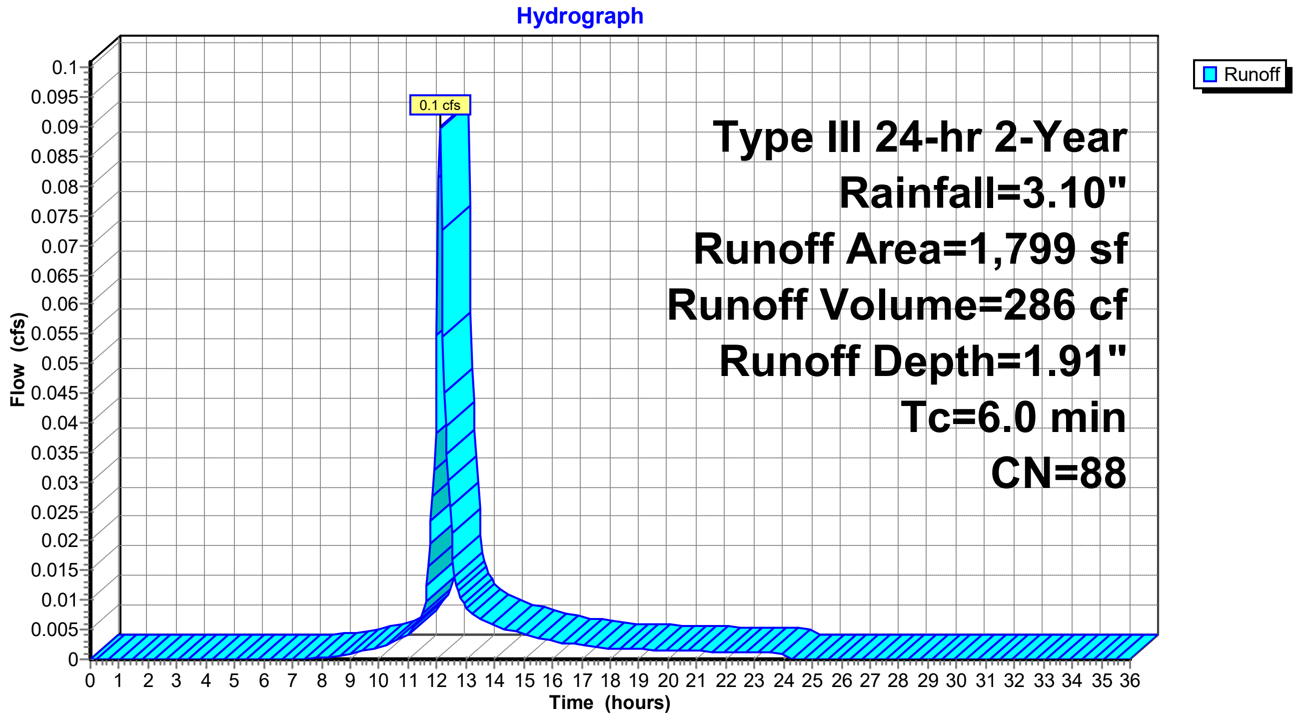
Runoff = 0.1 cfs @ 12.09 hrs, Volume= 286 cf, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 828 | 98 | Roofs, HSG A |
| 667 | 98 | Paved parking, HSG A |
| 304 | 39 | >75% Grass cover, Good, HSG A |
| 1,799 | 88 | Weighted Average |
| 304 | | 16.90% Pervious Area |
| 1,495 | | 83.10% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-3:



## Summary for Subcatchment PWA-4:

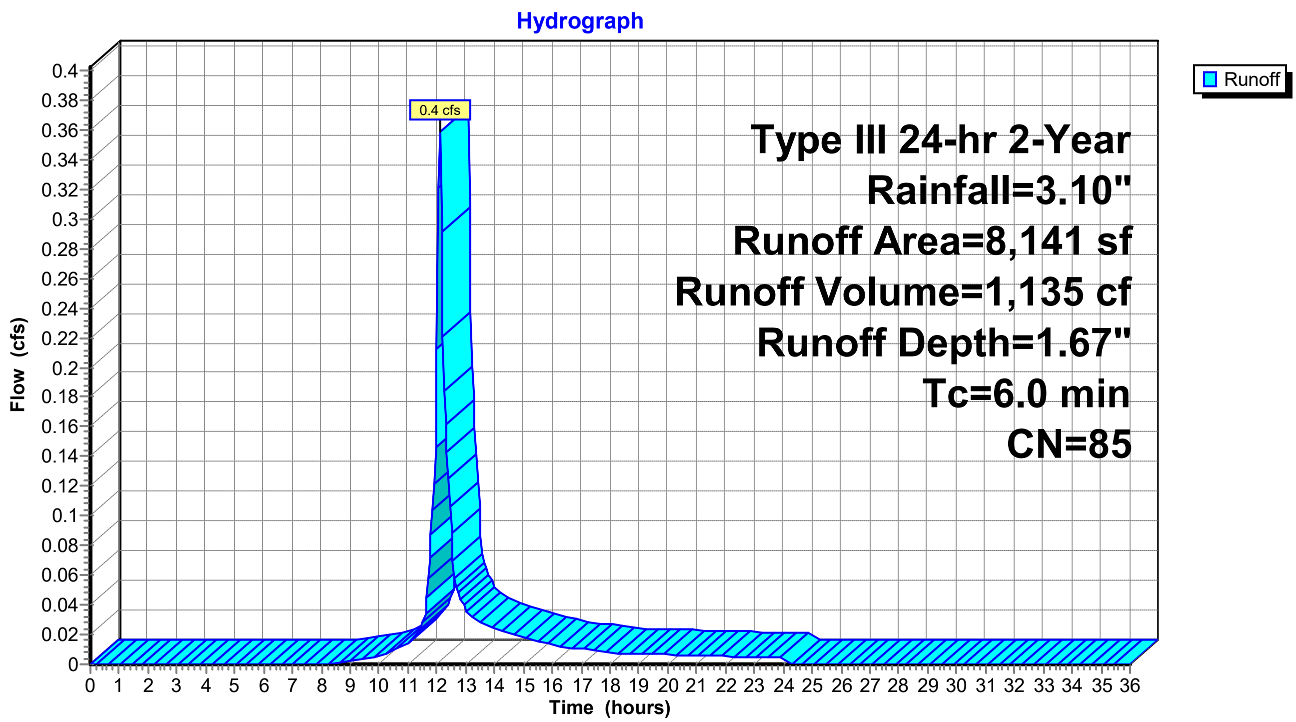
Runoff = 0.4 cfs @ 12.09 hrs, Volume= 1,135 cf, Depth= 1.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 3,525 | 98 | Roofs, HSG A |
| 2,881 | 98 | Paved parking, HSG A |
| 1,735 | 39 | >75% Grass cover, Good, HSG A |
| 8,141 | 85 | Weighted Average |
| 1,735 | | 21.31% Pervious Area |
| 6,406 | | 78.69% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-4:



## Summary for Subcatchment PWA-5:

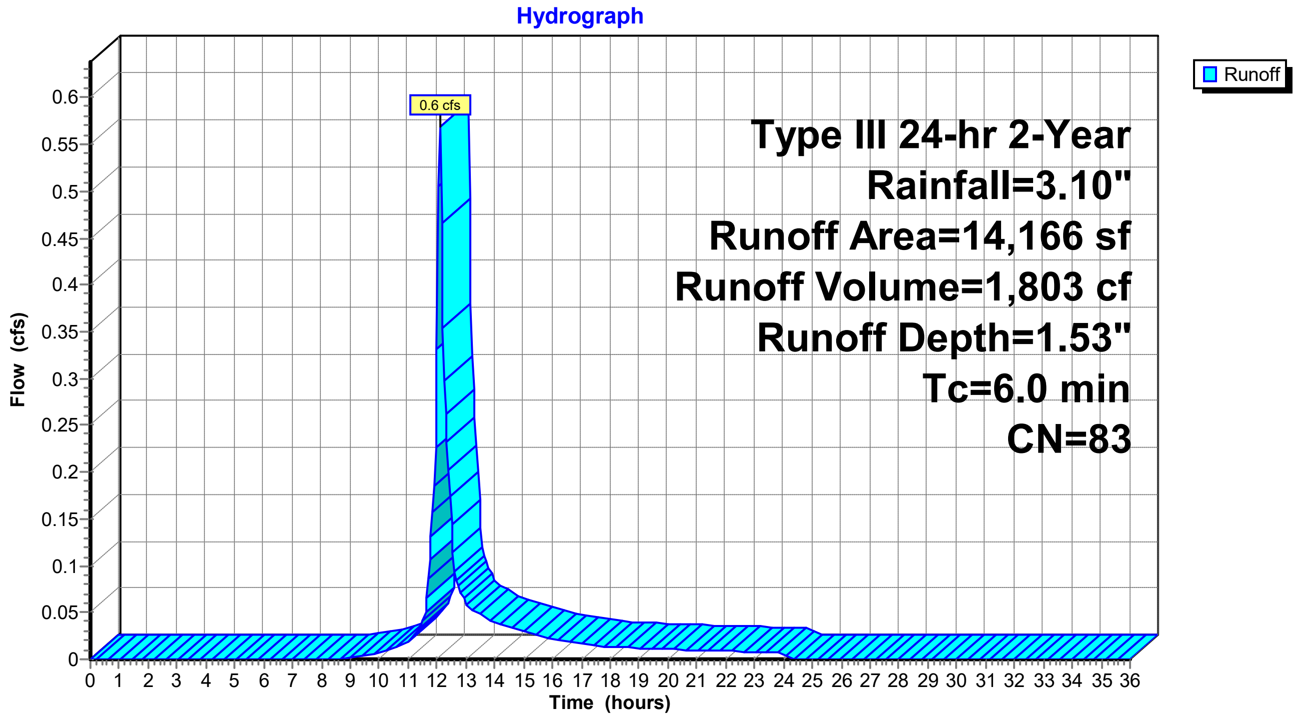
Runoff = 0.6 cfs @ 12.09 hrs, Volume= 1,803 cf, Depth= 1.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.10"

| Area (sf) | CN | Description |
|---|---|---|
| 6,226 | 98 | Roofs, HSG A |
| 4,314 | 98 | Paved parking, HSG A |
| 3,626 | 39 | >75% Grass cover, Good, HSG A |
| 14,166 | 83 | Weighted Average |
| 3,626 | | 25.60% Pervious Area |
| 10,540 | | 74.40% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

### Subcatchment PWA-5:



## Summary for Pond Infiltration Trench:

Inflow Area = 1,799 sf, 83.10% Impervious, Inflow Depth = 1.91" for 2-Year event
Inflow = 0.1 cfs @ 12.09 hrs, Volume= 286 cf
Outflow = 0.0 cfs @ 12.35 hrs, Volume= 286 cf, Atten= 62%, Lag= 15.8 min
Discarded = 0.0 cfs @ 12.35 hrs, Volume= 286 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 10.45' @ 12.35 hrs Surf.Area= 122 sf Storage= 46 cf

Plug-Flow detention time= 7.8 min calculated for 286 cf (100% of inflow)
Center-of-Mass det. time= 7.8 min ( 824.2 - 816.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 172 cf | **3.04'W x 40.00'L x 3.88'H Field A**<br>472 cf Overall - 42 cf Embedded = 430 cf x 40.0% Voids |
| #2A | 11.17' | 32 cf | **ADS N-12 12** x 2 Inside #1<br>Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf<br>Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf |
| | | 204 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.0 cfs @ 12.35 hrs HW=10.45' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.0 cfs)

## Pond Infiltration Trench: - Chamber Wizard Field A

**Chamber Model = ADS N-12 12**
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

14.5" Wide + 0.0" Spacing = 14.5" C-C

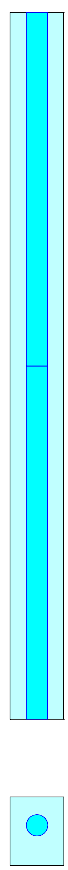
2 Chambers/Row x 20.00' Long = 40.00' Base Length
1 Rows x 14.5" Wide + 11.0" Side Stone x 2 = 3.04' Base Width
20.0" Base + 14.5" Chamber Height + 12.0" Cover = 3.88' Field Height

2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

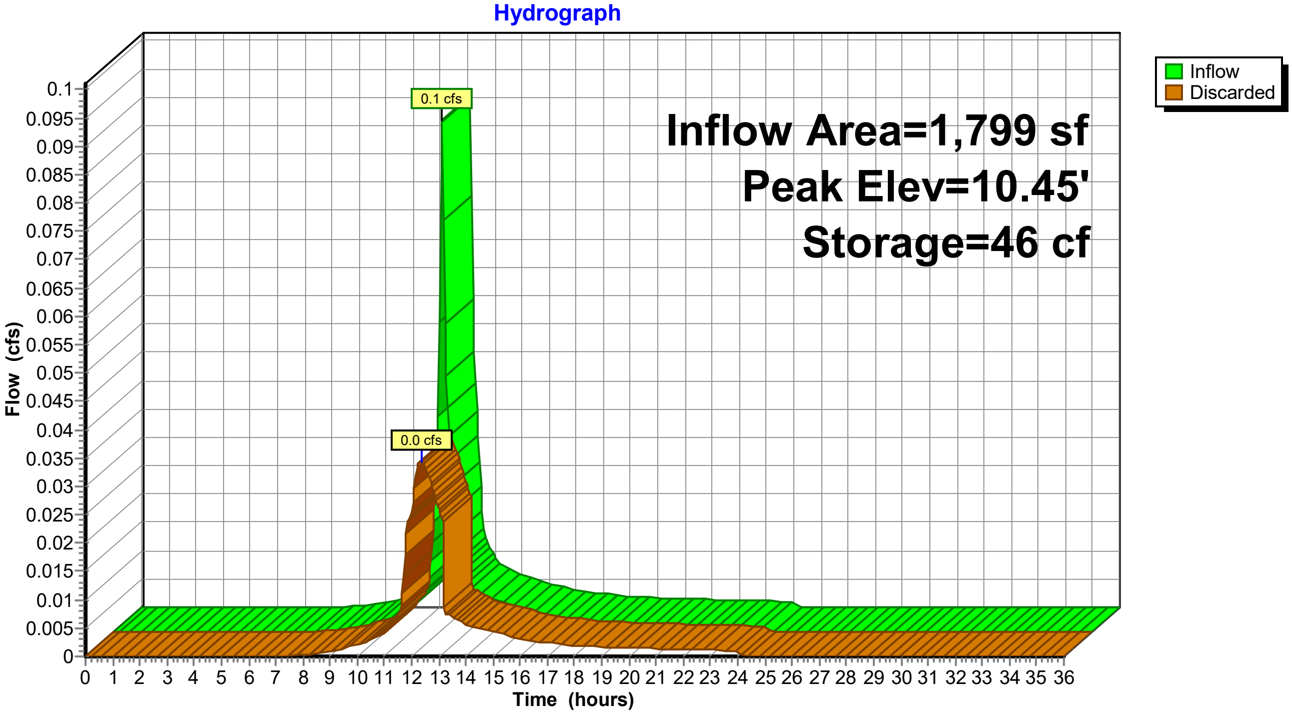
471.6 cf Field - 41.9 cf Chambers = 429.8 cf Stone x 40.0% Voids = 171.9 cf Stone Storage

Stone + Chamber Storage = 204.3 cf = 0.005 af

2 Chambers @ $ 0.00 /ea = $ 0.00
17.5 cy Field Excavation @ $ 0.00 /cy = $ 0.00
15.9 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00



## Pond Infiltration Trench:



## Summary for Pond System A:

Inflow Area = 8,141 sf, 78.69% Impervious, Inflow Depth = 1.67" for 2-Year event
Inflow = 0.4 cfs @ 12.09 hrs, Volume= 1,135 cf
Outflow = 0.1 cfs @ 12.40 hrs, Volume= 1,135 cf, Atten= 65%, Lag= 18.2 min
Discarded = 0.1 cfs @ 12.40 hrs, Volume= 1,135 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 10.26' @ 12.40 hrs Surf.Area= 479 sf Storage= 194 cf

Plug-Flow detention time= 8.6 min calculated for 1,133 cf (100% of inflow)
Center-of-Mass det. time= 8.6 min ( 836.1 - 827.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 450 cf | **20.50'W x 23.36'L x 3.50'H Field A**<br>1,676 cf Overall - 551 cf Embedded = 1,125 cf x 40.0% Voids |
| #2A | 10.00' | 551 cf | **StormTech SC-740** x 12 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,001 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.1 cfs @ 12.40 hrs HW=10.26' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.1 cfs)

## Pond System A: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C

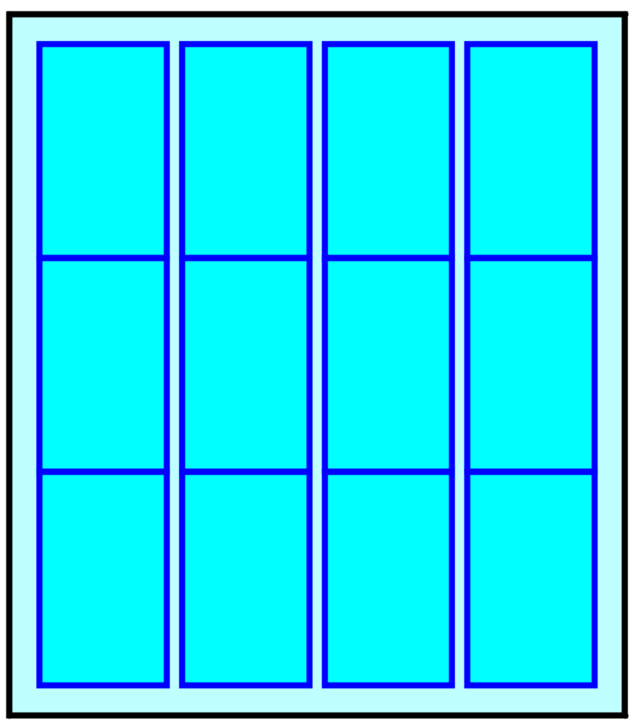
3 Chambers/Row x 7.12' Long = 21.36' + 12.0" End Stone x 2 = 23.36' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

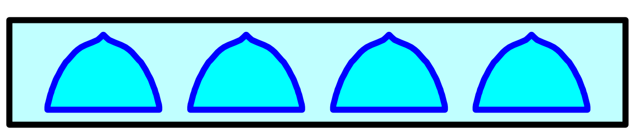
12 Chambers x 45.9 cf = 551.3 cf Chamber Storage

1,676.1 cf Field - 551.3 cf Chambers = 1,124.8 cf Stone x 40.0% Voids = 449.9 cf Stone Storage

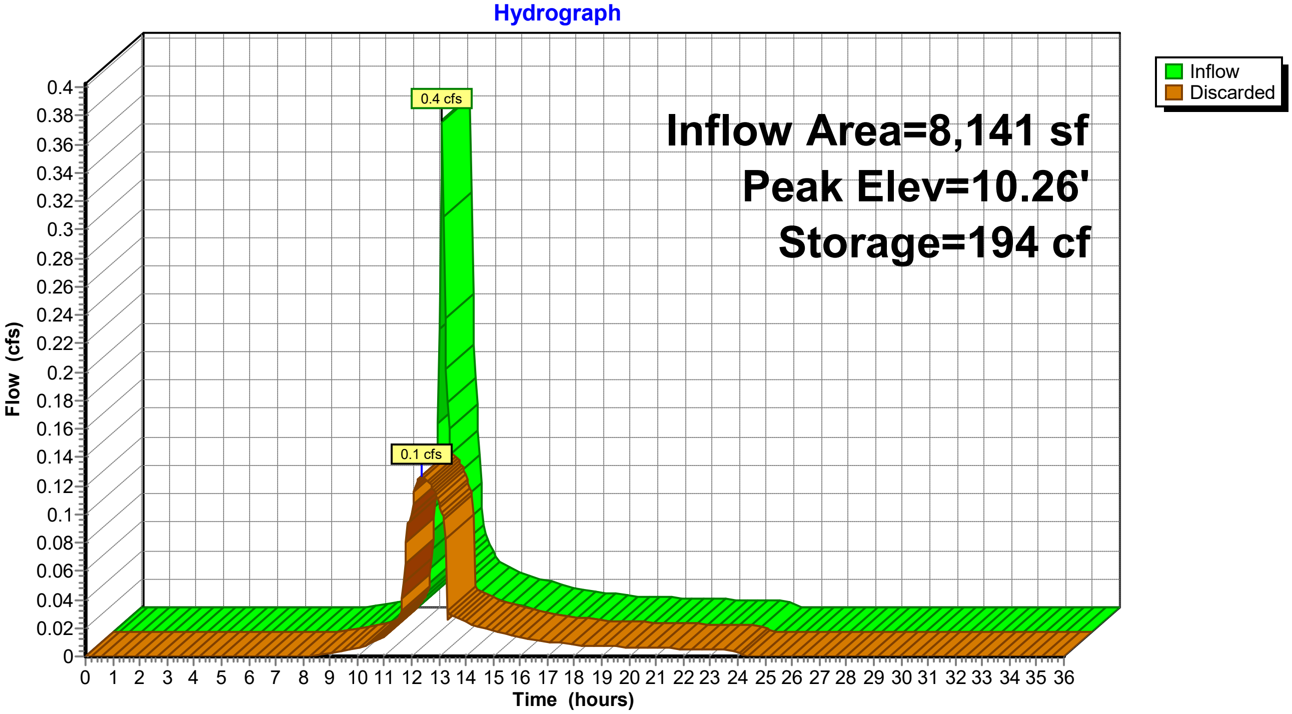
Stone + Chamber Storage = 1,001.2 cf = 0.023 af

12 Chambers @ $ 0.00 /ea = $ 0.00
62.1 cy Field Excavation @ $ 0.00 /cy = $ 0.00
41.7 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System A:



## Summary for Pond System B:

Inflow Area = 14,166 sf, 74.40% Impervious, Inflow Depth = 1.53" for 2-Year event
Inflow = 0.6 cfs @ 12.09 hrs, Volume= 1,803 cf
Outflow = 0.2 cfs @ 12.41 hrs, Volume= 1,803 cf, Atten= 65%, Lag= 18.7 min
Discarded = 0.2 cfs @ 12.41 hrs, Volume= 1,803 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 8.11' @ 12.41 hrs Surf.Area= 671 sf Storage= 326 cf

Plug-Flow detention time= 9.9 min calculated for 1,801 cf (100% of inflow)
Center-of-Mass det. time= 9.9 min ( 844.4 - 834.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 7.00' | 913 cf | **22.00'W x 30.48'L x 4.50'H Field A** |
| | | | 3,018 cf Overall - 735 cf Embedded = 2,282 cf x 40.0% Voids |
| #2A | 8.00' | 735 cf | **StormTech SC-740** x 16 Inside #1 |
| | | | Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf |
| | | | Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,648 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 7.00' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 5.00' |

**Discarded OutFlow** Max=0.2 cfs @ 12.41 hrs HW=8.11' (Free Discharge)
└**1=Exfiltration** ( Controls 0.2 cfs)

## Pond System B: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 12.0" Spacing = 63.0" C-C

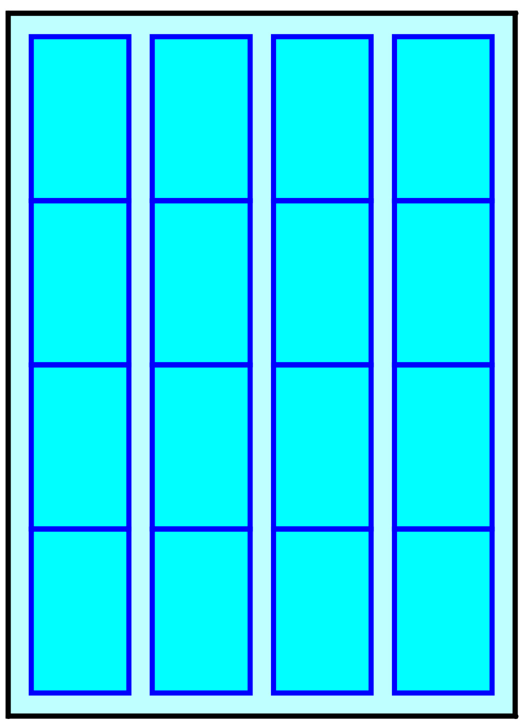
4 Chambers/Row x 7.12' Long = 28.48' + 12.0" End Stone x 2 = 30.48' Base Length
4 Rows x 51.0" Wide + 12.0" Spacing x 3 + 12.0" Side Stone x 2 = 22.00' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

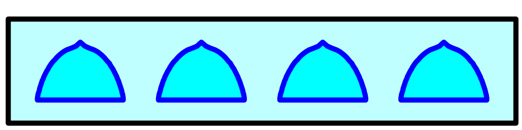
16 Chambers x 45.9 cf = 735.0 cf Chamber Storage

3,017.5 cf Field - 735.0 cf Chambers = 2,282.5 cf Stone x 40.0% Voids = 913.0 cf Stone Storage

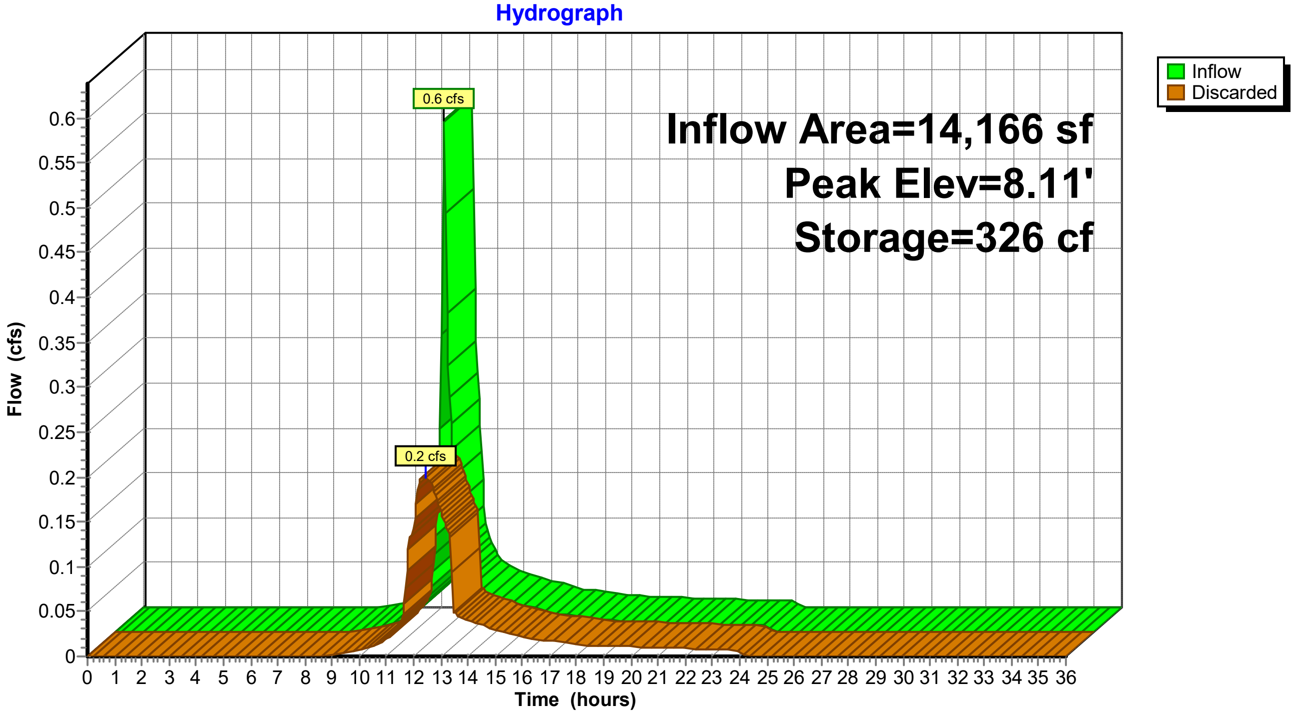
Stone + Chamber Storage = 1,648.0 cf = 0.038 af

16 Chambers @ $ 0.00 /ea = $ 0.00
111.8 cy Field Excavation @ $ 0.00 /cy = $ 0.00
84.5 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System B:



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PWA-1:** Runoff Area=4,463 sf 0.00% Impervious Runoff Depth=0.11"
Tc=6.0 min CN=39 Runoff=0.0 cfs 41 cf

**Subcatchment PWA-2:** Runoff Area=2,868 sf 0.00% Impervious Runoff Depth=0.11"
Tc=6.0 min CN=39 Runoff=0.0 cfs 26 cf

**Subcatchment PWA-3:** Runoff Area=1,799 sf 83.10% Impervious Runoff Depth=3.20"
Tc=6.0 min CN=88 Runoff=0.1 cfs 479 cf

**Subcatchment PWA-4:** Runoff Area=8,141 sf 78.69% Impervious Runoff Depth=2.91"
Tc=6.0 min CN=85 Runoff=0.6 cfs 1,974 cf

**Subcatchment PWA-5:** Runoff Area=14,166 sf 74.40% Impervious Runoff Depth=2.73"
Tc=6.0 min CN=83 Runoff=1.0 cfs 3,218 cf

**Pond Infiltration Trench:** Peak Elev=11.56' Storage=103 cf Inflow=0.1 cfs 479 cf
Outflow=0.0 cfs 479 cf

**Pond System A:** Peak Elev=11.04' Storage=482 cf Inflow=0.6 cfs 1,974 cf
Outflow=0.2 cfs 1,974 cf

**Pond System B:** Peak Elev=9.09' Storage=819 cf Inflow=1.0 cfs 3,218 cf
Outflow=0.3 cfs 3,218 cf

**Total Runoff Area = 31,437 sf Runoff Volume = 5,738 cf Average Runoff Depth = 2.19"**
**41.34% Pervious = 12,996 sf 58.66% Impervious = 18,441 sf**

## Summary for Subcatchment PWA-1:

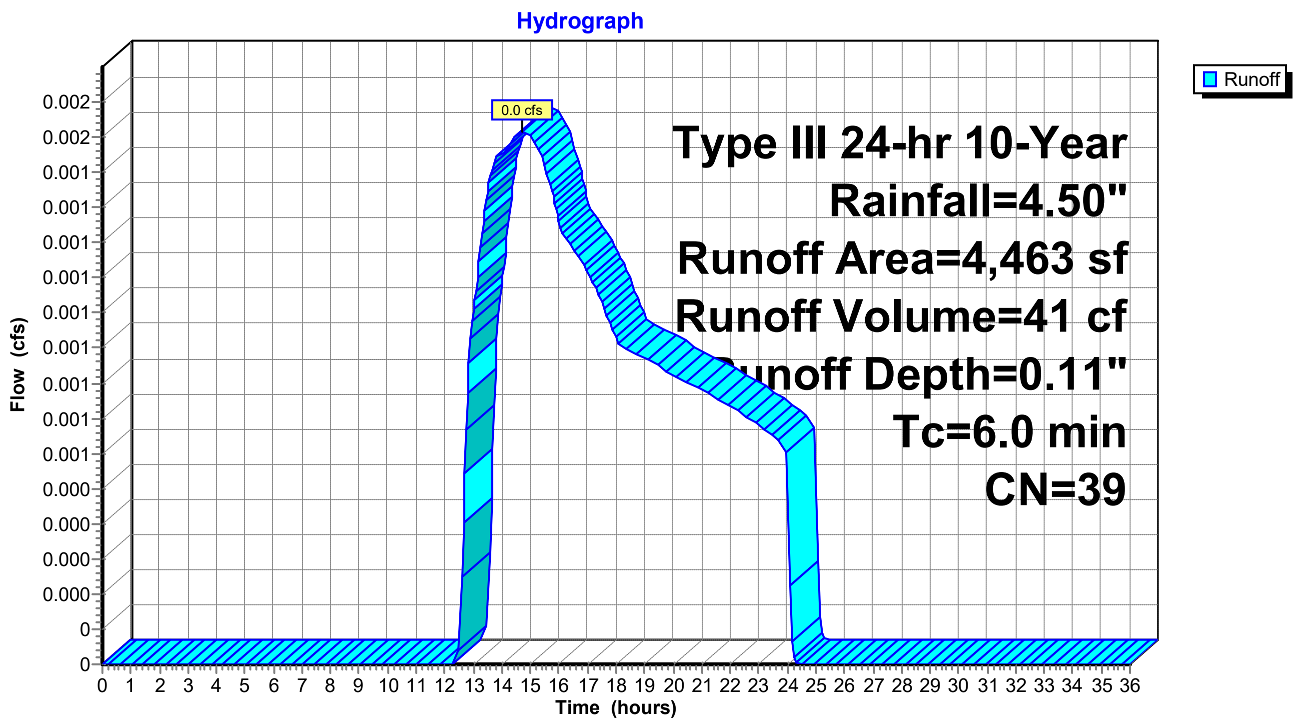
Runoff = 0.0 cfs @ 14.71 hrs, Volume= 41 cf, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 4,463 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 4,463 | 39 | Weighted Average |
| 4,463 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-1:



