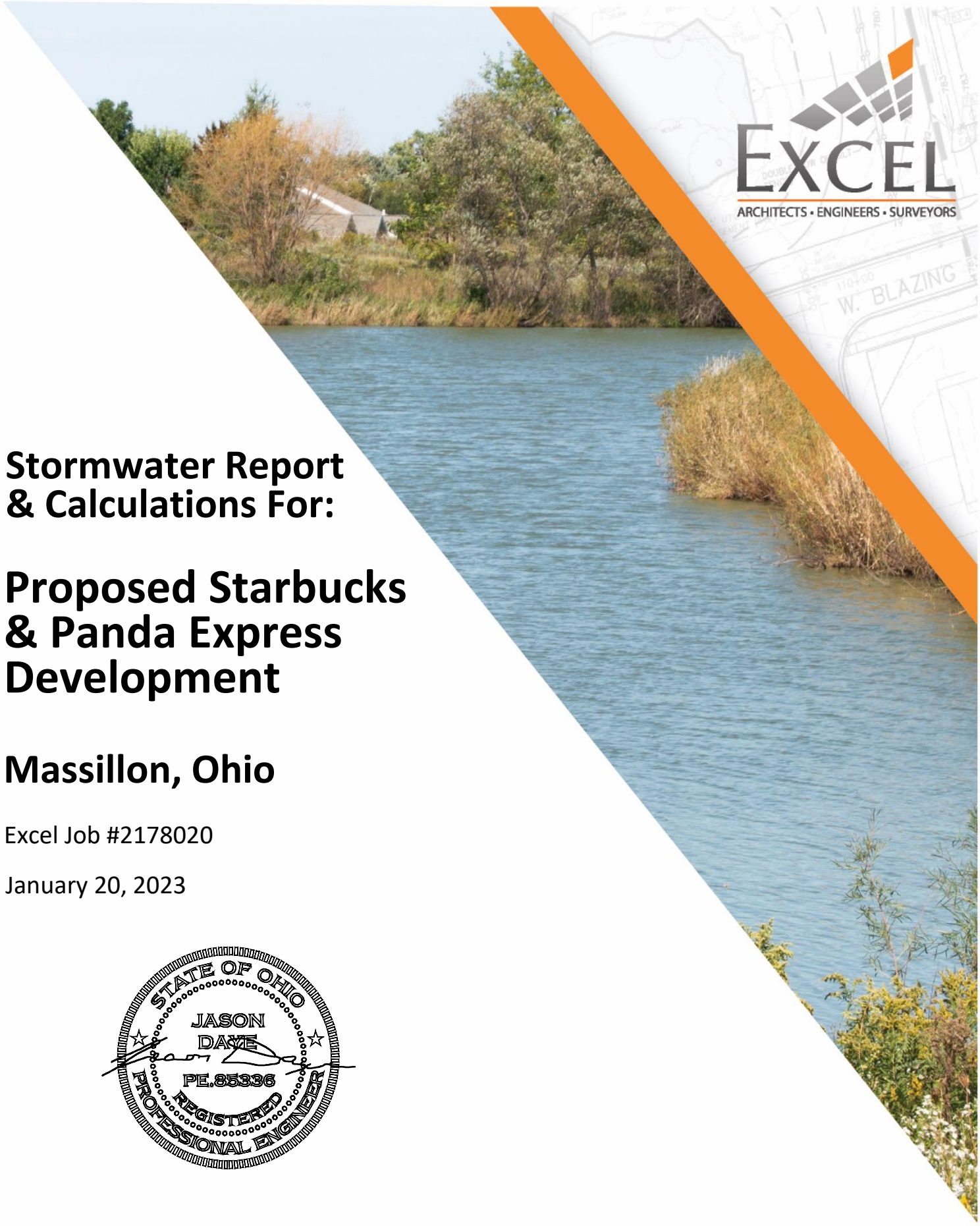

# Stormwater Report & Calculations For:

# Proposed Starbucks & Panda Express Development

## Massillon, Ohio

Excel Job #2178020

January 20, 2023

STATE OF OHIO
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# Appendices

# 0.0 Introduction

## 0.1 Existing Conditions

The proposed development project is located directly south of Lincoln Way E and centrally between the intersections of Lincoln Way E and 24th/25th streets in the City of Massillon, Ohio. The 2.27-acre project site is bound by Lincoln Way E to the north and is surrounded on all other sides by adjacent residential properties. The existing site is currently vacant/open land consisting of maintained lawn cover. It appears that residential homes may have historically existed on the subject site, but recent aerial photography indicates a consistent use of vacant/open land. The site currently drains overland from north to south with approximately 15 feet of elevation drop occurring from the northern extent of the site to the southern-most portion of the site. Regionally, the general area continues to topographically slope in the southwest direction and is located within the overall watershed of the Tuscarawas River. Reference Appendix A for a representation of the existing site and current drainage patterns.

## 0.2 Proposed Project Overview

The proposed development project involves construction of a new Panda Express quick-serve restaurant and Starbucks coffeehouse with associated site improvements. Site improvements include new paved parking areas, concrete drive-thru lanes, internal sidewalk networks, and new refuse enclosures. The project will result in approximately 2.37 acres of disturbed site area, which includes off-site utility trenching areas. Stormwater from the proposed development will be conveyed via onsite inlets and storm sewer network to a proposed underground detention system that will serve to meet the water quality and quantity requirements set forth by state and local requirements. The underground stormwater detention system will discharge via a new storm sewer connection to the City of Massillon storm sewer network located within 25th street. This system drains south and discharges southeast of McDonald Cir SE which is consistent with the existing overland drainage route. Reference Appendix B for a representation of the post-development site drainage patterns.

## 0.3 Stormwater Management Applicability

The proposed development project will disturb approximately 2.37 acres of land and is therefore subject to implementation of post-construction stormwater management controls on the subject site. The subject site will be required to meet the stormwater management water quality standards set forth by Stark County and Ohio EPA. Additionally, the site will be required to meet the stormwater post-development peak discharge standards set forth by the City of Massillon. The below sections of this report detail how the proposed project meets or exceeds the applicable state and local stormwater management requirements.

# 1.0 Design Criteria

## 1.1 Soils

Soil characteristics for the site were determined by utilizing available Web Soil Survey information. See Table 1 below for a summary of the web soil survey results and reference Appendix D for the associated web soil survey map. Based on these results, a curve number of 74 has been designated for site open space areas consistent with hydrologic group C soils. Site-specific geotechnical investigations have not yet been completed on the project site.

*Table 1: Web Soil Survey*

| MAP SYMBOL | SOIL TYPE | HYDROLOGIC RATING |
|---|---|---|
| CeB | Canfield-Urban Land Complex, 2 to 6 percent slopes | C/D |

## 1.2 Rainfall Data

NOAA Atlas 14, City of Massillon rainfall depths with a type II distribution were used for the site stormwater calculations. Reference Table 2 below for the site specific rainfall depths. Additional rainfall data is provided in Appendix G

*Table 2: NOAA Atlas 14 24-hour Rainfall Depth*

| DESIGN STORM | RAINFALL DEPTH (INCHES) |
|---|---|
| 2-YEAR | 2.44 |
| 5-YEAR | 3.04 |
| 10-YEAR | 3.56 |
| 25-YEAR | 4.33 |
| 50-YEAR | 5.00 |
| 100-YEAR | 5.73 |

# 2.0 Stormwater Management Requirements

## 2.1 Stormwater Quantity/Runoff Rate Control

**City of Massillon-** The post-developed rate of runoff is not permitted to exceed the pre-developed rate of runoff. The proposed development will be required to maintain or reduce the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, and 100-yr, 24-hour post development peak runoff discharge rates to the respective pre-development peak runoff discharge rates.

Stormwater from the post-development site will drain via a new onsite storm sewer network to a proposed underground stormwater detention system that will serve to reduce post-development peak flows to the pre-development conditions prior to discharging to the City of Massillon public storm sewer system. The underground detention system will consist of perforated 84" CMP pipe along with associated aggregate bedding and cover material. The voids within the aggregate will also act as temporary stormwater storage for the system. The system will discharge through an outlet control structure consisting of a storm manhole with an internal weir plate. The internal weir plate will have multiple orifice openings at varying elevations to control post-development peak flow rates to the pre-development conditions. Reference the construction plan set for specific orifice sizes and elevations used in the structure. Refer to Table 3 below for a summary of the post-development peak runoff rates in comparison to the pre-development rates. As shown in the table below, post-development rates are reduced to less than pre-development conditions for all storm events. Reference detailed HydroCAD calculations provided in Appendix C.

*Table 3: Detailed Runoff Summary*

| | **PRE-DEVELOPMENT** | **POST-DEVELOPMENT** | | | |
|---|---|---|---|---|---|
| **DESIGN STORM** | **Total Pre-Development Peak Discharge (cfs)** | **To Underground Detention (cfs)** | **Underground Detention Release Rate (cfs)** | **Undetained (cfs)** | Total Post Development (Combined Underground Detention Release & Undetained) (cfs) |
| **2 YR-24 HR** | **1.30** | 5.09 | 1.00 | 0.13 | **1.02** |
| **5 YR-24 HR** | **2.24** | 6.59 | 1.79 | 0.17 | **1.83** |
| **10 YR-24 HR** | **3.13** | 7.89 | 2.69 | 0.20 | **2.75** |
| **25 YR-24 HR** | **4.56** | 9.80 | 4.26 | 0.24 | **4.40** |
| **50 YR-24 HR** | **5.88** | 11.45 | 5.22 | 0.28 | **5.35** |
| **100 YR-24HR** | **7.36** | 13.24 | 6.29 | 0.32 | **6.45** |

*Table 4: Total Peak Discharge Release Summary*

| **DESIGN STORM** | **PREDEVELOPMENT (CFS)** | **POST DEVELOPMENT (CFS)** |
|---|---|---|
| **2 YR- 24 HR** | **1.30** | **1.02** |
| **5 YR- 24 HR** | **2.24** | **1.83** |
| **10 YR- 24 HR** | **3.13** | **2.75** |
| **25 YR- 24 HR** | **4.56** | **4.40** |
| **50 YR- 24 HR** | **5.88** | **5.35** |
| **100 YR- 24 HR** | **7.36** | **6.45** |

**Therefore, peak discharge requirements are met.**

### 2.2 Stormwater Quality/WQv

**Stark County/OH EPA-** The subject development will be held to the water quality requirements set forth by Stark County Soil and Water district. The development will need to provide treatment of the water quality volume which is derived from a 0.90 inch rainfall event. This results in a total water quality volume of 4,420 cu-ft (0.10 ac-ft) for the subject site. This volume must be detained and released over a period of not less than 24 hours. Additionally, no more than half of the volume can be released in the first 1/3 of the drawdown time. The underground detention system proposed on the subject site will provide the required water quality volume. The water quality volume will be release through a 1.3" orifice located in an outlet control structure. Reference Appendix E for water quality volume calculations.

**Therefore, water quality volume requirements have been met.**

### 2.3 Stormwater Quality/WQf

**Stark County/OH EPA-** Since the subject development will be utilizing an underground detention system to meet site stormwater requirements, pretreatment of the site stormwater is required up to the water quality flow rate. The development WQf is 3.27 cfs. A hydrodynamic separator (Contech Cascade Separator) is proposed on the project site. Based on the WQf, a CS-6 unit is required. See Appendix E for WQf calculations.

**Therefore, water quality flow requirements have been met.**

## 3.0 Storm Sewer Design

All storm sewer has been designed to convey the 100-year post development storm based on rational method calculations. See Appendix F for pipe drainage areas and pipe sizing calculations.

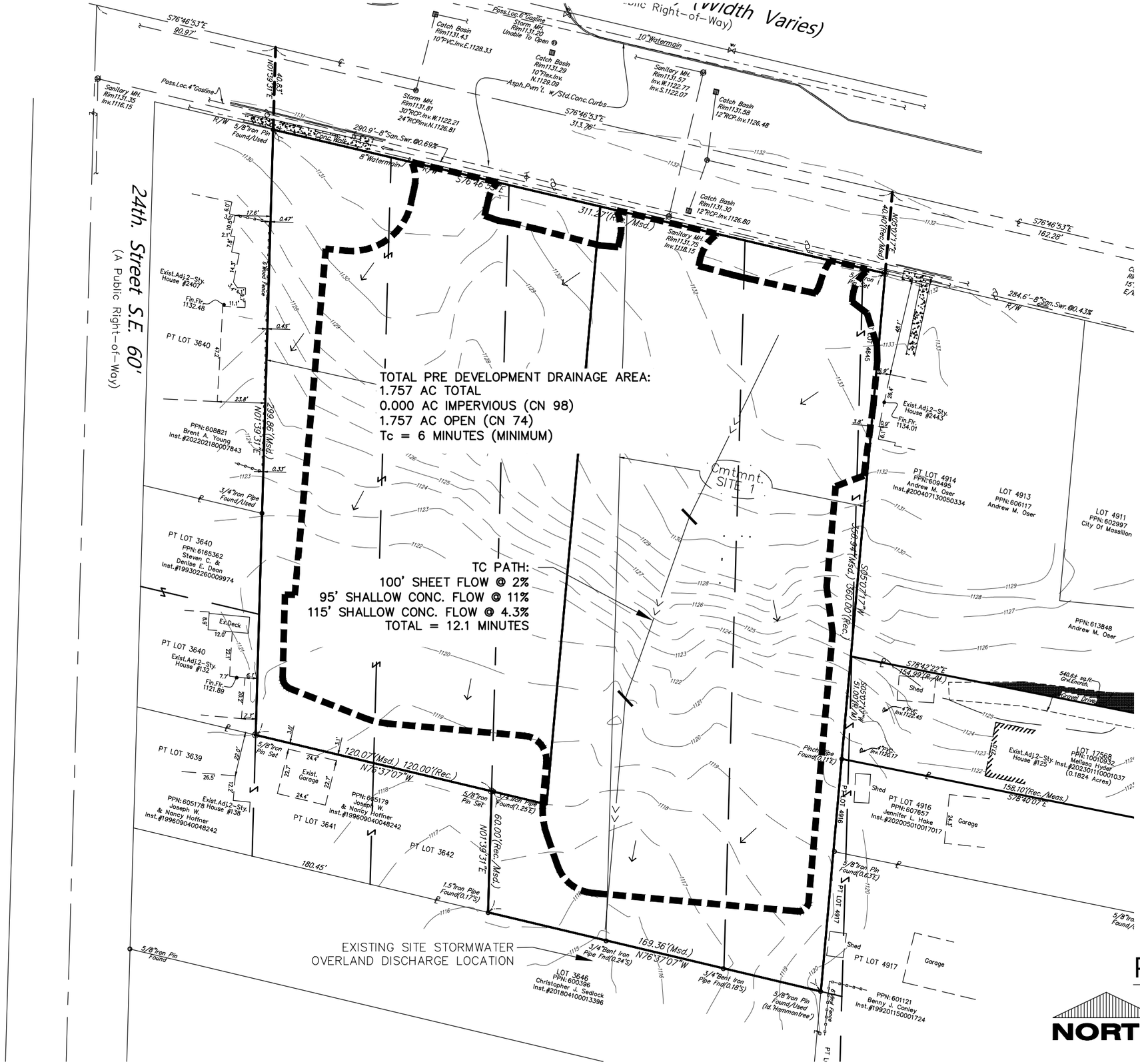
### 3.1 Emergency Overflow Route

The emergency overflow route for any events exceeding the 100-year storm event is to the south of the site to match the current site conditions.

## 4.0 Erosion Control

The erosion control specifications, construction sequence, site stabilization notes, seeding notes, dewatering notes, and post construction and maintenance plan will be included on sheet C0.1 and C1.2 of the construction plan set.

# Appendix A: Pre-Development Basin Area(s)




# PRE-DEVELOPMENT BASIN AREA(S)

# Appendix B: Post Development Basin Area(s)

POST DEVELOPMENT UNDETAINED PAVEMENT AREAS:
0.040 AC TOTAL
0.040 AC IMPERVIOUS (CN 98)
0.00 AC OPEN (CN 74)
Tc = 6 MINUTES (MINIMUM)

POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE:
1.717 AC TOTAL
1.404 AC IMPERVIOUS (CN 98)
0.313 AC OPEN (CN 74)
Tc = 6 MINUTES (MINIMUM)

SITE STORMWATER DISCHARGE LOCATION: CITY OF MASSILLON STORM SEWER SYSTEM

UNDERGROUND CMP STORMWATER STORAGE SYSTEM

24th. Street S.E. 60'
(A Public Right-of-Way)

25th. Street S.E. 40'
(A Public Right-of-Way)

PROPOSED STARBUCKS 2,250 SQ. FT. FOOTPRINT CRWL FF = 1132.50 ARCH FF = 100.00

PROPOSED PANDA EXPRESS 1,700 SQ. FT. FOOTPRINT CRWL FF = 1132.50 ARCH FF = 100.00

# POST-DEVELOPMENT BASIN AREA(S)

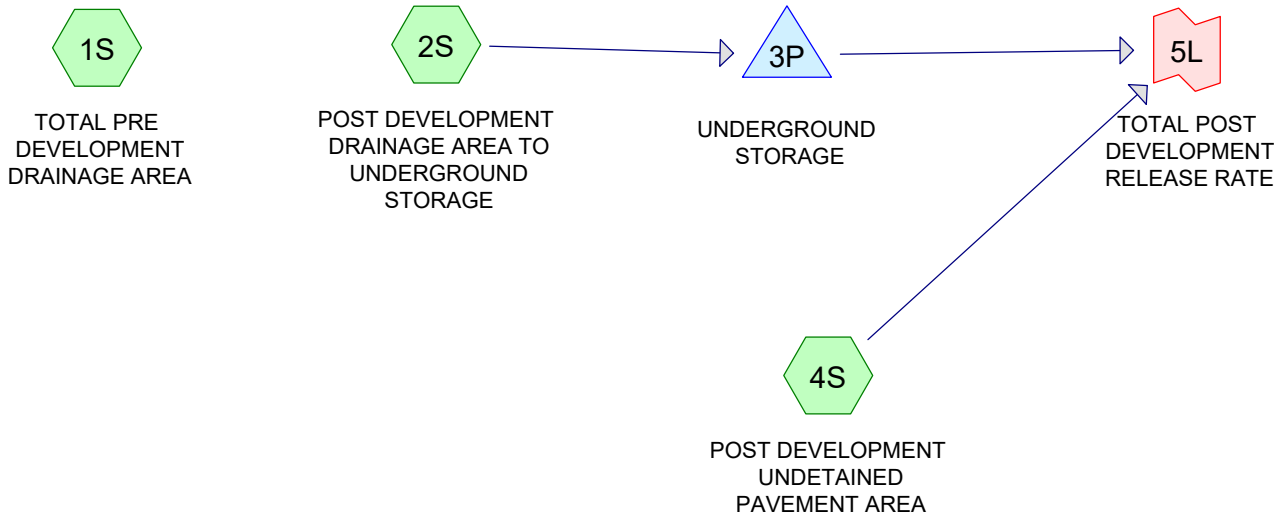
NORTH

1"= 50'

50' 0 50' 100'

SCALE 1"=50' (11X17) FEET

# Appendix C: Peak Discharge Calculations




Subcat Reach Pond Link

**Routing Diagram for Site TR-55 Final**

Prepared by {enter your company name here}, Printed 1/20/2023

## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 1.757 | 74 | Existing Lawn Area (1S) |
| 1.444 | 98 | Impervious (2S, 4S) |
| 0.313 | 74 | Open (2S) |
| **3.514** | **84** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.000 | HSG A | |
| 0.000 | HSG B | |
| 0.000 | HSG C | |
| 0.000 | HSG D | |
| 3.514 | Other | 1S, 2S, 4S |
| **3.514** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000 | 0.000 | 1.757 | 1.757 | Existing Lawn Area | 1S |
| 0.000 | 0.000 | 0.000 | 0.000 | 1.444 | 1.444 | Impervious | 2S, 4S |
| 0.000 | 0.000 | 0.000 | 0.000 | 0.313 | 0.313 | Open | 2S |
| **0.000** | **0.000** | **0.000** | **0.000** | **3.514** | **3.514** | **TOTAL AREA** | |

## Pipe Listing (all nodes)

| Line# | Node Number | In-Invert (feet) | Out-Invert (feet) | Length (feet) | Slope (ft/ft) | n | Diam/Width (inches) | Height (inches) | Inside-Fill (inches) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3P | 1,119.00 | 1,117.00 | 200.0 | 0.0100 | 0.012 | 18.0 | 0.0 | 0.0 |