## Summary for Subcatchment PWA-2:

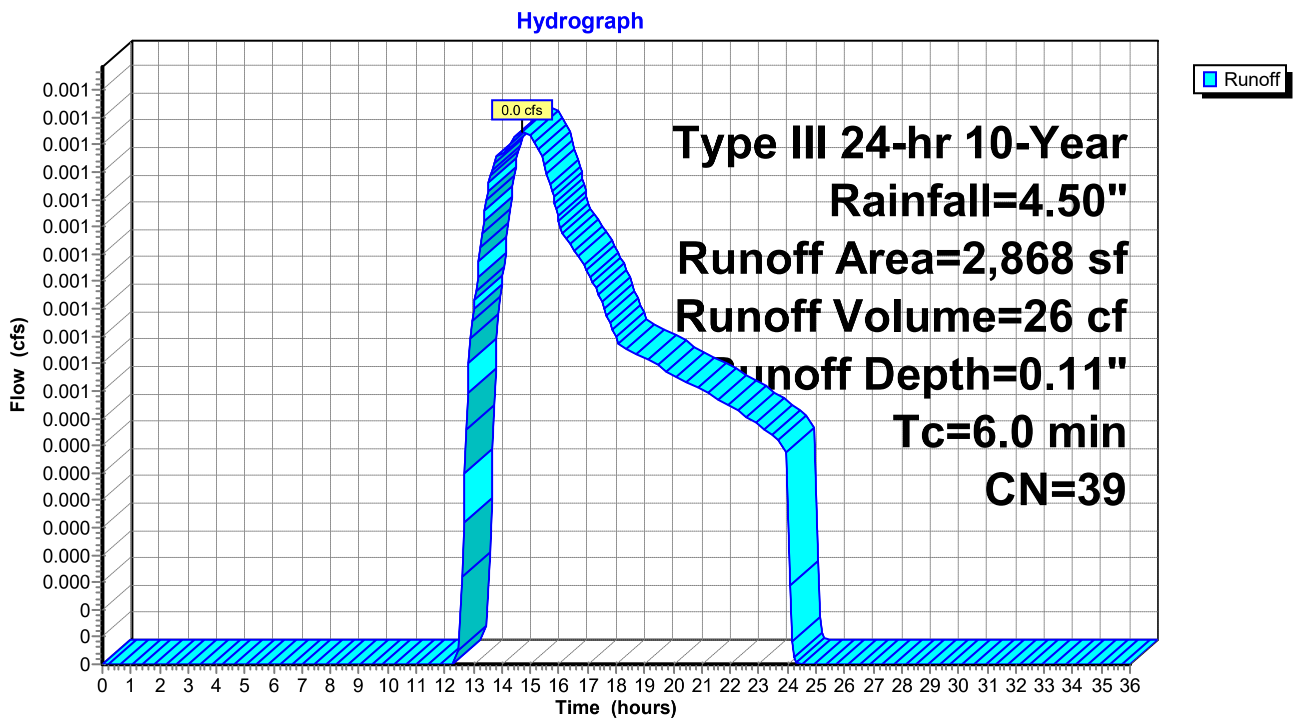
Runoff = 0.0 cfs @ 14.71 hrs, Volume= 26 cf, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 2,868 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 2,868 | 39 | Weighted Average |
| 2,868 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-2:



## Summary for Subcatchment PWA-3:

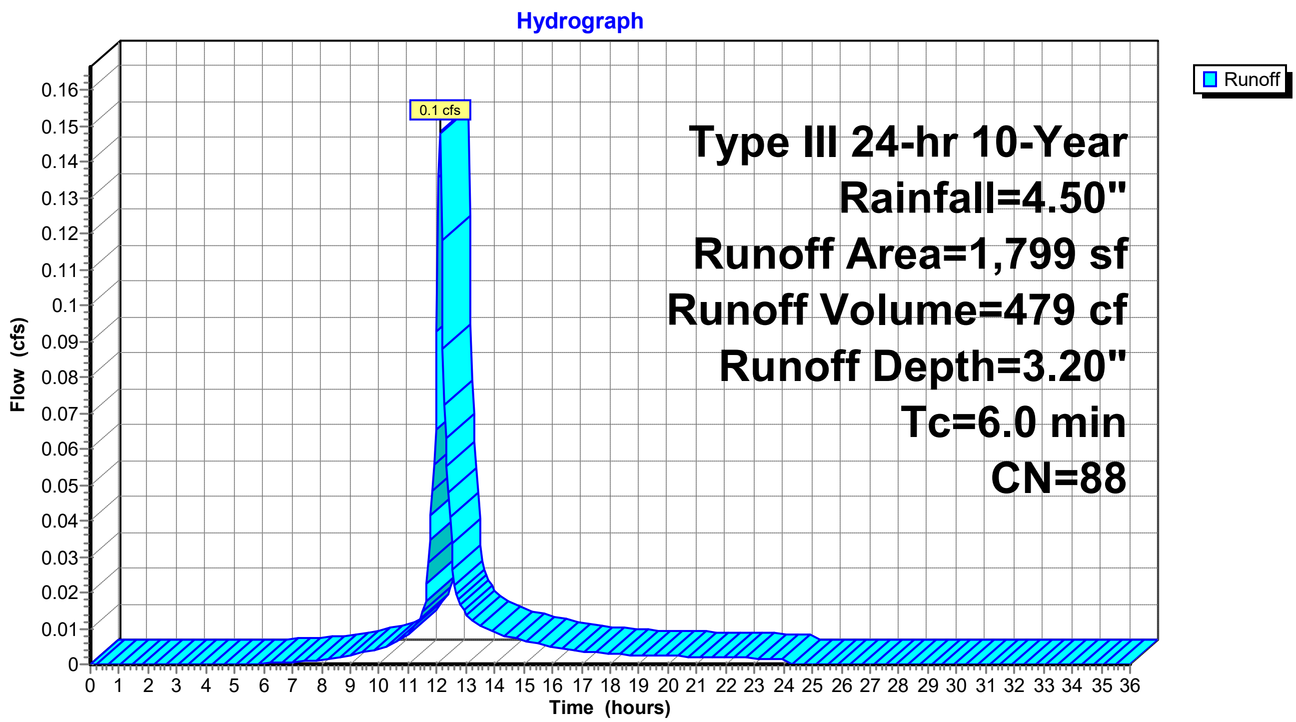
Runoff = 0.1 cfs @ 12.09 hrs, Volume= 479 cf, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 828 | 98 | Roofs, HSG A |
| 667 | 98 | Paved parking, HSG A |
| 304 | 39 | >75% Grass cover, Good, HSG A |
| 1,799 | 88 | Weighted Average |
| 304 | | 16.90% Pervious Area |
| 1,495 | | 83.10% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-3:



## Summary for Subcatchment PWA-4:

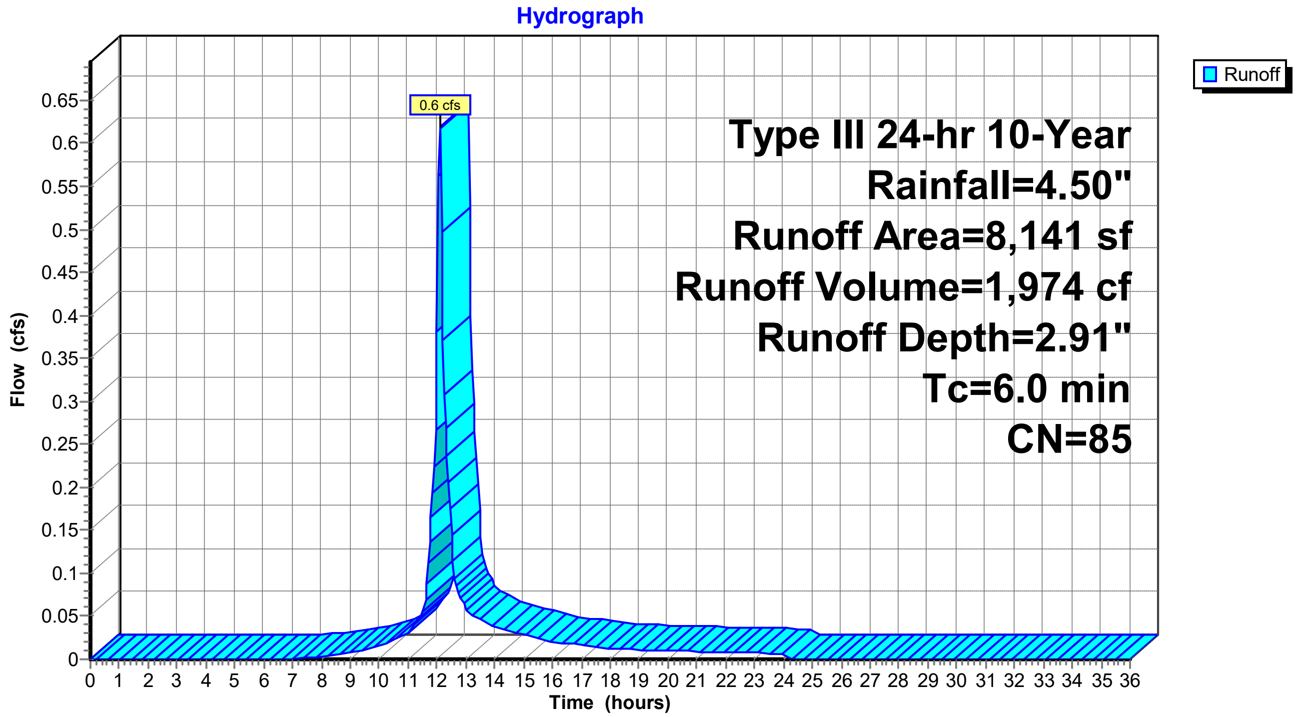
Runoff = 0.6 cfs @ 12.09 hrs, Volume= 1,974 cf, Depth= 2.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 3,525 | 98 | Roofs, HSG A |
| 2,881 | 98 | Paved parking, HSG A |
| 1,735 | 39 | >75% Grass cover, Good, HSG A |
| 8,141 | 85 | Weighted Average |
| 1,735 | | 21.31% Pervious Area |
| 6,406 | | 78.69% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-4:



## Summary for Subcatchment PWA-5:

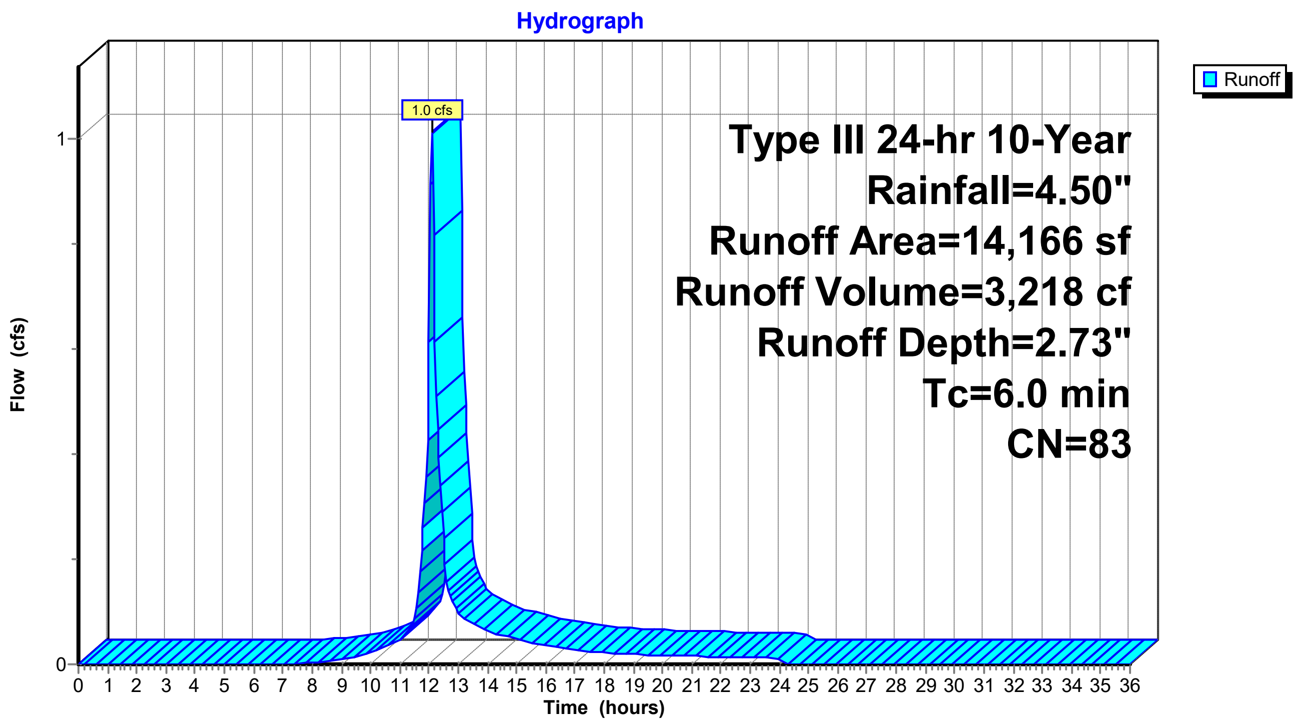
Runoff = 1.0 cfs @ 12.09 hrs, Volume= 3,218 cf, Depth= 2.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

| Area (sf) | CN | Description |
|---|---|---|
| 6,226 | 98 | Roofs, HSG A |
| 4,314 | 98 | Paved parking, HSG A |
| 3,626 | 39 | >75% Grass cover, Good, HSG A |
| 14,166 | 83 | Weighted Average |
| 3,626 | | 25.60% Pervious Area |
| 10,540 | | 74.40% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-5:



## Summary for Pond Infiltration Trench:

Inflow Area = 1,799 sf, 83.10% Impervious, Inflow Depth = 3.20" for 10-Year event
Inflow = 0.1 cfs @ 12.09 hrs, Volume= 479 cf
Outflow = 0.0 cfs @ 12.41 hrs, Volume= 479 cf, Atten= 68%, Lag= 19.0 min
Discarded = 0.0 cfs @ 12.41 hrs, Volume= 479 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 11.56' @ 12.41 hrs Surf.Area= 122 sf Storage= 103 cf

Plug-Flow detention time= 14.3 min calculated for 479 cf (100% of inflow)
Center-of-Mass det. time= 14.3 min ( 816.1 - 801.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 172 cf | **3.04'W x 40.00'L x 3.88'H Field A**<br>472 cf Overall - 42 cf Embedded = 430 cf x 40.0% Voids |
| #2A | 11.17' | 32 cf | **ADS N-12 12** x 2 Inside #1<br>Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf<br>Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf |
| | | 204 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.0 cfs @ 12.41 hrs HW=11.56' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.0 cfs)

## Pond Infiltration Trench: - Chamber Wizard Field A

**Chamber Model = ADS N-12 12**
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

14.5" Wide + 0.0" Spacing = 14.5" C-C

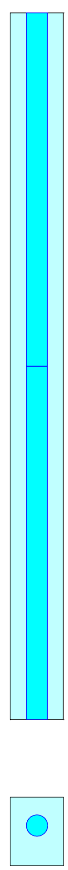
2 Chambers/Row x 20.00' Long = 40.00' Base Length
1 Rows x 14.5" Wide + 11.0" Side Stone x 2 = 3.04' Base Width
20.0" Base + 14.5" Chamber Height + 12.0" Cover = 3.88' Field Height

2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

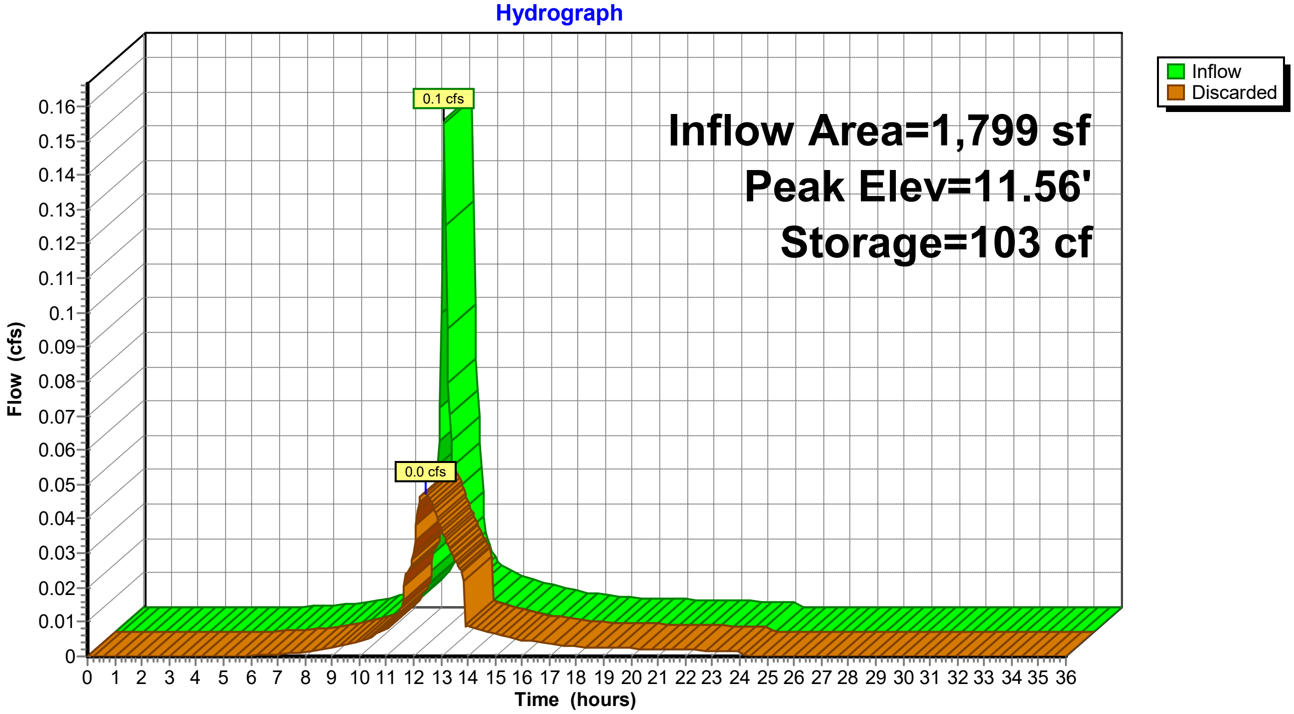
471.6 cf Field - 41.9 cf Chambers = 429.8 cf Stone x 40.0% Voids = 171.9 cf Stone Storage

Stone + Chamber Storage = 204.3 cf = 0.005 af

2 Chambers @ $ 0.00 /ea = $ 0.00
17.5 cy Field Excavation @ $ 0.00 /cy = $ 0.00
15.9 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00



## Pond Infiltration Trench:



## Summary for Pond System A:

Inflow Area = 8,141 sf, 78.69% Impervious, Inflow Depth = 2.91" for 10-Year event
Inflow = 0.6 cfs @ 12.09 hrs, Volume= 1,974 cf
Outflow = 0.2 cfs @ 12.47 hrs, Volume= 1,974 cf, Atten= 74%, Lag= 22.8 min
Discarded = 0.2 cfs @ 12.47 hrs, Volume= 1,974 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 11.04' @ 12.47 hrs Surf.Area= 479 sf Storage= 482 cf

Plug-Flow detention time= 19.4 min calculated for 1,971 cf (100% of inflow)
Center-of-Mass det. time= 19.4 min ( 831.1 - 811.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 450 cf | **20.50'W x 23.36'L x 3.50'H Field A** |
| | | | 1,676 cf Overall - 551 cf Embedded = 1,125 cf x 40.0% Voids |
| #2A | 10.00' | 551 cf | **StormTech SC-740** x 12 Inside #1 |
| | | | Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf |
| | | | Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,001 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.2 cfs @ 12.47 hrs HW=11.04' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.2 cfs)

## Pond System A: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C

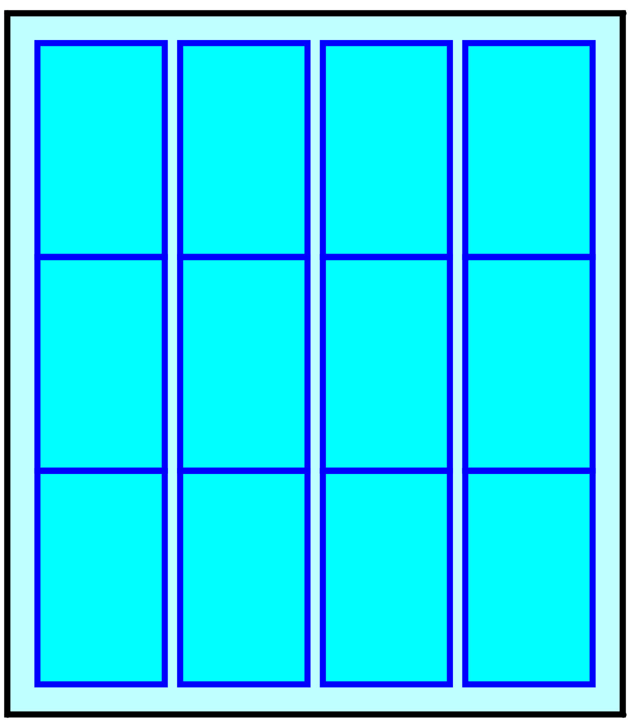
3 Chambers/Row x 7.12' Long = 21.36' + 12.0" End Stone x 2 = 23.36' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

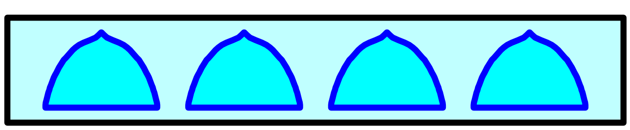
12 Chambers x 45.9 cf = 551.3 cf Chamber Storage

1,676.1 cf Field - 551.3 cf Chambers = 1,124.8 cf Stone x 40.0% Voids = 449.9 cf Stone Storage

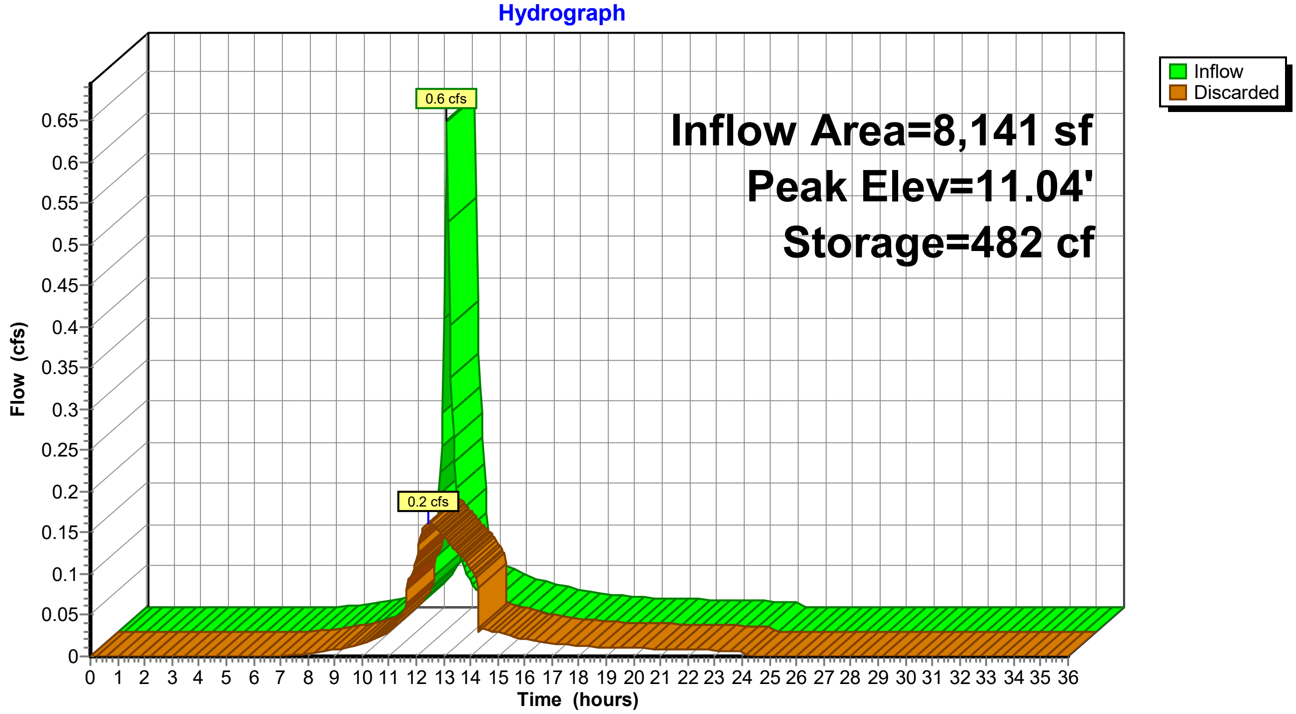
Stone + Chamber Storage = 1,001.2 cf = 0.023 af

12 Chambers @ $ 0.00 /ea = $ 0.00
62.1 cy Field Excavation @ $ 0.00 /cy = $ 0.00
41.7 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System A:



## Summary for Pond System B:

Inflow Area = 14,166 sf, 74.40% Impervious, Inflow Depth = 2.73" for 10-Year event
Inflow = 1.0 cfs @ 12.09 hrs, Volume= 3,218 cf
Outflow = 0.3 cfs @ 12.48 hrs, Volume= 3,218 cf, Atten= 74%, Lag= 23.2 min
Discarded = 0.3 cfs @ 12.48 hrs, Volume= 3,218 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 9.09' @ 12.48 hrs Surf.Area= 671 sf Storage= 819 cf

Plug-Flow detention time= 21.6 min calculated for 3,218 cf (100% of inflow)
Center-of-Mass det. time= 21.6 min ( 839.4 - 817.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 7.00' | 913 cf | **22.00'W x 30.48'L x 4.50'H Field A**<br>3,018 cf Overall - 735 cf Embedded = 2,282 cf x 40.0% Voids |
| #2A | 8.00' | 735 cf | **StormTech SC-740** x 16 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,648 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 7.00' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 5.00' |

**Discarded OutFlow** Max=0.3 cfs @ 12.48 hrs HW=9.09' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.3 cfs)

## Pond System B: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 12.0" Spacing = 63.0" C-C

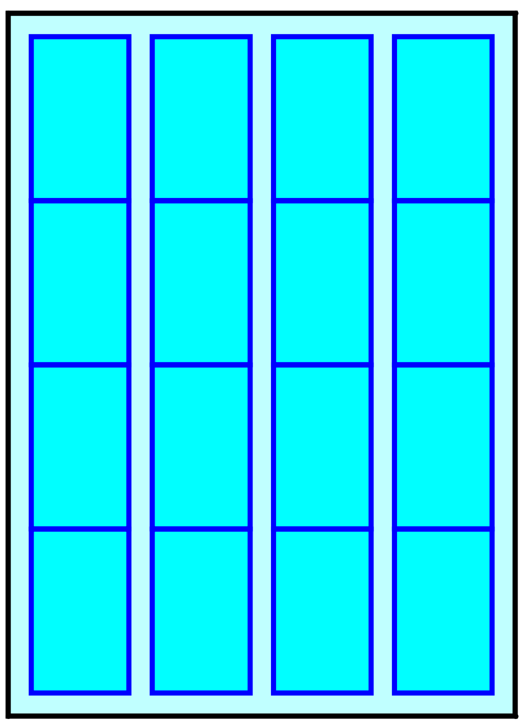
4 Chambers/Row x 7.12' Long = 28.48' + 12.0" End Stone x 2 = 30.48' Base Length
4 Rows x 51.0" Wide + 12.0" Spacing x 3 + 12.0" Side Stone x 2 = 22.00' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

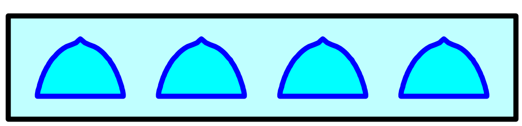
16 Chambers x 45.9 cf = 735.0 cf Chamber Storage

3,017.5 cf Field - 735.0 cf Chambers = 2,282.5 cf Stone x 40.0% Voids = 913.0 cf Stone Storage

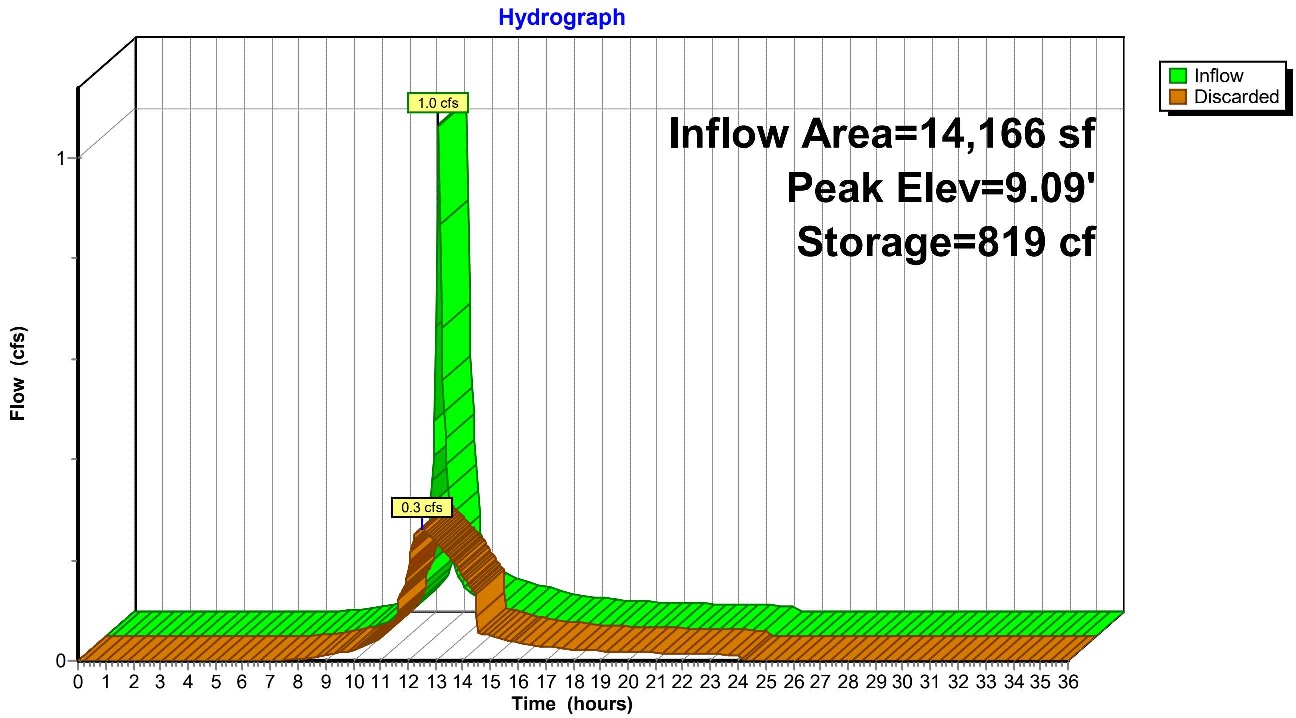
Stone + Chamber Storage = 1,648.0 cf = 0.038 af

16 Chambers @ $ 0.00 /ea = $ 0.00
111.8 cy Field Excavation @ $ 0.00 /cy = $ 0.00
84.5 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System B:



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PWA-1:** Runoff Area=4,463 sf 0.00% Impervious Runoff Depth=0.26"
Tc=6.0 min CN=39 Runoff=0.0 cfs 98 cf

**Subcatchment PWA-2:** Runoff Area=2,868 sf 0.00% Impervious Runoff Depth=0.26"
Tc=6.0 min CN=39 Runoff=0.0 cfs 63 cf

**Subcatchment PWA-3:** Runoff Area=1,799 sf 83.10% Impervious Runoff Depth=3.95"
Tc=6.0 min CN=88 Runoff=0.2 cfs 593 cf

**Subcatchment PWA-4:** Runoff Area=8,141 sf 78.69% Impervious Runoff Depth=3.65"
Tc=6.0 min CN=85 Runoff=0.8 cfs 2,474 cf

**Subcatchment PWA-5:** Runoff Area=14,166 sf 74.40% Impervious Runoff Depth=3.45"
Tc=6.0 min CN=83 Runoff=1.3 cfs 4,069 cf

**Pond Infiltration Trench:** Peak Elev=12.07' Storage=140 cf Inflow=0.2 cfs 593 cf
Outflow=0.1 cfs 593 cf

**Pond System A:** Peak Elev=11.57' Storage=658 cf Inflow=0.8 cfs 2,474 cf
Outflow=0.2 cfs 2,474 cf

**Pond System B:** Peak Elev=9.76' Storage=1,123 cf Inflow=1.3 cfs 4,069 cf
Outflow=0.3 cfs 4,069 cf

**Total Runoff Area = 31,437 sf Runoff Volume = 7,297 cf Average Runoff Depth = 2.79"**
**41.34% Pervious = 12,996 sf 58.66% Impervious = 18,441 sf**

## Summary for Subcatchment PWA-1:

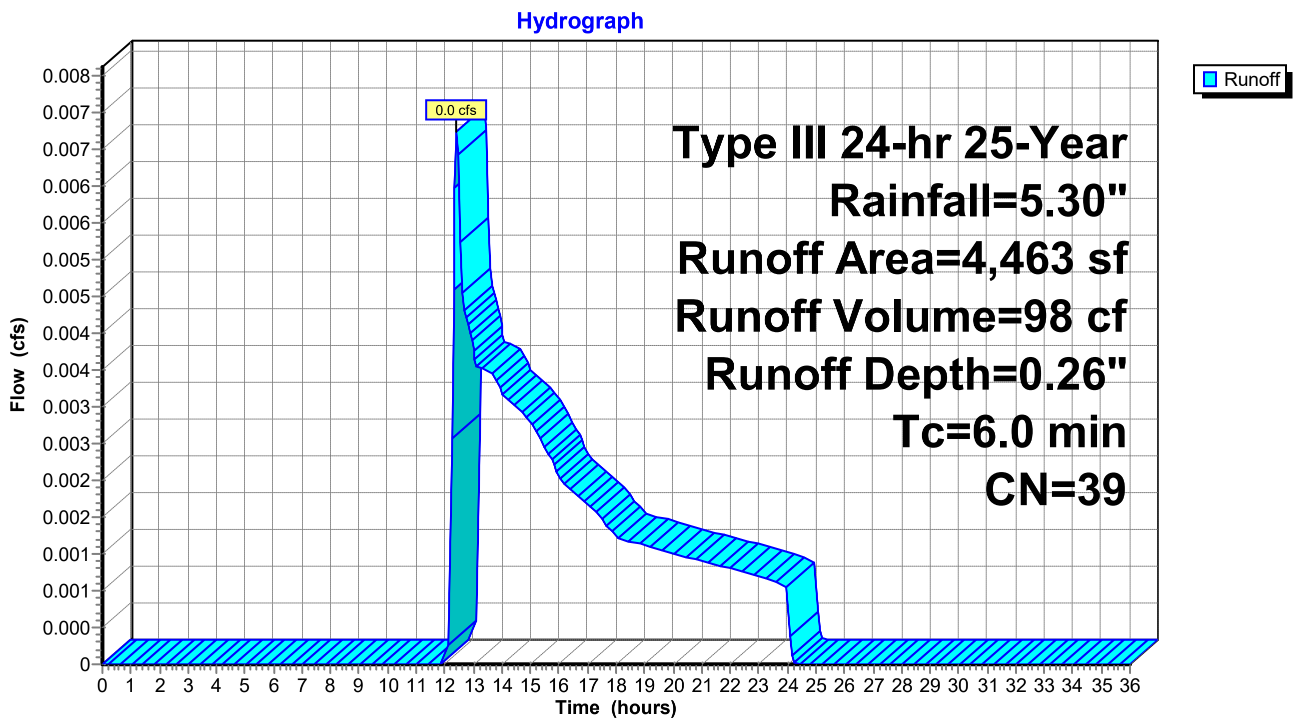
Runoff = 0.0 cfs @ 12.43 hrs, Volume= 98 cf, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

| Area (sf) | CN | Description |
|---|---|---|
| 4,463 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 4,463 | 39 | Weighted Average |
| 4,463 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

### Subcatchment PWA-1:



## Summary for Subcatchment PWA-2:

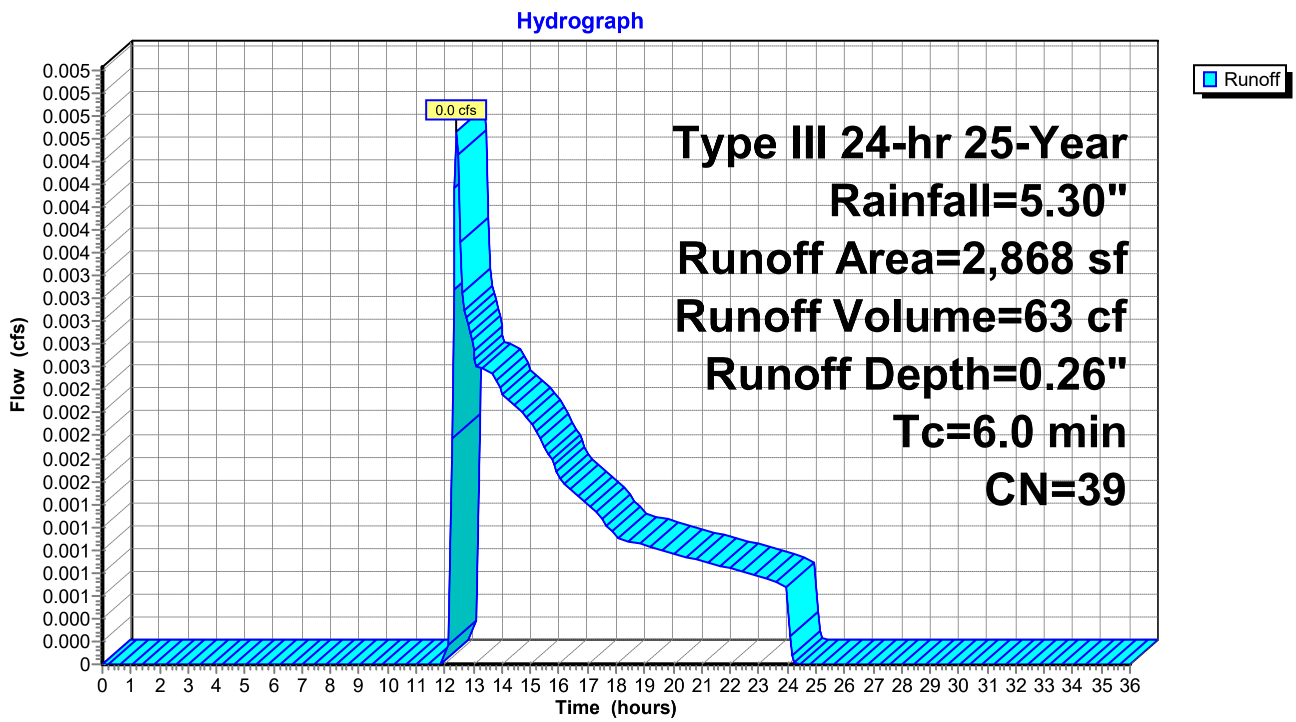
Runoff = 0.0 cfs @ 12.43 hrs, Volume= 63 cf, Depth= 0.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

| Area (sf) | CN | Description |
|---|---|---|
| 2,868 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 2,868 | 39 | Weighted Average |
| 2,868 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

### Subcatchment PWA-2:



## Summary for Subcatchment PWA-3:

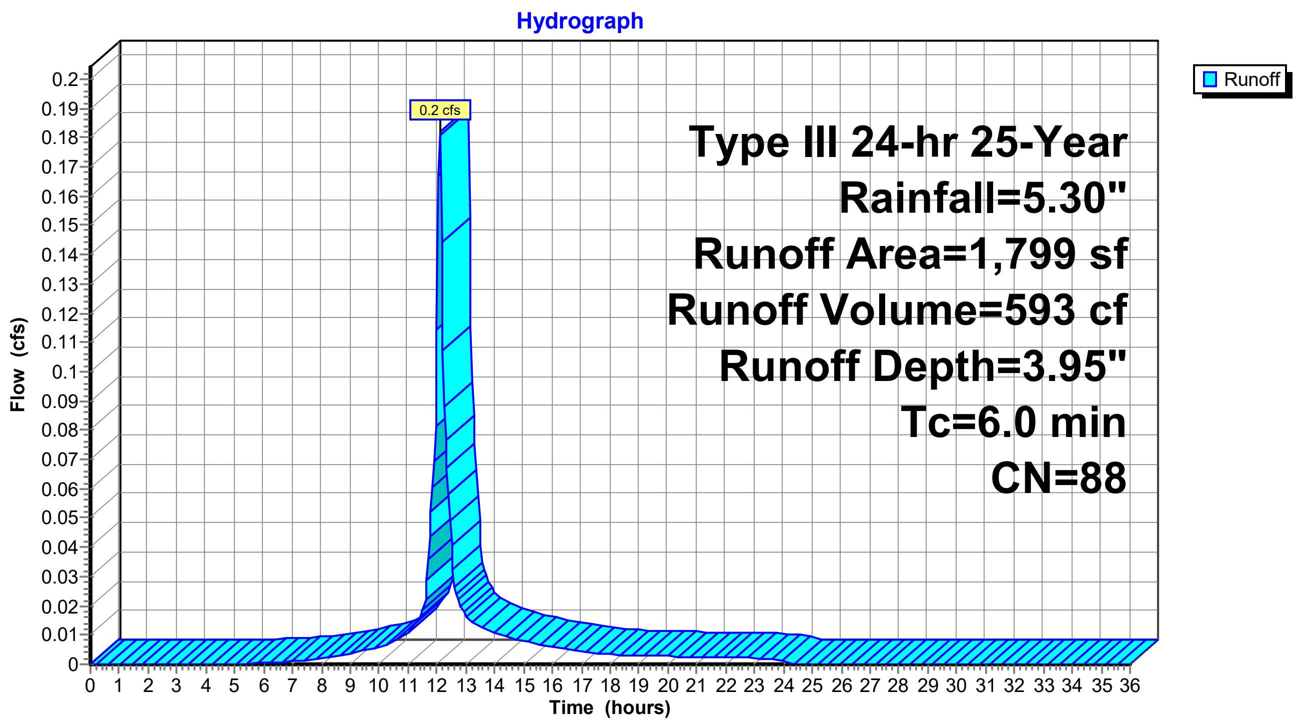
Runoff = 0.2 cfs @ 12.09 hrs, Volume= 593 cf, Depth= 3.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

| Area (sf) | CN | Description |
|---|---|---|
| 828 | 98 | Roofs, HSG A |
| 667 | 98 | Paved parking, HSG A |
| 304 | 39 | >75% Grass cover, Good, HSG A |
| 1,799 | 88 | Weighted Average |
| 304 | | 16.90% Pervious Area |
| 1,495 | | 83.10% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-3:



## Summary for Subcatchment PWA-4:

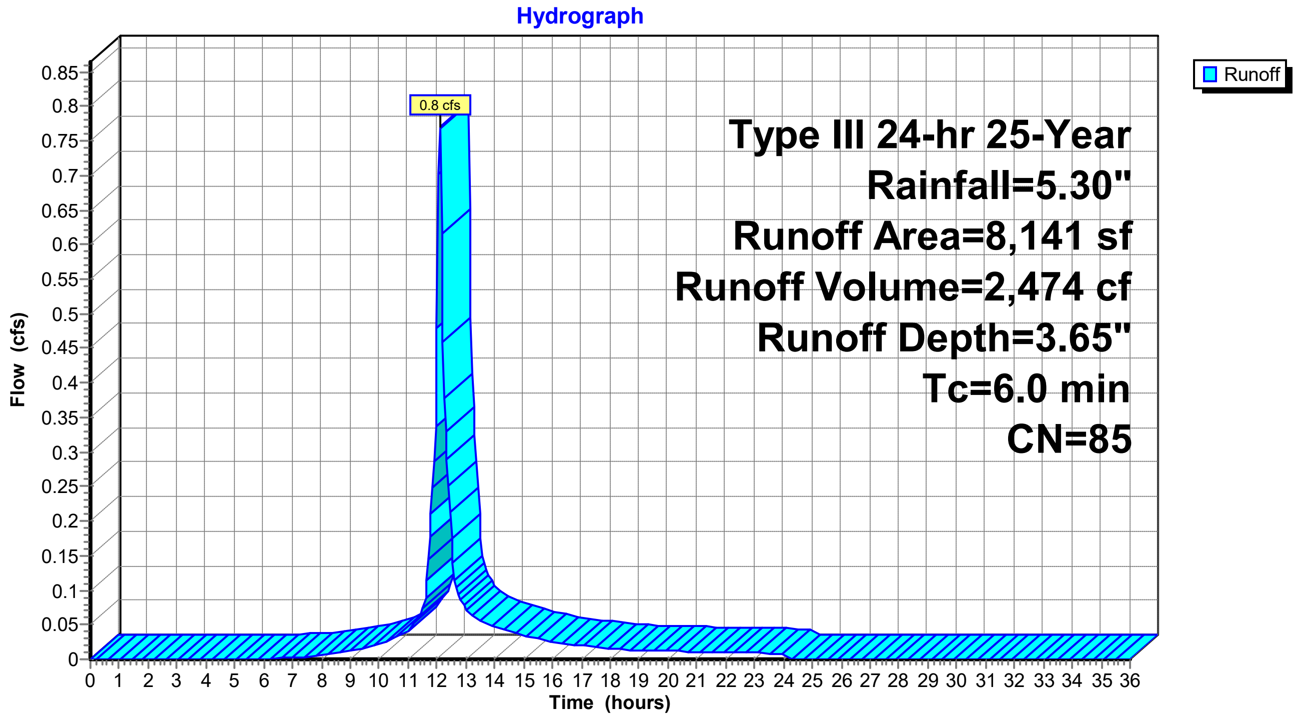
Runoff = 0.8 cfs @ 12.09 hrs, Volume= 2,474 cf, Depth= 3.65"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

| Area (sf) | CN | Description |
|---|---|---|
| 3,525 | 98 | Roofs, HSG A |
| 2,881 | 98 | Paved parking, HSG A |
| 1,735 | 39 | >75% Grass cover, Good, HSG A |
| 8,141 | 85 | Weighted Average |
| 1,735 | | 21.31% Pervious Area |
| 6,406 | | 78.69% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-4:



## Summary for Subcatchment PWA-5:

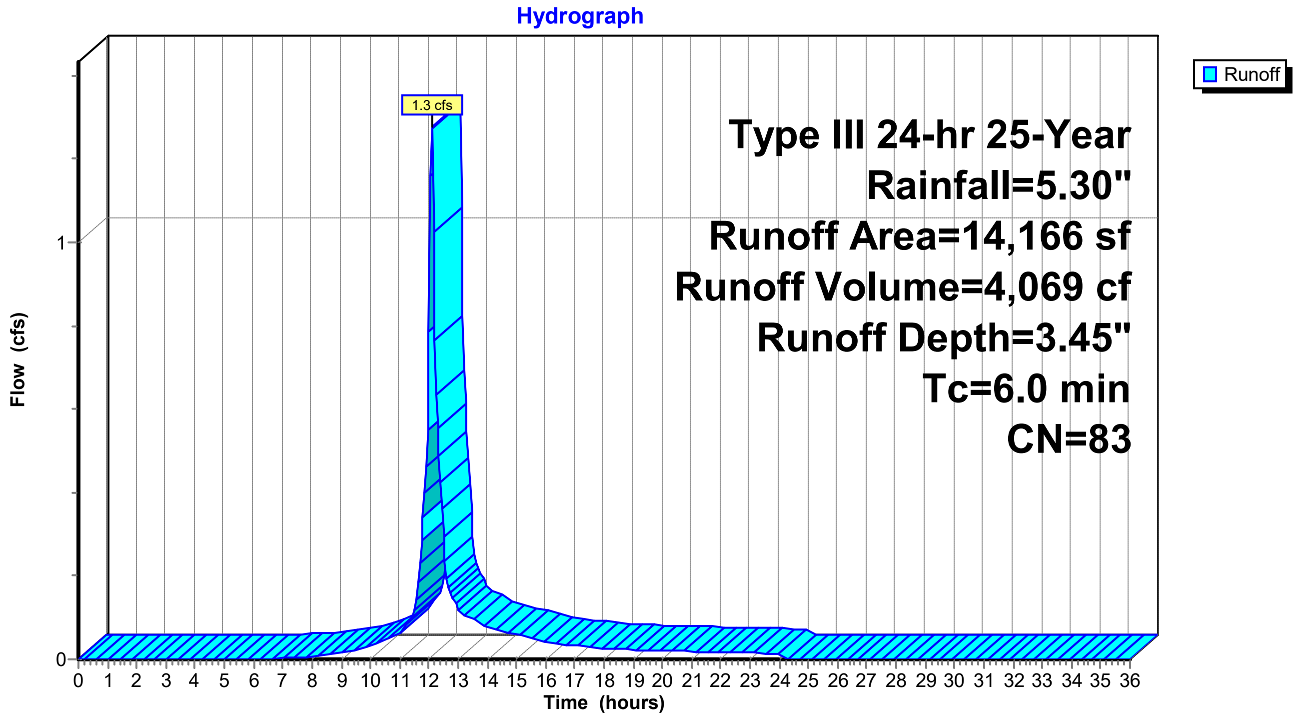
Runoff = 1.3 cfs @ 12.09 hrs, Volume= 4,069 cf, Depth= 3.45"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=5.30"

| Area (sf) | CN | Description |
|---|---|---|
| 6,226 | 98 | Roofs, HSG A |
| 4,314 | 98 | Paved parking, HSG A |
| 3,626 | 39 | >75% Grass cover, Good, HSG A |
| 14,166 | 83 | Weighted Average |
| 3,626 | | 25.60% Pervious Area |
| 10,540 | | 74.40% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-5:



## Summary for Pond Infiltration Trench:

Inflow Area = 1,799 sf, 83.10% Impervious, Inflow Depth = 3.95" for 25-Year event
Inflow = 0.2 cfs @ 12.09 hrs, Volume= 593 cf
Outflow = 0.1 cfs @ 12.43 hrs, Volume= 593 cf, Atten= 71%, Lag= 20.3 min
Discarded = 0.1 cfs @ 12.43 hrs, Volume= 593 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 12.07' @ 12.43 hrs Surf.Area= 122 sf Storage= 140 cf

Plug-Flow detention time= 17.7 min calculated for 592 cf (100% of inflow)
Center-of-Mass det. time= 17.7 min ( 813.5 - 795.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 172 cf | **3.04'W x 40.00'L x 3.88'H Field A** |
| | | | 472 cf Overall - 42 cf Embedded = 430 cf x 40.0% Voids |
| #2A | 11.17' | 32 cf | **ADS N-12 12** x 2 Inside #1 |
| | | | Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf |
| | | | Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf |
| | | 204 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.1 cfs @ 12.43 hrs HW=12.07' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.1 cfs)

## Pond Infiltration Trench: - Chamber Wizard Field A

**Chamber Model = ADS N-12 12**
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

14.5" Wide + 0.0" Spacing = 14.5" C-C

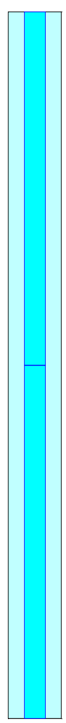
2 Chambers/Row x 20.00' Long = 40.00' Base Length
1 Rows x 14.5" Wide + 11.0" Side Stone x 2 = 3.04' Base Width
20.0" Base + 14.5" Chamber Height + 12.0" Cover = 3.88' Field Height

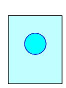
2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

471.6 cf Field - 41.9 cf Chambers = 429.8 cf Stone x 40.0% Voids = 171.9 cf Stone Storage

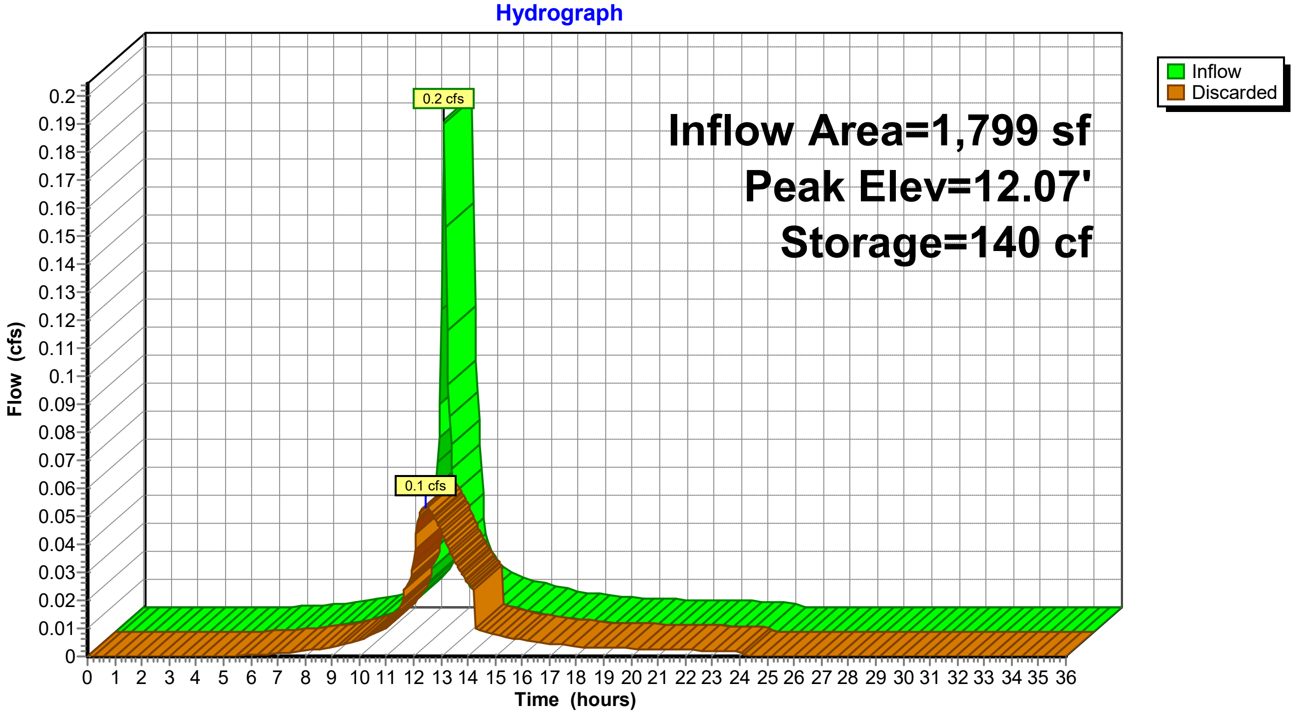
Stone + Chamber Storage = 204.3 cf = 0.005 af

2 Chambers @ $ 0.00 /ea = $ 0.00
17.5 cy Field Excavation @ $ 0.00 /cy = $ 0.00
15.9 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond Infiltration Trench:



## Summary for Pond System A:

Inflow Area = 8,141 sf, 78.69% Impervious, Inflow Depth = 3.65" for 25-Year event
Inflow = 0.8 cfs @ 12.09 hrs, Volume= 2,474 cf
Outflow = 0.2 cfs @ 12.49 hrs, Volume= 2,474 cf, Atten= 76%, Lag= 23.8 min
Discarded = 0.2 cfs @ 12.49 hrs, Volume= 2,474 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 11.57' @ 12.49 hrs Surf.Area= 479 sf Storage= 658 cf

Plug-Flow detention time= 24.9 min calculated for 2,470 cf (100% of inflow)
Center-of-Mass det. time= 24.8 min ( 830.1 - 805.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 450 cf | **20.50'W x 23.36'L x 3.50'H Field A**<br>1,676 cf Overall - 551 cf Embedded = 1,125 cf x 40.0% Voids |
| #2A | 10.00' | 551 cf | **StormTech SC-740** x 12 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,001 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.2 cfs @ 12.49 hrs HW=11.56' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.2 cfs)

## Pond System A: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C

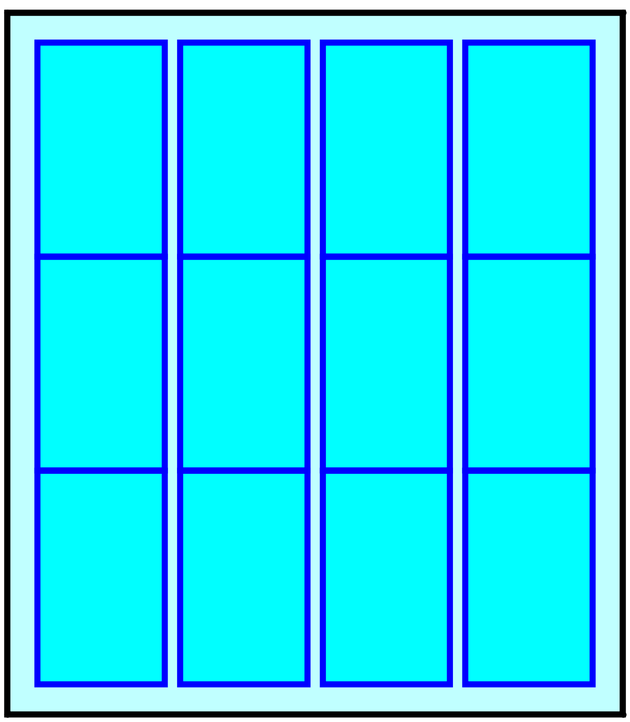
3 Chambers/Row x 7.12' Long = 21.36' + 12.0" End Stone x 2 = 23.36' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

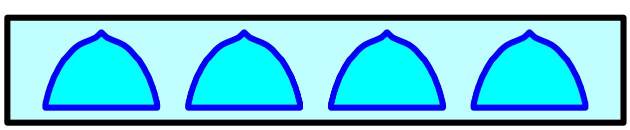
12 Chambers x 45.9 cf = 551.3 cf Chamber Storage

1,676.1 cf Field - 551.3 cf Chambers = 1,124.8 cf Stone x 40.0% Voids = 449.9 cf Stone Storage

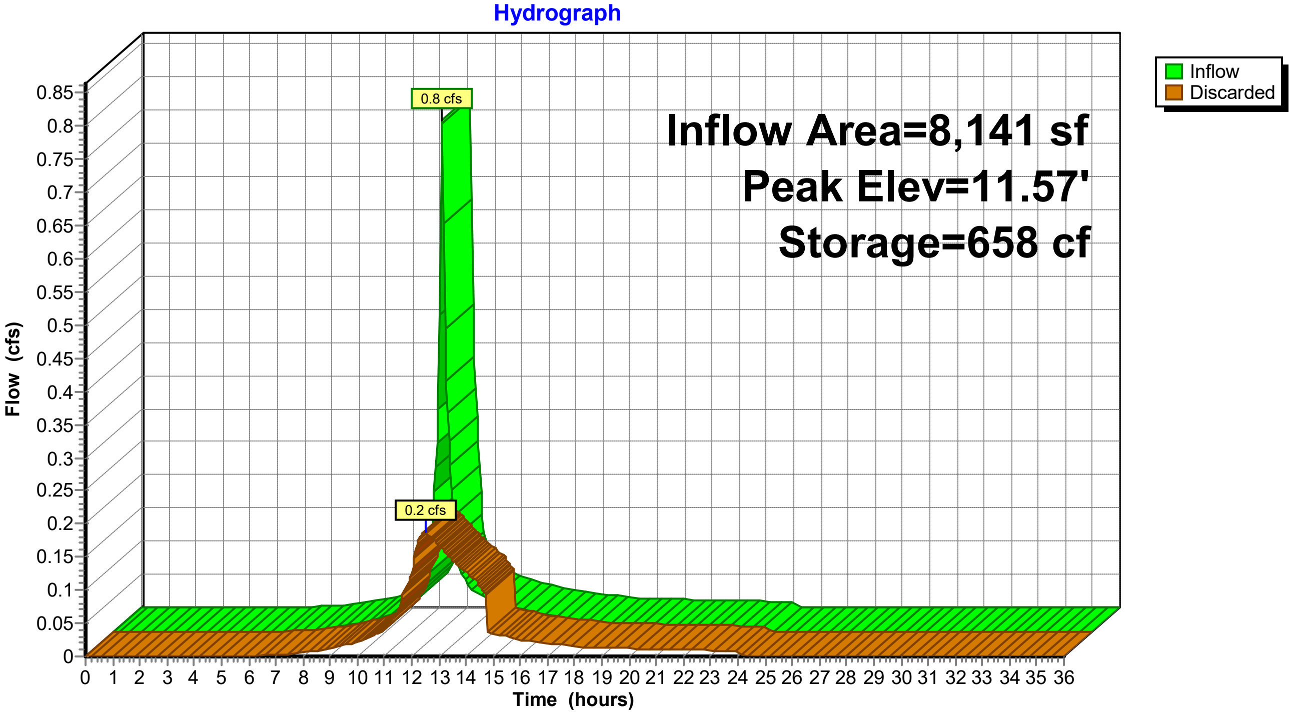
Stone + Chamber Storage = 1,001.2 cf = 0.023 af

12 Chambers @ $ 0.00 /ea = $ 0.00
62.1 cy Field Excavation @ $ 0.00 /cy = $ 0.00
41.7 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System A:



## Summary for Pond System B:

Inflow Area = 14,166 sf, 74.40% Impervious, Inflow Depth = 3.45" for 25-Year event
Inflow = 1.3 cfs @ 12.09 hrs, Volume= 4,069 cf
Outflow = 0.3 cfs @ 12.49 hrs, Volume= 4,069 cf, Atten= 76%, Lag= 24.1 min
Discarded = 0.3 cfs @ 12.49 hrs, Volume= 4,069 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 9.76' @ 12.49 hrs Surf.Area= 671 sf Storage= 1,123 cf

Plug-Flow detention time= 27.3 min calculated for 4,069 cf (100% of inflow)
Center-of-Mass det. time= 27.3 min ( 838.4 - 811.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 7.00' | 913 cf | **22.00'W x 30.48'L x 4.50'H Field A**<br>3,018 cf Overall - 735 cf Embedded = 2,282 cf x 40.0% Voids |
| #2A | 8.00' | 735 cf | **StormTech SC-740** x 16 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,648 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 7.00' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 5.00' |