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment1S: TOTAL PRE** Runoff Area=1.757 ac 0.00% Impervious Runoff Depth>0.57"
Flow Length=310' Tc=12.1 min CN=74 Runoff=1.30 cfs 0.084 af

**Subcatchment2S: POST DEVELOPMENT** Runoff Area=1.717 ac 81.77% Impervious Runoff Depth>1.81"
Tc=6.0 min CN=94 Runoff=5.09 cfs 0.259 af

**Subcatchment4S: POST DEVELOPMENT** Runoff Area=0.040 ac 100.00% Impervious Runoff Depth>2.21"
Tc=6.0 min CN=98 Runoff=0.13 cfs 0.007 af

**Pond 3P: UNDERGROUND STORAGE** Peak Elev=1,122.23' Storage=0.132 af Inflow=5.09 cfs 0.259 af
Outflow=1.00 cfs 0.163 af

**Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE** Inflow=1.02 cfs 0.170 af
Primary=1.02 cfs 0.170 af

**Total Runoff Area = 3.514 ac Runoff Volume = 0.350 af Average Runoff Depth = 1.20"**
**58.91% Pervious = 2.070 ac 41.09% Impervious = 1.444 ac**

## Summary for Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA

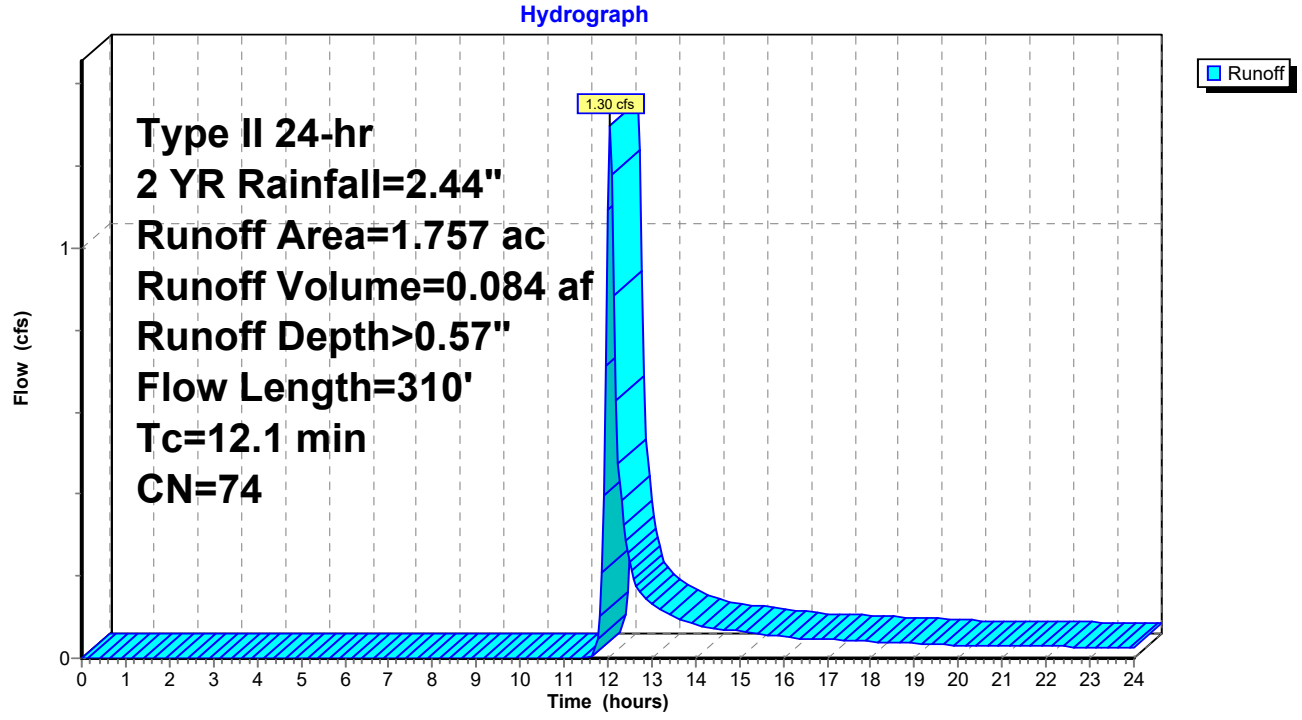
Runoff = 1.30 cfs @ 12.06 hrs, Volume= 0.084 af, Depth> 0.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=2.44"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.757 | 74 | Existing Lawn Area |
| | 1.757 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.2 | 100 | 0.0200 | 0.15 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.44" |
| 0.3 | 95 | 0.1100 | 5.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 0.6 | 115 | 0.0430 | 3.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 12.1 | 310 | Total | | | |

## Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA



## Summary for Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORA

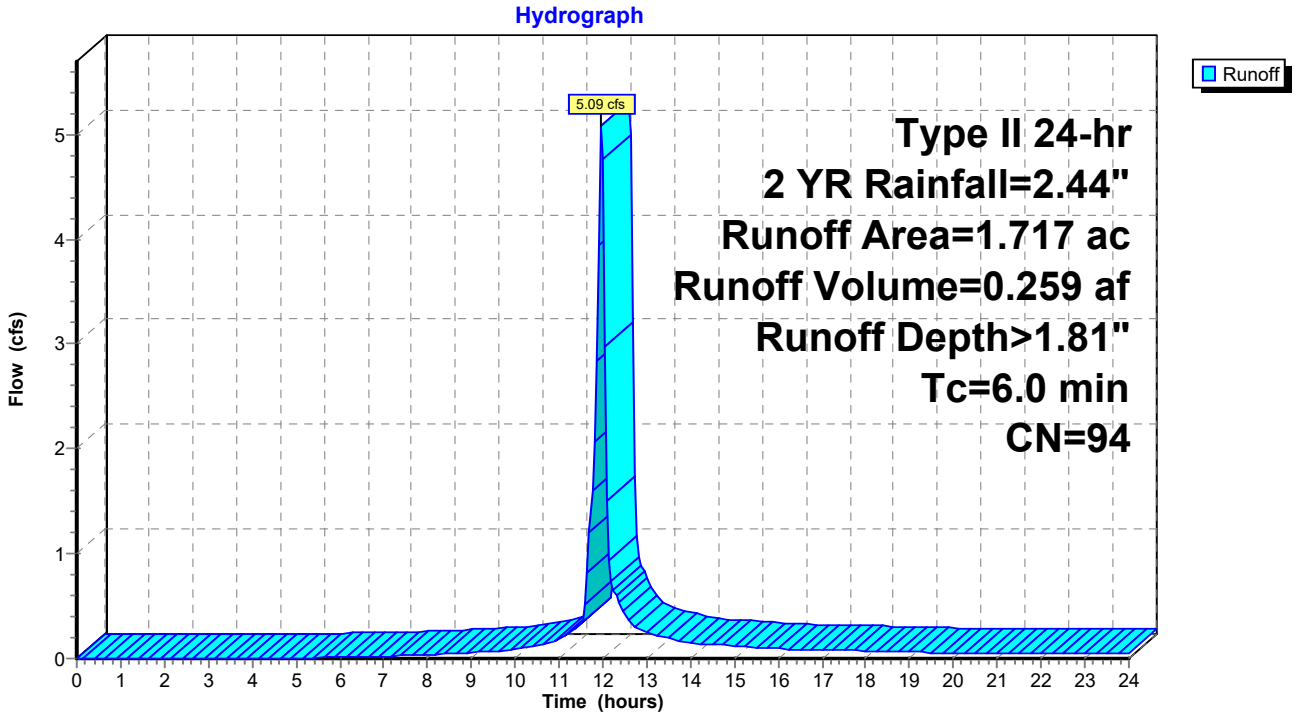
Runoff = 5.09 cfs @ 11.97 hrs, Volume= 0.259 af, Depth> 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=2.44"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.404 | 98 | Impervious |
| * | 0.313 | 74 | Open |
| | 1.717 | 94 | Weighted Average |
| | 0.313 | | 18.23% Pervious Area |
| | 1.404 | | 81.77% Impervious Area |

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

## Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE



## Summary for Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA

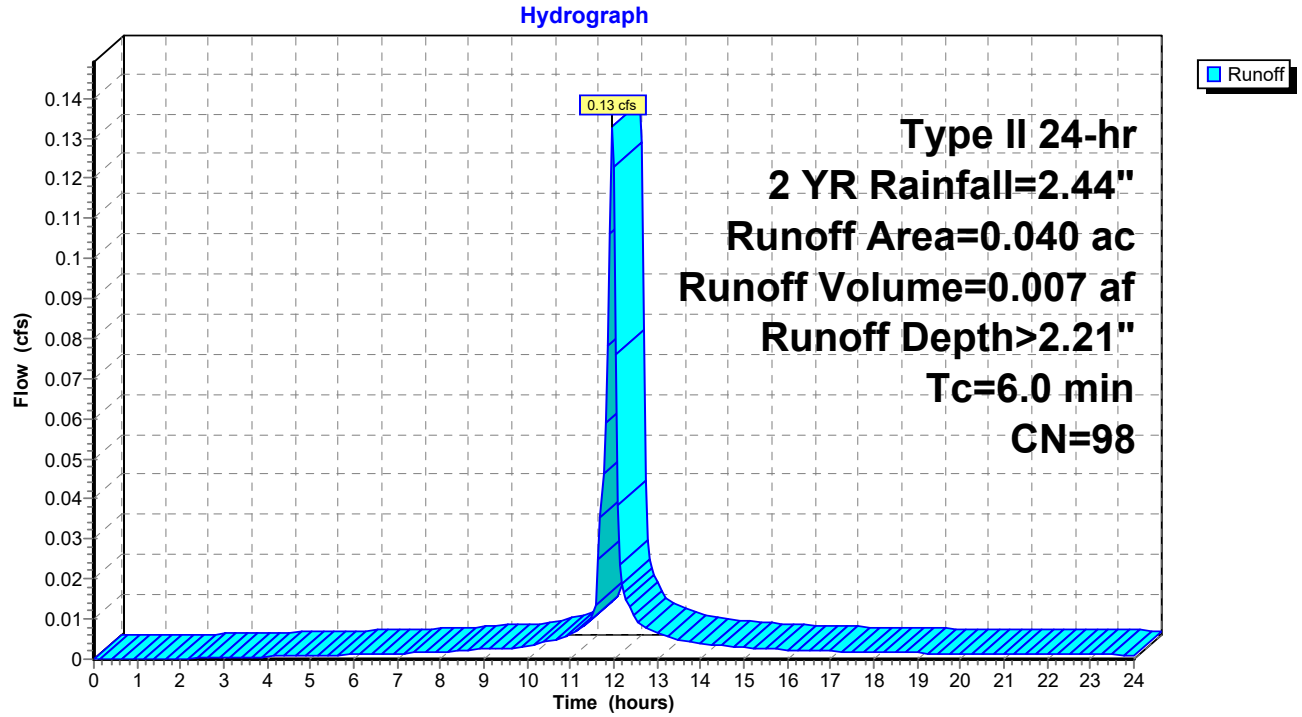
Runoff = 0.13 cfs @ 11.96 hrs, Volume= 0.007 af, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 2 YR Rainfall=2.44"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 0.040 | 98 | Impervious |
| | 0.040 | | 100.00% Impervious Area |

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

### Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA



## Summary for Pond 3P: UNDERGROUND STORAGE

Inflow Area = 1.717 ac, 81.77% Impervious, Inflow Depth > 1.81" for 2 YR event
Inflow = 5.09 cfs @ 11.97 hrs, Volume= 0.259 af
Outflow = 1.00 cfs @ 12.16 hrs, Volume= 0.163 af, Atten= 80%, Lag= 11.5 min
Primary = 1.00 cfs @ 12.16 hrs, Volume= 0.163 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,122.23' @ 12.16 hrs Surf.Area= 0.056 ac Storage= 0.132 af

Plug-Flow detention time= 215.9 min calculated for 0.162 af (63% of inflow)
Center-of-Mass det. time= 114.1 min ( 906.7 - 792.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 1,119.00' | 0.079 af | **29.00'W x 84.00'L x 7.50'H Field A**<br>0.419 af Overall - 0.223 af Embedded = 0.197 af x 40.0% Voids |
| #2A | 1,119.00' | 0.223 af | **CMP Round 84** x 12 Inside #1<br>Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf<br>Overall Size= 84.0"W x 84.0"H x 20.00'L<br>Row Length Adjustment= -5.00' x 38.48 sf x 3 rows<br>27.00' Header x 38.48 sf x 1 = 1,039.1 cf Inside |
| | | 0.301 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,119.00' | **18.0" Round Culvert**<br>L= 200.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 1,119.00' / 1,117.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.77 sf |
| #2 | Device 1 | 1,119.00' | **1.3" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 1,121.60' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 1,123.20' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #5 | Device 1 | 1,125.90' | **6.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=1.00 cfs @ 12.16 hrs HW=1,122.23' (Free Discharge)
└**1=Culvert** (Passes 1.00 cfs of 12.74 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.08 cfs @ 8.58 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.92 cfs @ 2.70 fps)
  ├**4=Orifice/Grate** ( Controls 0.00 cfs)
  └**5=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 3P: UNDERGROUND STORAGE - Chamber Wizard Field A

**Chamber Model = CMP Round 84 (Round Corrugated Metal Pipe)**
Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf
Overall Size= 84.0"W x 84.0"H x 20.00'L
Row Length Adjustment= -5.00' x 38.48 sf x 3 rows

84.0" Wide + 36.0" Spacing = 120.0" C-C Row Spacing

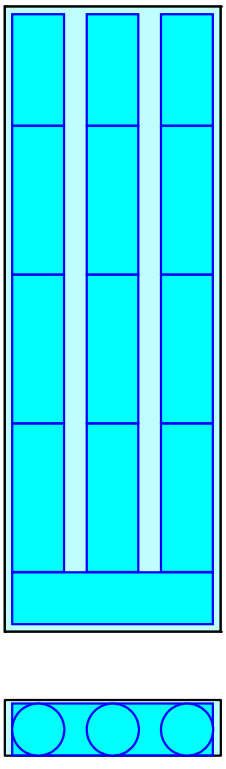
4 Chambers/Row x 20.00' Long -5.00' Row Adjustment +7.00' Header x 1 = 82.00' Row Length +12.0" End Stone x 2 = 84.00' Base Length
3 Rows x 84.0" Wide + 36.0" Spacing x 2 + 12.0" Side Stone x 2 = 29.00' Base Width
84.0" Chamber Height + 6.0" Cover = 7.50' Field Height

12 Chambers x 769.7 cf -5.00' Row Adjustment x 38.48 sf x 3 Rows + 27.00' Header x 38.48 sf = 9,698.1 cf Chamber Storage

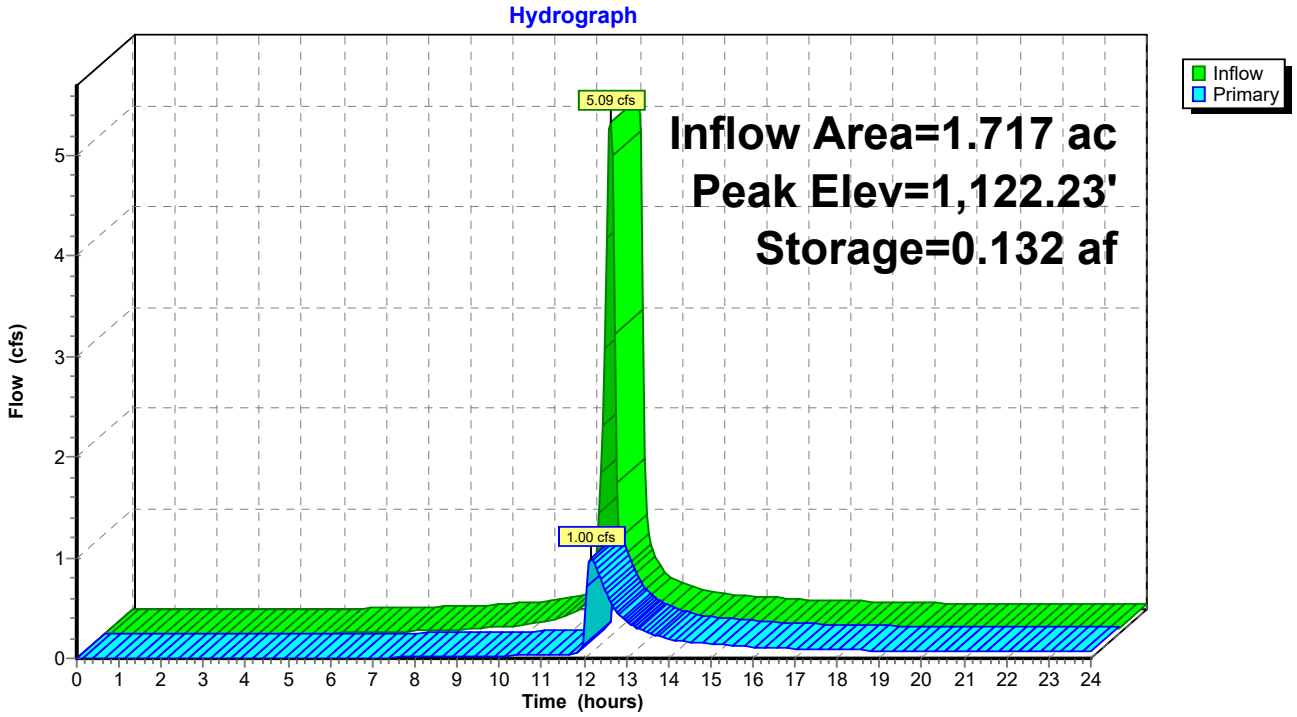
18,270.0 cf Field - 9,698.1 cf Chambers = 8,571.9 cf Stone x 40.0% Voids = 3,428.8 cf Stone Storage

Chamber Storage + Stone Storage = 13,126.9 cf = 0.301 af
Overall Storage Efficiency = 71.8%
Overall System Size = 84.00' x 29.00' x 7.50'

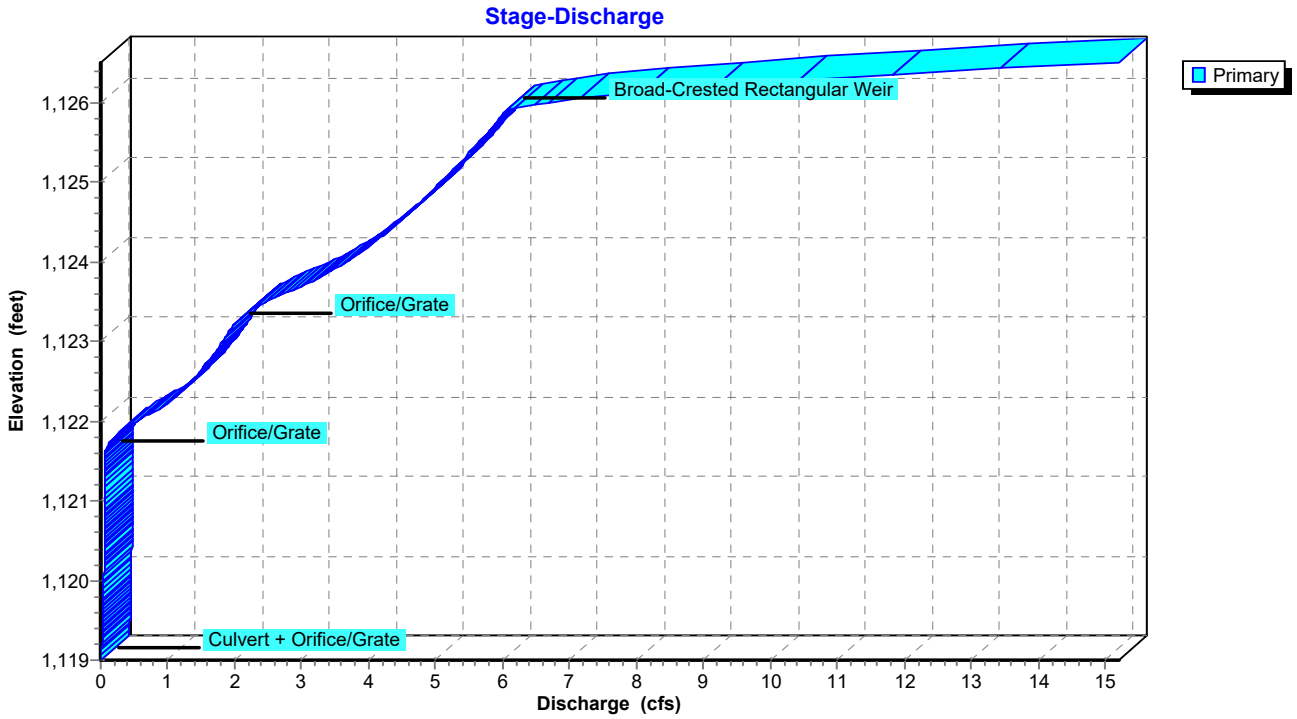
12 Chambers
676.7 cy Field
317.5 cy Stone