**Discarded OutFlow** Max=0.3 cfs @ 12.49 hrs HW=9.76' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.3 cfs)

## Pond System B: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 12.0" Spacing = 63.0" C-C

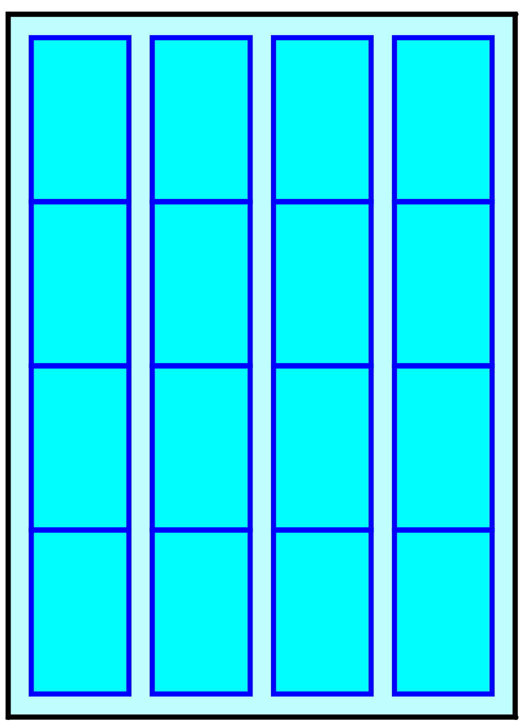
4 Chambers/Row x 7.12' Long = 28.48' + 12.0" End Stone x 2 = 30.48' Base Length
4 Rows x 51.0" Wide + 12.0" Spacing x 3 + 12.0" Side Stone x 2 = 22.00' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

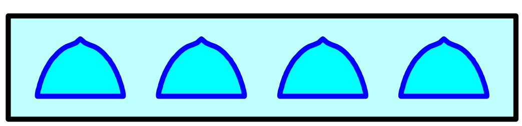
16 Chambers x 45.9 cf = 735.0 cf Chamber Storage

3,017.5 cf Field - 735.0 cf Chambers = 2,282.5 cf Stone x 40.0% Voids = 913.0 cf Stone Storage

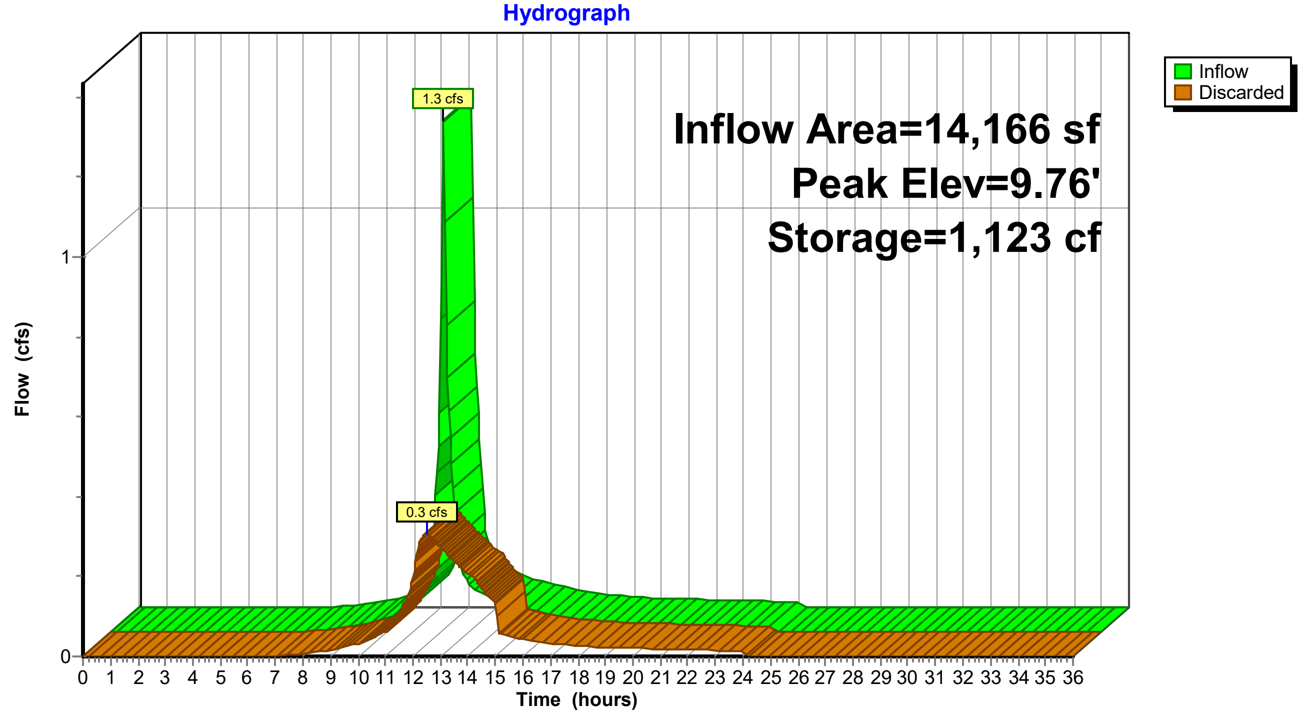
Stone + Chamber Storage = 1,648.0 cf = 0.038 af

16 Chambers @ $ 0.00 /ea = $ 0.00
111.8 cy Field Excavation @ $ 0.00 /cy = $ 0.00
84.5 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System B:



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PWA-1:** Runoff Area=4,463 sf 0.00% Impervious Runoff Depth=0.42"
Tc=6.0 min CN=39 Runoff=0.0 cfs 155 cf

**Subcatchment PWA-2:** Runoff Area=2,868 sf 0.00% Impervious Runoff Depth=0.42"
Tc=6.0 min CN=39 Runoff=0.0 cfs 100 cf

**Subcatchment PWA-3:** Runoff Area=1,799 sf 83.10% Impervious Runoff Depth=4.53"
Tc=6.0 min CN=88 Runoff=0.2 cfs 679 cf

**Subcatchment PWA-4:** Runoff Area=8,141 sf 78.69% Impervious Runoff Depth=4.21"
Tc=6.0 min CN=85 Runoff=0.9 cfs 2,855 cf

**Subcatchment PWA-5:** Runoff Area=14,166 sf 74.40% Impervious Runoff Depth=4.00"
Tc=6.0 min CN=83 Runoff=1.5 cfs 4,720 cf

**Pond Infiltration Trench:** Peak Elev=12.60' Storage=166 cf Inflow=0.2 cfs 679 cf
Outflow=0.1 cfs 679 cf

**Pond System A:** Peak Elev=12.01' Storage=792 cf Inflow=0.9 cfs 2,855 cf
Outflow=0.2 cfs 2,855 cf

**Pond System B:** Peak Elev=10.40' Storage=1,352 cf Inflow=1.5 cfs 4,720 cf
Outflow=0.3 cfs 4,720 cf

**Total Runoff Area = 31,437 sf Runoff Volume = 8,509 cf Average Runoff Depth = 3.25"**
**41.34% Pervious = 12,996 sf 58.66% Impervious = 18,441 sf**

## Summary for Subcatchment PWA-1:

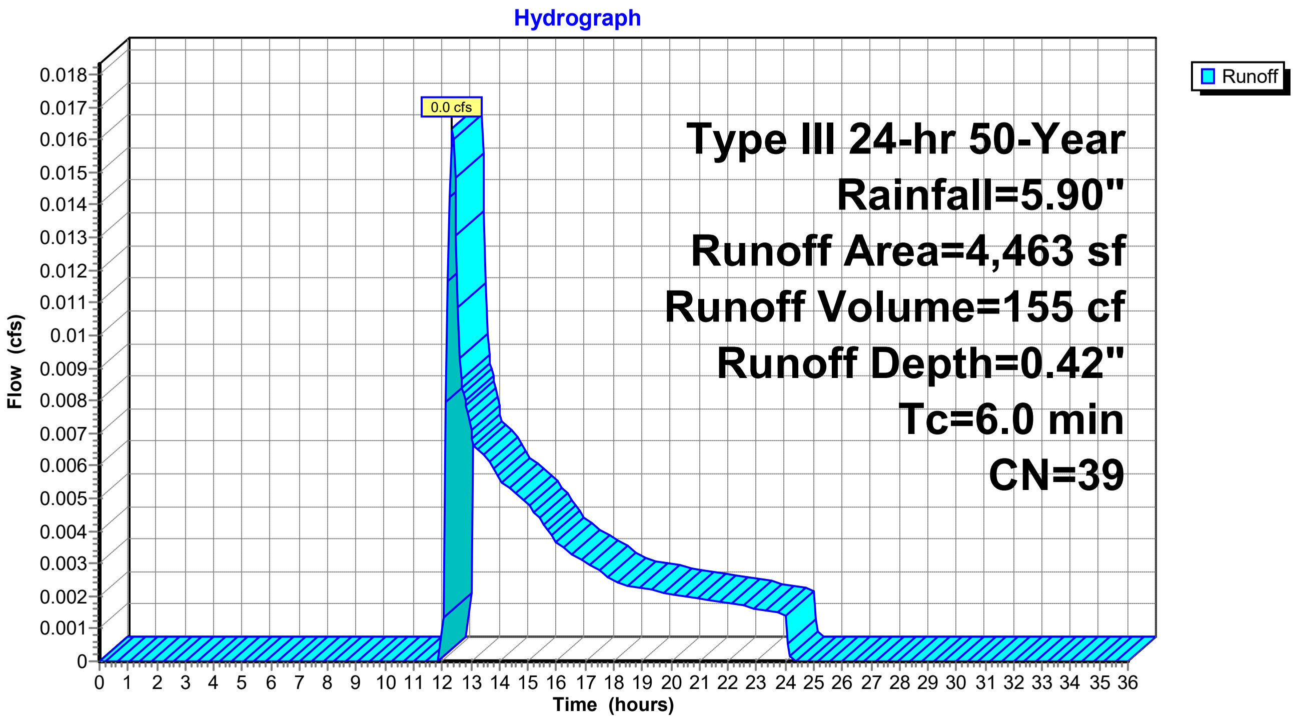
Runoff = 0.0 cfs @ 12.36 hrs, Volume= 155 cf, Depth= 0.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=5.90"

| Area (sf) | CN | Description |
|---|---|---|
| 4,463 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 4,463 | 39 | Weighted Average |
| 4,463 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-1:



## Summary for Subcatchment PWA-2:

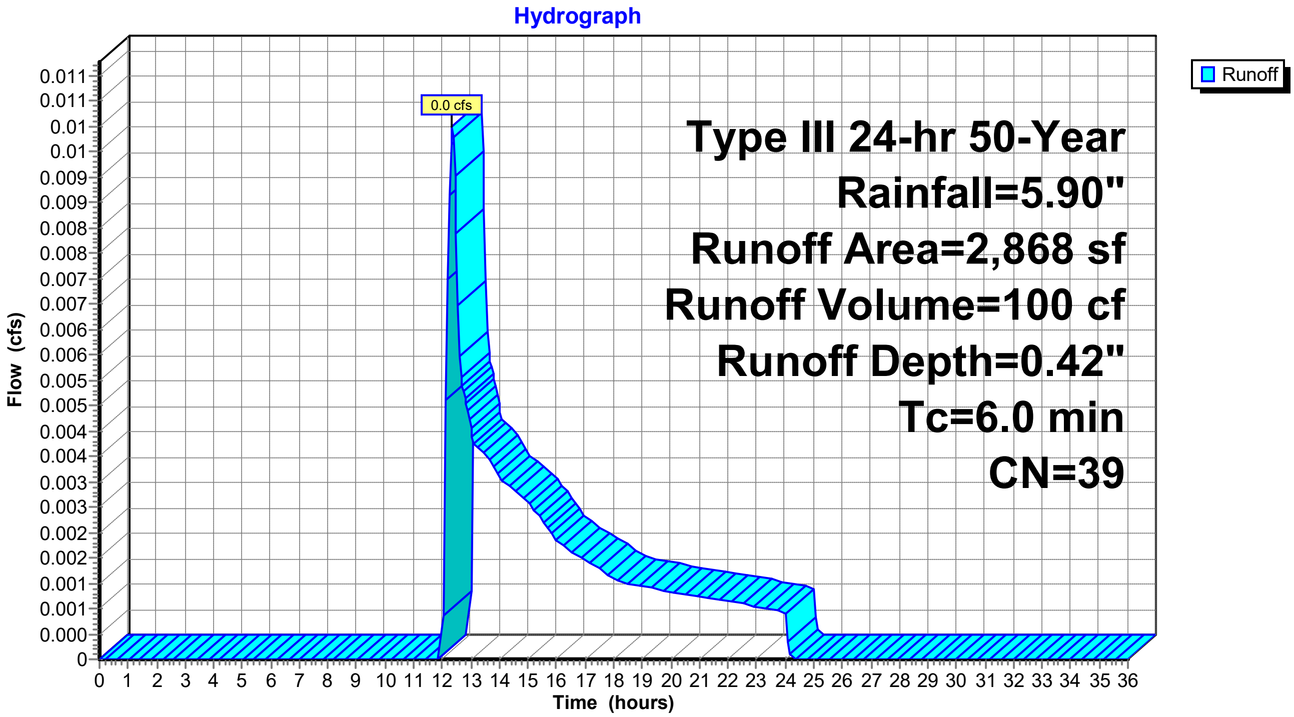
Runoff = 0.0 cfs @ 12.36 hrs, Volume= 100 cf, Depth= 0.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=5.90"

| Area (sf) | CN | Description |
|---|---|---|
| 2,868 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 2,868 | 39 | Weighted Average |
| 2,868 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-2:



## Summary for Subcatchment PWA-3:

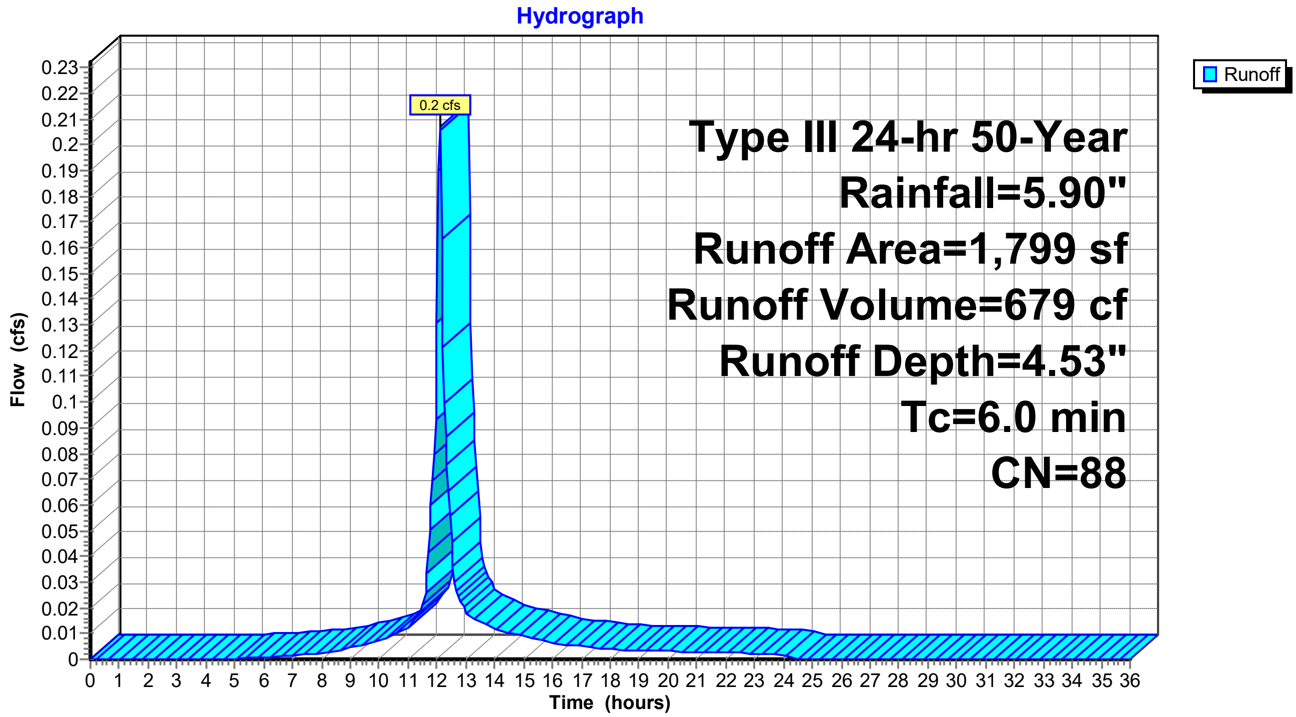
Runoff = 0.2 cfs @ 12.09 hrs, Volume= 679 cf, Depth= 4.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=5.90"

| Area (sf) | CN | Description |
|---|---|---|
| 828 | 98 | Roofs, HSG A |
| 667 | 98 | Paved parking, HSG A |
| 304 | 39 | >75% Grass cover, Good, HSG A |
| 1,799 | 88 | Weighted Average |
| 304 | | 16.90% Pervious Area |
| 1,495 | | 83.10% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-3:



## Summary for Subcatchment PWA-4:

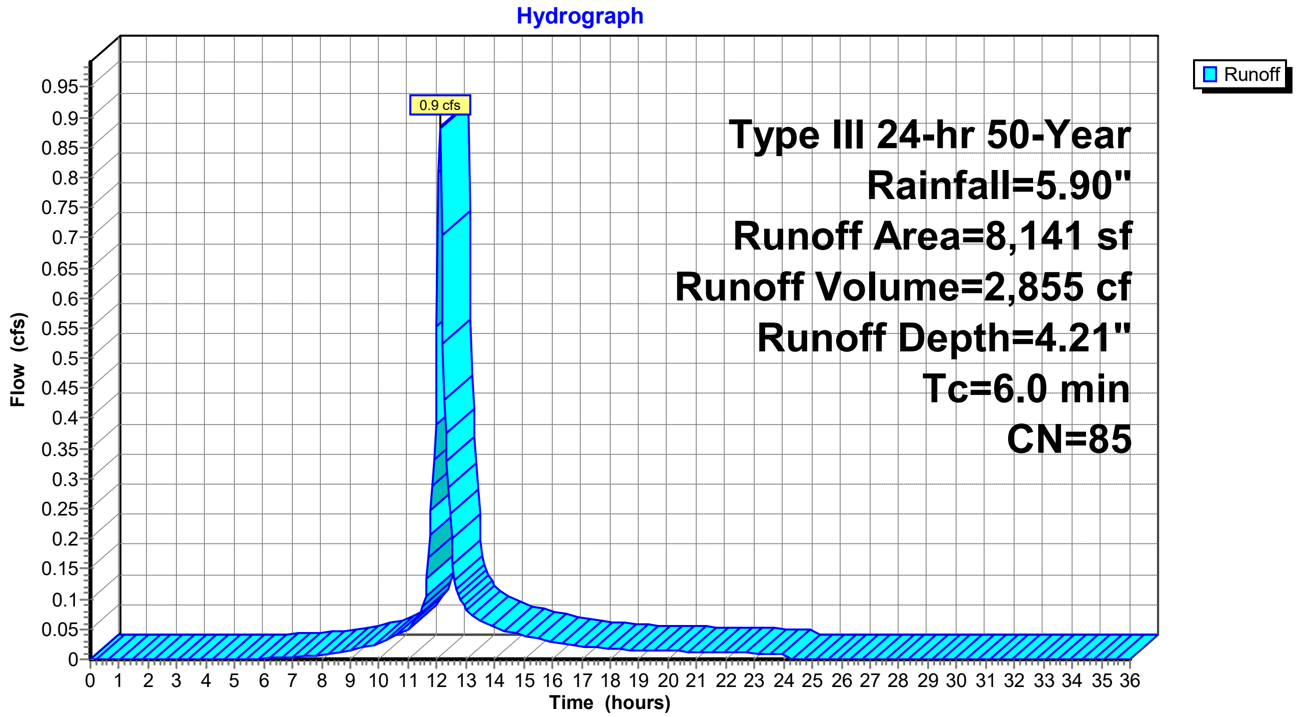
Runoff = 0.9 cfs @ 12.09 hrs, Volume= 2,855 cf, Depth= 4.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=5.90"

| Area (sf) | CN | Description |
|---|---|---|
| 3,525 | 98 | Roofs, HSG A |
| 2,881 | 98 | Paved parking, HSG A |
| 1,735 | 39 | >75% Grass cover, Good, HSG A |
| 8,141 | 85 | Weighted Average |
| 1,735 | | 21.31% Pervious Area |
| 6,406 | | 78.69% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-4:



## Summary for Subcatchment PWA-5:

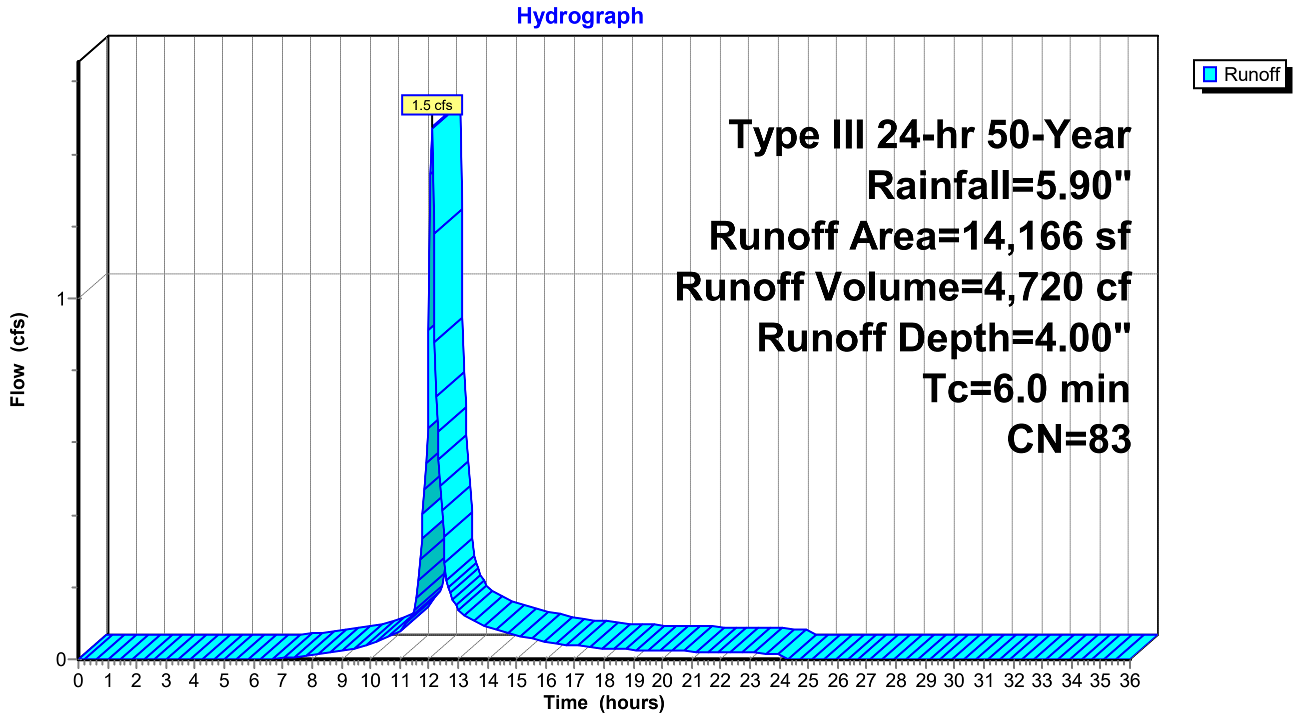
Runoff = 1.5 cfs @ 12.09 hrs, Volume= 4,720 cf, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 50-Year Rainfall=5.90"

| Area (sf) | CN | Description |
|---|---|---|
| 6,226 | 98 | Roofs, HSG A |
| 4,314 | 98 | Paved parking, HSG A |
| 3,626 | 39 | >75% Grass cover, Good, HSG A |
| 14,166 | 83 | Weighted Average |
| 3,626 | | 25.60% Pervious Area |
| 10,540 | | 74.40% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-5:



## Summary for Pond Infiltration Trench:

Inflow Area = 1,799 sf, 83.10% Impervious, Inflow Depth = 4.53" for 50-Year event
Inflow = 0.2 cfs @ 12.09 hrs, Volume= 679 cf
Outflow = 0.1 cfs @ 12.43 hrs, Volume= 679 cf, Atten= 71%, Lag= 20.6 min
Discarded = 0.1 cfs @ 12.43 hrs, Volume= 679 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 12.60' @ 12.43 hrs Surf.Area= 122 sf Storage= 166 cf

Plug-Flow detention time= 19.9 min calculated for 678 cf (100% of inflow)
Center-of-Mass det. time= 19.9 min ( 811.9 - 792.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 172 cf | **3.04'W x 40.00'L x 3.88'H Field A** |
| | | | 472 cf Overall - 42 cf Embedded = 430 cf x 40.0% Voids |
| #2A | 11.17' | 32 cf | **ADS N-12 12** x 2 Inside #1 |
| | | | Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf |
| | | | Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf |
| | | 204 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.1 cfs @ 12.43 hrs HW=12.59' (Free Discharge)
↑—**1=Exfiltration** ( Controls 0.1 cfs)

## Pond Infiltration Trench: - Chamber Wizard Field A

**Chamber Model = ADS N-12 12**
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

14.5" Wide + 0.0" Spacing = 14.5" C-C

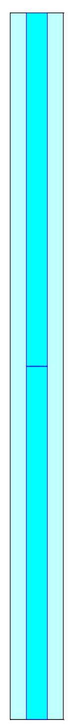
2 Chambers/Row x 20.00' Long = 40.00' Base Length
1 Rows x 14.5" Wide + 11.0" Side Stone x 2 = 3.04' Base Width
20.0" Base + 14.5" Chamber Height + 12.0" Cover = 3.88' Field Height

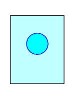
2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

471.6 cf Field - 41.9 cf Chambers = 429.8 cf Stone x 40.0% Voids = 171.9 cf Stone Storage

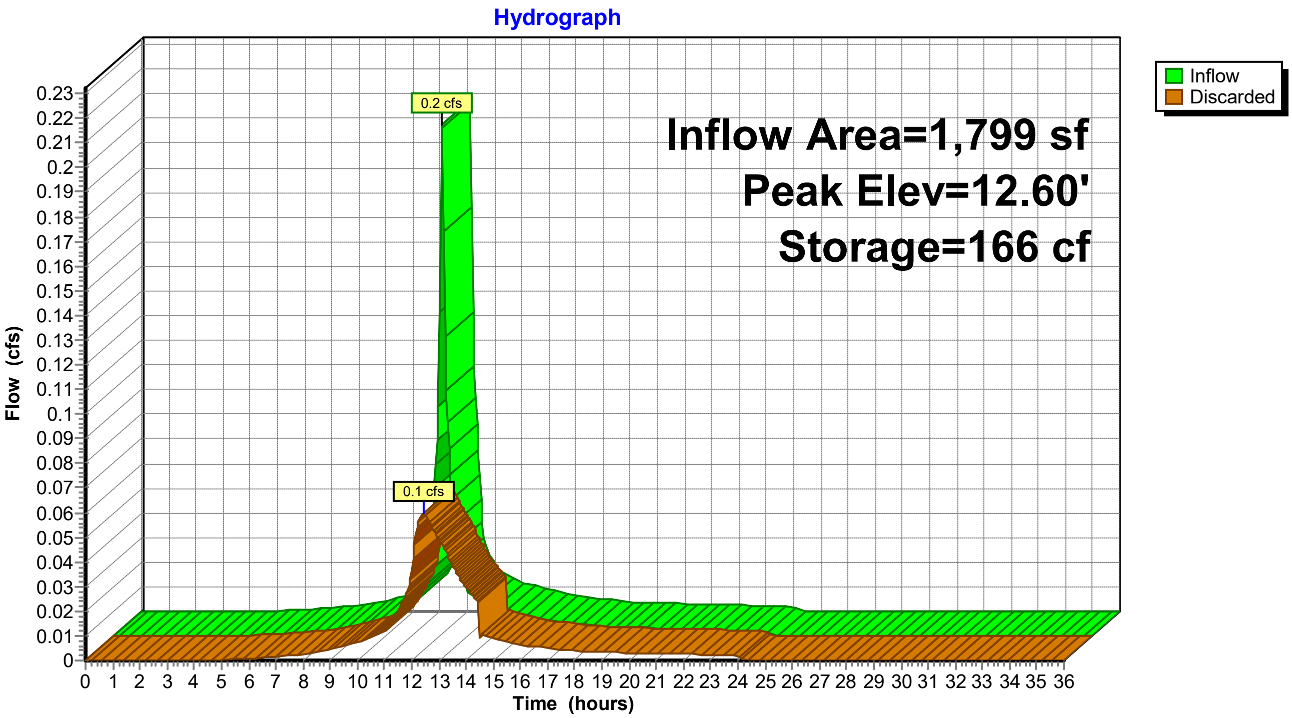
Stone + Chamber Storage = 204.3 cf = 0.005 af

2 Chambers @ $ 0.00 /ea = $ 0.00
17.5 cy Field Excavation @ $ 0.00 /cy = $ 0.00
15.9 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond Infiltration Trench:



## Summary for Pond System A:

Inflow Area = 8,141 sf, 78.69% Impervious, Inflow Depth = 4.21" for 50-Year event
Inflow = 0.9 cfs @ 12.09 hrs, Volume= 2,855 cf
Outflow = 0.2 cfs @ 12.49 hrs, Volume= 2,855 cf, Atten= 77%, Lag= 24.2 min
Discarded = 0.2 cfs @ 12.49 hrs, Volume= 2,855 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 12.01' @ 12.49 hrs Surf.Area= 479 sf Storage= 792 cf

Plug-Flow detention time= 28.4 min calculated for 2,851 cf (100% of inflow)
Center-of-Mass det. time= 28.3 min ( 829.6 - 801.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 450 cf | **20.50'W x 23.36'L x 3.50'H Field A**<br>1,676 cf Overall - 551 cf Embedded = 1,125 cf x 40.0% Voids |
| #2A | 10.00' | 551 cf | **StormTech SC-740** x 12 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,001 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area**<br>Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.2 cfs @ 12.49 hrs HW=12.01' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.2 cfs)

## Pond System A: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C

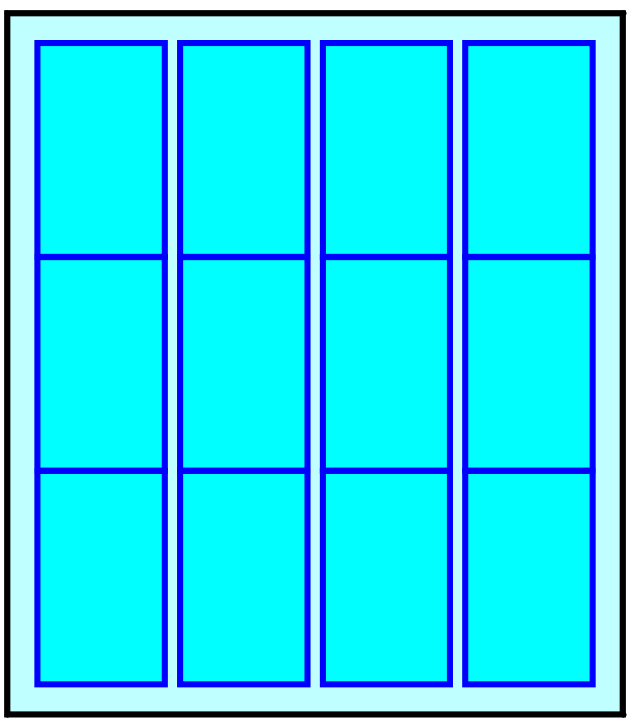
3 Chambers/Row x 7.12' Long = 21.36' + 12.0" End Stone x 2 = 23.36' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

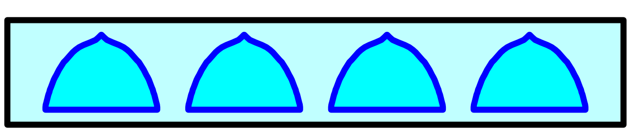
12 Chambers x 45.9 cf = 551.3 cf Chamber Storage