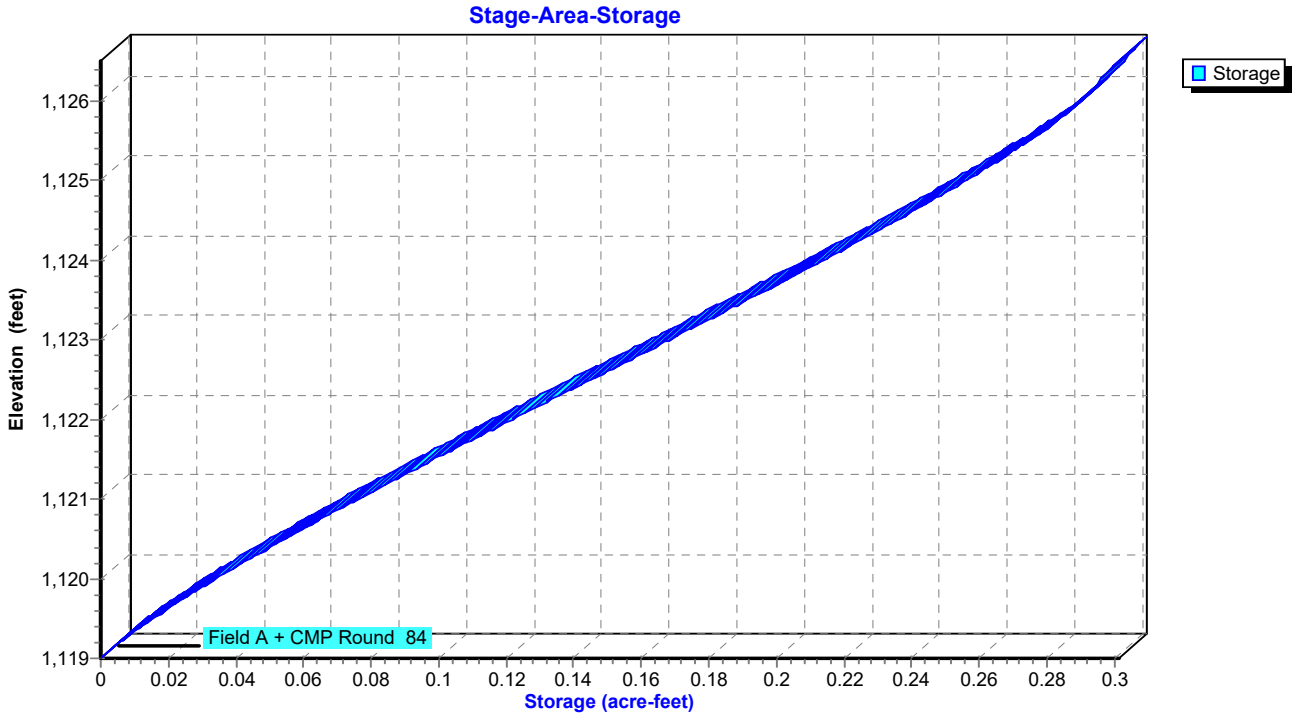
## Pond 3P: UNDERGROUND STORAGE




## Pond 3P: UNDERGROUND STORAGE



## Pond 3P: UNDERGROUND STORAGE

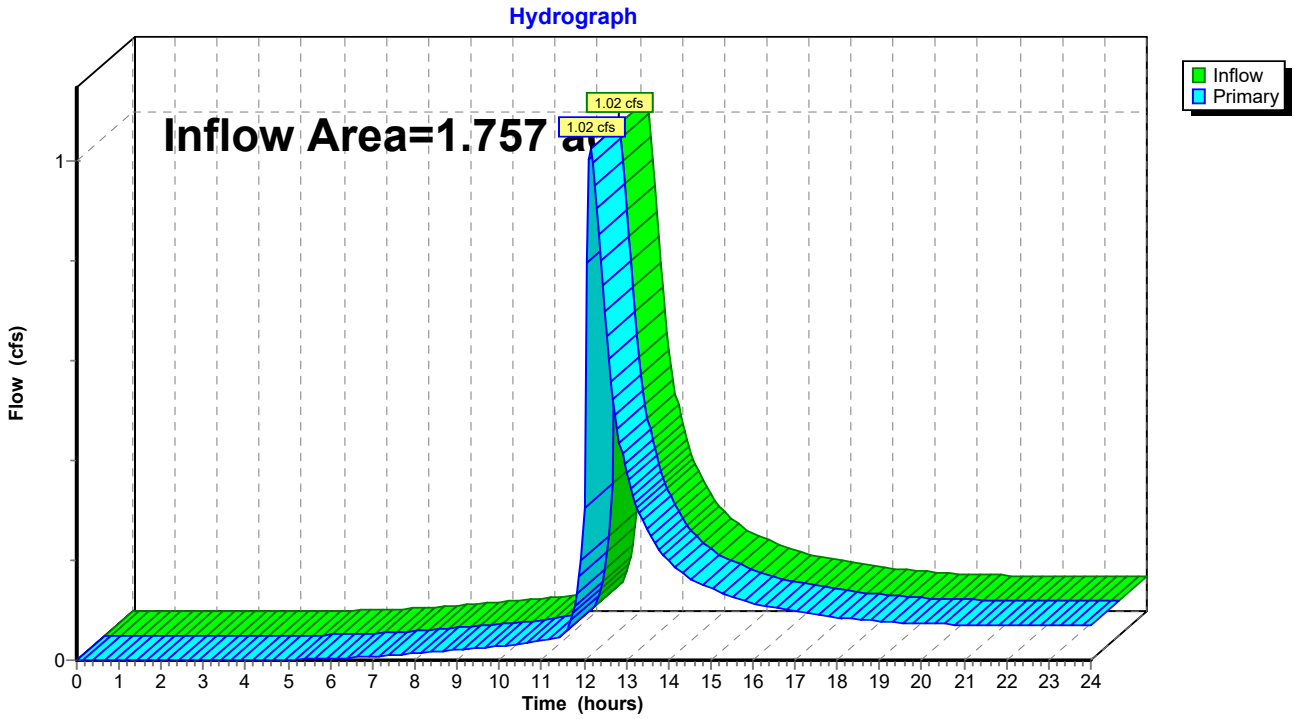


## Summary for Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE

Inflow Area = 1.757 ac, 82.19% Impervious, Inflow Depth > 1.16" for 2 YR event
Inflow = 1.02 cfs @ 12.15 hrs, Volume= 0.170 af
Primary = 1.02 cfs @ 12.15 hrs, Volume= 0.170 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment1S: TOTAL PRE** Runoff Area=1.757 ac 0.00% Impervious Runoff Depth>0.93"
Flow Length=310' Tc=12.1 min CN=74 Runoff=2.24 cfs 0.136 af

**Subcatchment2S: POST DEVELOPMENT** Runoff Area=1.717 ac 81.77% Impervious Runoff Depth>2.39"
Tc=6.0 min CN=94 Runoff=6.59 cfs 0.341 af

**Subcatchment4S: POST DEVELOPMENT** Runoff Area=0.040 ac 100.00% Impervious Runoff Depth>2.81"
Tc=6.0 min CN=98 Runoff=0.17 cfs 0.009 af

**Pond 3P: UNDERGROUND STORAGE** Peak Elev=1,122.96' Storage=0.167 af Inflow=6.59 cfs 0.341 af
Outflow=1.79 cfs 0.240 af

**Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE** Inflow=1.83 cfs 0.249 af
Primary=1.83 cfs 0.249 af

**Total Runoff Area = 3.514 ac Runoff Volume = 0.487 af Average Runoff Depth = 1.66"**
**58.91% Pervious = 2.070 ac 41.09% Impervious = 1.444 ac**

## Summary for Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA

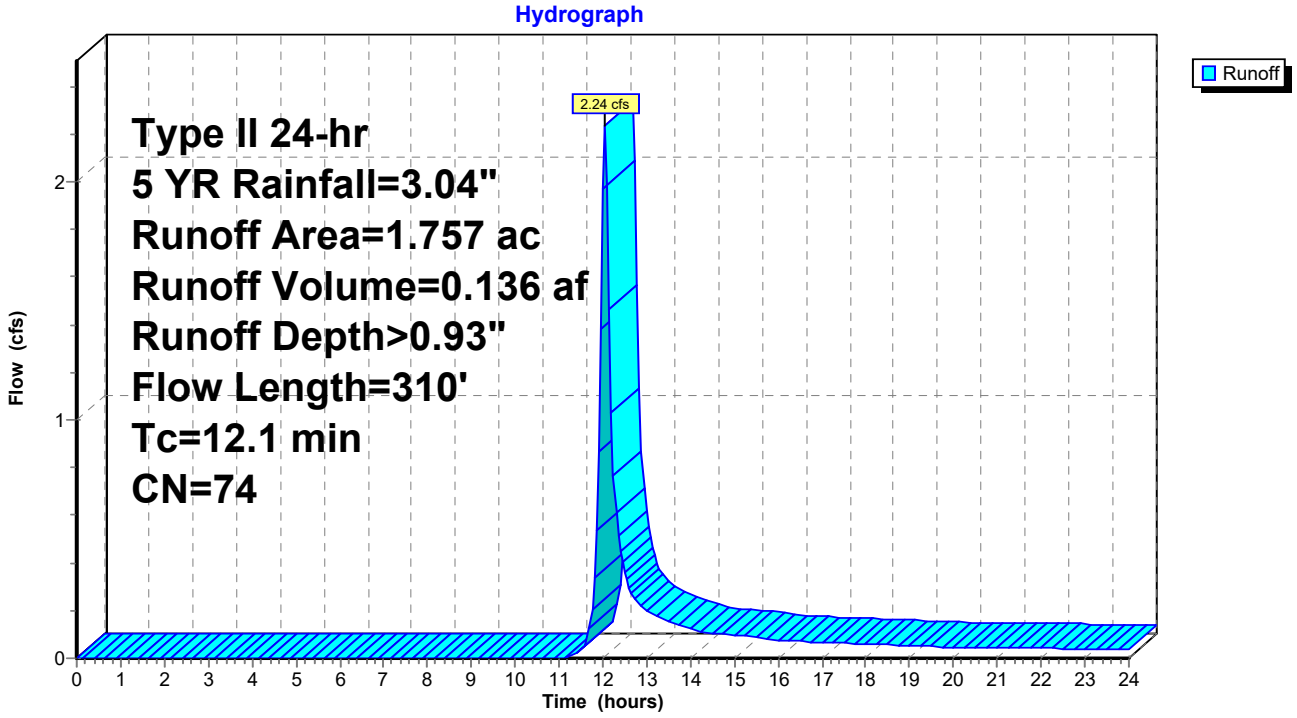
Runoff = 2.24 cfs @ 12.05 hrs, Volume= 0.136 af, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 YR Rainfall=3.04"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.757 | 74 | Existing Lawn Area |
| | 1.757 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.2 | 100 | 0.0200 | 0.15 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.44" |
| 0.3 | 95 | 0.1100 | 5.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 0.6 | 115 | 0.0430 | 3.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 12.1 | 310 | Total | | | |

## Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA



## Summary for Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORA

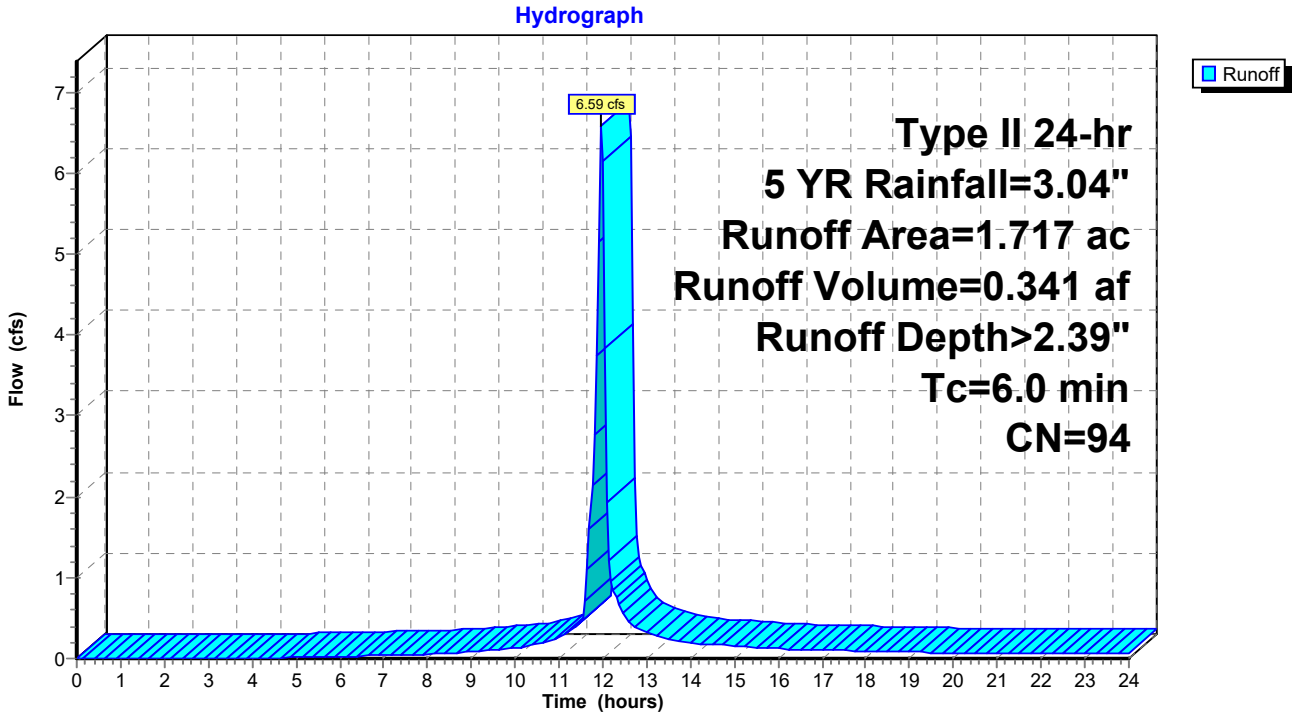
Runoff = 6.59 cfs @ 11.96 hrs, Volume= 0.341 af, Depth> 2.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 YR Rainfall=3.04"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.404 | 98 | Impervious |
| * | 0.313 | 74 | Open |
| | 1.717 | 94 | Weighted Average |
| | 0.313 | | 18.23% Pervious Area |
| | 1.404 | | 81.77% Impervious Area |

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

## Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE



## Summary for Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA

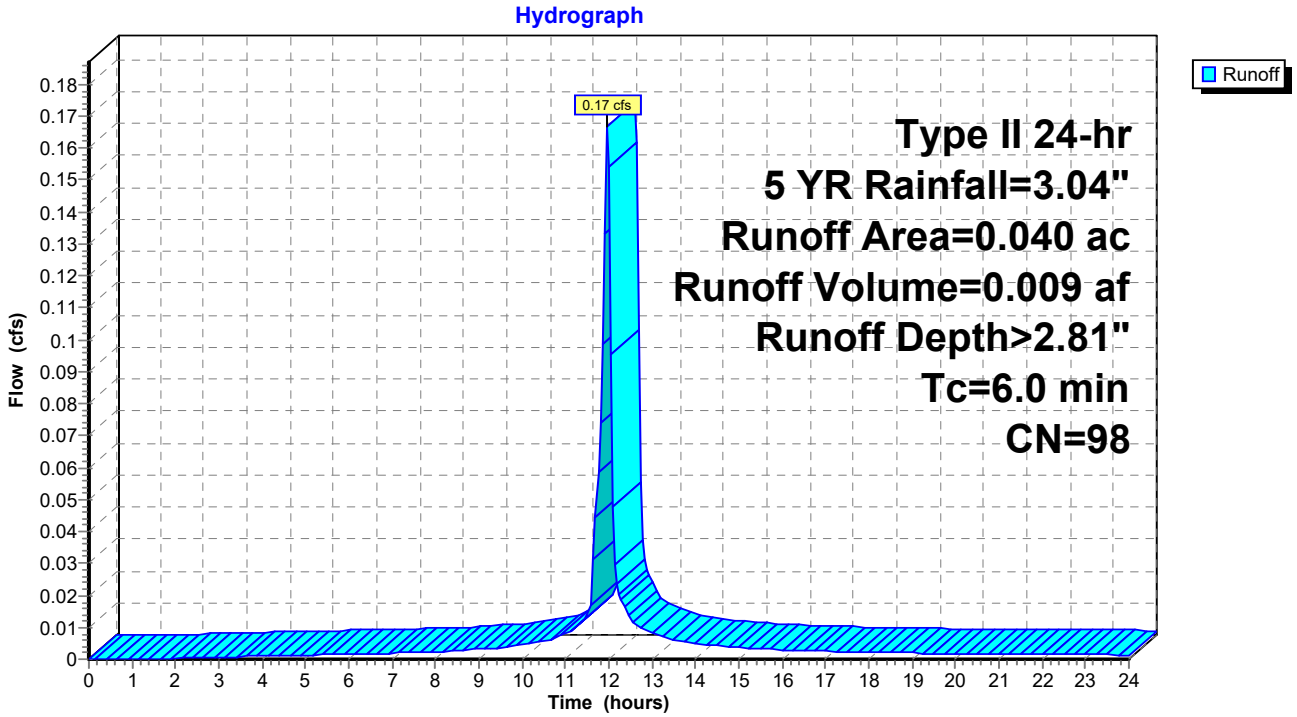
Runoff = 0.17 cfs @ 11.96 hrs, Volume= 0.009 af, Depth> 2.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 5 YR Rainfall=3.04"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 0.040 | 98 | Impervious |
| | 0.040 | | 100.00% Impervious Area |

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

### Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA



## Summary for Pond 3P: UNDERGROUND STORAGE

Inflow Area = 1.717 ac, 81.77% Impervious, Inflow Depth > 2.39" for 5 YR event
Inflow = 6.59 cfs @ 11.96 hrs, Volume= 0.341 af
Outflow = 1.79 cfs @ 12.12 hrs, Volume= 0.240 af, Atten= 73%, Lag= 9.2 min
Primary = 1.79 cfs @ 12.12 hrs, Volume= 0.240 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,122.96' @ 12.12 hrs Surf.Area= 0.056 ac Storage= 0.167 af

Plug-Flow detention time= 175.0 min calculated for 0.239 af (70% of inflow)
Center-of-Mass det. time= 81.1 min ( 866.0 - 785.0 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 1,119.00' | 0.079 af | **29.00'W x 84.00'L x 7.50'H Field A**<br>0.419 af Overall - 0.223 af Embedded = 0.197 af x 40.0% Voids |
| #2A | 1,119.00' | 0.223 af | **CMP Round 84** x 12 Inside #1<br>Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf<br>Overall Size= 84.0"W x 84.0"H x 20.00'L<br>Row Length Adjustment= -5.00' x 38.48 sf x 3 rows<br>27.00' Header x 38.48 sf x 1 = 1,039.1 cf Inside |
| | | 0.301 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,119.00' | **18.0" Round Culvert**<br>L= 200.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 1,119.00' / 1,117.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.77 sf |
| #2 | Device 1 | 1,119.00' | **1.3" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 1,121.60' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 1,123.20' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #5 | Device 1 | 1,125.90' | **6.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=1.78 cfs @ 12.12 hrs HW=1,122.95' (Free Discharge)
└**1=Culvert** (Passes 1.78 cfs of 13.92 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.09 cfs @ 9.50 fps)
  ├**3=Orifice/Grate** (Orifice Controls 1.69 cfs @ 4.85 fps)
  ├**4=Orifice/Grate** ( Controls 0.00 cfs)
  └**5=Broad-Crested Rectangular Weir**( Controls 0.00 cfs)