1,676.1 cf Field - 551.3 cf Chambers = 1,124.8 cf Stone x 40.0% Voids = 449.9 cf Stone Storage

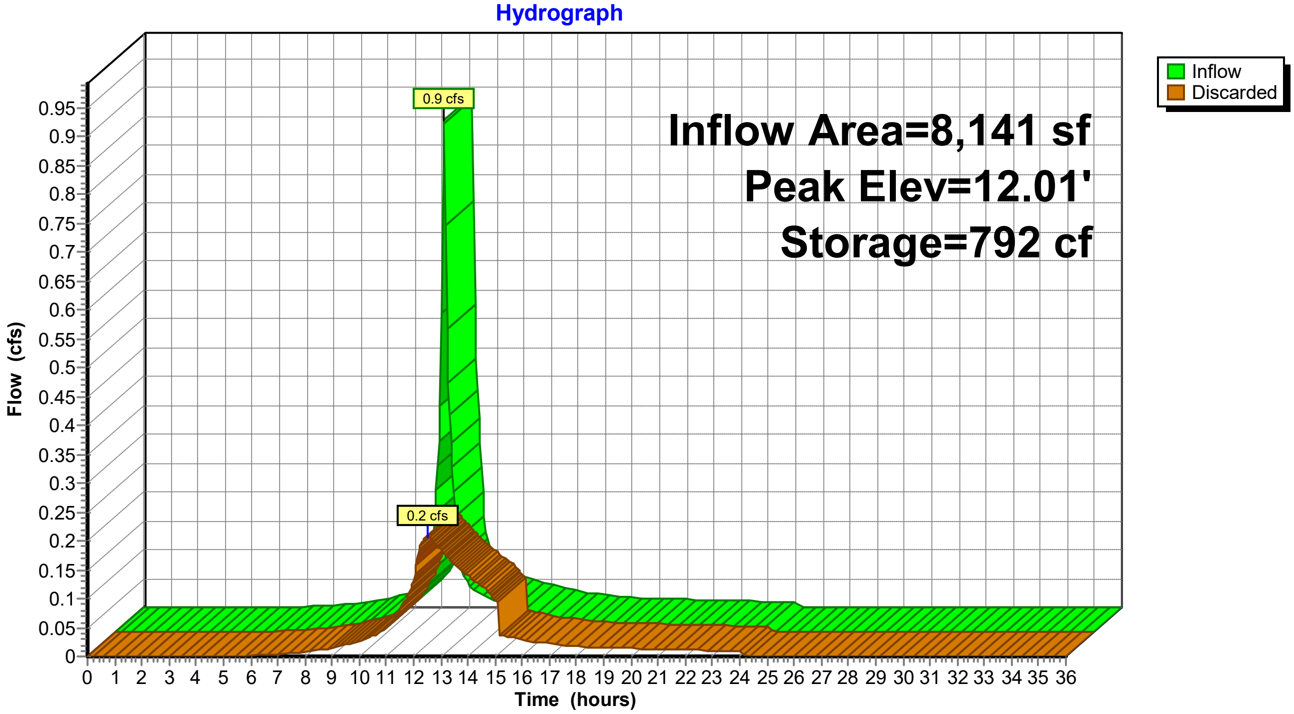
Stone + Chamber Storage = 1,001.2 cf = 0.023 af

12 Chambers @ $ 0.00 /ea = $ 0.00
62.1 cy Field Excavation @ $ 0.00 /cy = $ 0.00
41.7 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System A:



## Summary for Pond System B:

Inflow Area = 14,166 sf, 74.40% Impervious, Inflow Depth = 4.00" for 50-Year event
Inflow = 1.5 cfs @ 12.09 hrs, Volume= 4,720 cf
Outflow = 0.3 cfs @ 12.49 hrs, Volume= 4,720 cf, Atten= 77%, Lag= 24.3 min
Discarded = 0.3 cfs @ 12.49 hrs, Volume= 4,720 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 10.40' @ 12.49 hrs Surf.Area= 671 sf Storage= 1,352 cf

Plug-Flow detention time= 30.9 min calculated for 4,714 cf (100% of inflow)
Center-of-Mass det. time= 30.9 min ( 837.8 - 806.9 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 7.00' | 913 cf | **22.00'W x 30.48'L x 4.50'H Field A** |
| | | | 3,018 cf Overall - 735 cf Embedded = 2,282 cf x 40.0% Voids |
| #2A | 8.00' | 735 cf | **StormTech SC-740** x 16 Inside #1 |
| | | | Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf |
| | | | Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,648 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 7.00' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 5.00' |

**Discarded OutFlow** Max=0.3 cfs @ 12.49 hrs HW=10.40' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.3 cfs)

## Pond System B: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 12.0" Spacing = 63.0" C-C

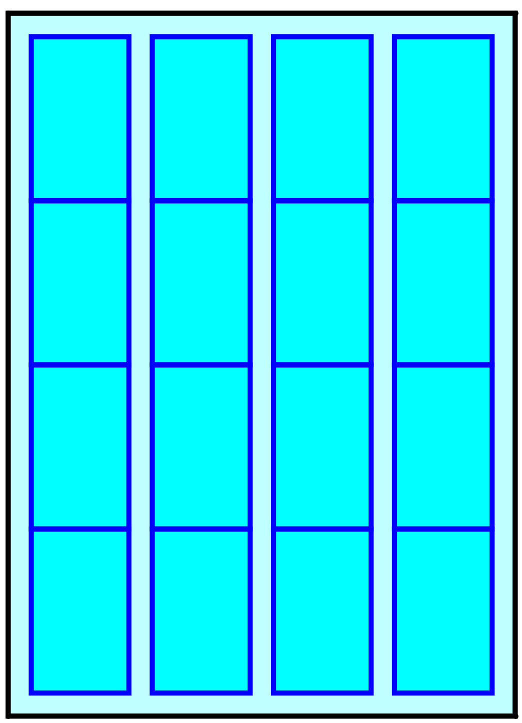
4 Chambers/Row x 7.12' Long = 28.48' + 12.0" End Stone x 2 = 30.48' Base Length
4 Rows x 51.0" Wide + 12.0" Spacing x 3 + 12.0" Side Stone x 2 = 22.00' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

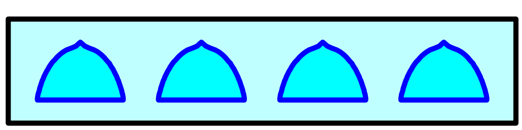
16 Chambers x 45.9 cf = 735.0 cf Chamber Storage

3,017.5 cf Field - 735.0 cf Chambers = 2,282.5 cf Stone x 40.0% Voids = 913.0 cf Stone Storage

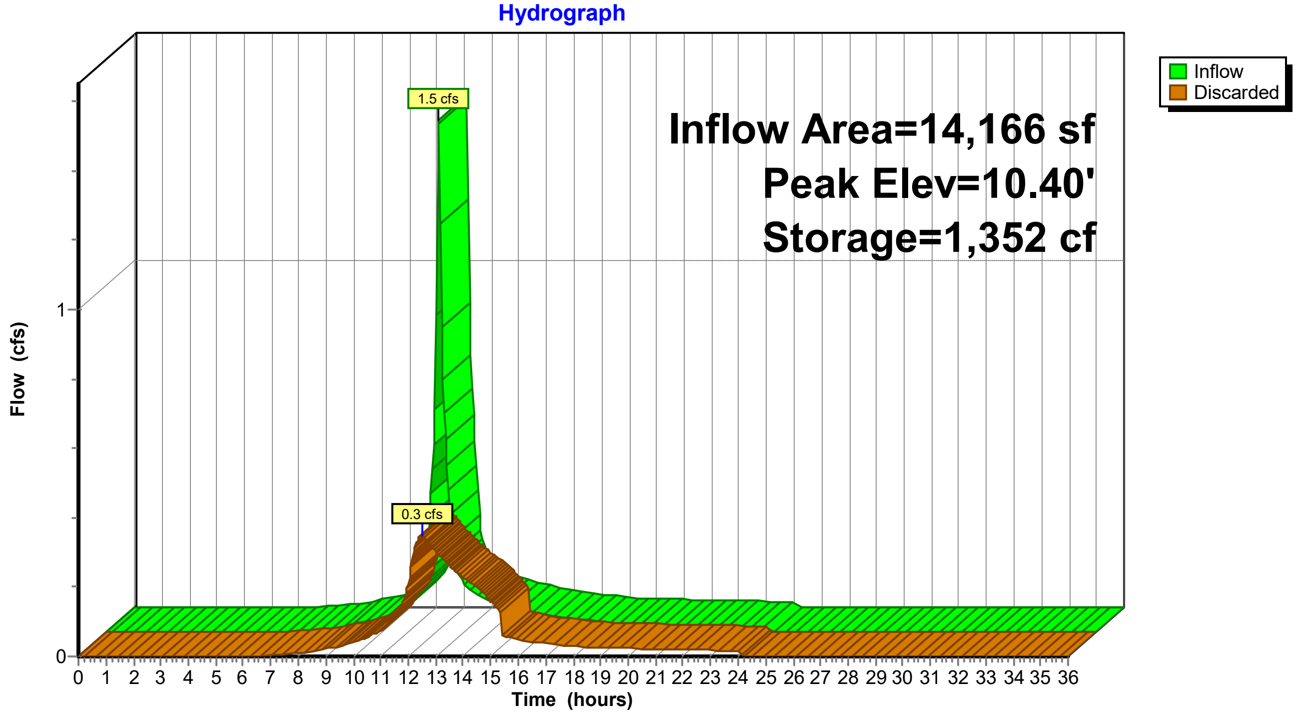
Stone + Chamber Storage = 1,648.0 cf = 0.038 af

16 Chambers @ $ 0.00 /ea = $ 0.00
111.8 cy Field Excavation @ $ 0.00 /cy = $ 0.00
84.5 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System B:



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment PWA-1:** Runoff Area=4,463 sf 0.00% Impervious Runoff Depth=0.60"
Tc=6.0 min CN=39 Runoff=0.0 cfs 222 cf

**Subcatchment PWA-2:** Runoff Area=2,868 sf 0.00% Impervious Runoff Depth=0.60"
Tc=6.0 min CN=39 Runoff=0.0 cfs 143 cf

**Subcatchment PWA-3:** Runoff Area=1,799 sf 83.10% Impervious Runoff Depth=5.11"
Tc=6.0 min CN=88 Runoff=0.2 cfs 766 cf

**Subcatchment PWA-4:** Runoff Area=8,141 sf 78.69% Impervious Runoff Depth=4.78"
Tc=6.0 min CN=85 Runoff=1.0 cfs 3,240 cf

**Subcatchment PWA-5:** Runoff Area=14,166 sf 74.40% Impervious Runoff Depth=4.56"
Tc=6.0 min CN=83 Runoff=1.7 cfs 5,380 cf

**Pond Infiltration Trench:** Peak Elev=13.14' Storage=193 cf Inflow=0.2 cfs 766 cf
Outflow=0.1 cfs 766 cf

**Pond System A:** Peak Elev=12.59' Storage=924 cf Inflow=1.0 cfs 3,240 cf
Outflow=0.2 cfs 3,240 cf

**Pond System B:** Peak Elev=11.23' Storage=1,574 cf Inflow=1.7 cfs 5,380 cf
Outflow=0.4 cfs 5,380 cf

**Total Runoff Area = 31,437 sf Runoff Volume = 9,752 cf Average Runoff Depth = 3.72"**
**41.34% Pervious = 12,996 sf 58.66% Impervious = 18,441 sf**

## Summary for Subcatchment PWA-1:

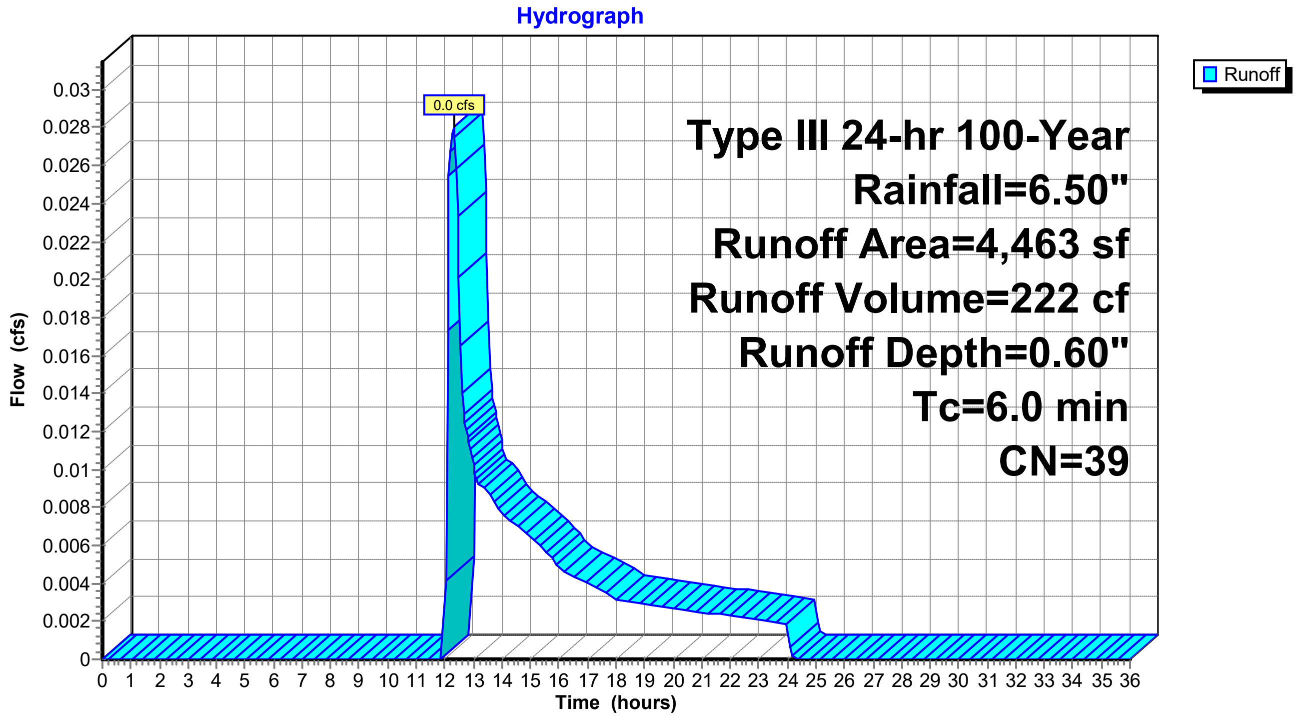
Runoff = 0.0 cfs @ 12.29 hrs, Volume= 222 cf, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 4,463 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 4,463 | 39 | Weighted Average |
| 4,463 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-1:



## Summary for Subcatchment PWA-2:

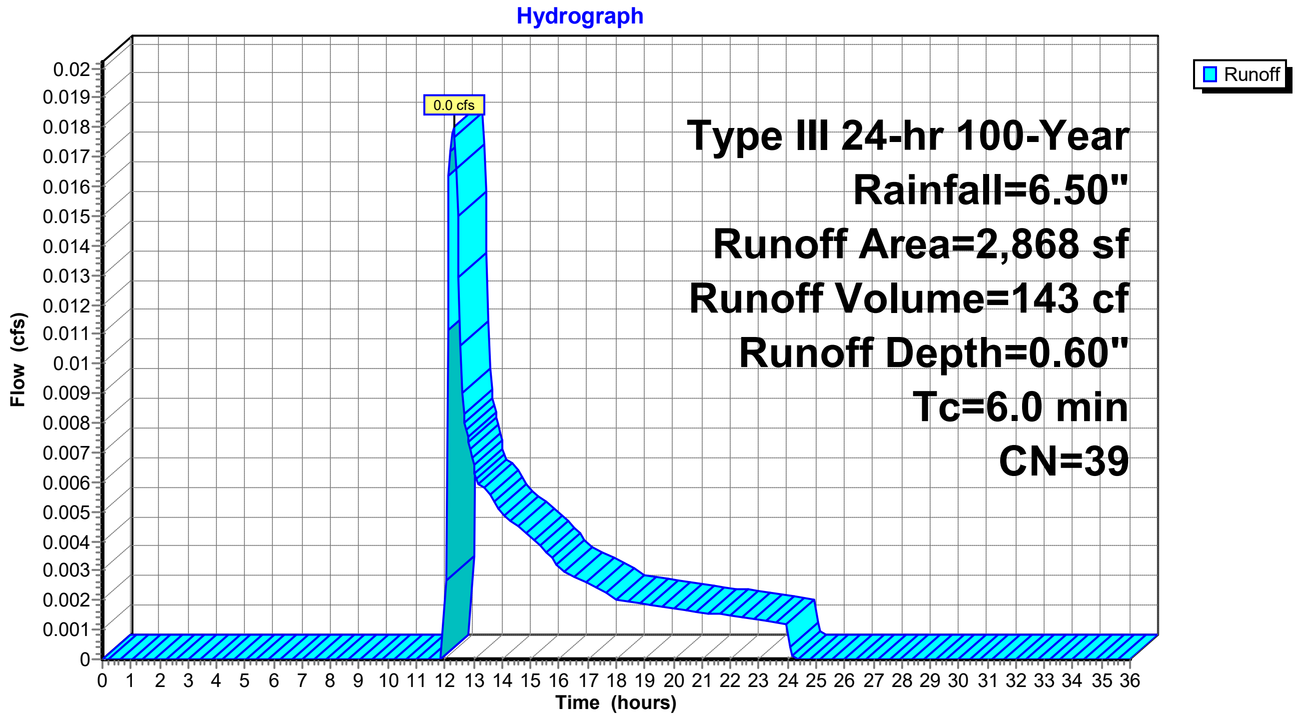
Runoff = 0.0 cfs @ 12.29 hrs, Volume= 143 cf, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 2,868 | 39 | >75% Grass cover, Good, HSG A |
| 0 | 98 | Roofs, HSG A |
| 0 | 98 | Paved parking, HSG A |
| 0 | 30 | Woods, Good, HSG A |
| 2,868 | 39 | Weighted Average |
| 2,868 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-2:



## Summary for Subcatchment PWA-3:

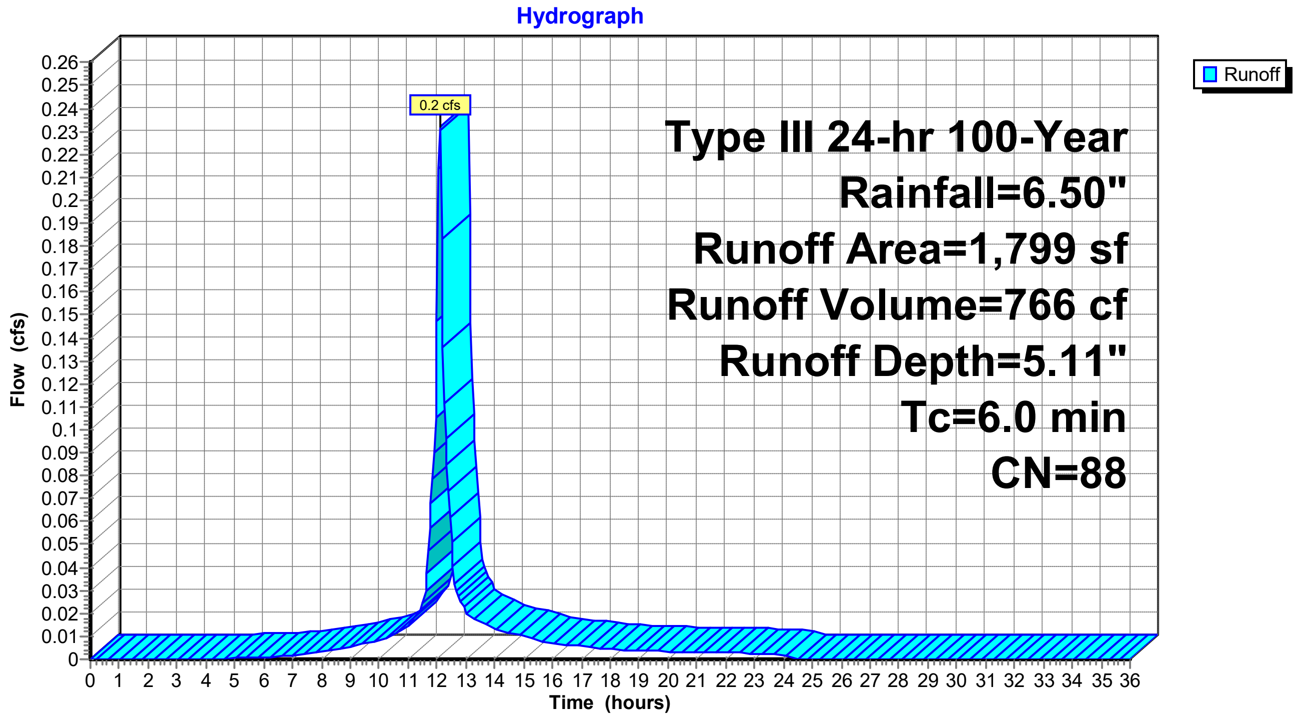
Runoff = 0.2 cfs @ 12.09 hrs, Volume= 766 cf, Depth= 5.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 828 | 98 | Roofs, HSG A |
| 667 | 98 | Paved parking, HSG A |
| 304 | 39 | >75% Grass cover, Good, HSG A |
| 1,799 | 88 | Weighted Average |
| 304 | | 16.90% Pervious Area |
| 1,495 | | 83.10% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-3:



## Summary for Subcatchment PWA-4:

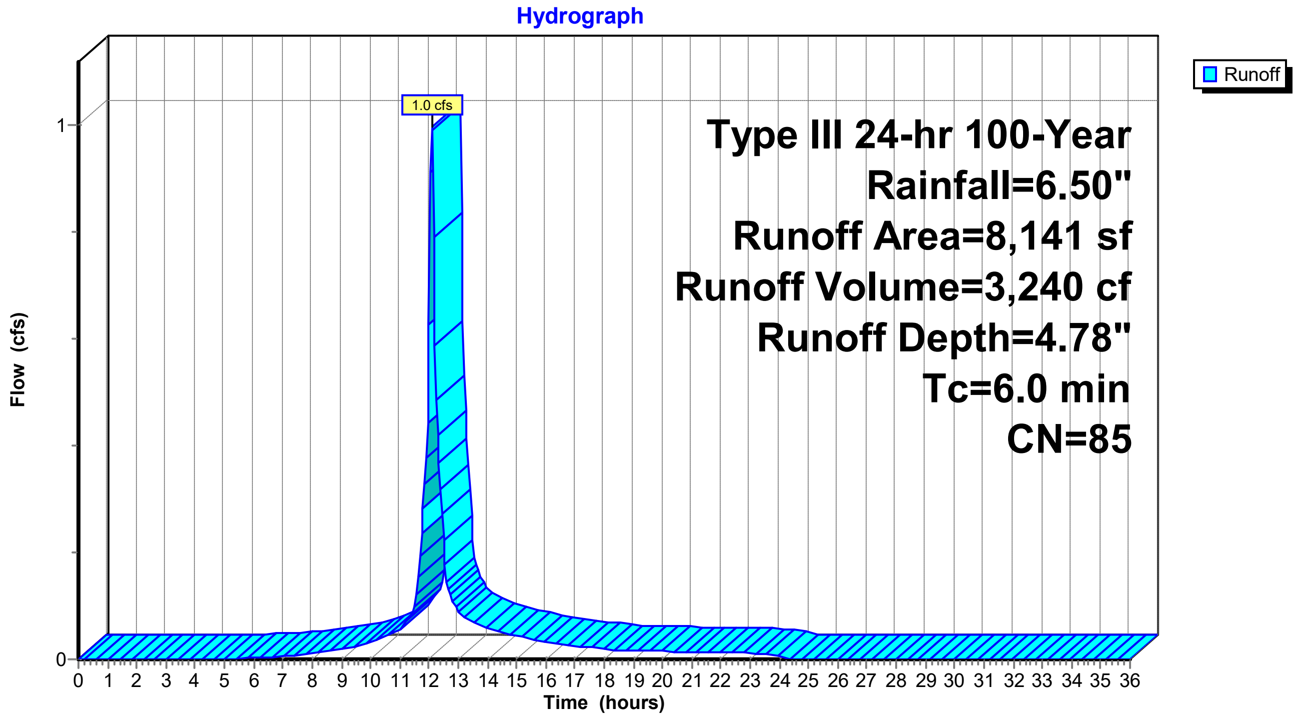
Runoff = 1.0 cfs @ 12.09 hrs, Volume= 3,240 cf, Depth= 4.78"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 3,525 | 98 | Roofs, HSG A |
| 2,881 | 98 | Paved parking, HSG A |
| 1,735 | 39 | >75% Grass cover, Good, HSG A |
| 8,141 | 85 | Weighted Average |
| 1,735 | | 21.31% Pervious Area |
| 6,406 | | 78.69% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-4:



## Summary for Subcatchment PWA-5:

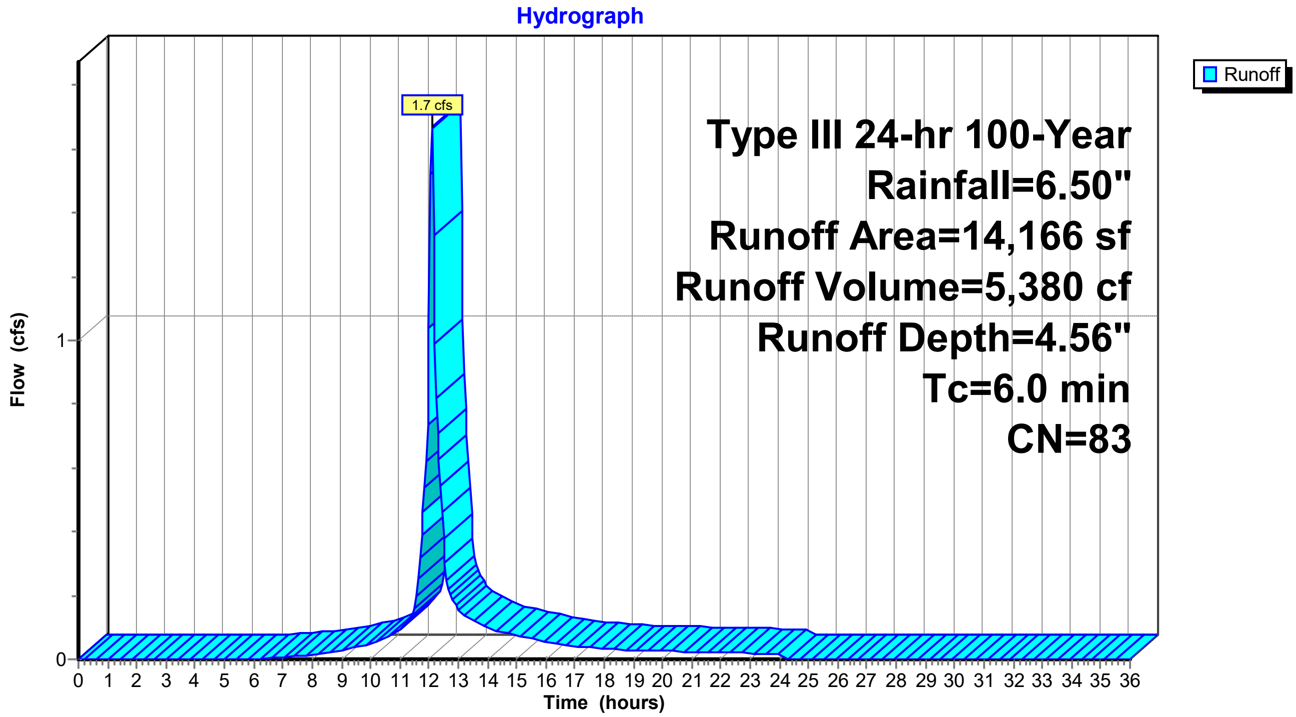
Runoff = 1.7 cfs @ 12.09 hrs, Volume= 5,380 cf, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=6.50"

| Area (sf) | CN | Description |
|---|---|---|
| 6,226 | 98 | Roofs, HSG A |
| 4,314 | 98 | Paved parking, HSG A |
| 3,626 | 39 | >75% Grass cover, Good, HSG A |
| 14,166 | 83 | Weighted Average |
| 3,626 | | 25.60% Pervious Area |
| 10,540 | | 74.40% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry, 6** |

## Subcatchment PWA-5:



## Summary for Pond Infiltration Trench:

| | | | |
|---|---|---|---|
| Inflow Area = | 1,799 sf, | 83.10% Impervious, | Inflow Depth = 5.11" for 100-Year event |
| Inflow = | 0.2 cfs @ | 12.09 hrs, Volume= | 766 cf |
| Outflow = | 0.1 cfs @ | 12.43 hrs, Volume= | 766 cf, Atten= 72%, Lag= 20.7 min |
| Discarded = | 0.1 cfs @ | 12.43 hrs, Volume= | 766 cf |

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 13.14' @ 12.43 hrs Surf.Area= 122 sf Storage= 193 cf

Plug-Flow detention time= 21.7 min calculated for 765 cf (100% of inflow)
Center-of-Mass det. time= 21.6 min ( 810.4 - 788.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 172 cf | **3.04'W x 40.00'L x 3.88'H Field A** |
| | | | 472 cf Overall - 42 cf Embedded = 430 cf x 40.0% Voids |
| #2A | 11.17' | 32 cf | **ADS N-12 12** x 2 Inside #1 |
| | | | Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf |
| | | | Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf |
| | | 204 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.1 cfs @ 12.43 hrs HW=13.14' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.1 cfs)

## Pond Infiltration Trench: - Chamber Wizard Field A

**Chamber Model = ADS N-12 12**
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

14.5" Wide + 0.0" Spacing = 14.5" C-C

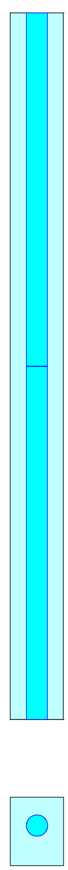
2 Chambers/Row x 20.00' Long = 40.00' Base Length
1 Rows x 14.5" Wide + 11.0" Side Stone x 2 = 3.04' Base Width
20.0" Base + 14.5" Chamber Height + 12.0" Cover = 3.88' Field Height

2 Chambers x 16.2 cf = 32.4 cf Chamber Storage
2 Chambers x 20.9 cf = 41.9 cf Displacement

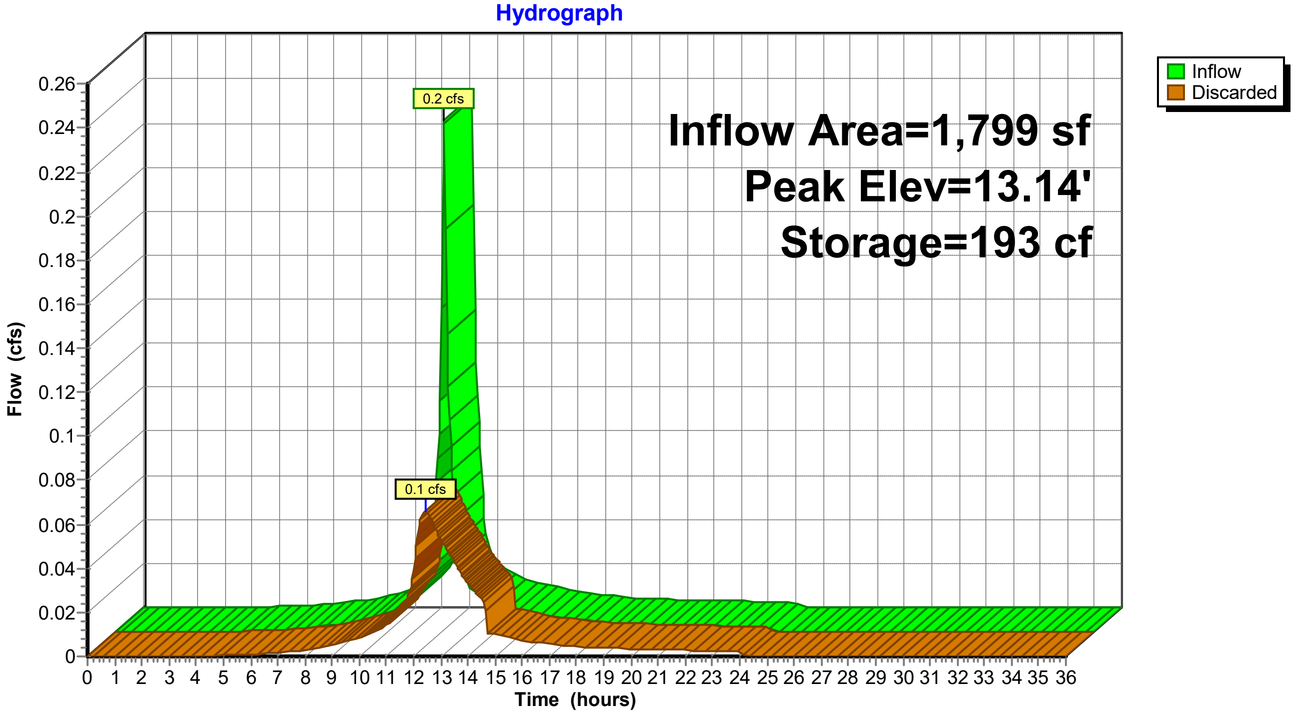
471.6 cf Field - 41.9 cf Chambers = 429.8 cf Stone x 40.0% Voids = 171.9 cf Stone Storage