## Pond 3P: UNDERGROUND STORAGE - Chamber Wizard Field A

**Chamber Model = CMP Round 84 (Round Corrugated Metal Pipe)**
Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf
Overall Size= 84.0"W x 84.0"H x 20.00'L
Row Length Adjustment= -5.00' x 38.48 sf x 3 rows

84.0" Wide + 36.0" Spacing = 120.0" C-C Row Spacing

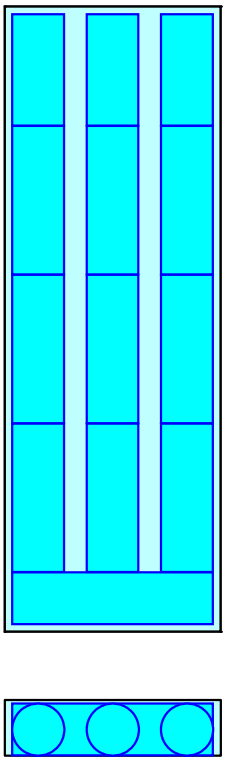
4 Chambers/Row x 20.00' Long -5.00' Row Adjustment +7.00' Header x 1 = 82.00' Row Length +12.0" End Stone x 2 = 84.00' Base Length
3 Rows x 84.0" Wide + 36.0" Spacing x 2 + 12.0" Side Stone x 2 = 29.00' Base Width
84.0" Chamber Height + 6.0" Cover = 7.50' Field Height

12 Chambers x 769.7 cf -5.00' Row Adjustment x 38.48 sf x 3 Rows + 27.00' Header x 38.48 sf = 9,698.1 cf Chamber Storage

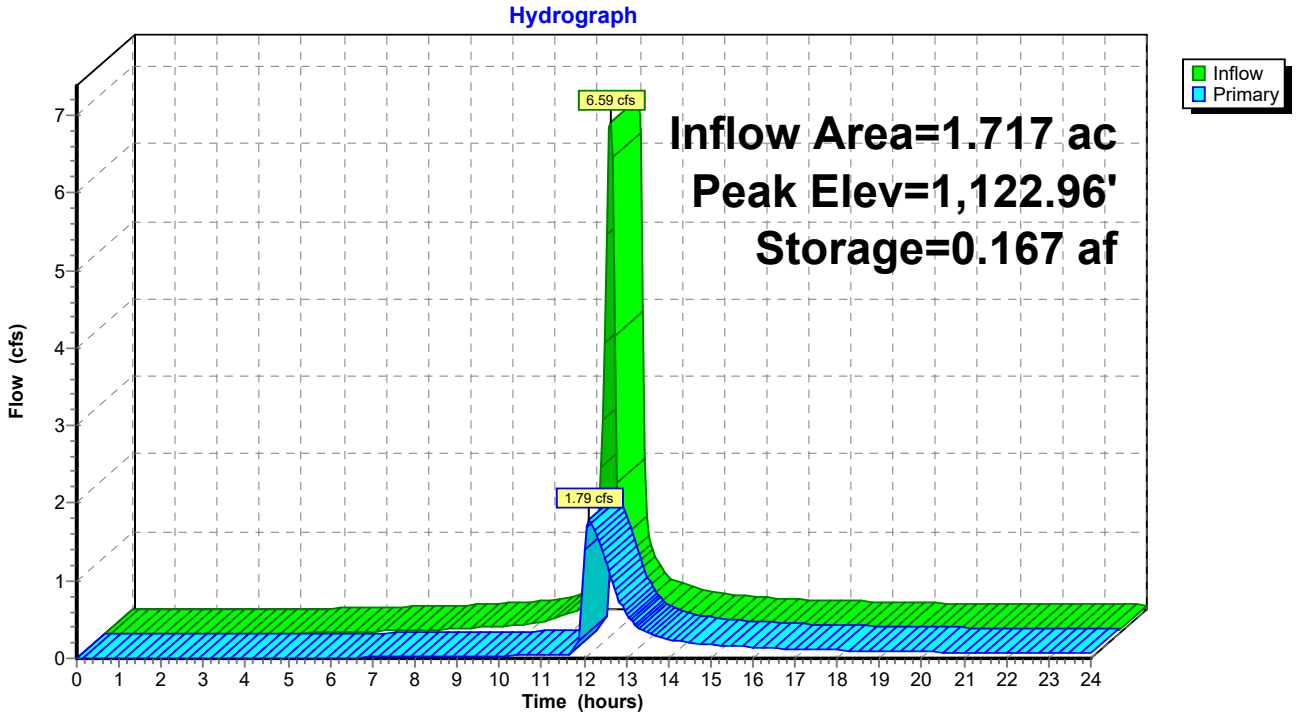
18,270.0 cf Field - 9,698.1 cf Chambers = 8,571.9 cf Stone x 40.0% Voids = 3,428.8 cf Stone Storage

Chamber Storage + Stone Storage = 13,126.9 cf = 0.301 af
Overall Storage Efficiency = 71.8%
Overall System Size = 84.00' x 29.00' x 7.50'

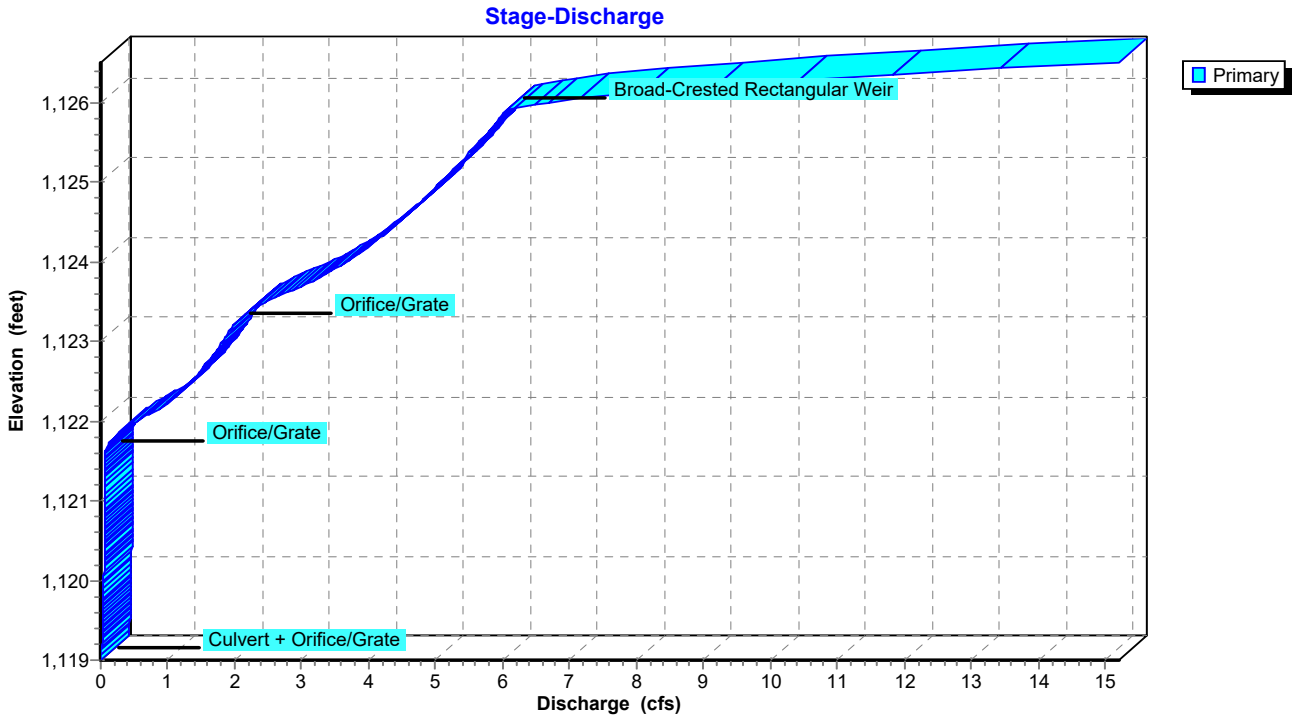
12 Chambers
676.7 cy Field
317.5 cy Stone



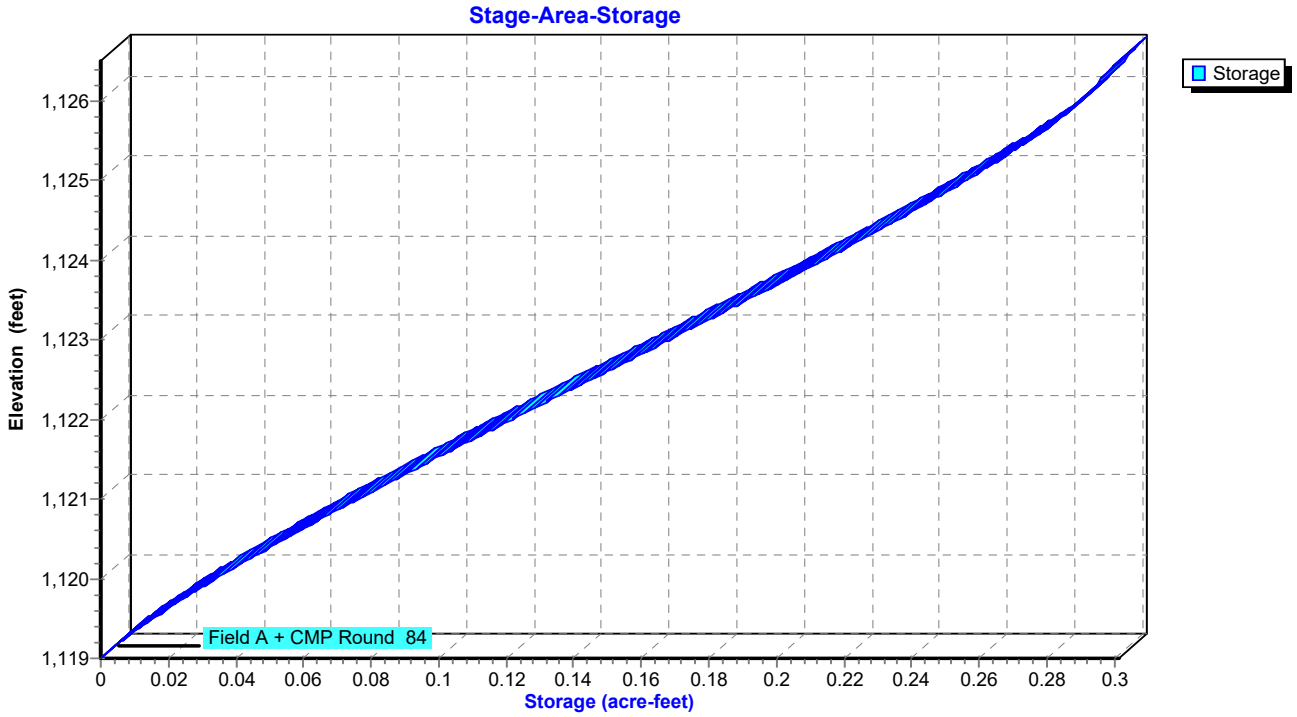
## Pond 3P: UNDERGROUND STORAGE




## Pond 3P: UNDERGROUND STORAGE



## Pond 3P: UNDERGROUND STORAGE

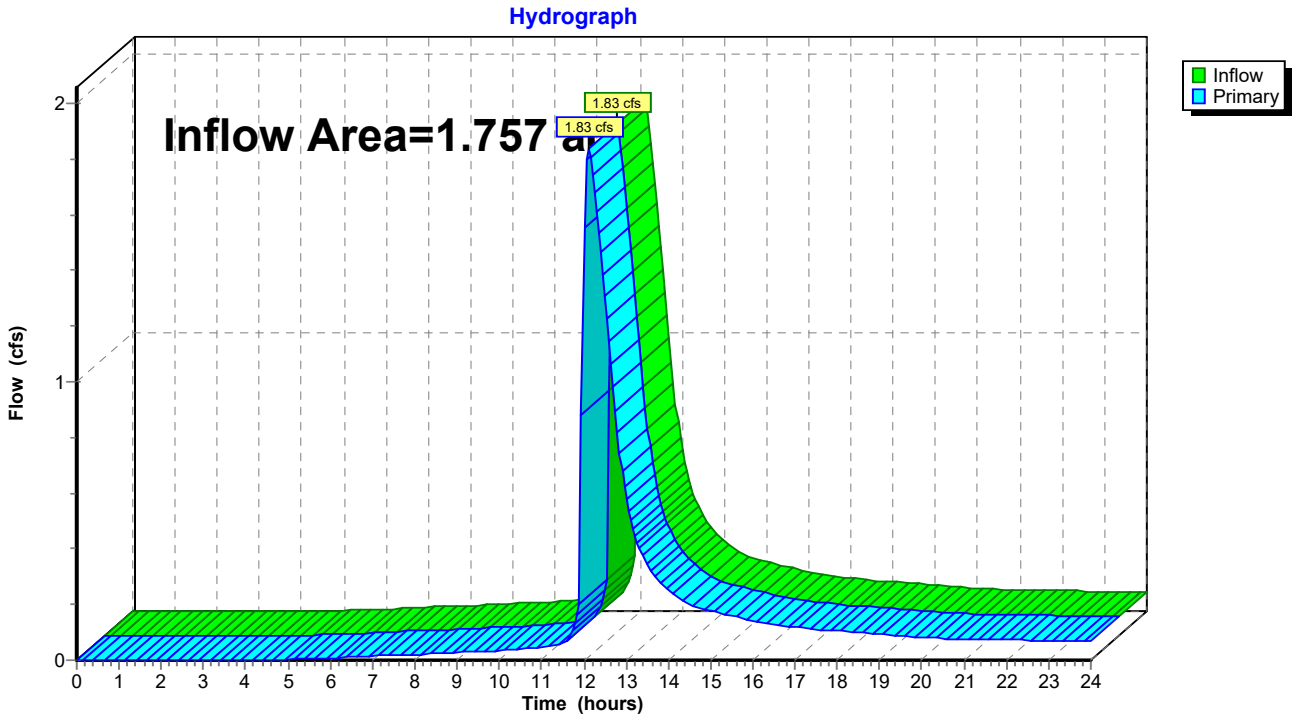


## Summary for Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE

Inflow Area = 1.757 ac, 82.19% Impervious, Inflow Depth > 1.70" for 5 YR event
Inflow = 1.83 cfs @ 12.10 hrs, Volume= 0.249 af
Primary = 1.83 cfs @ 12.10 hrs, Volume= 0.249 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment1S: TOTAL PRE** Runoff Area=1.757 ac 0.00% Impervious Runoff Depth>1.28"
Flow Length=310' Tc=12.1 min CN=74 Runoff=3.13 cfs 0.187 af

**Subcatchment2S: POST DEVELOPMENT** Runoff Area=1.717 ac 81.77% Impervious Runoff Depth>2.89"
Tc=6.0 min CN=94 Runoff=7.89 cfs 0.414 af

**Subcatchment4S: POST DEVELOPMENT** Runoff Area=0.040 ac 100.00% Impervious Runoff Depth>3.32"
Tc=6.0 min CN=98 Runoff=0.20 cfs 0.011 af

**Pond 3P: UNDERGROUND STORAGE** Peak Elev=1,123.58' Storage=0.195 af Inflow=7.89 cfs 0.414 af
Outflow=2.69 cfs 0.309 af

**Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE** Inflow=2.75 cfs 0.321 af
Primary=2.75 cfs 0.321 af

**Total Runoff Area = 3.514 ac Runoff Volume = 0.612 af Average Runoff Depth = 2.09"**
**58.91% Pervious = 2.070 ac 41.09% Impervious = 1.444 ac**

## Summary for Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA

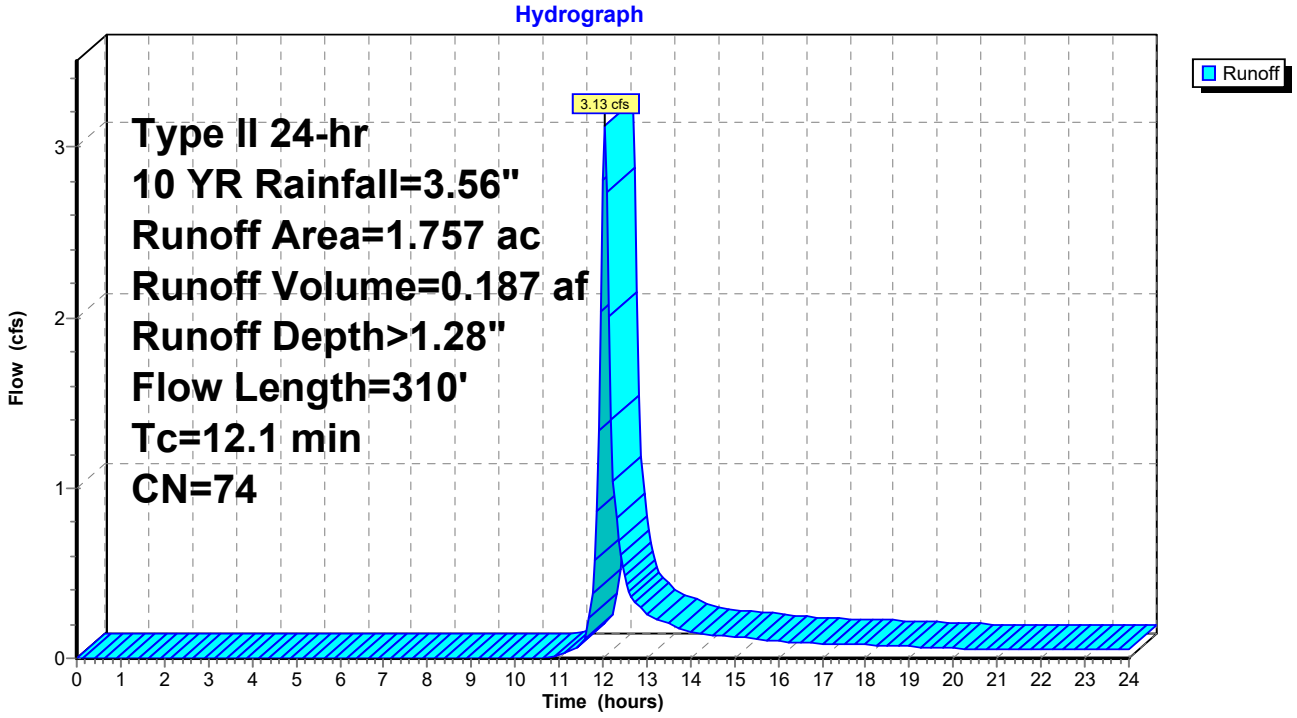
Runoff = 3.13 cfs @ 12.05 hrs, Volume= 0.187 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=3.56"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.757 | 74 | Existing Lawn Area |
| | 1.757 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.2 | 100 | 0.0200 | 0.15 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.44" |
| 0.3 | 95 | 0.1100 | 5.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 0.6 | 115 | 0.0430 | 3.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 12.1 | 310 | Total | | | |

## Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA



## Summary for Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORA

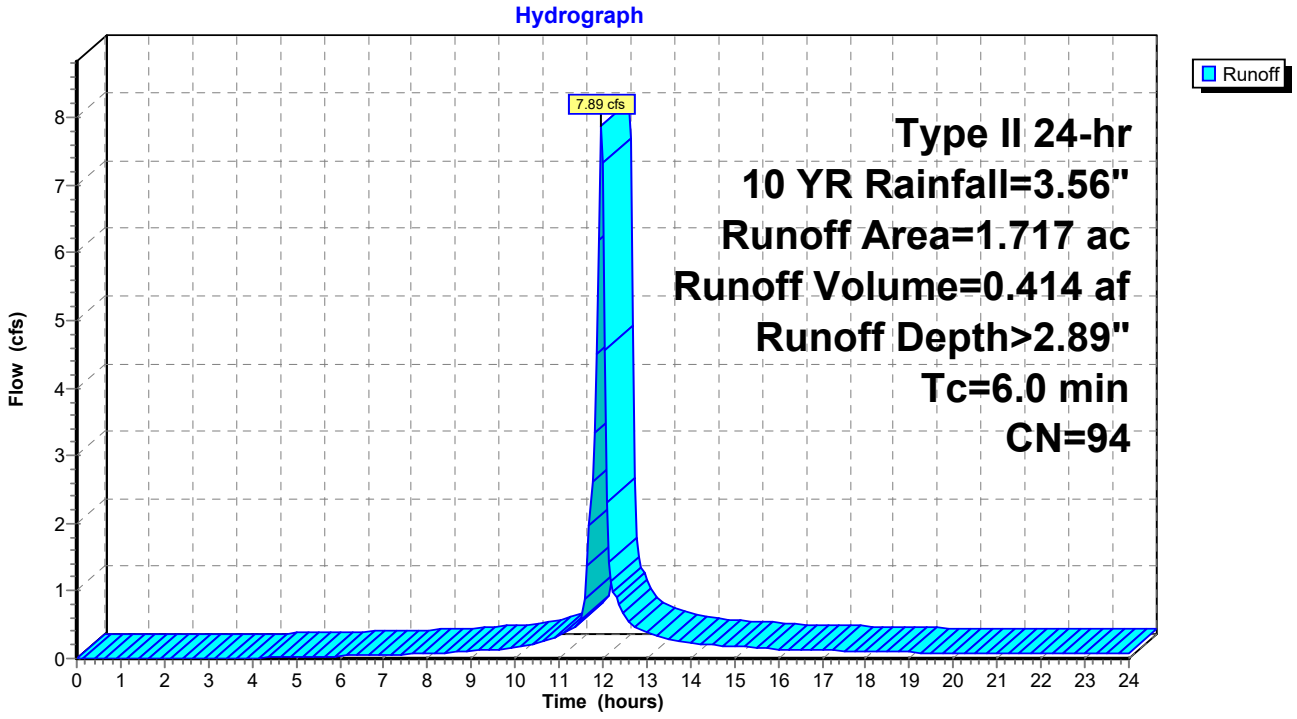
Runoff = 7.89 cfs @ 11.96 hrs, Volume= 0.414 af, Depth> 2.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=3.56"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.404 | 98 | Impervious |
| * | 0.313 | 74 | Open |
| | 1.717 | 94 | Weighted Average |
| | 0.313 | | 18.23% Pervious Area |
| | 1.404 | | 81.77% Impervious Area |

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

## Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE



## Summary for Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA

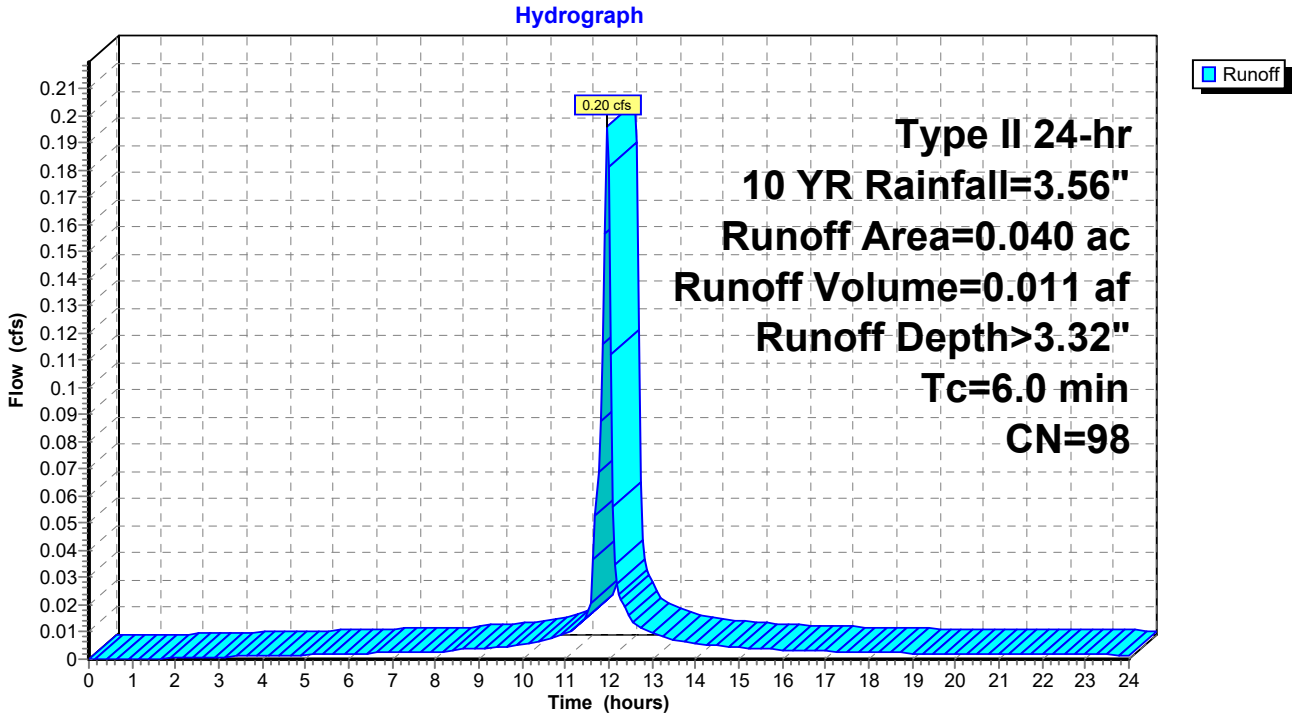
Runoff = 0.20 cfs @ 11.96 hrs, Volume= 0.011 af, Depth> 3.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 10 YR Rainfall=3.56"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 0.040 | 98 | Impervious |
| | 0.040 | | 100.00% Impervious Area |

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

### Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA



## Summary for Pond 3P: UNDERGROUND STORAGE

Inflow Area = 1.717 ac, 81.77% Impervious, Inflow Depth > 2.89" for 10 YR event
Inflow = 7.89 cfs @ 11.96 hrs, Volume= 0.414 af
Outflow = 2.69 cfs @ 12.10 hrs, Volume= 0.309 af, Atten= 66%, Lag= 8.3 min
Primary = 2.69 cfs @ 12.10 hrs, Volume= 0.309 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,123.58' @ 12.10 hrs Surf.Area= 0.056 ac Storage= 0.195 af

Plug-Flow detention time= 158.4 min calculated for 0.309 af (75% of inflow)
Center-of-Mass det. time= 69.8 min ( 849.5 - 779.7 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 1,119.00' | 0.079 af | **29.00'W x 84.00'L x 7.50'H Field A**<br>0.419 af Overall - 0.223 af Embedded = 0.197 af x 40.0% Voids |
| #2A | 1,119.00' | 0.223 af | **CMP Round 84** x 12 Inside #1<br>Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf<br>Overall Size= 84.0"W x 84.0"H x 20.00'L<br>Row Length Adjustment= -5.00' x 38.48 sf x 3 rows<br>27.00' Header x 38.48 sf x 1 = 1,039.1 cf Inside |
| | | 0.301 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,119.00' | **18.0" Round Culvert**<br>L= 200.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 1,119.00' / 1,117.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.77 sf |
| #2 | Device 1 | 1,119.00' | **1.3" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 1,121.60' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 1,123.20' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #5 | Device 1 | 1,125.90' | **6.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=2.68 cfs @ 12.10 hrs HW=1,123.58' (Free Discharge)
↑**1=Culvert** (Passes 2.68 cfs of 14.88 cfs potential flow)
↑**2=Orifice/Grate** (Orifice Controls 0.09 cfs @ 10.24 fps)
**3=Orifice/Grate** (Orifice Controls 2.16 cfs @ 6.18 fps)
**4=Orifice/Grate** (Orifice Controls 0.43 cfs @ 2.10 fps)
**5=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 3P: UNDERGROUND STORAGE - Chamber Wizard Field A

**Chamber Model = CMP Round 84 (Round Corrugated Metal Pipe)**
Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf
Overall Size= 84.0"W x 84.0"H x 20.00'L
Row Length Adjustment= -5.00' x 38.48 sf x 3 rows

84.0" Wide + 36.0" Spacing = 120.0" C-C Row Spacing

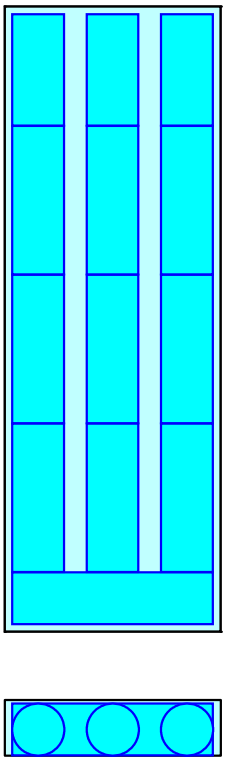
4 Chambers/Row x 20.00' Long -5.00' Row Adjustment +7.00' Header x 1 = 82.00' Row Length +12.0" End Stone x 2 = 84.00' Base Length
3 Rows x 84.0" Wide + 36.0" Spacing x 2 + 12.0" Side Stone x 2 = 29.00' Base Width
84.0" Chamber Height + 6.0" Cover = 7.50' Field Height

12 Chambers x 769.7 cf -5.00' Row Adjustment x 38.48 sf x 3 Rows + 27.00' Header x 38.48 sf = 9,698.1 cf Chamber Storage

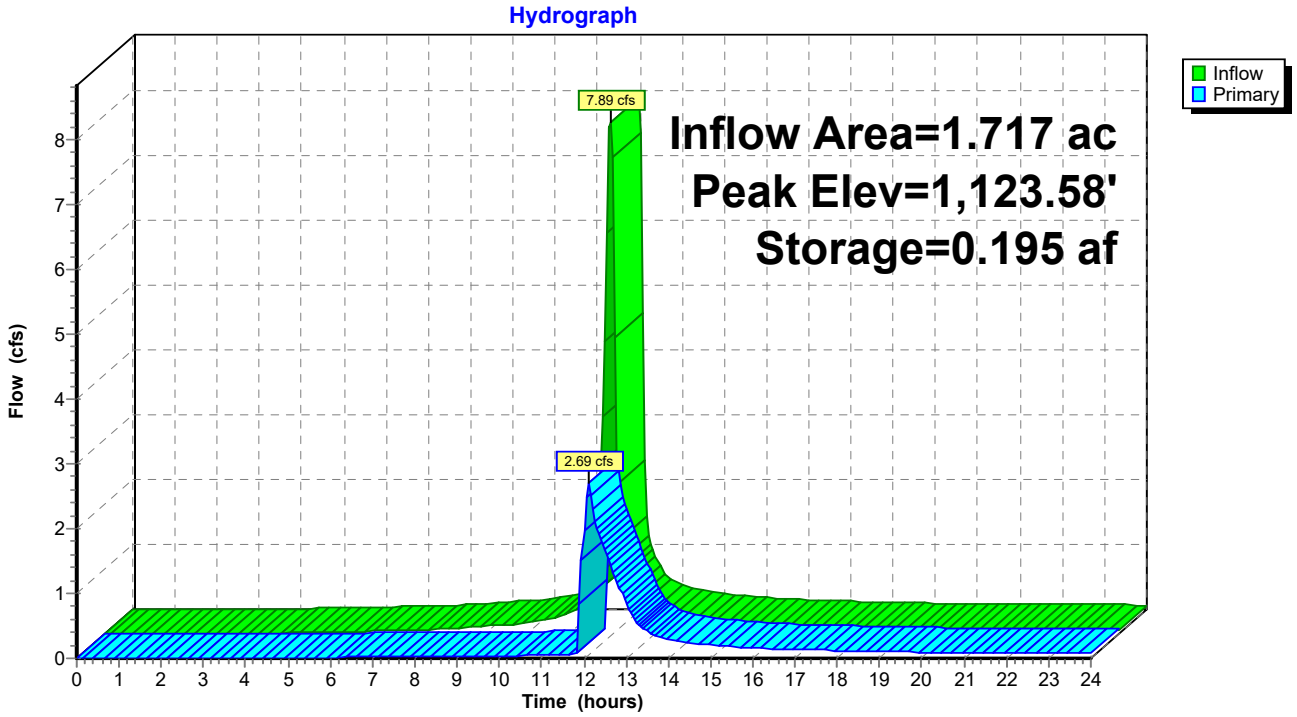
18,270.0 cf Field - 9,698.1 cf Chambers = 8,571.9 cf Stone x 40.0% Voids = 3,428.8 cf Stone Storage

Chamber Storage + Stone Storage = 13,126.9 cf = 0.301 af
Overall Storage Efficiency = 71.8%
Overall System Size = 84.00' x 29.00' x 7.50'

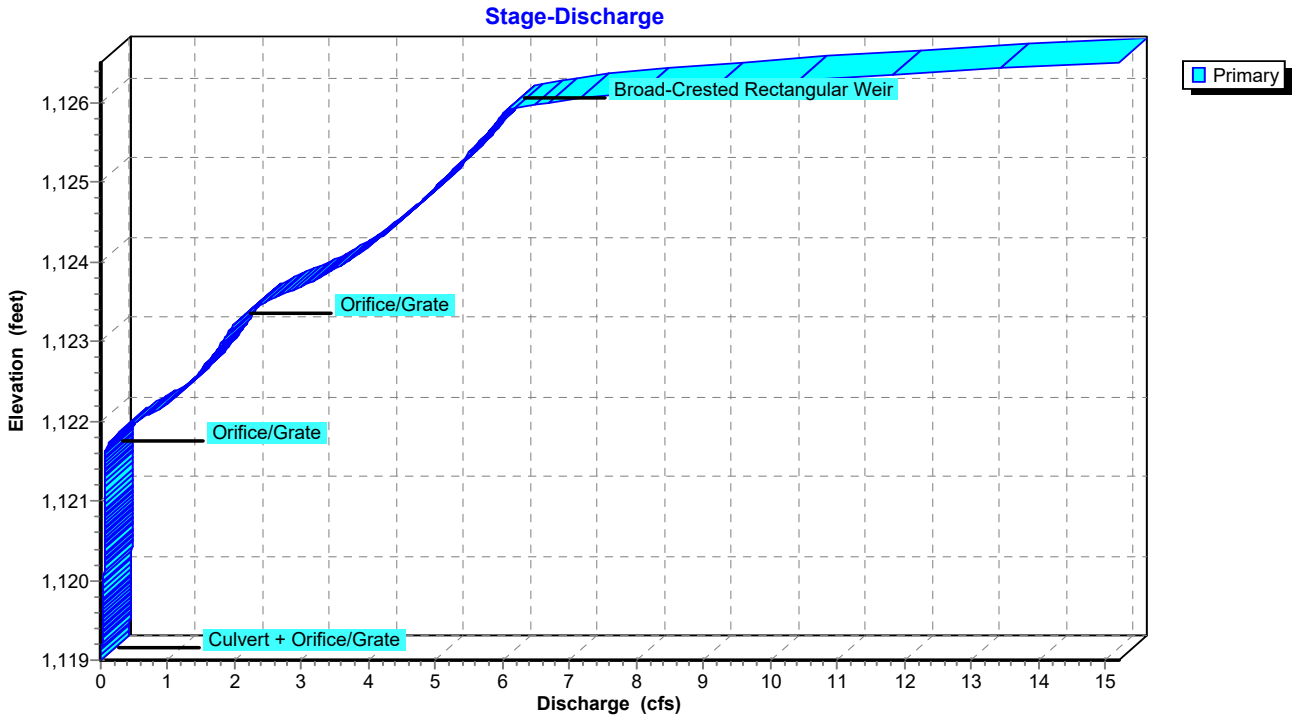
12 Chambers
676.7 cy Field
317.5 cy Stone



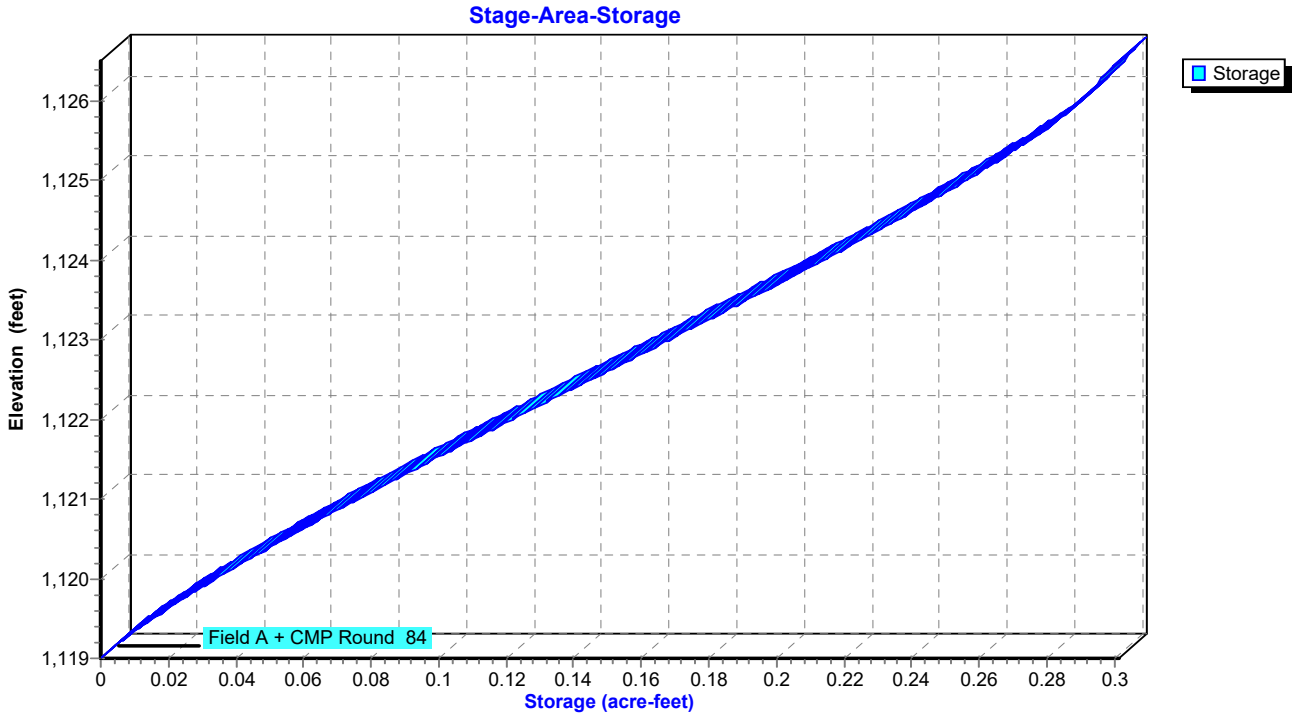
## Pond 3P: UNDERGROUND STORAGE




## Pond 3P: UNDERGROUND STORAGE



## Pond 3P: UNDERGROUND STORAGE

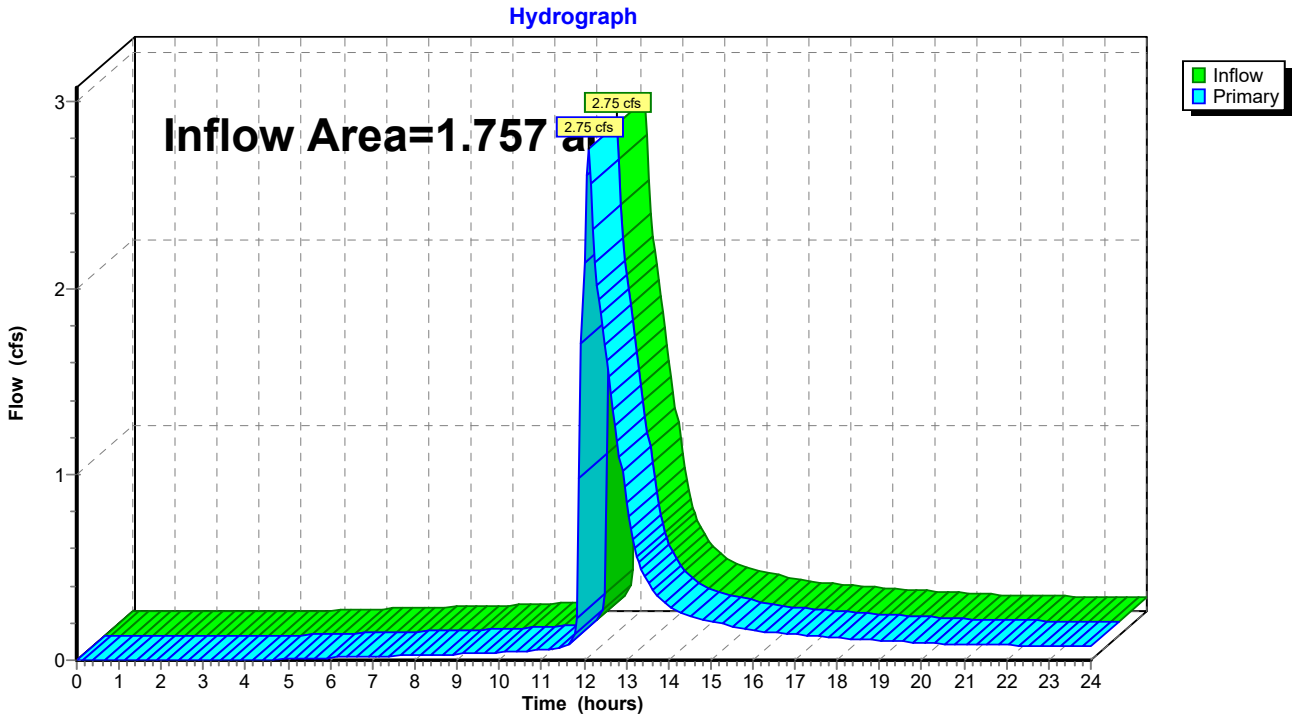


## Summary for Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE

Inflow Area = 1.757 ac, 82.19% Impervious, Inflow Depth > 2.19" for 10 YR event
Inflow = 2.75 cfs @ 12.10 hrs, Volume= 0.321 af
Primary = 2.75 cfs @ 12.10 hrs, Volume= 0.321 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment1S: TOTAL PRE** Runoff Area=1.757 ac 0.00% Impervious Runoff Depth>1.84"
Flow Length=310' Tc=12.1 min CN=74 Runoff=4.56 cfs 0.269 af