Stone + Chamber Storage = 204.3 cf = 0.005 af

2 Chambers @ $ 0.00 /ea = $ 0.00
17.5 cy Field Excavation @ $ 0.00 /cy = $ 0.00
15.9 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00



## Pond Infiltration Trench:



## Summary for Pond System A:

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 8,141 sf, | 78.69% Impervious, | Inflow Depth = 4.78" | for 100-Year event |
| Inflow = | 1.0 cfs @ | 12.09 hrs, Volume= | 3,240 cf | |
| Outflow = | 0.2 cfs @ | 12.49 hrs, Volume= | 3,240 cf, | Atten= 77%, Lag= 24.1 min |
| Discarded = | 0.2 cfs @ | 12.49 hrs, Volume= | 3,240 cf | |

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 12.59' @ 12.49 hrs Surf.Area= 479 sf Storage= 924 cf

Plug-Flow detention time= 31.2 min calculated for 3,236 cf (100% of inflow)
Center-of-Mass det. time= 31.2 min ( 828.9 - 797.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 9.50' | 450 cf | **20.50'W x 23.36'L x 3.50'H Field A** |
| | | | 1,676 cf Overall - 551 cf Embedded = 1,125 cf x 40.0% Voids |
| #2A | 10.00' | 551 cf | **StormTech SC-740** x 12 Inside #1 |
| | | | Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf |
| | | | Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,001 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 9.50' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 7.50' |

**Discarded OutFlow** Max=0.2 cfs @ 12.49 hrs HW=12.59' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.2 cfs)

## Pond System A: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C

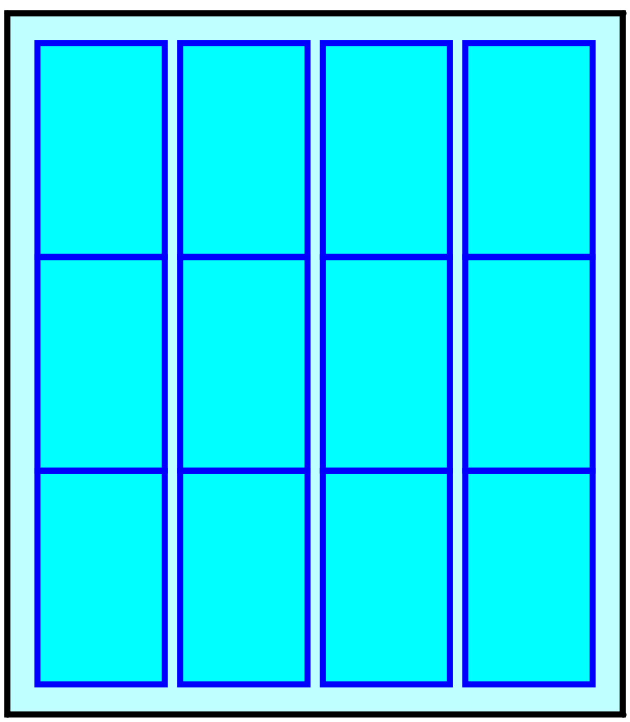
3 Chambers/Row x 7.12' Long = 21.36' + 12.0" End Stone x 2 = 23.36' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

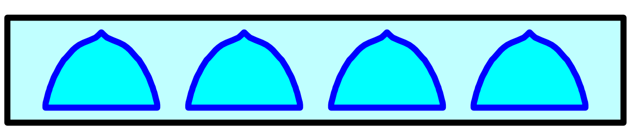
12 Chambers x 45.9 cf = 551.3 cf Chamber Storage

1,676.1 cf Field - 551.3 cf Chambers = 1,124.8 cf Stone x 40.0% Voids = 449.9 cf Stone Storage

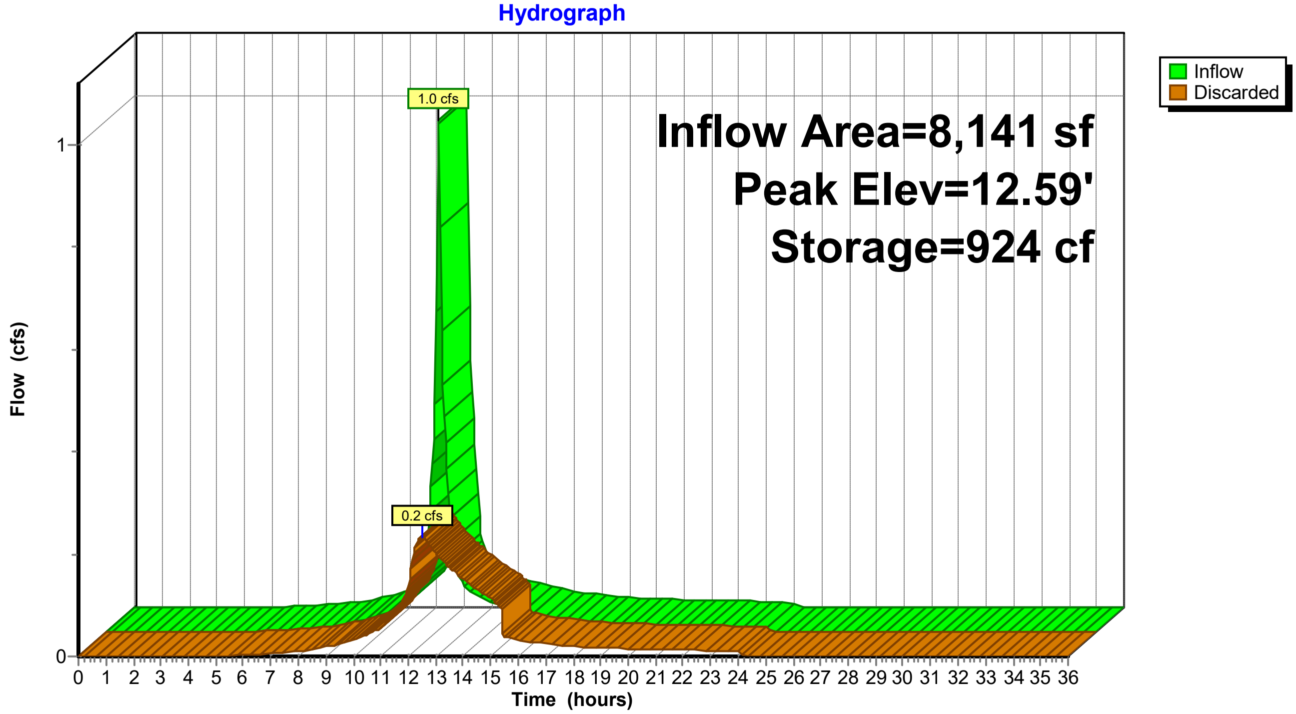
Stone + Chamber Storage = 1,001.2 cf = 0.023 af

12 Chambers @ $ 0.00 /ea = $ 0.00
62.1 cy Field Excavation @ $ 0.00 /cy = $ 0.00
41.7 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00





## Pond System A:



## Summary for Pond System B:

Inflow Area = 14,166 sf, 74.40% Impervious, Inflow Depth = 4.56" for 100-Year event
Inflow = 1.7 cfs @ 12.09 hrs, Volume= 5,380 cf
Outflow = 0.4 cfs @ 12.49 hrs, Volume= 5,380 cf, Atten= 76%, Lag= 23.9 min
Discarded = 0.4 cfs @ 12.49 hrs, Volume= 5,380 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 11.23' @ 12.49 hrs Surf.Area= 671 sf Storage= 1,574 cf

Plug-Flow detention time= 33.6 min calculated for 5,373 cf (100% of inflow)
Center-of-Mass det. time= 33.5 min ( 836.7 - 803.2 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 7.00' | 913 cf | **22.00'W x 30.48'L x 4.50'H Field A** |
| | | | 3,018 cf Overall - 735 cf Embedded = 2,282 cf x 40.0% Voids |
| #2A | 8.00' | 735 cf | **StormTech SC-740** x 16 Inside #1 |
| | | | Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf |
| | | | Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap |
| | | 1,648 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 7.00' | **8.270 in/hr Exfiltration over Surface area** |
| | | | Conductivity to Groundwater Elevation = 5.00' |

**Discarded OutFlow** Max=0.4 cfs @ 12.49 hrs HW=11.22' (Free Discharge)
└─**1=Exfiltration** ( Controls 0.4 cfs)

## Pond System B: - Chamber Wizard Field A

**Chamber Model = StormTech SC-740**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 12.0" Spacing = 63.0" C-C

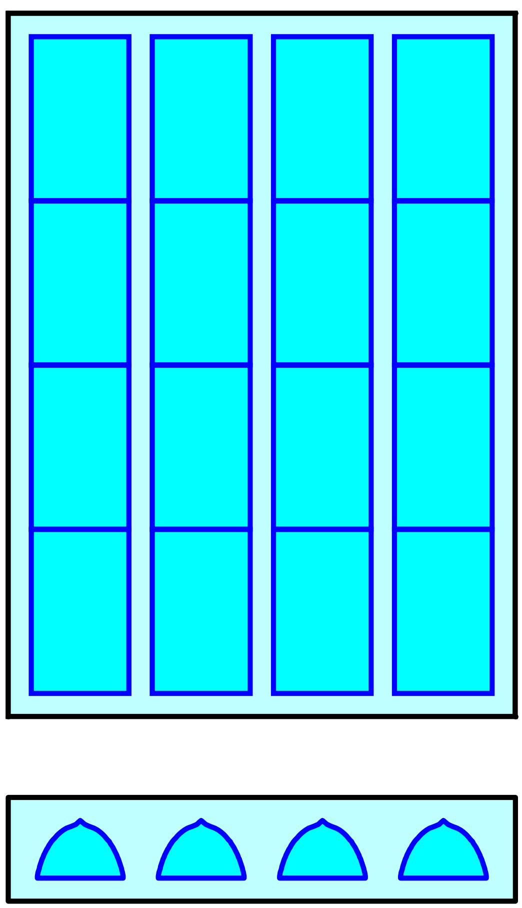
4 Chambers/Row x 7.12' Long = 28.48' + 12.0" End Stone x 2 = 30.48' Base Length
4 Rows x 51.0" Wide + 12.0" Spacing x 3 + 12.0" Side Stone x 2 = 22.00' Base Width
12.0" Base + 30.0" Chamber Height + 12.0" Cover = 4.50' Field Height

16 Chambers x 45.9 cf = 735.0 cf Chamber Storage

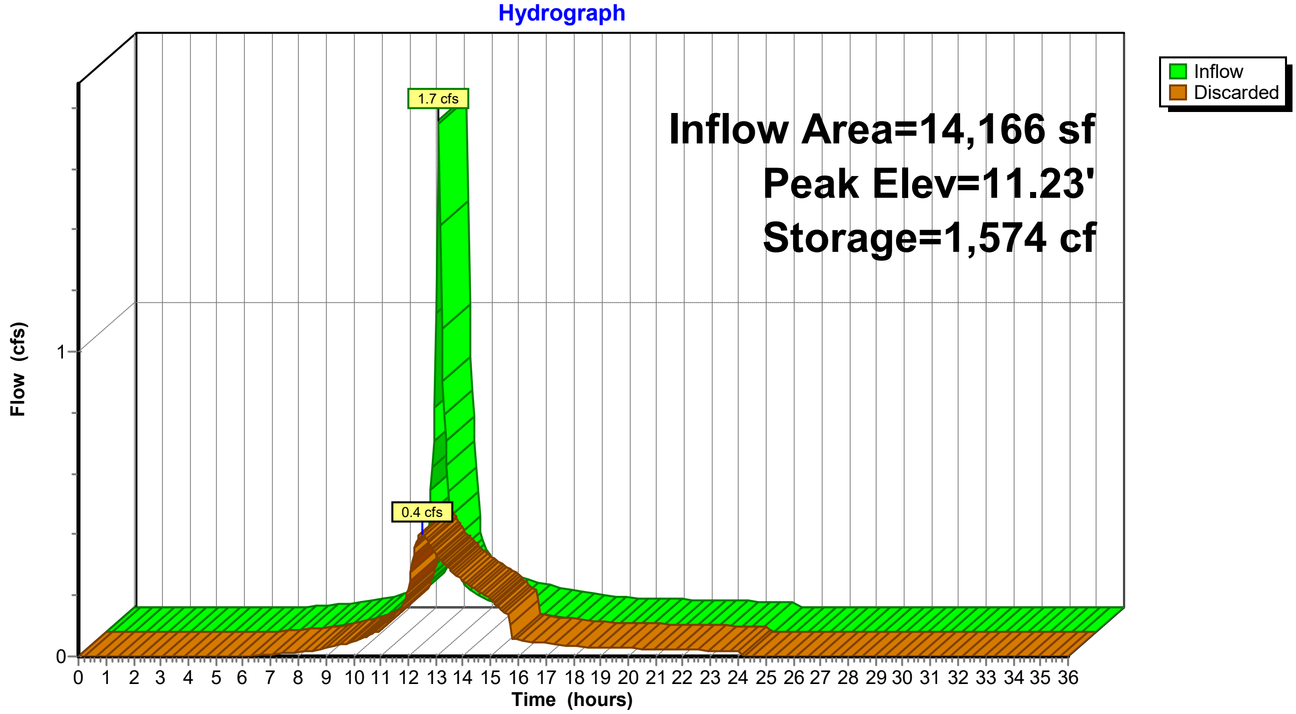
3,017.5 cf Field - 735.0 cf Chambers = 2,282.5 cf Stone x 40.0% Voids = 913.0 cf Stone Storage

Stone + Chamber Storage = 1,648.0 cf = 0.038 af

16 Chambers @ $ 0.00 /ea = $ 0.00
111.8 cy Field Excavation @ $ 0.00 /cy = $ 0.00
84.5 cy Stone @ $ 0.00 /cy = $ 0.00
Total Cost = $ 0.00



## Pond System B:



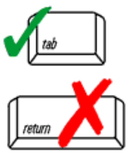
# TAB 3

**Massachusetts Department of Environmental Protection**
Bureau of Resource Protection - Wetlands Program

# Checklist for Stormwater Report

## A. Introduction

**Important:** When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.




A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

## B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

*Note:* Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

## Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

COMMONWEALTH OF MASSACHUSETTS
JAMES E.
HANLEY
CIVIL
No. 47708
REGISTERED
PROFESSIONAL ENGINEER

5/17/2023

Signature and Date

## Checklist

**Project Type:** Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

## Checklist (continued)

**LID Measures:** Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

☒ No disturbance to any Wetland Resource Areas

☒ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☐ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

  ☐ Credit 1

  ☐ Credit 2

  ☐ Credit 3

☒ Use of “country drainage” versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Infiltration trench and subsurface chambers

**Standard 1: No New Untreated Discharges**

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

## **Checklist** (continued)

**Standard 2: Peak Rate Attenuation**

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

**Standard 3: Recharge**

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

## Checklist (continued)

**Standard 3: Recharge** (continued)

☒ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

**Standard 4: Water Quality**

The Long-Term Pollution Prevention Plan typically includes the following:
- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

☐ is within the Zone II or Interim Wellhead Protection Area

☐ is near or to other critical areas

☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

## **Checklist** (continued)

**Standard 4: Water Quality** (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

**Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)**

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

**Standard 6: Critical Areas**

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

## Checklist (continued)

**Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable**

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

**Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control**

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

# Checklist for Stormwater Report

## **Checklist** (continued)

**Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control** (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

**Standard 9: Operation and Maintenance Plan**

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

**Standard 10: Prohibition of Illicit Discharges**

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

**Commonwealth of Massachusetts**
**City/Town of** Salisbury

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## A. Facility Information

Larkin
Owner Name

159 Beach Road
Street Address

Map/Lot #

Salisbury
City

MA
State

Zip Code

## B. Site Information

**Test pits for drainage purposes only**

1. (Check one) ☐ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: Web Soil Survey (Source) 32A/255B (Soil Map Unit)

Wareham and Windsor loamy sand
Soil Name

Soil Limitations

Soil Parent material

Landform

3. Surficial Geological Report Available? ☐ Yes ☐ No If yes: Year Published/Source ______ Map Unit ______

Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☐ No

5. Within a velocity zone? ☐ Yes ☐ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: ______ Wetland Type

7. Current Water Resource Conditions (USGS): ______ Month/Day/ Year Range: ☐ Above Normal ☐ Normal ☐ Below Normal

8. Other references reviewed:

**Commonwealth of Massachusetts**
**City/Town of** Salisbury

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-5 (Hole #) 5/8/23 (Date) ______ (Time) ______ (Weather) ______ (Latitude) ______ (Longitude:)

1. Land Use Commercial (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: ______ ______ Landform ______ Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body ______ feet Drainage Way ______ feet Wetlands ______ feet

   Property Line >10 feet Drinking Water Well ______ feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 84" Depth Weeping from Pit ______ Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-60 | Topsoil | above sandy fill | | | | | | | | | |
| 60-64 | A | Sandy Loam | 10YR3/2 | | | | | | Massive | Friable | |
| 64-78 | B | Loamy Sand | 7.5YR3/4 | | | | | | Massive | Friable | |
| 78-120 | C | Sand | 10YR7/6 | 78" | High Chroma | >5 | | | Single Grain | Loose | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes: ______

**Commonwealth of Massachusetts**
**City/Town of** Salisbury

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-6 (Hole #) 5/8/23 (Date) ______ (Time) ______ (Weather) ______ (Latitude) ______ (Longitude:)

1. Land Use Commercial (e.g., woodland, agricultural field, vacant lot, etc.) ______ (Vegetation) ______ (Surface Stones (e.g., cobbles, stones, boulders, etc.)) ______ (Slope (%))

   Description of Location: ______

2. Soil Parent Material: ______ ______ (Landform) ______ (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body ______ feet Drainage Way ______ feet Wetlands ______ feet
   Property Line >10 feet Drinking Water Well ______ feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 90" Depth Weeping from Pit ______ Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-60 | Topsoil | above sandy fill | | | | | | | | | |
| 60-68 | A | Sandy Loam | 10YR3/2 | — | — | — | — | — | Massive | Friable | |
| 68-80 | B | Loamy Sand | 7.5YR3/4 | — | — | — | — | — | Massive | Friable | |
| 80-120 | C | Sand | 10YR7/6 | 80" | High Chroma | >5 | — | — | Single Grain | Loose | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes: ______

**Commonwealth of Massachusetts**
**City/Town of** Salisbury

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

**Deep Observation Hole Number:** TP-7 (Hole #) 5/8/23 (Date) ______ Time ______ Weather ______ Latitude ______ Longitude:

1. Land Use Commercial (e.g., woodland, agricultural field, vacant lot, etc.) ______ Vegetation ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) ______ Slope (%)

   Description of Location: ______

2. Soil Parent Material: ______ ______ Landform ______ Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body ______ feet Drainage Way ______ feet Wetlands ______ feet

   Property Line >10 feet Drinking Water Well ______ feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

**Soil Log**

| Depth (in) | Soil Horizon /Layer | Soil Texture (USDA | Soil Matrix: Color-Moist (Munsell) | Redoximorphic Features | | | Coarse Fragments % by Volume | | Soil Structure | Soil Consistence (Moist) | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depth | Color | Percent | Gravel | Cobbles & Stones | | | |
| 0-12 | A | Sandy Loam | 10YR3/2 | — | — | — | — | — | Massive | Friable | |
| 12-21 | B | Loamy Sand | 10YR5/6 | — | — | — | — | — | Massive | Friable | |
| 21-120 | C | Sand | 10YR7/6 | 90" | High Chroma | >5 | — | — | Single Grain | Loose | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Additional Notes:

**Commonwealth of Massachusetts**
**City/Town of** Salisbury

# Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

## F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

| | |
|---|---|
| | 5/8/23 |
| Signature of Soil Evaluator | Date |
| William Hall, P.E., S.E. 13592 | 6/30/24 |
| Typed or Printed Name of Soil Evaluator / License # | Expiration Date of License |
| | |
| Name of Approving Authority Witness | Approving Authority |

**Note:** In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

## Field Diagrams: Use this area for field diagrams:

| | | | |
|---|---|---|---|
| Project: | 159 Beach Road | Project Number: | 21-10254 |
| Location: | Salisbury, MA | Prepared By: | William Hall, P.E. |
| Client: | Larkin Real Estate Group, Inc. | Date: | May 17, 2023 |

## STORMWATER MANAGEMENT STANDARDS CALCULATIONS

### Standard 1: Velocity & Rip-Rap Apron Sizing and Gradation Calculations

- Not Applicable, no outlets proposed.

Conclusion: No stormwater discharges are proposed, the Stormwater Management System conforms to Standard 1.

### Standard 2: Peak Discharge Summary (CFS)

| Design Point 1 | 2-Year (3.1-IN) | 10-Year (4.5-IN) | 25-Year (5.3-IN) | 50-Year (5.9-IN) | 100-Year (6.5-IN) |
|---|---|---|---|---|---|
| Pre-Development Conditions: | 0.3 | 0.6 | 0.8 | 1.0 | 1.1 |
| Post Development Conditions: | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| Design Point 2 | 2-Year (3.1-IN) | 10-Year (4.5-IN) | 25-Year (5.3-IN) | 50-Year (5.9-IN) | 100-Year (6.5-IN) |
|---|---|---|---|---|---|
| Pre-Development Conditions: | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Post Development Conditions: | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

Conclusion: The Stormwater Management System conforms to Standard 2.

### Standard 3: Recharge Calculations (Static Method)

#### Subsurface Chamber System A

| Hydrologic Soils Group: | A | B | C | D | | |
|---|---|---|---|---|---|---|
| Total Proposed Impervious Area: | 0.15 | 0.00 | 0.00 | 0.00 | 0.15 | |
| Target Factor: | 0.60 | 0.35 | 0.25 | 0.10 | | |
| Required Recharge Volume: | 320 | 0 | 0 | 0 | 320 | CF |

| | | |
|---|---|---|
| Volume Provided: | 1,001 | CF |

Determine Drawdown Time

| | | |
|---|---|---|
| Saturated Hydraulic Conductivity (Rawls Rate): | 8.27 | IN/HR |
| Bottom Area of Infiltration Basin: | 479 | SF |
| Drawdown Time: | 3.0 | HRS |

## Subsurface Chamber System B

| | A | B | C | D | | |
|---|---|---|---|---|---|---|
| Hydrologic Soils Group: | A | B | C | D | | |
| Total Proposed Impervious Area: | 0.24 | 0.00 | 0.00 | 0.00 | 0.24 | |
| Target Factor: | 0.60 | 0.35 | 0.25 | 0.10 | | |
| Required Recharge Volume: | 527 | 0 | 0 | 0 | 527 | CF |
| Volume Provided: | | | | | 1,648 | CF |

Determine Drawdown Time

| | | |
|---|---|---|
| Saturated Hydraulic Conductivity (Rawls Rate): | 8.27 | IN/HR |
| Bottom Area of Infiltration Basin: | 671 | SF |
| Drawdown Time: | 3.6 | HRS |

## Infiltration Trench

| | A | B | C | D | | |
|---|---|---|---|---|---|---|
| Hydrologic Soils Group: | A | B | C | D | | |
| Total Proposed Impervious Area: | 0.03 | 0.00 | 0.00 | 0.00 | 0.03 | |
| Target Factor: | 0.60 | 0.35 | 0.25 | 0.10 | | |
| Required Recharge Volume: | 75 | 0 | 0 | 0 | 75 | CF |
| Volume Provided: | | | | | 201 | CF |

Determine Drawdown Time

| | | |
|---|---|---|
| Saturated Hydraulic Conductivity (Rawls Rate): | 8.27 | IN/HR |
| Bottom Area of Infiltration Basin: | 122 | SF |
| Drawdown Time: | 2.4 | HRS |

Conclusion: The volume provided exceeds the minimum recharge volume required. In addition, the BMPs drain within 72-HRS to comply with DEP regulations. The Stormwater Management System conforms to Standard 3.

## Standard 4: Water Quality Volume Calculations

### Subsurface Chamber System A

| | | |
|---|---|---|
| Water Quality Depth: | 1.0 | IN |
| Total Proposed Impervious Area: | 0.15 | Acres |
| Required Water Quality Volume: | 534 | CF |
| Provided Water Quality Volume: | 1,001 | CF |

### Subsurface Chamber System A

| | | |
|---|---|---|
| Water Quality Depth: | 1.0 | IN |
| Total Proposed Impervious Area: | 0.24 | Acres |
| Required Water Quality Volume: | 878 | CF |
| Provided Water Quality Volume: | 1,648 | CF |

### Infiltration Trench

| | | |
|---|---|---|
| Water Quality Depth: | 1.0 | IN |
| Total Proposed Impervious Area: | 0.03 | Acres |
| Required Water Quality Volume: | 125 | CF |
| Provided Water Quality Volume: | 201 | CF |

## TSS Removal Rate Calculations

Treatment Provided From Subsurface Chamber Systems A & B

| | TSS Removal Rate | Starting TSS Load | Amount Removed | Remaining Load |
|---|---|---|---|---|
| Hydrodynamic Separator | 90% | 1.00 | 0.90 | 0.10 |
| Subsurface Chambers | 80% | 0.10 | 0.08 | 0.02 |
| TSS Removed through Pervious Pavement: | | | | 98.0% |

Treatment Provided From Infiltration Trench

| | TSS Removal Rate | Starting TSS Load | Amount Removed | Remaining Load |
|---|---|---|---|---|
| Infiltration Trench with Filter Strip: | 80% | 1.00 | 0.80 | 0.20 |
| TSS Removed through Infiltration Trench: | | | | 80.0% |

Conclusion: The volume provided by the infiltration structures exceeds the Water Quality Volume, therefore the TSS Removal Rate meets 80%. The Stormwater Management System conforms to Standard 4.

## Standard 5: Land Uses With Higher Potential Pollutant Loads

Conclusion: The proposed use is not considered a Land Use with Higher Potential Pollutant Loads. This Standard is NOT Applicable.

## Standard 6: Critical Areas

Conclusion: The proposal is not located within a Critical Area. This Standard is NOT Applicable.

## Standard 7: Redevelopment

Conclusion: The development does not meet the criteria for Redevelopment.

## Standard 8: Construction Period Controls

Conclusion: The project is not covered by a NPDES Construction General Permit. An erosion and sedimentation control plan has been submitted to address construction period pollution prevention measures and to reduce the potential for erosion and sedimentation. The Stormwater Management System Conforms to Standard 8.

## Standard 9: Operations and Maintenance Plan

Conclusion: An Operations and Maintenance Plan has been prepared and provided with this summary. The Stormwater Management System Conforms to Standard 9.

## Standard 10: Illicit Discharges to Drainage System

Conclusion: All off-site discharges are comprised entirely of stormwater. The Stormwater Management System Conforms to Standard 10.

| | | |
|---|---|---|
| **Project:** | **159 Beach Road** | CONTECH ENGINEERED SOLUTIONS |
| **Location:** | **Salisbury, MA** | |
| **Prepared For:** | **Civil Design Consultants** | |

**Purpose:** To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

**Reference:** Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

**Procedure:** Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi$^2$/watershed inches (csm/in).

Compute Q Rate using the following equation:

**Q = (qu) (A) (WQV)**

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

| Structure Name | Impv. (acres) | A (miles$^2$) | $t_c$ (min) | $t_c$ (hr) | WQV (in) | qu (csm/in.) | Q (cfs) |
|---|---|---|---|---|---|---|---|
| WQU 1 | 0.07 | 0.0001031 | 6.0 | 0.100 | 1.00 | 774.00 | 0.08 |
| WQU 2 | 0.10 | 0.0001547 | 6.0 | 0.100 | 1.00 | 774.00 | 0.12 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

The WQf sizing calculation selects the minimum size CDS/Cascade/StormCeptor model capable of operating at the computed WQf peak flowrate prior to bypassing. It assumes free discharge of the WQf through the unit and ignores the routing effect of any upstream storm drain piping. As with all hydrodynamic separators, there will be some impact to the Hydraulic Gradient of the corresponding drainage system, and evaluation of this impact should be considered in the design.

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

## CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

## 159 BEACH ROAD
## SALISBURY, MA

| | | | |
|---|---|---|---|
| Area | 0.07 ac | Unit Site Designation | WQU 1 |
| Weighted C | 0.9 | Rainfall Station # | 67 |
| $t_c$ | 6 min | | |
| CDS Model | 1515-3 | CDS Treatment Capacity | 1.0 cfs |

| Rainfall Intensity[1] (in/hr) | Percent Rainfall Volume[1] | Cumulative Rainfall Volume | Total Flowrate (cfs) | Treated Flowrate (cfs) | Incremental Removal (%) |
|---|---|---|---|---|---|
| 0.08 | 41.0% | 41.0% | 0.00 | 0.00 | 39.8 |
| 0.16 | 23.9% | 64.9% | 0.01 | 0.01 | 23.1 |
| 0.24 | 11.5% | 76.5% | 0.01 | 0.01 | 11.1 |
| 0.32 | 7.4% | 83.9% | 0.02 | 0.02 | 7.1 |
| 0.40 | 4.4% | 88.3% | 0.02 | 0.02 | 4.3 |
| 0.48 | 2.9% | 91.2% | 0.03 | 0.03 | 2.8 |
| 0.56 | 1.8% | 93.0% | 0.03 | 0.03 | 1.7 |
| 0.64 | 1.2% | 94.2% | 0.04 | 0.04 | 1.1 |
| 0.72 | 1.6% | 95.8% | 0.04 | 0.04 | 1.5 |
| 0.80 | 0.8% | 96.6% | 0.05 | 0.05 | 0.7 |
| 1.00 | 0.6% | 97.1% | 0.06 | 0.06 | 0.5 |
| 1.40 | 1.4% | 98.6% | 0.08 | 0.08 | 1.3 |
| 1.80 | 0.9% | 99.5% | 0.11 | 0.11 | 0.8 |
| 2.20 | 0.5% | 100.0% | 0.13 | 0.13 | 0.5 |
| | | | | | 96.2 |
| | | | | Removal Efficiency Adjustment[2] = | 0.0% |
| | | | | Predicted % Annual Rainfall Treated = | 100.0% |
| | | | | **Predicted Net Annual Load Removal Efficiency =** | **96.2%** |

1 - Based on 7 years of data from NCDC station #3276, Groveland, Essex County, MA

2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Stormceptor®

CONTECH ENGINEERED SOLUTIONS

# Brief Stormceptor Sizing Report - WQU 2

| Project Information & Location | | | |
|---|---|---|---|
| **Project Name** | 159 Beach Road | **Project Number** | 746695 |
| **City** | Salisbury | **State/ Province** | Massachusetts |
| **Country** | United States of America | **Date** | 5/5/2023 |
| **Designer Information** | | **EOR Information (optional)** | |
| **Name** | Josh Stackhouse | **Name** | |
| **Company** | Contech Engineered Solutions | **Company** | |
| **Phone #** | 207-219-9110 | **Phone #** | |
| **Email** | jstackhouse@conteches.com | **Email** | |

**Stormwater Treatment Recommendation**

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

| | |
|---|---|
| **Site Name** | WQU 2 |
| **Target TSS Removal (%)** | 80 |
| **TSS Removal (%) Provided** | 96 |
| **Recommended Stormceptor Model** | STC 450i |

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

| Stormceptor Sizing Summary | |
|---|---|
| **Stormceptor Model** | **% TSS Removal Provided** |
| STC 450i | 96 |
| STC 900 | 98 |
| STC 1200 | 98 |
| STC 1800 | 98 |
| STC 2400 | 99 |
| STC 3600 | 99 |
| STC 4800 | 99 |
| STC 6000 | 99 |
| STC 7200 | 99 |
| STC 11000 | 100 |
| STC 13000 | 100 |
| STC 16000 | 100 |

Stormceptor®

CONTECH ENGINEERED SOLUTIONS

## Sizing Details

| Drainage Area | |
|---|---|
| Total Area (acres) | 0.10 |
| Imperviousness % | 100.0 |

| Rainfall | |
|---|---|
| Station Name | ROCKPORT 1 ESE |
| State/Province | Massachusetts |
| Station ID # | 6977 |
| Years of Records | 36 |
| Latitude | 42°39'0"N |
| Longitude | 70°36'0"W |

| Water Quality Objective | |
|---|---|
| TSS Removal (%) | 80.0 |
| Runoff Volume Capture (%) | |
| Oil Spill Capture Volume (Gal) | |
| Peak Conveyed Flow Rate (CFS) | |
| Water Quality Flow Rate (CFS) | |

| Up Stream Storage | |
|---|---|
| Storage (ac-ft) | Discharge (cfs) |
| 0.000 | 0.000 |

| Up Stream Flow Diversion | |
|---|---|
| Max. Flow to Stormceptor (cfs) | |

**Particle Size Distribution (PSD)**
**The selected PSD defines TSS removal**

| OK-110 | | |
|---|---|---|
| Particle Diameter (microns) | Distribution % | Specific Gravity |
| 1.0 | 0.0 | 2.65 |
| 53.0 | 3.0 | 2.65 |
| 75.0 | 15.0 | 2.65 |
| 88.0 | 25.0 | 2.65 |
| 106.0 | 41.0 | 2.65 |
| 125.0 | 15.0 | 2.65 |
| 150.0 | 1.0 | 2.65 |
| 212.0 | 0.0 | 2.65 |

## Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

**For Stormceptor Specifications and Drawings Please Visit:**
**https://www.conteches.com/technical-guides/search?filter=1WBC0O5EYX**

# CDS Guide
## Operation, Design, Performance and Maintenance

## CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

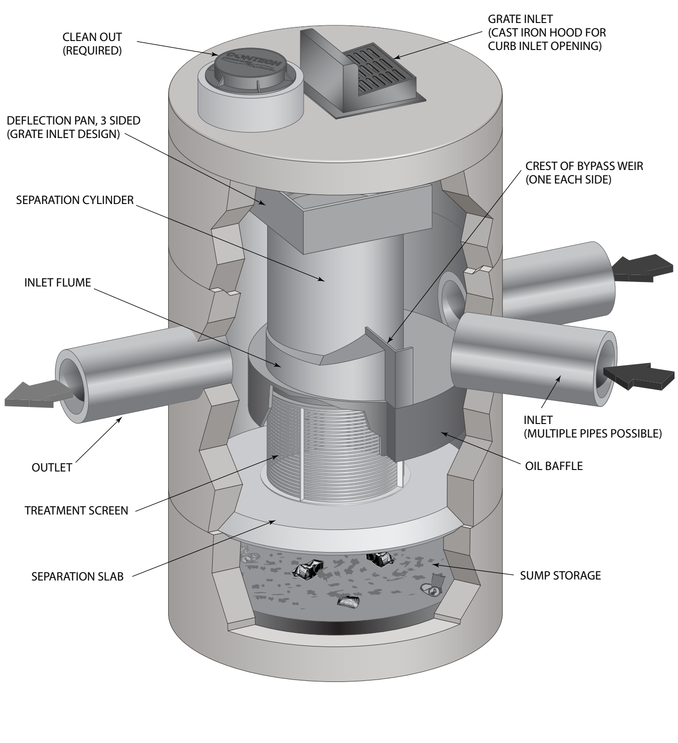
## Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.




## Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns ($\mu$m). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns ($\mu$m) or 50 microns ($\mu$m).

### Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

### Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

### Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

### Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

### Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

## Performance

### Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 $\mu$m) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 $\mu$m) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

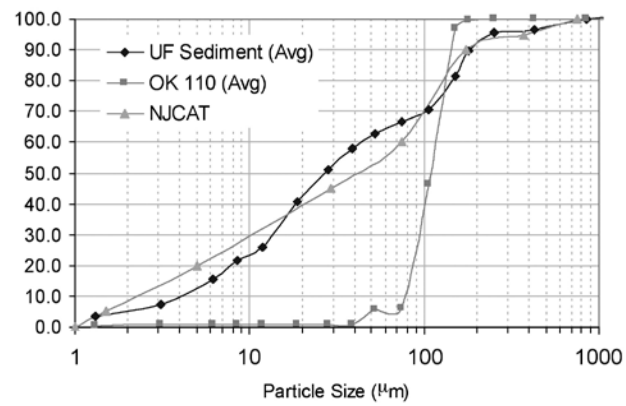



Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

## Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

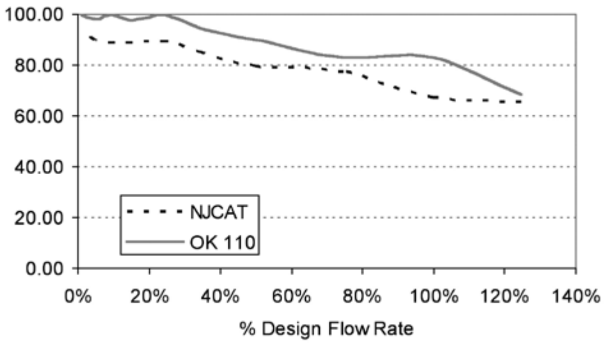



Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 $\mu$m).

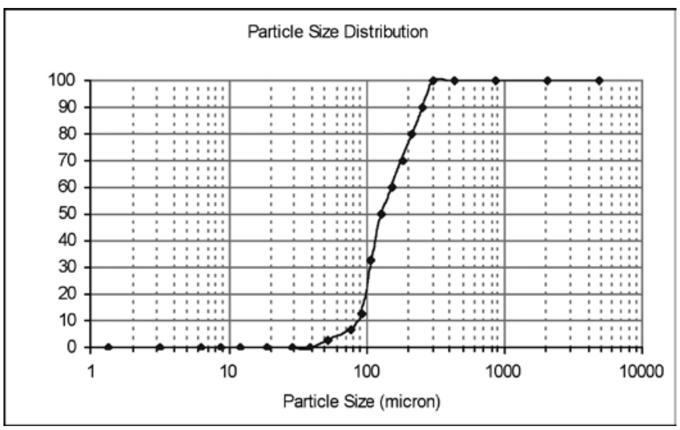



Figure 3. WASDOE PSD

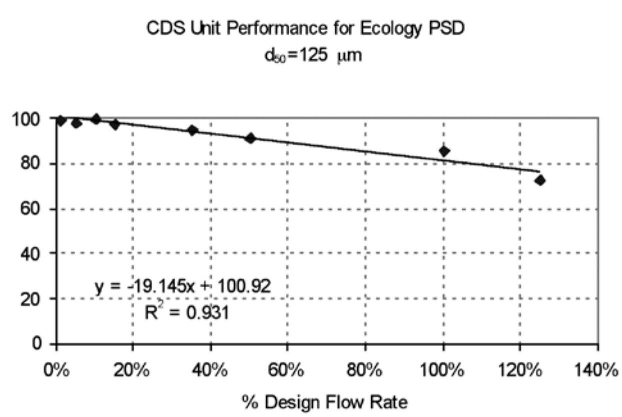



Figure 4. Modeled performance for WASDOE PSD.

## Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

## Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

## Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

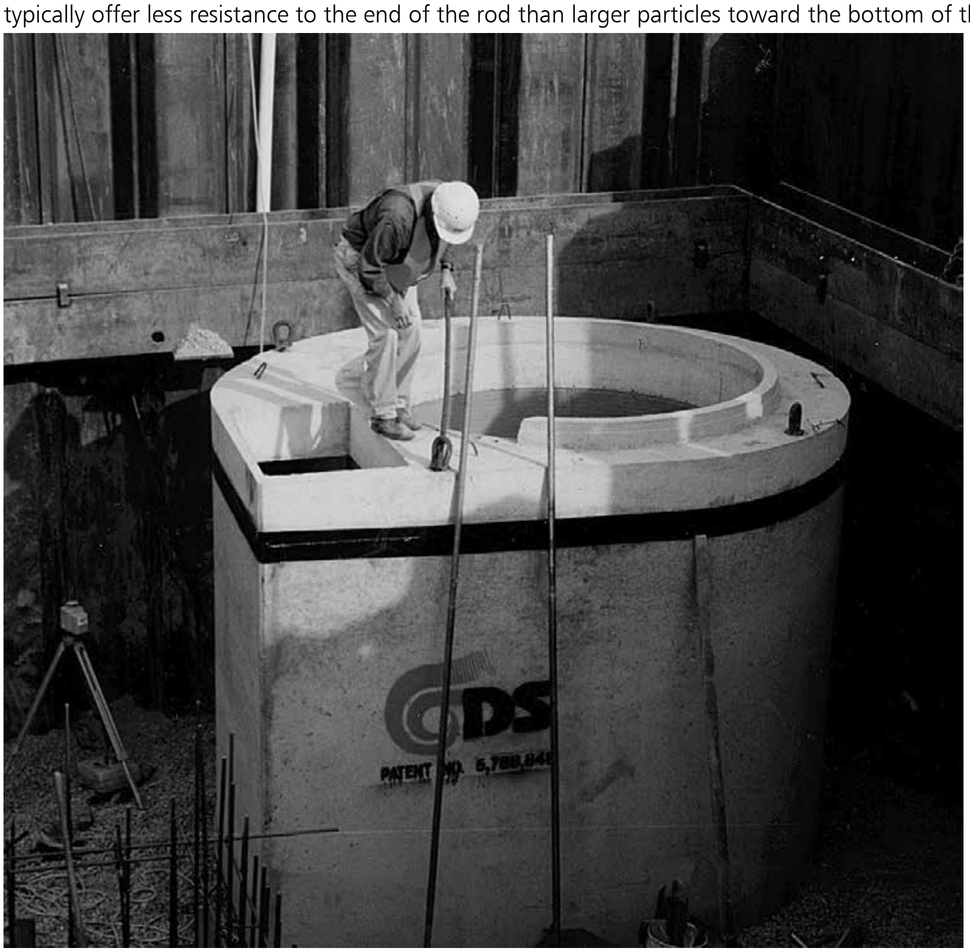
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

| CDS Model | Diameter | | Distance from Water Surface to Top of Sediment Pile | | Sediment Storage Capacity | |
|---|---|---|---|---|---|---|
| | ft | m | ft | m | $y^3$ | $m^3$ |
| CDS1515 | 3 | 0.9 | 3.0 | 0.9 | 0.5 | 0.4 |
| CDS2015 | 4 | 1.2 | 3.0 | 0.9 | 0.9 | 0.7 |
| CDS2015 | 5 | 1.5 | 3.0 | 0.9 | 1.3 | 1.0 |
| CDS2020 | 5 | 1.5 | 3.5 | 1.1 | 1.3 | 1.0 |
| CDS2025 | 5 | 1.5 | 4.0 | 1.2 | 1.3 | 1.0 |
| CDS3020 | 6 | 1.8 | 4.0 | 1.2 | 2.1 | 1.6 |
| CDS3025 | 6 | 1.8 | 4.0 | 1.2 | 2.1 | 1.6 |
| CDS3030 | 6 | 1.8 | 4.6 | 1.4 | 2.1 | 1.6 |
| CDS3035 | 6 | 1.8 | 5.0 | 1.5 | 2.1 | 1.6 |
| CDS4030 | 8 | 2.4 | 4.6 | 1.4 | 5.6 | 4.3 |
| CDS4040 | 8 | 2.4 | 5.7 | 1.7 | 5.6 | 4.3 |
| CDS4045 | 8 | 2.4 | 6.2 | 1.9 | 5.6 | 4.3 |
| CDS5640 | 10 | 3.0 | 6.3 | 1.9 | 8.7 | 6.7 |
| CDS5653 | 10 | 3.0 | 7.7 | 2.3 | 8.7 | 6.7 |
| CDS5668 | 10 | 3.0 | 9.3 | 2.8 | 8.7 | 6.7 |
| CDS5678 | 10 | 3.0 | 10.3 | 3.1 | 8.7 | 6.7 |

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



# CDS Inspection & Maintenance Log

CDS Model: ______________________________ Location: ______________________________

| Date | Water depth to sediment[1] | Floatable Layer Thickness[2] | Describe Maintenance Performed | Maintenance Personnel | Comments |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile**.

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

CONTECH® ENGINEERED SOLUTIONS

800-338-1122

www.ContechES.com



Contech Engineered Solutions provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, earth stabilization and stormwater treatment products. For information on other Contech division offerings, visit www.ContechES.com or call 800.338.1122

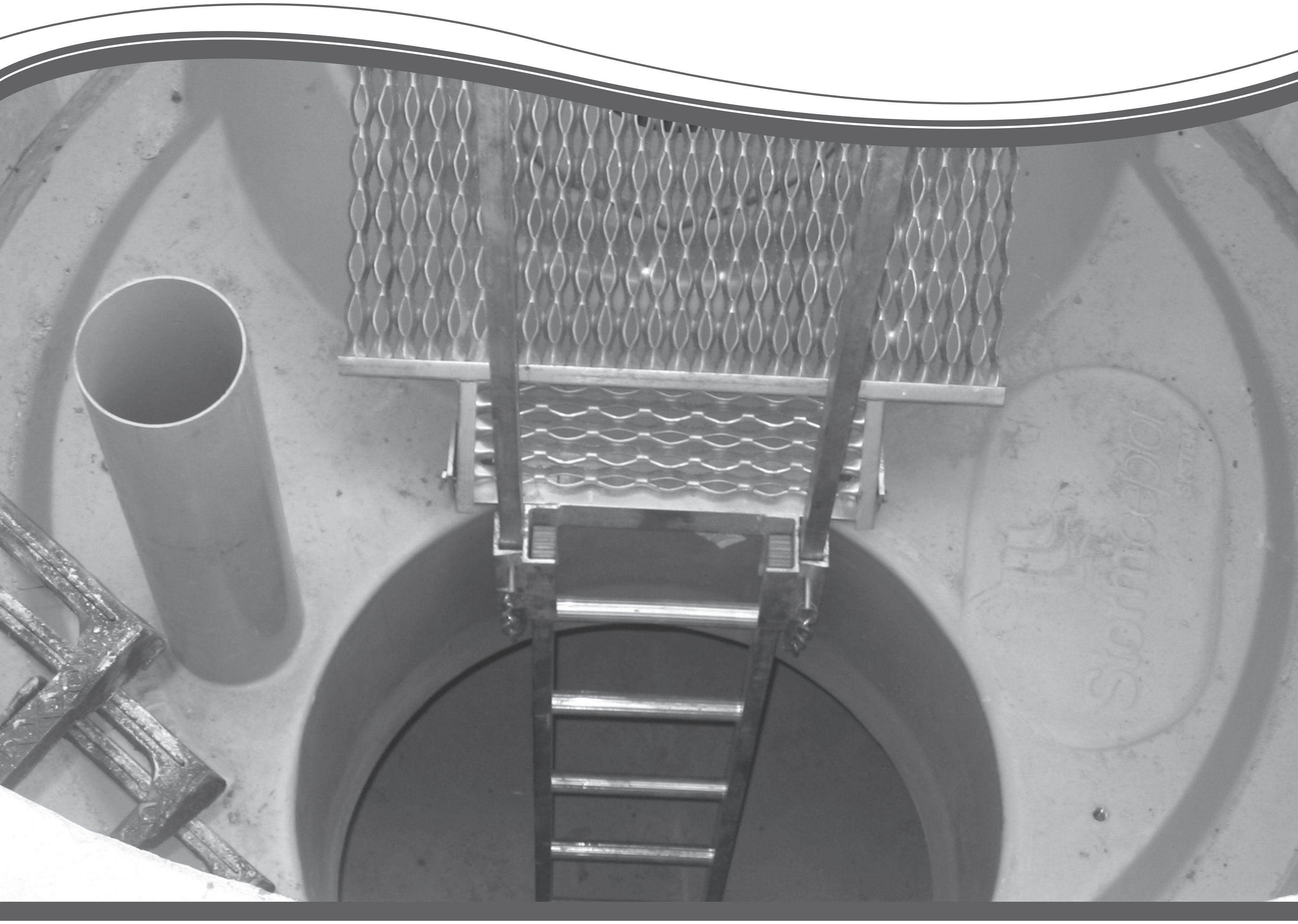


The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

cds_manual 3/17 PDF

RECYCLED PAPER

# Stormceptor® STC
# Operation and Maintenance Guide



## Stormceptor Design Notes

- Only the STC 450i is adaptable to function with a catch basin inlet and/or inline pipes.
- Only the Stormceptor models STC 450i to STC 7200 may accommodate multiple inlet pipes.

### Inlet and outlet invert elevation differences are as follows:

| Inlet and Outlet Pipe Invert Elevations Differences | | | |
|---|---|---|---|
| Inlet Pipe Configuration | STC 450i | STC 900 to STC 7200 | STC 11000 to STC 16000 |
| Single inlet pipe | 3 in. (75 mm) | 1 in. (25 mm) | 3 in. (75 mm) |
| Multiple inlet pipes | 3 in. (75 mm) | 3 in. (75 mm) | Only one inlet pipe. |

### Maximum inlet and outlet pipe diameters:

| Inlet/Outlet Configuration | Inlet Unit STC 450i | In-Line Unit STC 900 to STC 7200 | Series* STC 11000 to STC 16000 |
|---|---|---|---|
| Straight Through | 24 inch (600 mm) | 42 inch (1050 mm) | 60 inch (1500 mm) |
| Bend (90 degrees) | 18 inch (450 mm) | 33 inch (825 mm) | 33 inch (825 mm) |

- The inlet and in-line Stormceptor units can accommodate turns to a maximum of 90 degrees.
- Minimum distance from top of grade to crown is 2 feet (0.6 m)
- Submerged conditions. A unit is submerged when the standing water elevation at the proposed location of the Stormceptor unit is greater than the outlet invert elevation during zero flow conditions. In these cases, please contact your local Stormceptor representative and provide the following information:
- Top of grade elevation
- Stormceptor inlet and outlet pipe diameters and invert elevations
- Standing water elevation
- Stormceptor head loss, K = 1.3 (for submerged condition, K = 4)

# OPERATION AND MAINTENANCE GUIDE
## Table of Content

# 1. About Stormceptor

The Stormceptor® STC (Standard Treatment Cell) was developed by Imbrium™ Systems to address the growing need to remove and isolate pollution from the storm drain system before it enters the environment. The Stormceptor STC targets hydrocarbons and total suspended solids (TSS) in stormwater runoff. It improves water quality by removing contaminants through the gravitational settling of fine sediments and floatation of hydrocarbons while preventing the re-suspension or scour of previously captured pollutants.

The development of the Stormceptor STC revolutionized stormwater treatment, and created an entirely new category of environmental technology. Protecting thousands of waterways around the world, the Stormceptor System has set the standard for effective stormwater treatment.

## 1.1. Patent Information

The Stormceptor technology is protected by the following patents:

- Australia Patent No. 693,164 • 693,164 • 707,133 • 729,096 • 779401
- Austrian Patent No. 289647
- Canadian Patent No 2,009,208 •2,137,942 • 2,175,277 • 2,180,305 • 2,180,383 • 2,206,338 • 2,327,768 (Pending)
- China Patent No 1168439
- Denmark DK 711879
- German DE 69534021
- Indonesian Patent No 16688
- Japan Patent No 9-11476 (Pending)
- Korea 10-2000-0026101 (Pending)
- Malaysia Patent No PI9701737 (Pending)
- New Zealand Patent No 314646
- United States Patent No 4,985,148 • 5,498,331 • 5,725,760 • 5,753,115 • 5,849,181 • 6,068,765 • 6,371,690
- Stormceptor OSR Patent Pending • Stormceptor LCS Patent Pending

# 2. Stormceptor Design Overview

## 2.1. Design Philosophy

The patented Stormceptor System has been designed to focus on the environmental objective of providing long-term pollution control. The unique and innovative Stormceptor design allows for continuous positive treatment of runoff during all rainfall events, while ensuring that all captured pollutants are retained within the system, even during intense storm events.

An integral part of the Stormceptor design is PCSWMM for Stormceptor - sizing software developed in conjunction with Computational Hydraulics Inc. (CHI) and internationally acclaimed expert, Dr. Bill James. Using local historical rainfall data and continuous simulation modeling, this software allows a Stormceptor unit to be designed for each individual site and the corresponding water quality objectives.

By using PCSWMM for Stormceptor, the Stormceptor System can be designed to remove a wide range of particles (typically from 20 to 2,000 microns), and can also be customized to remove a specific particle size distribution (PSD). The specified PSD should accurately reflect what is in the stormwater runoff to ensure the device is achieving the desired water quality objective. Since stormwater runoff contains small particles (less than 75 microns), it is important to design a treatment system to remove smaller particles in addition to coarse particles.

## 2.2. Benefits

The Stormceptor System removes free oil and suspended solids from stormwater, preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits, capabilities and applications of the Stormceptor System are as follows:

- Provides continuous positive treatment during all rainfall events
- Can be designed to remove over 80% of the annual sediment load
- Removes a wide range of particles
- Can be designed to remove a specific particle size distribution (PSD)
- Captures free oil from stormwater
- Prevents scouring or re-suspension of trapped pollutants
- Pre-treatment to reduce maintenance costs for downstream treatment measures (ponds, swales, detention basins, filters)
- Groundwater recharge protection
- Spills capture and mitigation
- Simple to design and specify
- Designed to your local watershed conditions
- Small footprint to allow for easy retrofit installations
- Easy to maintain (vacuum truck)
- Multiple inlets can connect to a single unit
- Suitable as a bend structure
- Pre-engineered for traffic loading (minimum AASHTO HS-20)
- Minimal elevation drop between inlet and outlet pipes
- Small head loss
- Additional protection provided by an 18" (457 mm) fiberglass skirt below the top of the insert, for the containment of hydrocarbons in the event of a spill.

## 2.3. Environmental Benefit

Freshwater resources are vital to the health and welfare of their surrounding communities. There is increasing public awareness, government regulations and corporate commitment to reducing the pollution entering our waterways. A major source of this pollution originates from stormwater runoff from urban areas. Rainfall runoff carries oils, sediment and other contaminants from roads and parking lots discharging directly into our streams, lakes and coastal waterways.

The Stormceptor System is designed to isolate contaminants from getting into the natural environment. The Stormceptor technology provides protection for the environment from spills that occur at service stations and vehicle accident sites, while also removing contaminated sediment in runoff that washes from roads and parking lots.

# 3. Key Operation Features

## 3.1. Scour Prevention

A key feature of the Stormceptor System is its patented scour prevention technology. This innovation ensures pollutants are captured and retained during all rainfall events, even extreme storms. The Stormceptor System provides continuous positive treatment for all rainfall events, including intense storms. Stormceptor slows incoming runoff, controlling and reducing velocities in the lower chamber to create a non-turbulent environment that promotes free oils and floatable debris to rise and sediment to settle.

The patented scour prevention technology, the fiberglass insert, regulates flows into the lower chamber through a combination of a weir and orifice while diverting high energy flows away through the upper chamber to prevent scouring. Laboratory testing demonstrated no scouring when tested up to 125% of the unit's operating rate, with the unit loaded to 100% sediment capacity (NJDEP, 2005). Second, the depth of the lower chamber ensures the sediment storage zone is adequately separated from the path of flow in the lower chamber to prevent scouring.

## 3.2. Operational Hydraulic Loading Rate

Designers and regulators need to evaluate the treatment capacity and performance of manufactured stormwater treatment systems. A commonly used parameter is the "operational hydraulic loading rate" which originated as a design methodology for wastewater treatment devices.

Operational hydraulic loading rate may be calculated by dividing the flow rate into a device by its settling area. This represents the critical settling velocity that is the prime determinant to quantify the influent particle size and density captured by the device. PCSWMM for Stormceptor uses a similar parameter that is calculated by dividing the hydraulic detention time in the device by the fall distance of the sediment.

$$v_{SC} = \frac{H}{6_H} = \frac{Q}{A_S}$$

Where:

$v_{SC}$ = critical settling velocity, ft/s (m/s)

H = tank depth, ft (m)

$Ø_H$ = hydraulic detention time, ft/s (m/s)

Q = volumetric flow rate, ft3/s (m3/s)

$A_S$ = surface area, $ft^2$ ($m^2$)

(Tchobanoglous, G. and Schroeder, E.D. 1987. Water Quality. Addison Wesley.)

Unlike designing typical wastewater devices, stormwater systems are designed for highly variable flow rates including intense peak flows. PCSWMM for Stormceptor incorporates all of the flows into its calculations, ensuring that the operational hydraulic loading rate is considered not only for one flow rate, but for all flows including extreme events.

## 3.3. Double Wall Containment

The Stormceptor System was conceived as a pollution identifier to assist with identifying illicit discharges. The fiberglass insert has a continuous skirt that lines the concrete barrel wall for a depth of 18 inches (457 mm) that provides double wall containment for hydrocarbons storage. This protective barrier ensures that toxic floatables do not migrate through the concrete wall into the surrounding soils.

# 4. Stormceptor Product Line

## 4.1. Stormceptor Models

A summary of Stormceptor models and capacities are listed in Table 1.

**Table 1. Stormceptor Models**

| Stormceptor Model | Total Storage Volume U.S. Gal (L) | Hydrocarbon Storage Capacity U.S. Gal (L) | Maximum Sediment Capacity ft$^3$ (L) |
|---|---|---|---|
| STC 450i | 470 (1,780) | 86 (330) | 46 (1,302) |
| STC 900 | 952 (3,600) | 251 (950) | 89 (2,520) |
| STC 1200 | 1,234 (4,670) | 251 (950) | 127 (3,596) |
| STC 1800 | 1,833 (6,940) | 251 (950) | 207 (5,861) |
| STC 2400 | 2,462 (9,320) | 840 (3,180) | 205 (5,805) |
| STC 3600 | 3,715 (1,406) | 840 (3,180) | 373 (10,562) |
| STC 4800 | 5,059 (1,950) | 909 (3,440) | 543 (15,376) |
| STC 6000 | 6,136 (23,230) | 909 (3,440) | 687 (19,453) |
| STC 7200 | 7,420 (28,090) | 1,059 (4,010) | 839 (23,757) |
| STC 11000 | 11,194 (42,370) | 2,797 (10, 590) | 1,086 (30,752) |
| STC 13000 | 13,348 (50,530) | 2,797 (10, 590) | 1,374 (38,907) |
| STC 16000 | 15,918 (60,260) | 3,055 (11, 560) | 1,677 (47,487) |

NOTE: Storage volumes may vary slightly from region to region. For detailed information, contact your local Stormceptor representative.

## 4.2. Inline Stormceptor

The Inline Stormceptor, Figure 1, is the standard design for most stormwater treatment applications. The patented Stormceptor design allows the Inline unit to maintain continuous positive treatment of total suspended solids (TSS) year-round, regardless of flow rate. The Inline Stormceptor is composed of a precast concrete tank with a fiberglass insert situated at the invert of the storm sewer pipe, creating an upper chamber above the insert and a lower chamber below the insert.

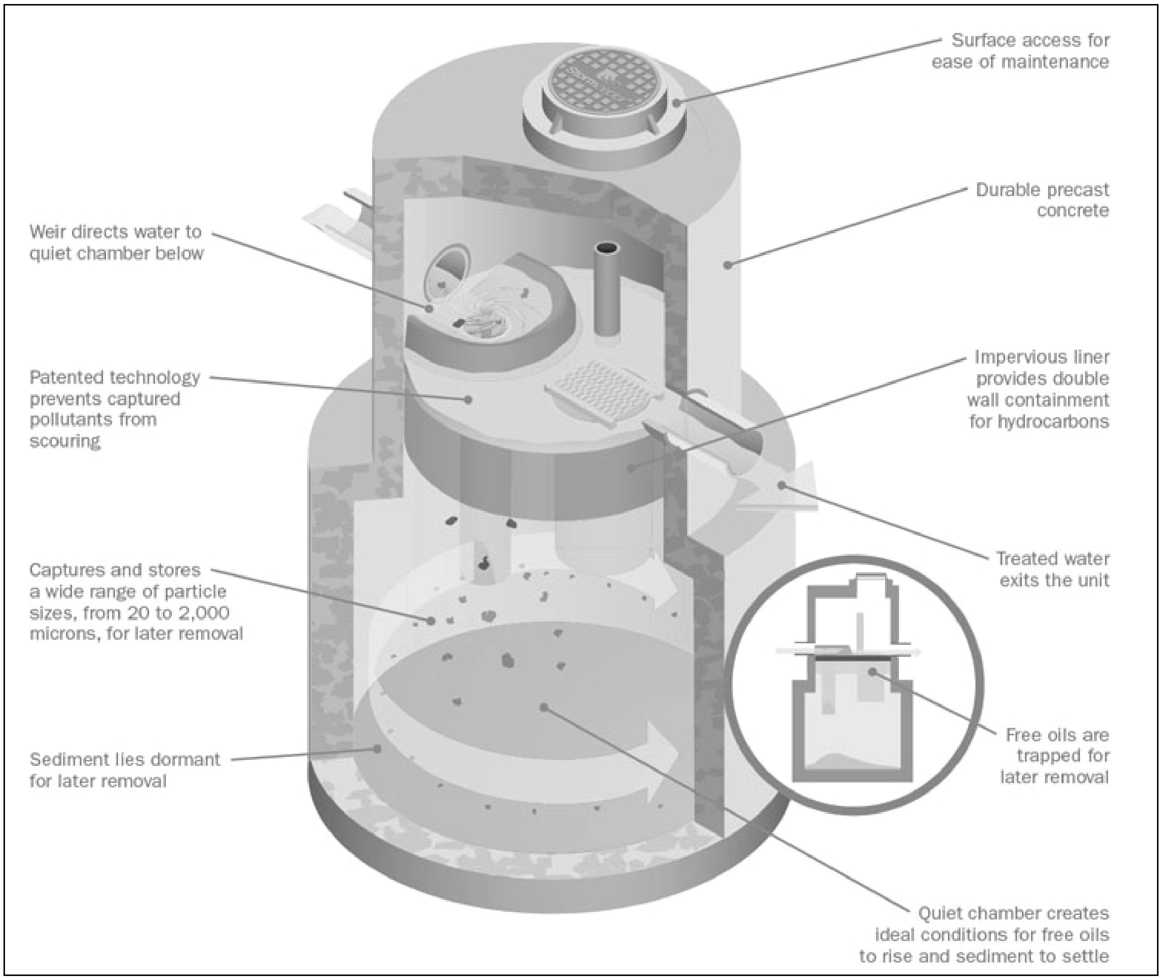



**Figure 1. Inline Stormceptor**

## Operation

As water flows into the Stormceptor unit, it is slowed and directed to the lower chamber by a weir and drop tee. The stormwater enters the lower chamber, a non-turbulent environment, allowing free oils to rise and sediment to settle. The oil is captured underneath the fiberglass insert and shielded from exposure to the concrete walls by a fiberglass skirt. After the pollutants separate, treated water continues up a riser pipe, and exits the lower chamber on the downstream side of the weir before leaving the unit. During high flow events, the Stormceptor System's patented scour prevention technology ensures continuous pollutant removal and prevents re-suspension of previously captured pollutants.