**Subcatchment2S: POST DEVELOPMENT** Runoff Area=1.717 ac 81.77% Impervious Runoff Depth>3.65"
Tc=6.0 min CN=94 Runoff=9.80 cfs 0.522 af

**Subcatchment4S: POST DEVELOPMENT** Runoff Area=0.040 ac 100.00% Impervious Runoff Depth>4.09"
Tc=6.0 min CN=98 Runoff=0.24 cfs 0.014 af

**Pond 3P: UNDERGROUND STORAGE** Peak Elev=1,124.37' Storage=0.230 af Inflow=9.80 cfs 0.522 af
Outflow=4.26 cfs 0.415 af

**Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE** Inflow=4.40 cfs 0.429 af
Primary=4.40 cfs 0.429 af

**Total Runoff Area = 3.514 ac Runoff Volume = 0.804 af Average Runoff Depth = 2.75"**
**58.91% Pervious = 2.070 ac 41.09% Impervious = 1.444 ac**

## Summary for Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA

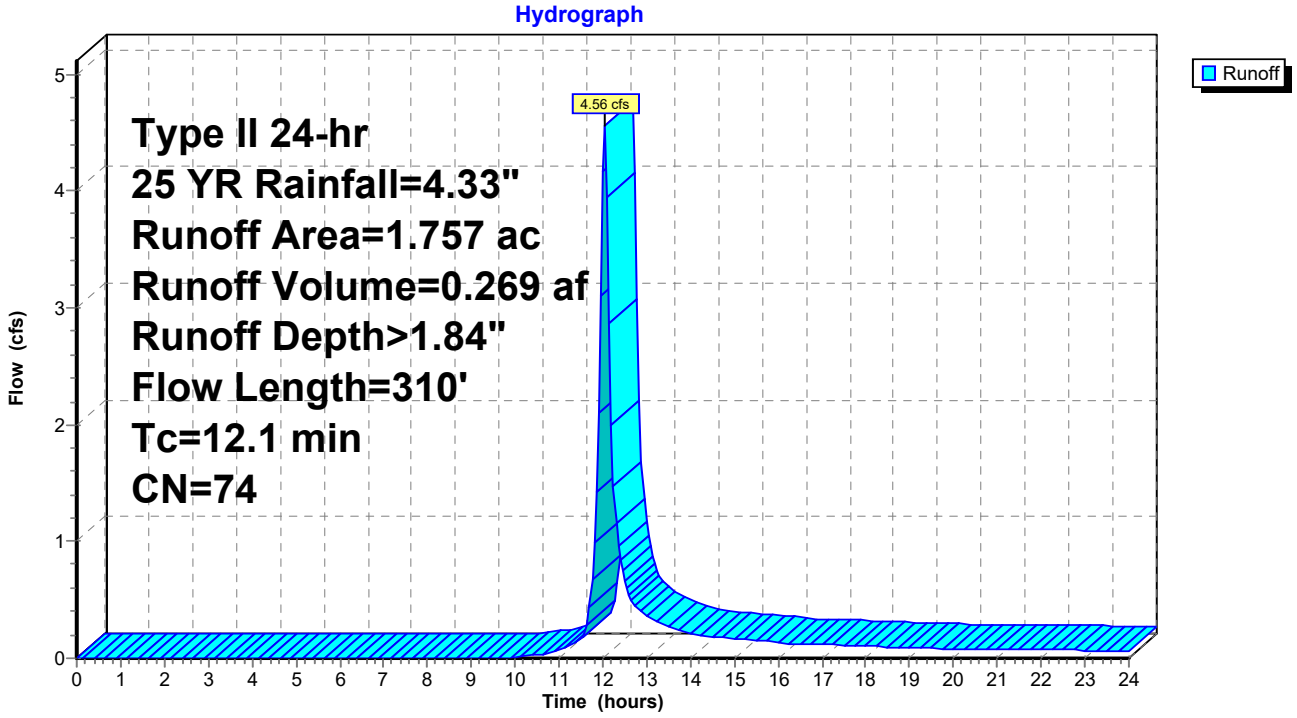
Runoff = 4.56 cfs @ 12.04 hrs, Volume= 0.269 af, Depth> 1.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 YR Rainfall=4.33"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.757 | 74 | Existing Lawn Area |
| | 1.757 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.2 | 100 | 0.0200 | 0.15 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.44" |
| 0.3 | 95 | 0.1100 | 5.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 0.6 | 115 | 0.0430 | 3.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 12.1 | 310 | Total | | | |

## Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA



## Summary for Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORA

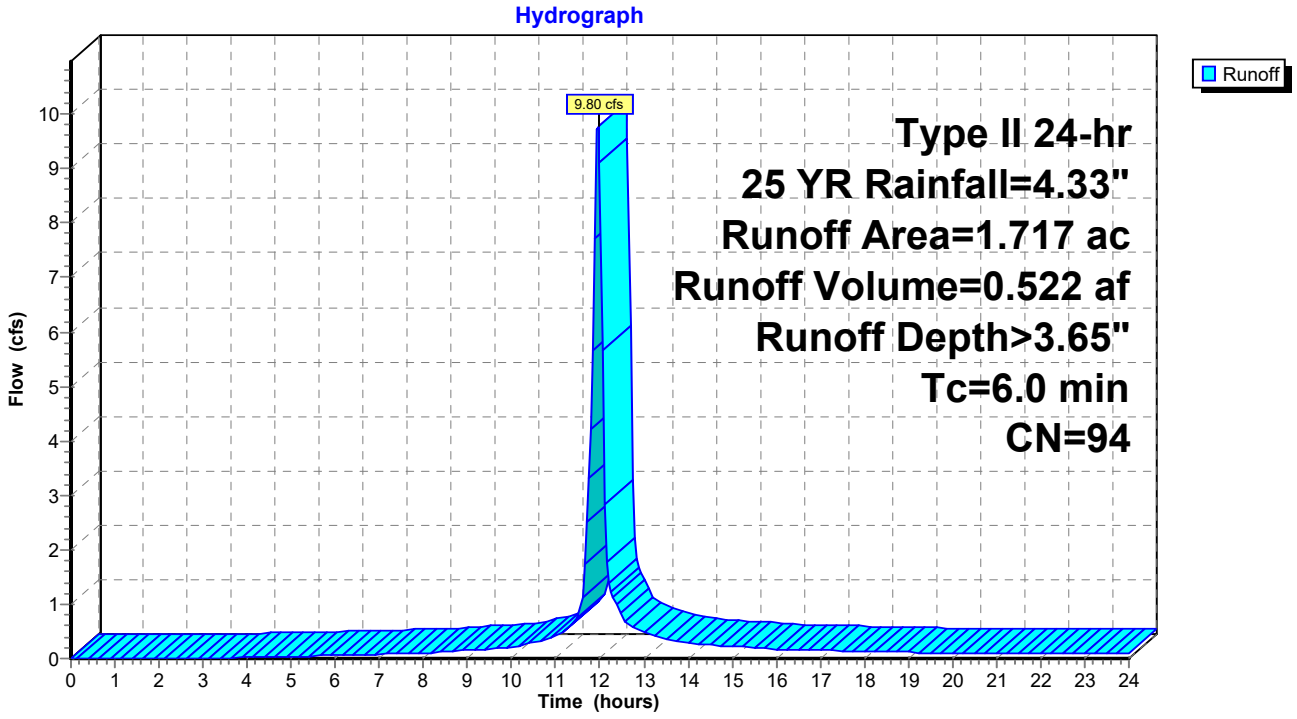
Runoff = 9.80 cfs @ 11.96 hrs, Volume= 0.522 af, Depth> 3.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 YR Rainfall=4.33"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.404 | 98 | Impervious |
| * | 0.313 | 74 | Open |
| | 1.717 | 94 | Weighted Average |
| | 0.313 | | 18.23% Pervious Area |
| | 1.404 | | 81.77% Impervious Area |

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

## Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE



## Summary for Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA

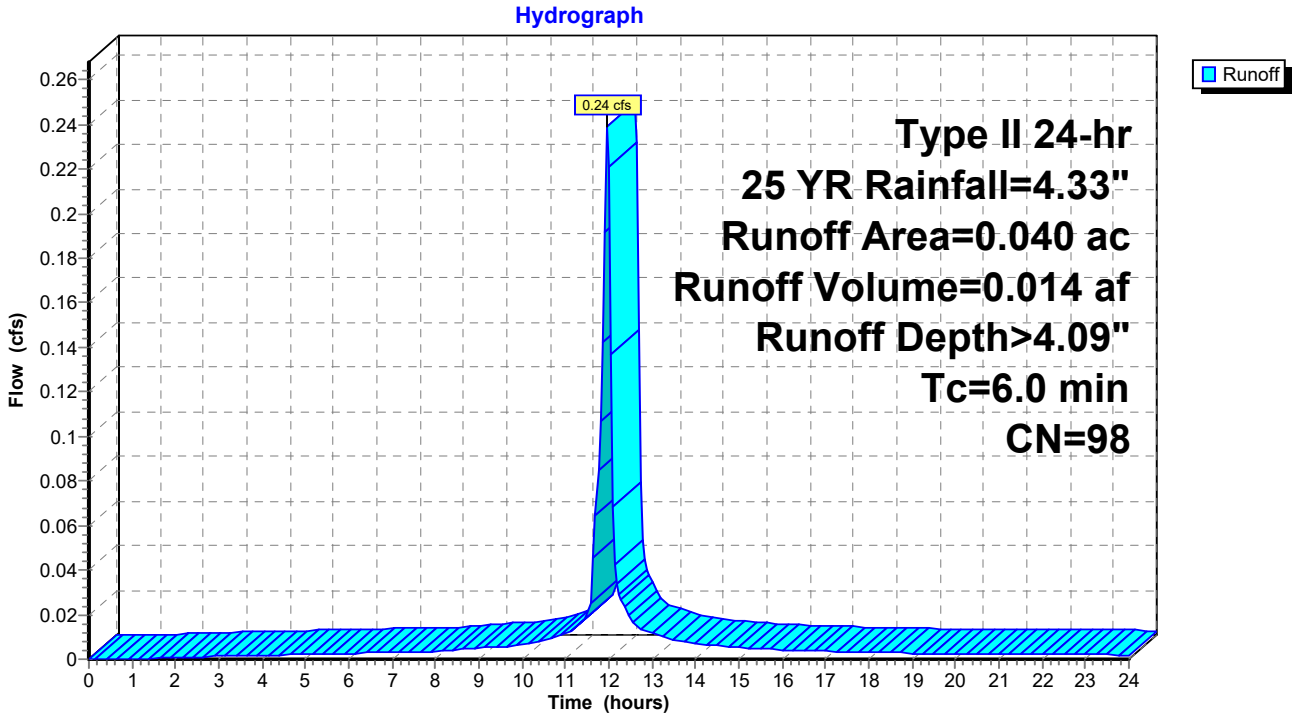
Runoff = 0.24 cfs @ 11.96 hrs, Volume= 0.014 af, Depth> 4.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 YR Rainfall=4.33"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 0.040 | 98 | Impervious |
| | 0.040 | | 100.00% Impervious Area |

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

### Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA



## Summary for Pond 3P: UNDERGROUND STORAGE

Inflow Area = 1.717 ac, 81.77% Impervious, Inflow Depth > 3.65" for 25 YR event
Inflow = 9.80 cfs @ 11.96 hrs, Volume= 0.522 af
Outflow = 4.26 cfs @ 12.08 hrs, Volume= 0.415 af, Atten= 57%, Lag= 6.8 min
Primary = 4.26 cfs @ 12.08 hrs, Volume= 0.415 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,124.37' @ 12.08 hrs Surf.Area= 0.056 ac Storage= 0.230 af

Plug-Flow detention time= 141.0 min calculated for 0.415 af (79% of inflow)
Center-of-Mass det. time= 61.8 min ( 835.5 - 773.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 1,119.00' | 0.079 af | **29.00'W x 84.00'L x 7.50'H Field A**<br>0.419 af Overall - 0.223 af Embedded = 0.197 af x 40.0% Voids |
| #2A | 1,119.00' | 0.223 af | **CMP Round 84** x 12 Inside #1<br>Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf<br>Overall Size= 84.0"W x 84.0"H x 20.00'L<br>Row Length Adjustment= -5.00' x 38.48 sf x 3 rows<br>27.00' Header x 38.48 sf x 1 = 1,039.1 cf Inside |
| | | 0.301 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,119.00' | **18.0" Round Culvert**<br>L= 200.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 1,119.00' / 1,117.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.77 sf |
| #2 | Device 1 | 1,119.00' | **1.3" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 1,121.60' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 1,123.20' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #5 | Device 1 | 1,125.90' | **6.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=4.23 cfs @ 12.08 hrs HW=1,124.34' (Free Discharge)
↑└**1=Culvert** (Passes 4.23 cfs of 15.96 cfs potential flow)
↑ ├**2=Orifice/Grate** (Orifice Controls 0.10 cfs @ 11.07 fps)
 ├**3=Orifice/Grate** (Orifice Controls 2.61 cfs @ 7.48 fps)
 ├**4=Orifice/Grate** (Orifice Controls 1.51 cfs @ 4.34 fps)
 └**5=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 3P: UNDERGROUND STORAGE - Chamber Wizard Field A

**Chamber Model = CMP Round 84 (Round Corrugated Metal Pipe)**
Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf
Overall Size= 84.0"W x 84.0"H x 20.00'L
Row Length Adjustment= -5.00' x 38.48 sf x 3 rows

84.0" Wide + 36.0" Spacing = 120.0" C-C Row Spacing

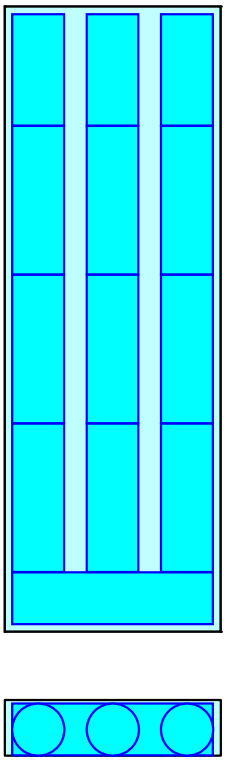
4 Chambers/Row x 20.00' Long -5.00' Row Adjustment +7.00' Header x 1 = 82.00' Row Length +12.0" End Stone x 2 = 84.00' Base Length
3 Rows x 84.0" Wide + 36.0" Spacing x 2 + 12.0" Side Stone x 2 = 29.00' Base Width
84.0" Chamber Height + 6.0" Cover = 7.50' Field Height

12 Chambers x 769.7 cf -5.00' Row Adjustment x 38.48 sf x 3 Rows + 27.00' Header x 38.48 sf = 9,698.1 cf Chamber Storage

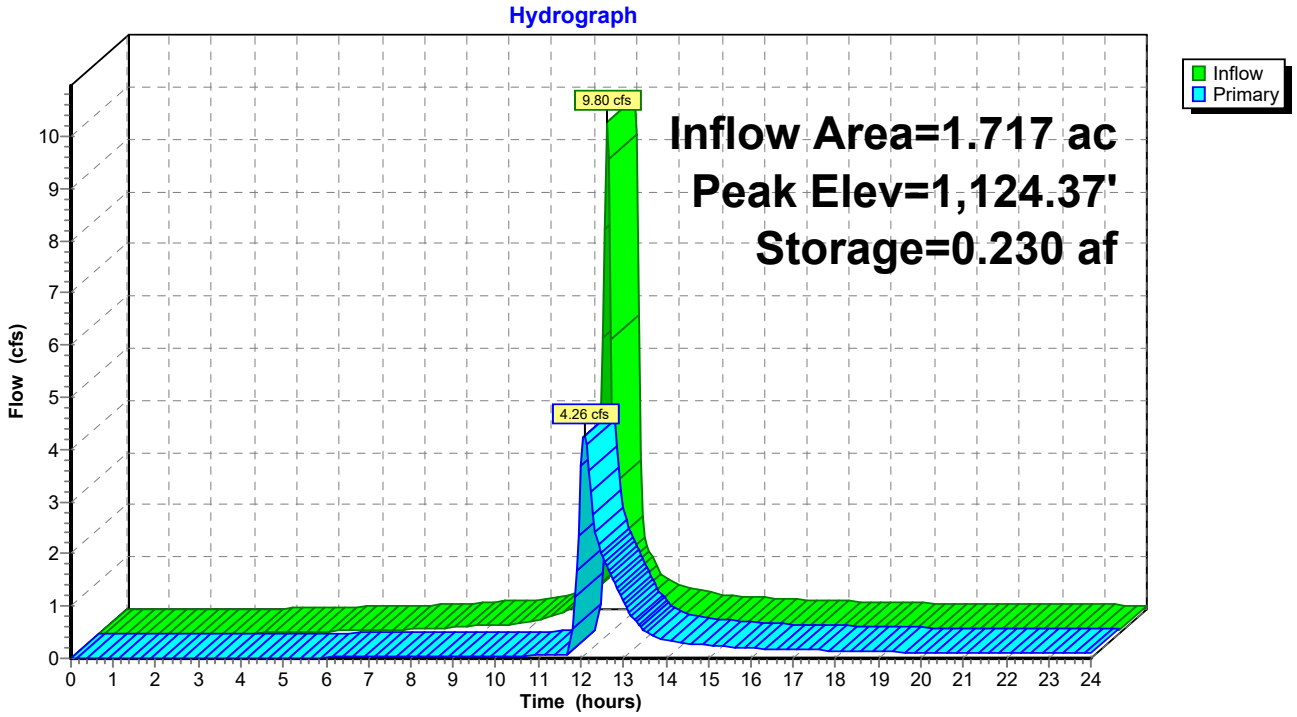
18,270.0 cf Field - 9,698.1 cf Chambers = 8,571.9 cf Stone x 40.0% Voids = 3,428.8 cf Stone Storage

Chamber Storage + Stone Storage = 13,126.9 cf = 0.301 af
Overall Storage Efficiency = 71.8%
Overall System Size = 84.00' x 29.00' x 7.50'