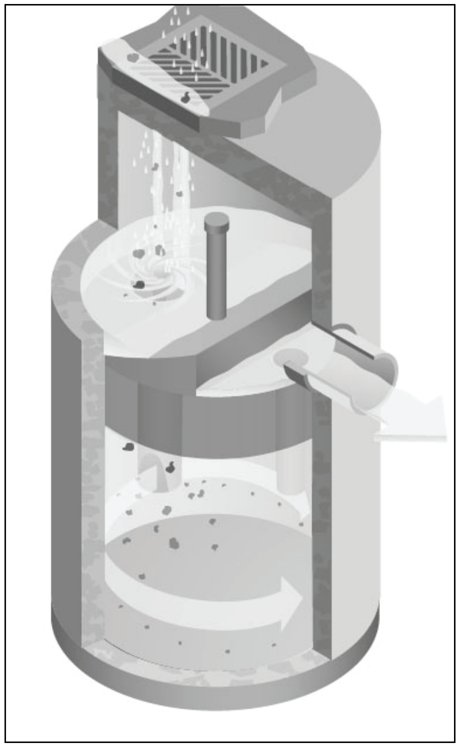


**Figure 2. Inlet Stormceptor**

### 4.3. Inlet Stormceptor

The Inlet Stormceptor System, Figure 2, was designed to provide protection for parking lots, loading bays, gas stations and other spill-prone areas. The Inlet Stormceptor is designed to remove sediment from stormwater introduced through a grated inlet, a storm sewer pipe, or both.

The Inlet Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

### 4.4. Series Stormceptor

Designed to treat larger drainage areas, the Series Stormceptor System, Figure 3, consists of two adjacent Stormceptor models that function in parallel. This design eliminates the need for additional structures and piping to reduce installation costs.

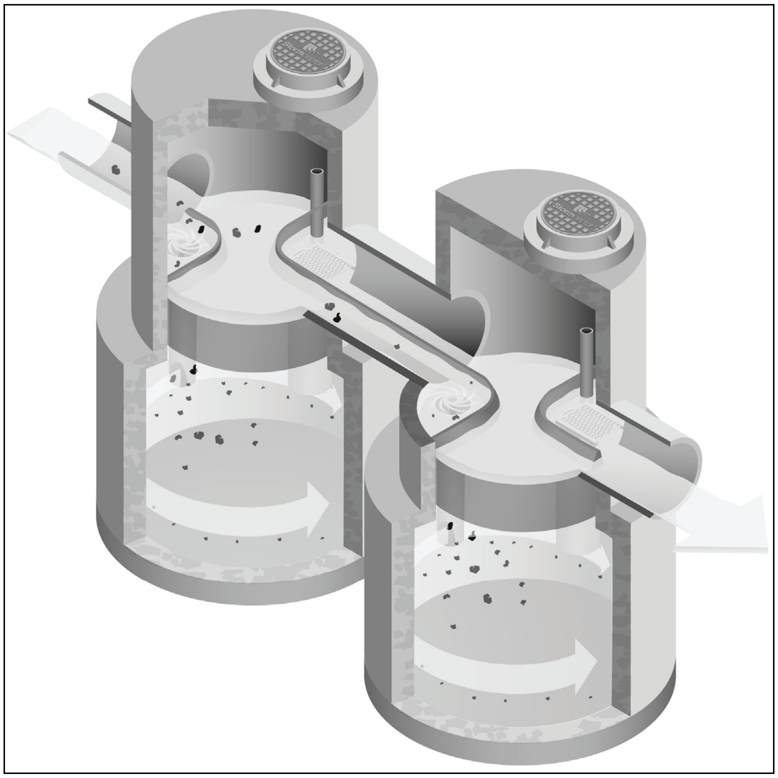


**Figure 3. Series System**

The Series Stormceptor design operates in the same manner as the Inline unit, providing continuous positive treatment, and ensuring that captured material is not re-suspended.

## 5. Sizing the Stormceptor System

The Stormceptor System is a versatile product that can be used for many different aspects of water quality improvement. While addressing these needs, there are conditions that the designer needs to be aware of in order to size the Stormceptor model to meet the demands of each individual site in an efficient and cost-effective manner.

PCSWMM for Stormceptor is the support tool used for identifying the appropriate Stormceptor model. In order to size a unit, it is recommended the user follow the seven design steps in the program. The steps are as follows:

### STEP 1 – Project Details

The first step prior to sizing the Stormceptor System is to clearly identify the water quality objective for the development. It is recommended that a level of annual sediment (TSS) removal be identified and defined by a particle size distribution.

### STEP 2 – Site Details

Identify the site development by the drainage area and the level of imperviousness. It is recommended that imperviousness be calculated based on the actual area of imperviousness based on paved surfaces, sidewalks and rooftops.

### STEP 3 – Upstream Attenuation

The Stormceptor System is designed as a water quality device and is sometimes used in conjunction with onsite water quantity control devices such as ponds or underground detention systems. When possible, a greater benefit is typically achieved when installing a Stormceptor unit upstream of a detention facility. By placing the Stormceptor unit upstream of a detention structure, a benefit of less maintenance of the detention facility is realized.

## STEP 4 – Particle Size Distribution

It is critical that the PSD be defined as part of the water quality objective. PSD is critical for the design of treatment system for a unit process of gravity settling and governs the size of a treatment system. A range of particle sizes has been provided and it is recommended that clays and silt-sized particles be considered in addition to sand and gravel-sized particles. Options and sample PSDs are provided in PCSWMM for Stormceptor. The default particle size distribution is the Fine Distribution, Table 2, option.

**Table 2. Fine Distribution**

| Particle Size | Distribution | Specific Gravity |
|---|---|---|
| 20 | 20% | 1.3 |
| 60 | 20% | 1.8 |
| 150 | 20% | 2.2 |
| 400 | 20% | 2.65 |
| 2000 | 20% | 2.65 |

If the objective is the long-term removal of 80% of the total suspended solids on a given site, the PSD should be representative of the expected sediment on the site. For example, a system designed to remove 80% of coarse particles (greater than 75 microns) would provide relatively poor removal efficiency of finer particles that may be naturally prevalent in runoff from the site.

Since the small particle fraction contributes a disproportionately large amount of the total available particle surface area for pollutant adsorption, a system designed primarily for coarse particle capture will compromise water quality objectives.

## STEP 5 – Rainfall Records

Local historical rainfall has been acquired from the U.S. National Oceanic and Atmospheric Administration, Environment Canada and regulatory agencies across North America. The rainfall data provided with PCSMM for Stormceptor provides an accurate estimation of small storm hydrology by modeling actual historical storm events including duration, intensities and peaks.

## STEP 6 – Summary

At this point, the program may be executed to predict the level of TSS removal from the site. Once the simulation has completed, a table shall be generated identifying the TSS removal of each Stormceptor unit.

## STEP 7 – Sizing Summary

Performance estimates of all Stormceptor units for the given site parameters will be displayed in a tabular format. The unit that meets the water quality objective, identified in Step 1, will be highlighted.

### 5.1. PCSWMM for Stormceptor

The Stormceptor System has been developed in conjunction with PCSWMM for Stormceptor as a technological solution to achieve water quality goals. Together, these two innovations model, simulate, predict and calculate the water quality objectives desired by a design engineer for TSS removal.

PCSWMM for Stormceptor is a proprietary sizing program which uses site specific inputs to a computer model to simulate sediment accumulation, hydrology and long-term total suspended solids removal. The model has been calibrated to field monitoring results from Stormceptor units that have been monitored in North America. The sizing methodology can be described by three processes:

1. Determination of real time hydrology
2. Buildup and wash off of TSS from impervious land areas
3. TSS transport through the Stormceptor (settling and discharge). The use of a calibrated model is the preferred method for sizing stormwater quality structures for the following reasons:
    » The hydrology of the local area is properly and accurately incorporated in the sizing (distribution of flows, flow rate ranges and peaks, back-to-back storms, inter-event times)
    » The distribution of TSS with the hydrology is properly and accurately considered in the sizing
    » Particle size distribution is properly considered in the sizing
    » The sizing can be optimized for TSS removal
    » The cost benefit of alternate TSS removal criteria can be easily assessed
    » The program assesses the performance of all Stormceptor models. Sizing may be selected based on a specific water quality outcome or based on the Maximum Extent Practicable

For more information regarding PCSWMM for Stormceptor, contact your local Stormceptor representative, or visit www.imbriumsystems.com to download a free copy of the program.

### 5.2. Sediment Loading Characteristics

The way in which sediment is transferred to stormwater can have a considerable effect on which type of system is implemented. On typical impervious surfaces (e.g. parking lots) sediment will build over time and wash off with the next rainfall. When rainfall patterns are examined, a short intense storm will have a higher concentration of sediment than a long slow drizzle. Together with rainfall data representing the site's typical rainfall patterns, sediment loading characteristics play a part in the correct sizing of a stormwater quality device.

Typical Sites

For standard site design of the Stormceptor System, PCSWMM for Stormceptor is utilized to accurately assess the unit's performance. As an integral part of the product's design, the program can be used to meet local requirements for total suspended solid removal. Typical installations of manufactured stormwater treatment devices would occur on areas such as paved parking lots or paved roads. These are considered "stable" surfaces which have non – erodible surfaces.

Unstable Sites

While standard sites consist of stable concrete or asphalt surfaces, sites such as gravel parking lots, or maintenance yards with stockpiles of sediment would be classified as "unstable". These types of sites do not exhibit first flush characteristics, are highly erodible and exhibit atypical sediment loading characteristics and must therefore be sized more carefully. Contact your local Stormceptor representative for assistance in selecting a proper unit sized for such unstable sites.

## 6. Spill Controls

When considering the removal of total petroleum hydrocarbons (TPH) from a storm sewer system there are two functions of the system: oil removal, and spill capture.

'Oil Removal' describes the capture of the minute volumes of free oil mobilized from impervious surfaces. In this instance relatively low concentrations, volumes and flow rates are considered. While the Stormceptor unit will still provide an appreciable oil removal function during higher flow events and/or with higher TPH concentrations, desired effluent limits may be exceeded under these conditions.

‘Spill Capture’ describes a manner of TPH removal more appropriate to recovery of a relatively high volume of a single phase deleterious liquid that is introduced to the storm sewer system over a relatively short duration. The two design criteria involved when considering this manner of introduction are overall volume and the specific gravity of the material. A standard Stormceptor unit will be able to capture and retain a maximum spill volume and a minimum specific gravity.

For spill characteristics that fall outside these limits, unit modifications are required. Contact your local Stormceptor Representative for more information.

One of the key features of the Stormceptor technology is its ability to capture and retain spills. While the standard Stormceptor System provides excellent protection for spill control, there are additional options to enhance spill protection if desired.

## 6.1. Oil Level Alarm

The oil level alarm is an electronic monitoring system designed to trigger a visual and audible alarm when a pre-set level of oil is reached within the lower chamber. As a standard, the oil

level alarm is designed to trigger at approximately 85% of the unit’s available depth level for oil capture. The feature acts as a safeguard against spills caused by exceeding the oil storage capacity of the separator and eliminates the need for manual oil level inspection.

The oil level alarm installed on the Stormceptor insert is illustrated in Figure 4.

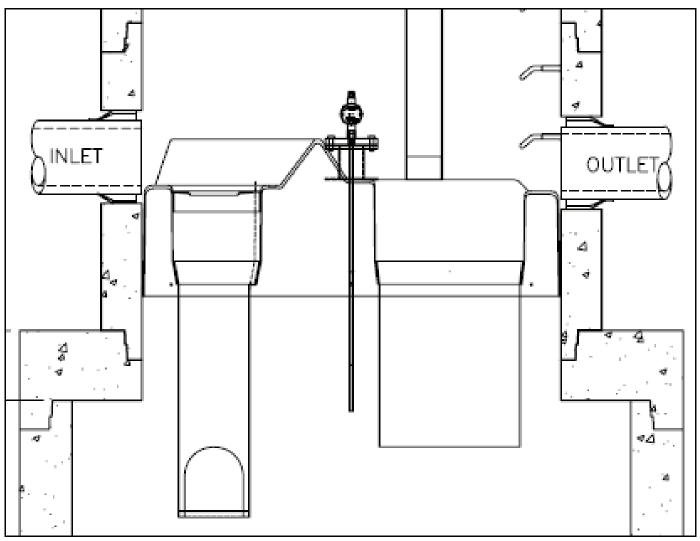



**Figure 4. Oil level alarm**

## 6.2. Increased Volume Storage Capacity

The Stormceptor unit may be modified to store a greater spill volume than is typically available. Under such a scenario, instead of installing a larger than required unit, modifications can be made to the recommended Stormceptor model to accommodate larger volumes. Contact your local Stormceptor representative for additional information and assistance for modifications.

# 7. Stormceptor Options

The Stormceptor System allows flexibility to incorporate to existing and new storm drainage infrastructure. The following section identifies considerations that should be reviewed when installing the system into a drainage network. For conditions that fall outside of the recommendations in this section, please contact your local Stormceptor representative for further guidance.

## 7.1. Installation Depth Minimum Cover

The minimum distance from the top of grade to the crown of the inlet pipe is 24 inches (600 mm). For situations that have a lower minimum distance, contact your local Stormceptor representative.

## 7.2. Maximum Inlet and Outlet Pipe Diameters

Maximum inlet and outlet pipe diameters are illustrated in Figure 5. Contact your local Stormceptor representative for larger pipe diameters

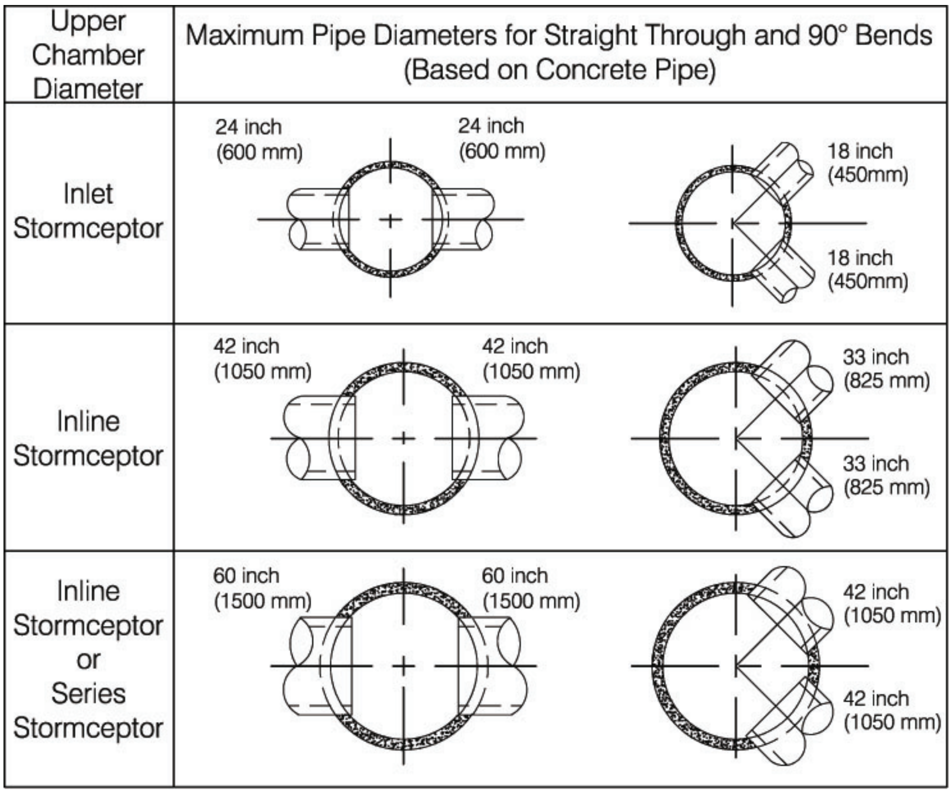



**Figure 5. Maximum pipe diameters for straight through and bend applications**

*The bend should only be incorporated into the second structure (downstream structure) of the Series Stormceptor System

## 7.3. Bends

The Stormceptor System can be used to change horizontal alignment in the storm drain network up to a maximum of 90 degrees. Figure 6 illustrates the typical bend situations of the Stormceptor System. Bends should only be applied to the second structure (downstream structure) of the Series Stormceptor System.

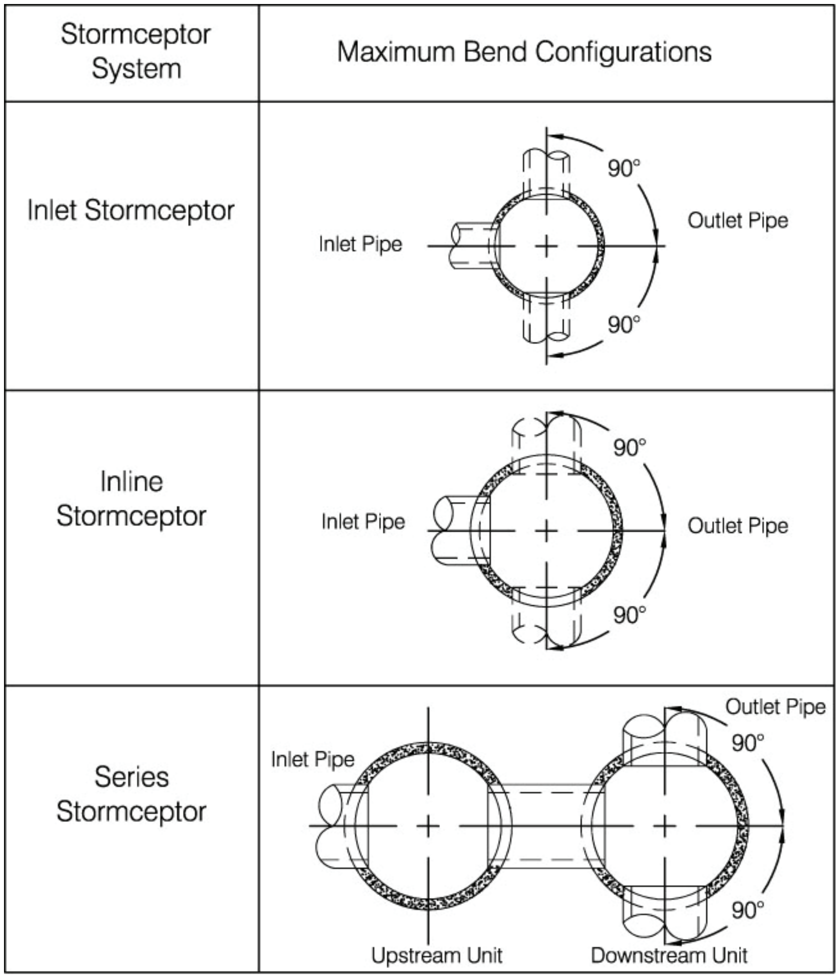



**Figure 6. Maximum bend angles**

## 7.4. Multiple Inlet Pipes

The Inlet and Inline Stormceptor System can accommodate two or more inlet pipes. The maximum number of inlet pipes that can be accommodated into a Stormceptor unit is a function of the number, alignment and diameter of the pipes and its effects on the structural integrity of the precast concrete. When multiple inlet pipes are used for new developments, each inlet pipe shall have an invert elevation 3 inches (75 mm) higher than the outlet pipe invert elevation.

## 7.5. Inlet/Outlet Pipe Invert Elevations

Recommended inlet and outlet pipe invert differences are listed in Table 3.

**Table 3. Recommended Drops Between Inlet and Outlet Pipe Inverts**

| Number of Inlet Pipes | Inlet System | In-Line System | Series System |
|---|---|---|---|
| 1 | 3 inches (75 mm) | 1 inch (25 mm) | 3 inches (75 mm) |
| >1 | 3 inches (75 mm) | 3 inches (75 mm) | Not Applicable |

## 7.6. Shallow Stormceptor

In cases where there may be restrictions to the depth of burial of storm sewer systems. In this situation, for selected Stormceptor models, the lower chamber components may be increased in diameter to reduce the overall depth of excavation required.

## 7.7. Customized Live Load

The Stormceptor system is typically designed for local highway truck loading (AASHTO HS- 20). When the project requires live loads greater than HS-20, the Stormceptor System may be customized structurally for a pre-specified live load. Contact your local Stormceptor representative for customized loading conditions.

## 7.8. Pre-treatment

The Stormceptor System may be sized to remove sediment and for spills control in conjunction with other stormwater BMPs to meet the water quality objective. For pretreatment applications, the Stormceptor System should be the first unit in a treatment train. The benefits of pre-treatment include the extension of the operational life (extension of maintenance frequency) of large stormwater management facilities, prevention of spills and lower total life- cycle maintenance cost.

## 7.9. Head loss

The head loss through the Stormceptor System is similar to a 60 degree bend at a manhole. The K value for calculating minor losses is approximately 1.3 (minor loss = k*1.3v2/2g).

However, when a Submerged modification is applied to a Stormceptor unit, the corresponding K value is 4.

## 7.10. Submerged

The Submerged modification, Figure 7, allows the Stormceptor System to operate in submerged or partially submerged storm sewers. This configuration can be installed on all models of the Stormceptor System by modifying the fiberglass insert. A customized weir height and a secondary drop tee are added.

Submerged instances are defined as standing water in the storm drain system during zero flow conditions. In these instances, the following information is necessary for the proper design and application of submerged modifications:

- Stormceptor top of grade elevation
- Stormceptor outlet pipe invert elevation
- Standing water elevation

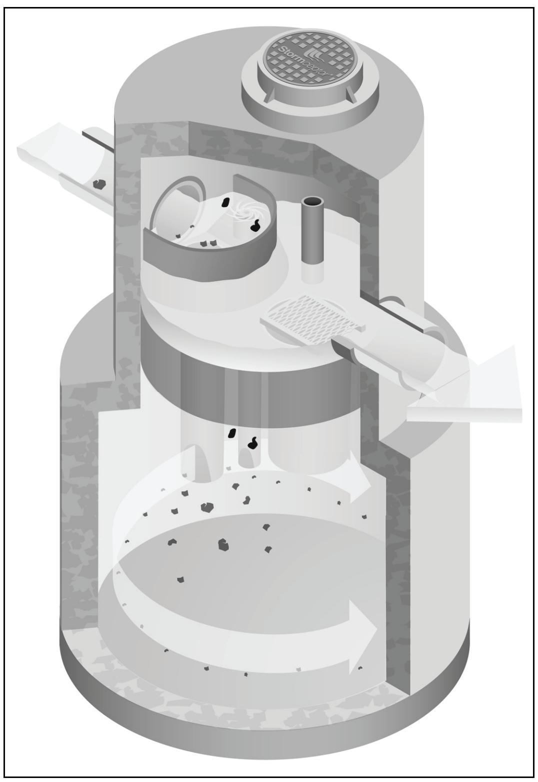


**Figure 7. Submerged Stormceptor**

# 8. Comparing Technologies

Designers have many choices available to achieve water quality goals in the treatment of stormwater runoff. Since many alternatives are available for use in stormwater quality treatment it is important to consider how to make an appropriate comparison between “approved alternatives”. The following is a guide to assist with the accurate comparison of differing technologies and performance claims.

## 8.1. Particle Size Distribution (PSD)

The most sensitive parameter to the design of a stormwater quality device is the selection of the design particle size. While it is recommended that the actual particle size distribution (PSD) for sites be measured prior to sizing, alternative values for particle size should be selected to represent what is likely to occur naturally on the site. A reasonable estimate of a particle size distribution likely to be found on parking lots or other impervious surfaces should consist of a wide range of particles such as 20 microns to 2,000 microns (Ontario MOE, 1994).

There is no absolute right particle size distribution or specific gravity and the user is cautioned to review the site location, characteristics, material handling practices and regulatory requirements when selecting a particle size distribution. When comparing technologies, designs using different PSDs will result in incomparable TSS removal efficiencies. The PSD of the TSS removed needs to be standard between two products to allow for an accurate comparison.

## 8.2. Scour Prevention

In order to accurately predict the performance of a manufactured treatment device, there must be confidence that it will perform under all conditions. Since rainfall patterns cannot be predicted, stormwater quality devices placed in storm sewer systems must be able to withstand extreme events, and ensure that all pollutants previously captured are retained in the system.

In order to have confidence in a system‘s performance under extreme conditions, independent validation of scour prevention is essential when examining different technologies. Lack of independent verification of scour prevention should make a designer wary of accepting any product’s performance claims.

## 8.3. Hydraulics

Full scale laboratory testing has been used to confirm the hydraulics of the Stormceptor System. Results of lab testing have been used to physically design the Stormceptor System and the sewer pipes entering and leaving the unit. Key benefits of Stormceptor are:

- Low head loss (typical k value of 1.3)
- Minimal inlet/outlet invert elevation drop across the structure
- Use as a bend structure
- Accommodates multiple inlets

The adaptability of the treatment device to the storm sewer design infrastructure can affect the overall performance and cost of the site.

## 8.4. Hydrology

Stormwater quality treatment technologies need to perform under varying climatic conditions. These can vary from long low intensity rainfall to short duration, high intensity storms. Since a treatment device is expected to perform under all these conditions, it makes sense that any system’s design should accommodate those conditions as well.

Long-term continuous simulation evaluates the performance of a technology under the varying conditions expected in the climate of the subject site. Single, peak event design does not provide this information and is not equivalent to long-term simulation. Designers should request long-term simulation performance to ensure the technology can meet the long-term water quality objective.

## 9. Testing

The Stormceptor System has been the most widely monitored stormwater treatment technology in the world. Performance verification and monitoring programs are completed to the strictest standards and integrity. Since its introduction in 1990, numerous independent field tests and studies detailing the effectiveness of the Stormceptor System have been completed.

- Coventry University, UK – 97% removal of oil, 83% removal of sand and 73% removal of peat
- National Water Research Institute, Canada, - scaled testing for the development of the Stormceptor System identifying both TSS removal and scour prevention.
- New Jersey TARP Program – full scale testing of an STC 900 demonstrating 75% TSS removal of particles from 1 to 1000 microns. Scour testing completed demonstrated that the system does not scour. The New Jersey Department of Environmental Protection was followed.
- City of Indianapolis – full scale testing of an STC 900 demonstrating over 80% TSS removal of particles from 50 microns to 300 microns at 130% of the unit's operating rate. Scour testing completed demonstrated that the system does not scour.
- Westwood Massachusetts (1997), demonstrated >80% TSS removal
- Como Park (1997), demonstrated 76% TSS removal
- Ontario MOE SWAMP Program – 57% removal of 1 to 25 micron particles
- Laval Quebec – 50% removal of 1 to 25 micron particles

## 10. Installation

The installation of the concrete Stormceptor should conform in general to state highway, or local specifications for the installation of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

### 10.1. Excavation

Excavation for the installation of the Stormceptor should conform to state highway, or local specifications. Topsoil removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials.

Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12 inches (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

In areas with a high water table, continuous dewatering may be required to ensure that the excavation is stable and free of water.

### 10.2. Backfilling

Backfill material should conform to state highway or local specifications. Backfill material should be placed in uniform layers not exceeding 12 inches (300mm) in depth and compacted to state highway or local specifications.

## 11. Stormceptor Construction Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. Aggregate base
2. Base slab
3. Lower chamber sections
4. Upper chamber section with fiberglass insert
5. Connect inlet and outlet pipes
6. Assembly of fiberglass insert components (drop tee, riser pipe, oil cleanout port and orifice plate
7. Remainder of upper chamber
8. Frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the precast concrete manufacturer's recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary. Once the Stormceptor has been constructed, any lift holes must be plugged with mortar.

# 12. Maintenance

## 12.1. Health and Safety

The Stormceptor System has been designed considering safety first. It is recommended that confined space entry protocols be followed if entry to the unit is required. In addition, the fiberglass insert has the following health and safety features:

- Designed to withstand the weight of personnel
- A safety grate is located over the 24 inch (600 mm) riser pipe opening
- Ladder rungs can be provided for entry into the unit, if required

## 12.2. Maintenance Procedures

Maintenance of the Stormceptor system is performed using vacuum trucks. No entry into the unit is required for maintenance (in most cases). The vacuum service industry is a well- established sector of the service industry that cleans underground tanks, sewers and catch basins. Costs to clean a Stormceptor will vary based on the size of unit and transportation distances.

The need for maintenance can be determined easily by inspecting the unit from the surface. The depth of oil in the unit can be determined by inserting a dipstick in the oil inspection/cleanout port.

Similarly, the depth of sediment can be measured from the surface without entry into the Stormceptor via a dipstick tube equipped with a ball valve. This tube would be inserted through the riser pipe. Maintenance should be performed once the sediment depth exceeds the guideline values provided in the Table 4.

**Table 4. Sediment Depths Indicating Required Servicing***

| Particle Size | Specific Gravity |
|---|---|
| Model | Sediment Depth inches (mm) |
| 450i | 8 (200) |
| 900 | 8 (200) |
| 1200 | 10 (250) |
| 1800 | 15 (381) |
| 2400 | 12 (300) |
| 3600 | 17 (430) |
| 4800 | 15 (380) |
| 6000 | 18 (460) |
| 7200 | 15 (381) |
| 11000 | 17 (380) |
| 13000 | 20 (500) |
| 16000 | 17 (380) |
| * based on 15% of the Stormceptor unit's total storage | |

Although annual servicing is recommended, the frequency of maintenance may need to be increased or reduced based on local conditions (i.e. if the unit is filling up with sediment more quickly than projected, maintenance may be required semi-annually; conversely once the site has stabilized maintenance may only be required every two or three years).

Oil is removed through the oil inspection/cleanout port and sediment is removed through the riser pipe. Alternatively oil could be removed from the 24 inches (600 mm) opening if water is removed from the lower chamber to lower the oil level below the drop pipes.

The following procedures should be taken when cleaning out Stormceptor:

1. Check for oil through the oil cleanout port
2. Remove any oil separately using a small portable pump
3. Decant the water from the unit to the sanitary sewer, if permitted by the local regulating authority, or into a separate containment tank
4. Remove the sludge from the bottom of the unit using the vacuum truck
5. Re-fill Stormceptor with water where required by the local jurisdiction

## 12.3. Submerged Stormceptor

Careful attention should be paid to maintenance of the Submerged Stormceptor System. In cases where the storm drain system is submerged, there is a requirement to plug both the inlet and outlet pipes to economically clean out the unit.

## 12.4. Hydrocarbon Spills

The Stormceptor is often installed in areas where the potential for spills is great. The Stormceptor System should be cleaned immediately after a spill occurs by a licensed liquid waste hauler.

## 12.5. Disposal

Requirements for the disposal of material from the Stormceptor System are similar to that of any other stormwater Best Management Practice (BMP) where permitted. Disposal options for the sediment may range from disposal in a sanitary trunk sewer upstream of a sewage treatment plant, to disposal in a sanitary landfill site. Petroleum waste products collected in the Stormceptor (free oil/chemical/fuel spills) should be removed by a licensed waste management company.

## 12.6. Oil Sheens

With a steady influx of water with high concentrations of oil, a sheen may be noticeable at the Stormceptor outlet. This may occur because a rainbow or sheen can be seen at very small oil concentrations (<10 mg/L). Stormceptor will remove over 98% of all free oil spills from storm sewer systems for dry weather or frequently occurring runoff events.

The appearance of a sheen at the outlet with high influent oil concentrations does not mean the unit is not working to this level of removal. In addition, if the influent oil is emulsified the Stormceptor will not be able to remove it. The Stormceptor is designed for free oil removal and not emulsified conditions.


**SUPPORT**

Drawings and specifications are available at www.ContechES.com.

Site-specific design support is available from our engineers.



CONTECH ENGINEERED SOLUTIONS
800-925-5240
www.ContechES.com