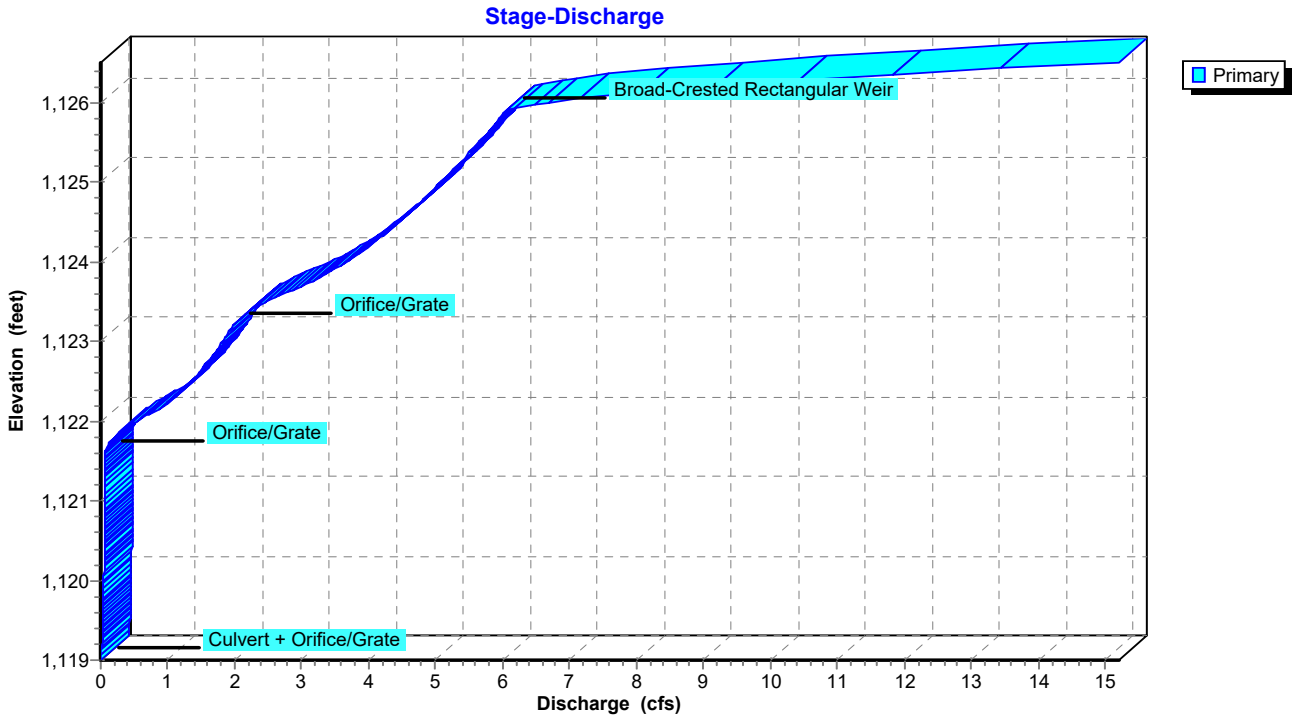
12 Chambers
676.7 cy Field
317.5 cy Stone



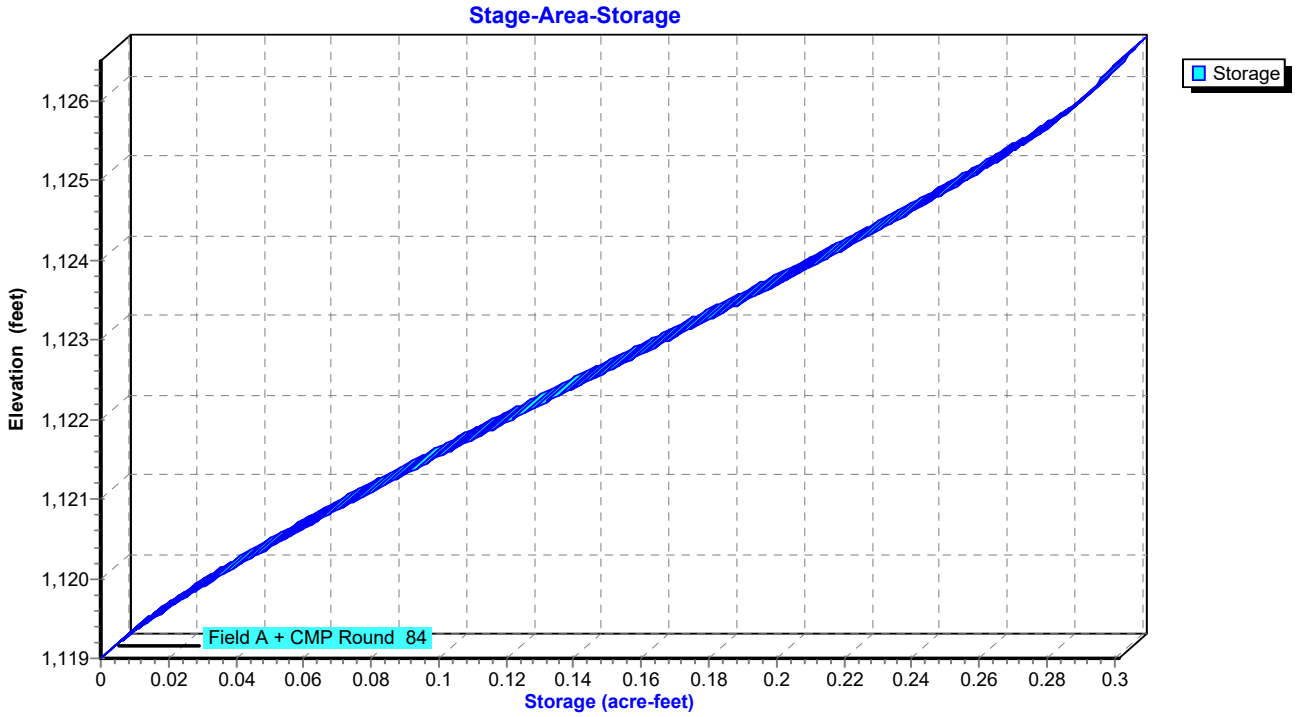
## Pond 3P: UNDERGROUND STORAGE




## Pond 3P: UNDERGROUND STORAGE



## Pond 3P: UNDERGROUND STORAGE

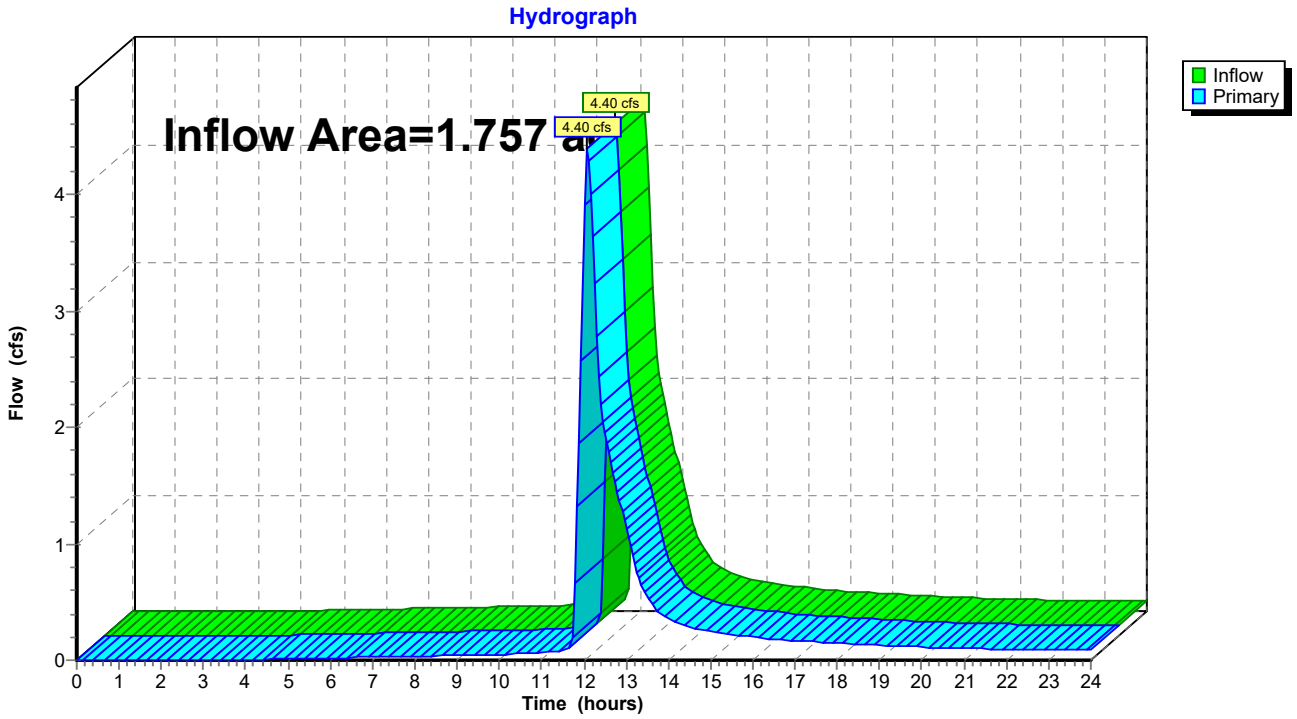


## Summary for Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE

Inflow Area = 1.757 ac, 82.19% Impervious, Inflow Depth > 2.93" for 25 YR event
Inflow = 4.40 cfs @ 12.07 hrs, Volume= 0.429 af
Primary = 4.40 cfs @ 12.07 hrs, Volume= 0.429 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment1S: TOTAL PRE** Runoff Area=1.757 ac 0.00% Impervious Runoff Depth>2.36"
Flow Length=310' Tc=12.1 min CN=74 Runoff=5.88 cfs 0.345 af

**Subcatchment2S: POST DEVELOPMENT** Runoff Area=1.717 ac 81.77% Impervious Runoff Depth>4.30"
Tc=6.0 min CN=94 Runoff=11.45 cfs 0.616 af

**Subcatchment4S: POST DEVELOPMENT** Runoff Area=0.040 ac 100.00% Impervious Runoff Depth>4.76"
Tc=6.0 min CN=98 Runoff=0.28 cfs 0.016 af

**Pond 3P: UNDERGROUND STORAGE** Peak Elev=1,125.11' Storage=0.260 af Inflow=11.45 cfs 0.616 af
Outflow=5.22 cfs 0.509 af

**Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE** Inflow=5.35 cfs 0.525 af
Primary=5.35 cfs 0.525 af

**Total Runoff Area = 3.514 ac Runoff Volume = 0.977 af Average Runoff Depth = 3.34"**
**58.91% Pervious = 2.070 ac 41.09% Impervious = 1.444 ac**

## Summary for Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA

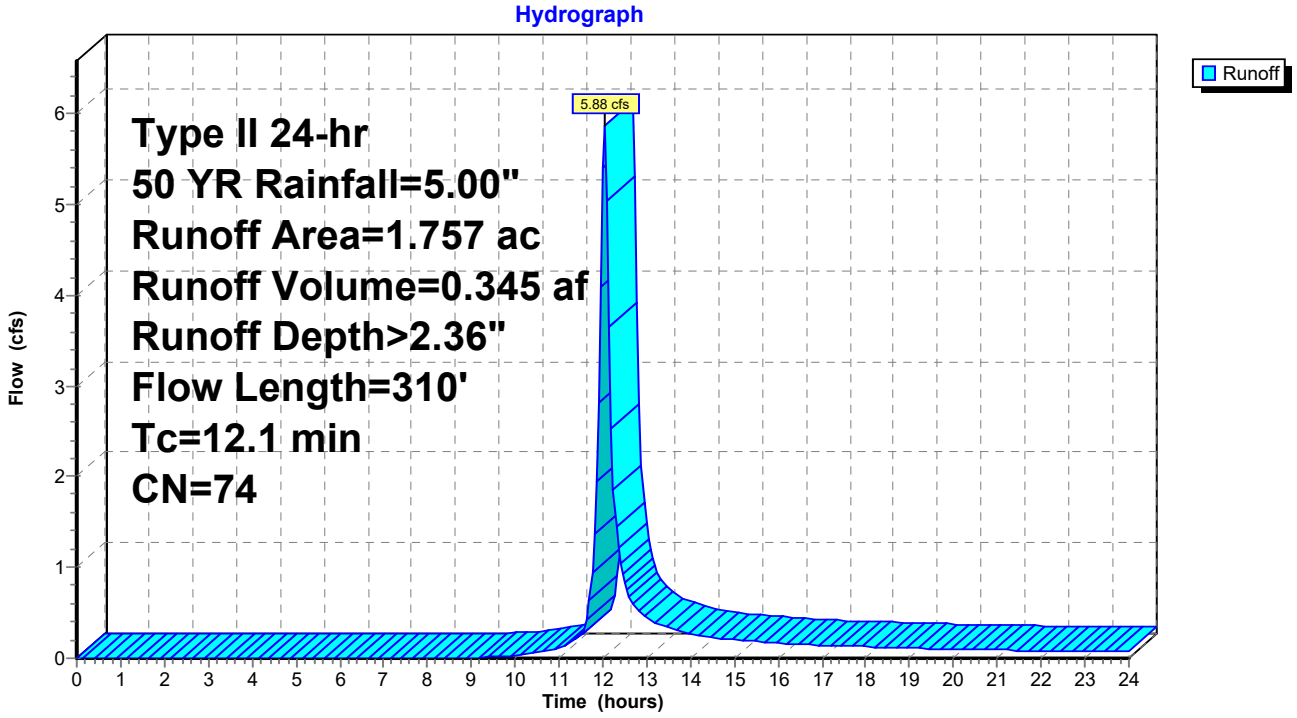
Runoff = 5.88 cfs @ 12.04 hrs, Volume= 0.345 af, Depth> 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50 YR Rainfall=5.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.757 | 74 | Existing Lawn Area |
| | 1.757 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.2 | 100 | 0.0200 | 0.15 | | **Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 2.44" |
| 0.3 | 95 | 0.1100 | 5.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow** Unpaved Kv= 16.1 fps |
| 0.6 | 115 | 0.0430 | 3.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow** Unpaved Kv= 16.1 fps |
| 12.1 | 310 | Total | | | |

## Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA



## Summary for Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORA

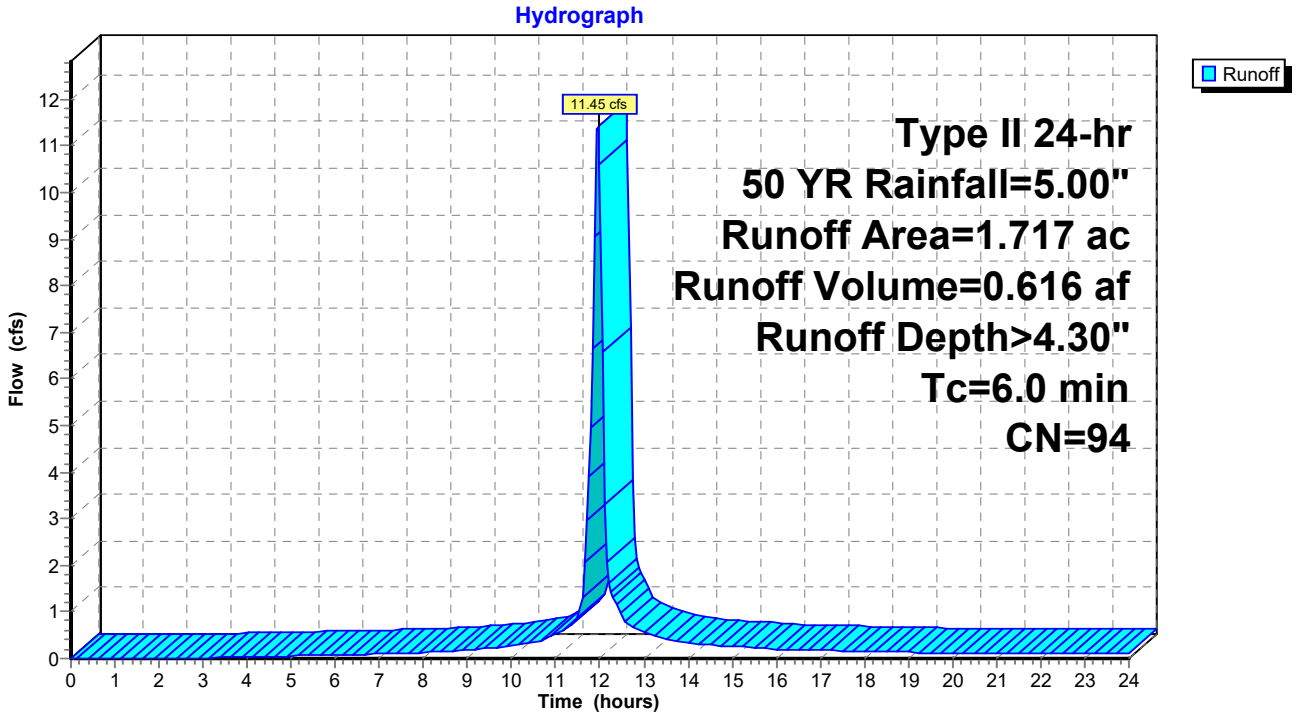
Runoff = 11.45 cfs @ 11.96 hrs, Volume= 0.616 af, Depth> 4.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50 YR Rainfall=5.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.404 | 98 | Impervious |
| * | 0.313 | 74 | Open |
| | 1.717 | 94 | Weighted Average |
| | 0.313 | | 18.23% Pervious Area |
| | 1.404 | | 81.77% Impervious Area |

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

## Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE



## Summary for Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA

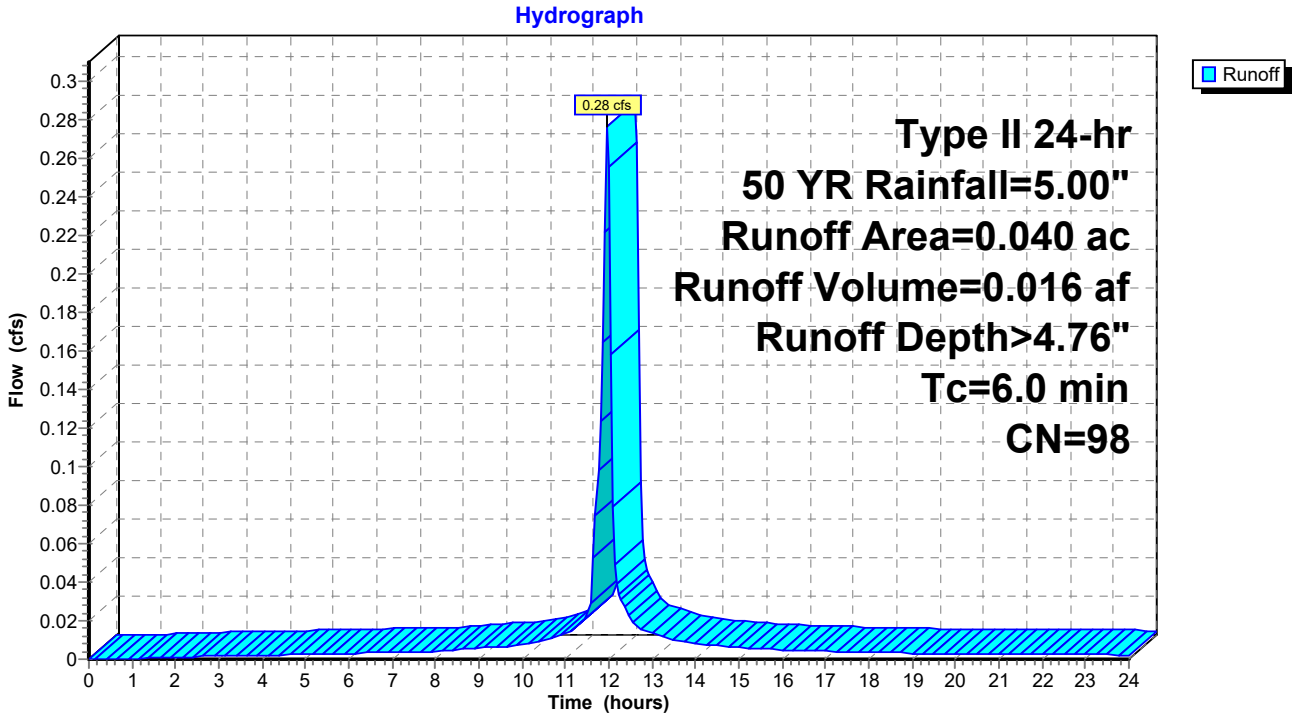
Runoff = 0.28 cfs @ 11.96 hrs, Volume= 0.016 af, Depth> 4.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 50 YR Rainfall=5.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 0.040 | 98 | Impervious |
| | 0.040 | | 100.00% Impervious Area |

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

### Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA



## Summary for Pond 3P: UNDERGROUND STORAGE

Inflow Area = 1.717 ac, 81.77% Impervious, Inflow Depth > 4.30" for 50 YR event
Inflow = 11.45 cfs @ 11.96 hrs, Volume= 0.616 af
Outflow = 5.22 cfs @ 12.07 hrs, Volume= 0.509 af, Atten= 54%, Lag= 6.6 min
Primary = 5.22 cfs @ 12.07 hrs, Volume= 0.509 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,125.11' @ 12.07 hrs Surf.Area= 0.056 ac Storage= 0.260 af

Plug-Flow detention time= 132.3 min calculated for 0.509 af (83% of inflow)
Center-of-Mass det. time= 58.7 min ( 828.1 - 769.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 1,119.00' | 0.079 af | **29.00'W x 84.00'L x 7.50'H Field A**<br>0.419 af Overall - 0.223 af Embedded = 0.197 af x 40.0% Voids |
| #2A | 1,119.00' | 0.223 af | **CMP Round 84** x 12 Inside #1<br>Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf<br>Overall Size= 84.0"W x 84.0"H x 20.00'L<br>Row Length Adjustment= -5.00' x 38.48 sf x 3 rows<br>27.00' Header x 38.48 sf x 1 = 1,039.1 cf Inside |
| | | 0.301 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,119.00' | **18.0" Round Culvert**<br>L= 200.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 1,119.00' / 1,117.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.77 sf |
| #2 | Device 1 | 1,119.00' | **1.3" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 1,121.60' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 1,123.20' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #5 | Device 1 | 1,125.90' | **6.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=5.16 cfs @ 12.07 hrs HW=1,125.06' (Free Discharge)
└**1=Culvert** (Passes 5.16 cfs of 16.91 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.11 cfs @ 11.80 fps)
  ├**3=Orifice/Grate** (Orifice Controls 2.97 cfs @ 8.52 fps)
  ├**4=Orifice/Grate** (Orifice Controls 2.08 cfs @ 5.96 fps)
  └**5=Broad-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 3P: UNDERGROUND STORAGE - Chamber Wizard Field A

**Chamber Model = CMP Round 84 (Round Corrugated Metal Pipe)**
Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf
Overall Size= 84.0"W x 84.0"H x 20.00'L
Row Length Adjustment= -5.00' x 38.48 sf x 3 rows

84.0" Wide + 36.0" Spacing = 120.0" C-C Row Spacing

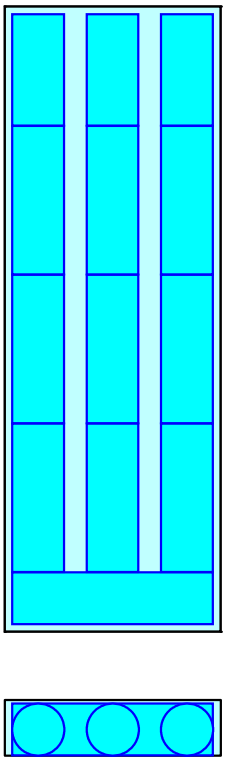
4 Chambers/Row x 20.00' Long -5.00' Row Adjustment +7.00' Header x 1 = 82.00' Row Length +12.0" End Stone x 2 = 84.00' Base Length
3 Rows x 84.0" Wide + 36.0" Spacing x 2 + 12.0" Side Stone x 2 = 29.00' Base Width
84.0" Chamber Height + 6.0" Cover = 7.50' Field Height

12 Chambers x 769.7 cf -5.00' Row Adjustment x 38.48 sf x 3 Rows + 27.00' Header x 38.48 sf = 9,698.1 cf Chamber Storage

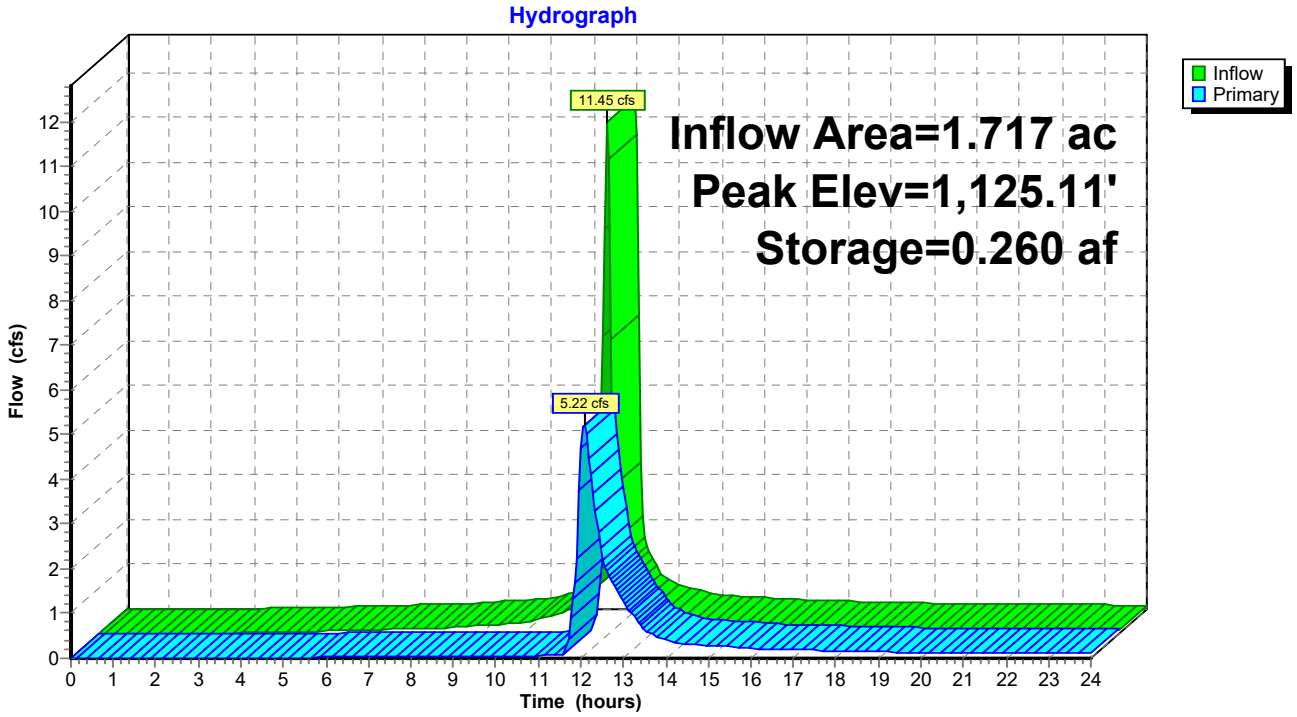
18,270.0 cf Field - 9,698.1 cf Chambers = 8,571.9 cf Stone x 40.0% Voids = 3,428.8 cf Stone Storage

Chamber Storage + Stone Storage = 13,126.9 cf = 0.301 af
Overall Storage Efficiency = 71.8%
Overall System Size = 84.00' x 29.00' x 7.50'

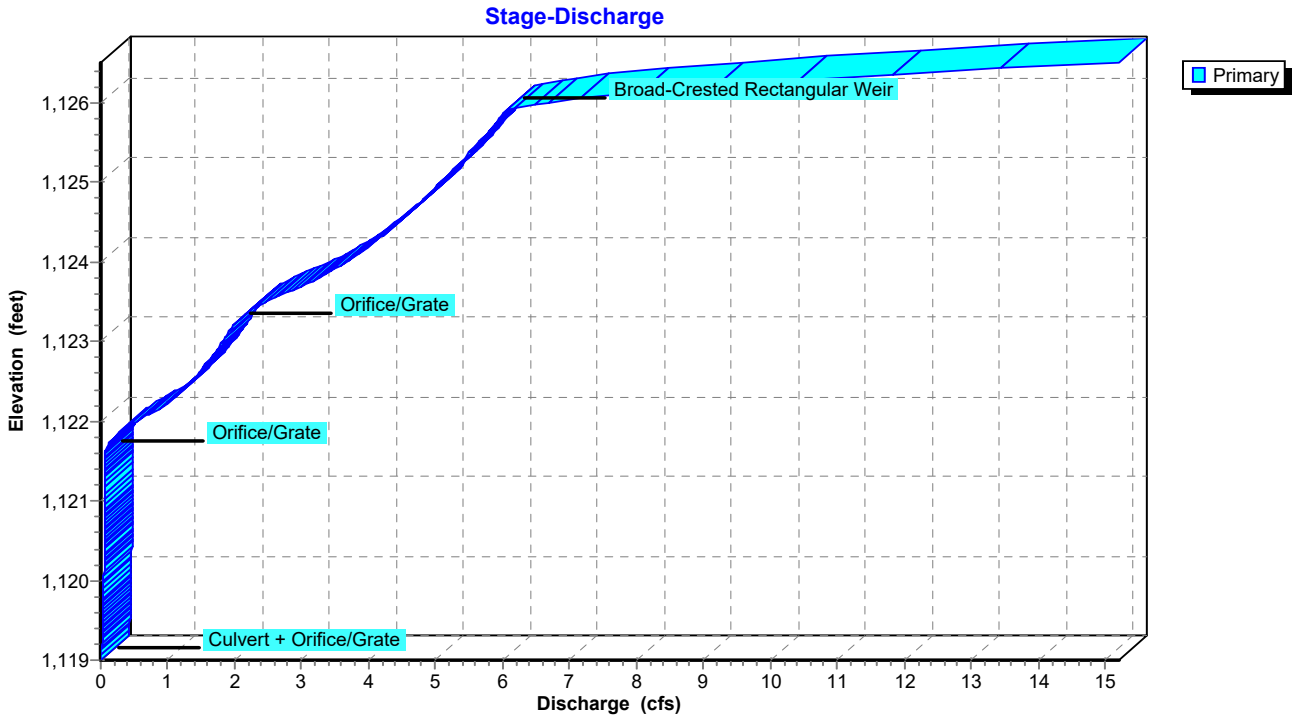
12 Chambers
676.7 cy Field
317.5 cy Stone



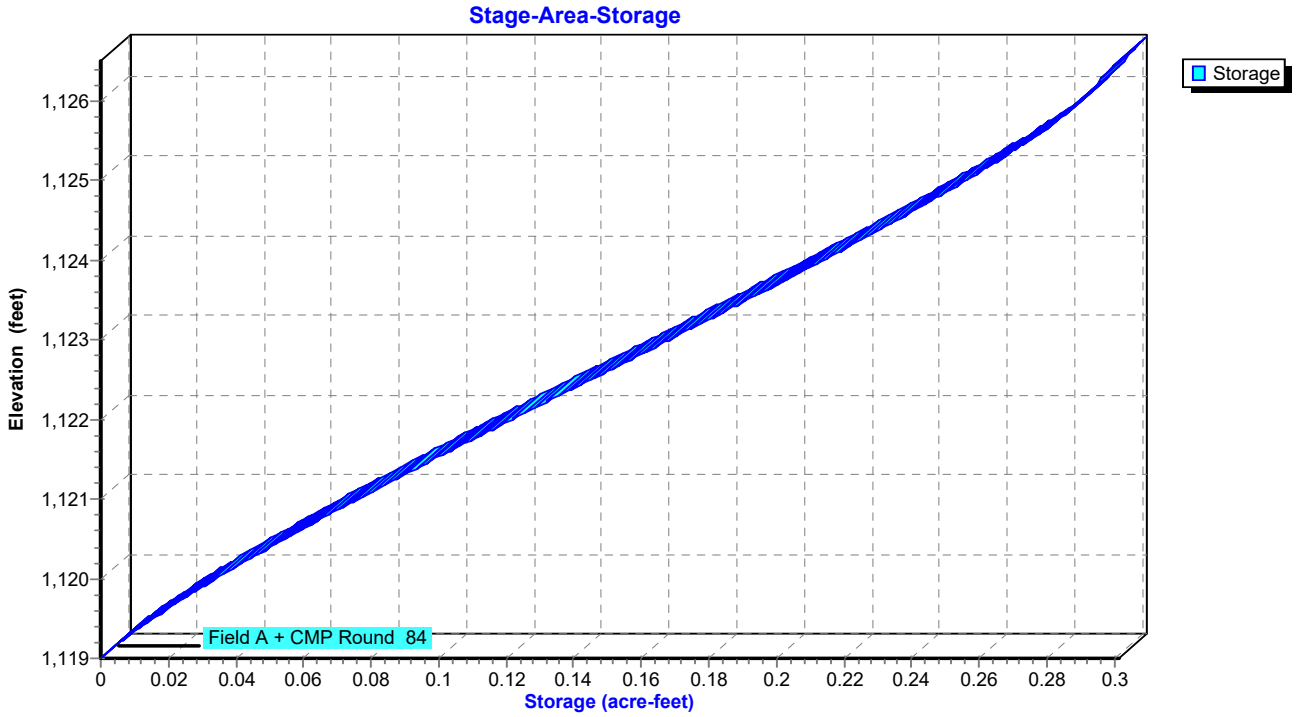
## Pond 3P: UNDERGROUND STORAGE




## Pond 3P: UNDERGROUND STORAGE



## Pond 3P: UNDERGROUND STORAGE

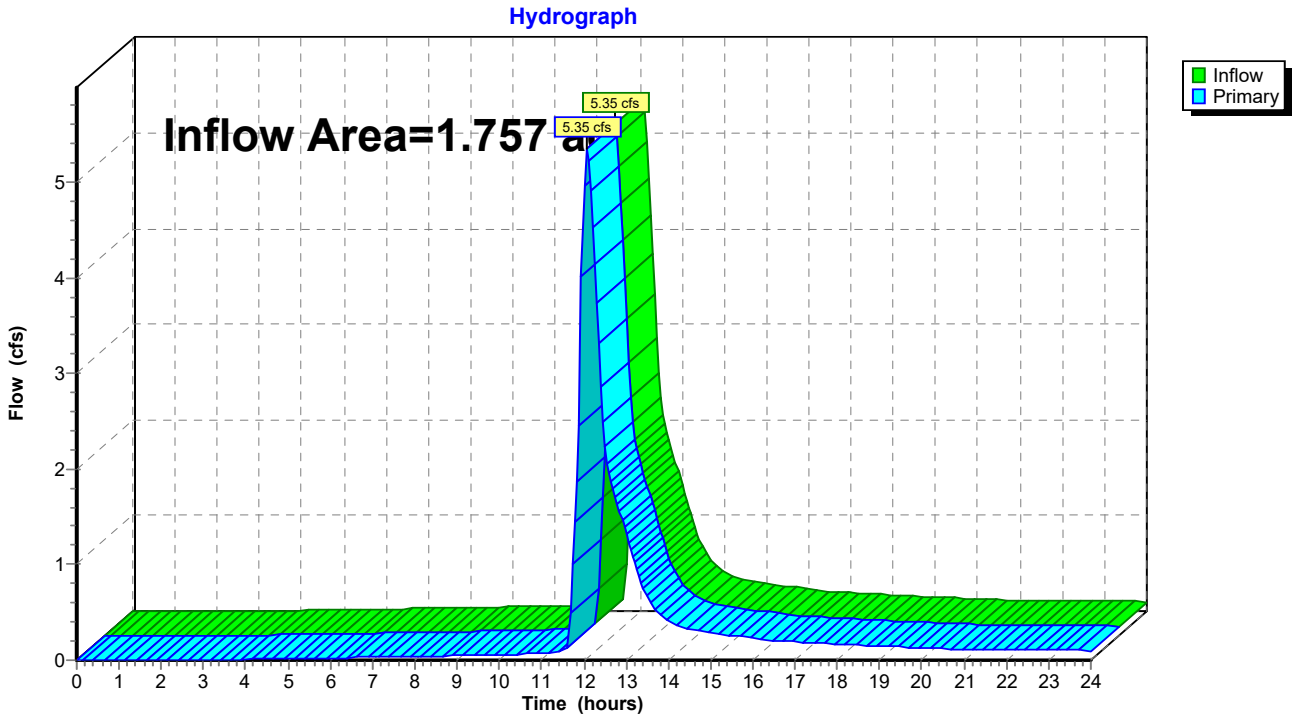


## Summary for Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE

Inflow Area = 1.757 ac, 82.19% Impervious, Inflow Depth > 3.58" for 50 YR event
Inflow = 5.35 cfs @ 12.06 hrs, Volume= 0.525 af
Primary = 5.35 cfs @ 12.06 hrs, Volume= 0.525 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment1S: TOTAL PRE** Runoff Area=1.757 ac 0.00% Impervious Runoff Depth>2.95"
Flow Length=310' Tc=12.1 min CN=74 Runoff=7.36 cfs 0.432 af

**Subcatchment2S: POST DEVELOPMENT** Runoff Area=1.717 ac 81.77% Impervious Runoff Depth>5.03"
Tc=6.0 min CN=94 Runoff=13.24 cfs 0.719 af

**Subcatchment4S: POST DEVELOPMENT** Runoff Area=0.040 ac 100.00% Impervious Runoff Depth>5.49"
Tc=6.0 min CN=98 Runoff=0.32 cfs 0.018 af

**Pond 3P: UNDERGROUND STORAGE** Peak Elev=1,125.99' Storage=0.290 af Inflow=13.24 cfs 0.719 af
Outflow=6.29 cfs 0.611 af

**Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE** Inflow=6.45 cfs 0.629 af
Primary=6.45 cfs 0.629 af

**Total Runoff Area = 3.514 ac Runoff Volume = 1.169 af Average Runoff Depth = 3.99"**
**58.91% Pervious = 2.070 ac 41.09% Impervious = 1.444 ac**

## Summary for Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA

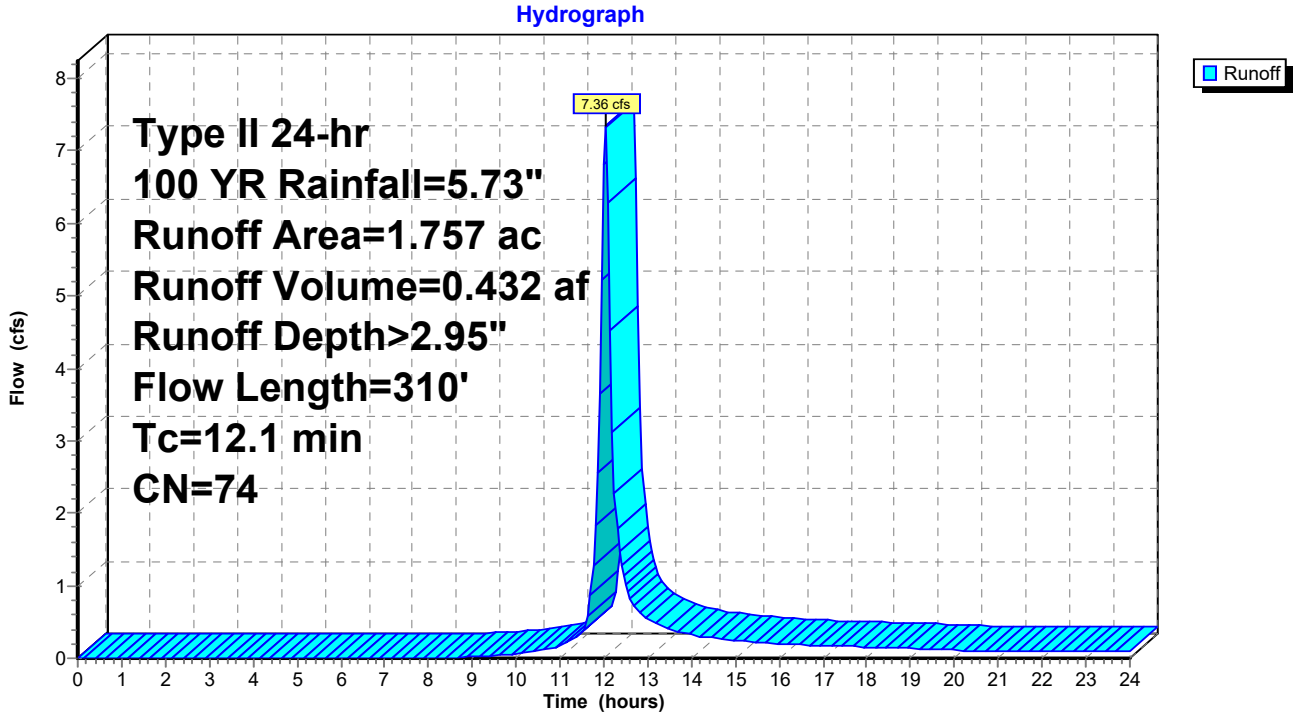
Runoff = 7.36 cfs @ 12.04 hrs, Volume= 0.432 af, Depth> 2.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=5.73"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.757 | 74 | Existing Lawn Area |
| | 1.757 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 11.2 | 100 | 0.0200 | 0.15 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.44" |
| 0.3 | 95 | 0.1100 | 5.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 0.6 | 115 | 0.0430 | 3.34 | | **Shallow Concentrated Flow, Shallow Conc. Flow**<br>Unpaved Kv= 16.1 fps |
| 12.1 | 310 | Total | | | |

## Subcatchment 1S: TOTAL PRE DEVELOPMENT DRAINAGE AREA



## Summary for Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORA

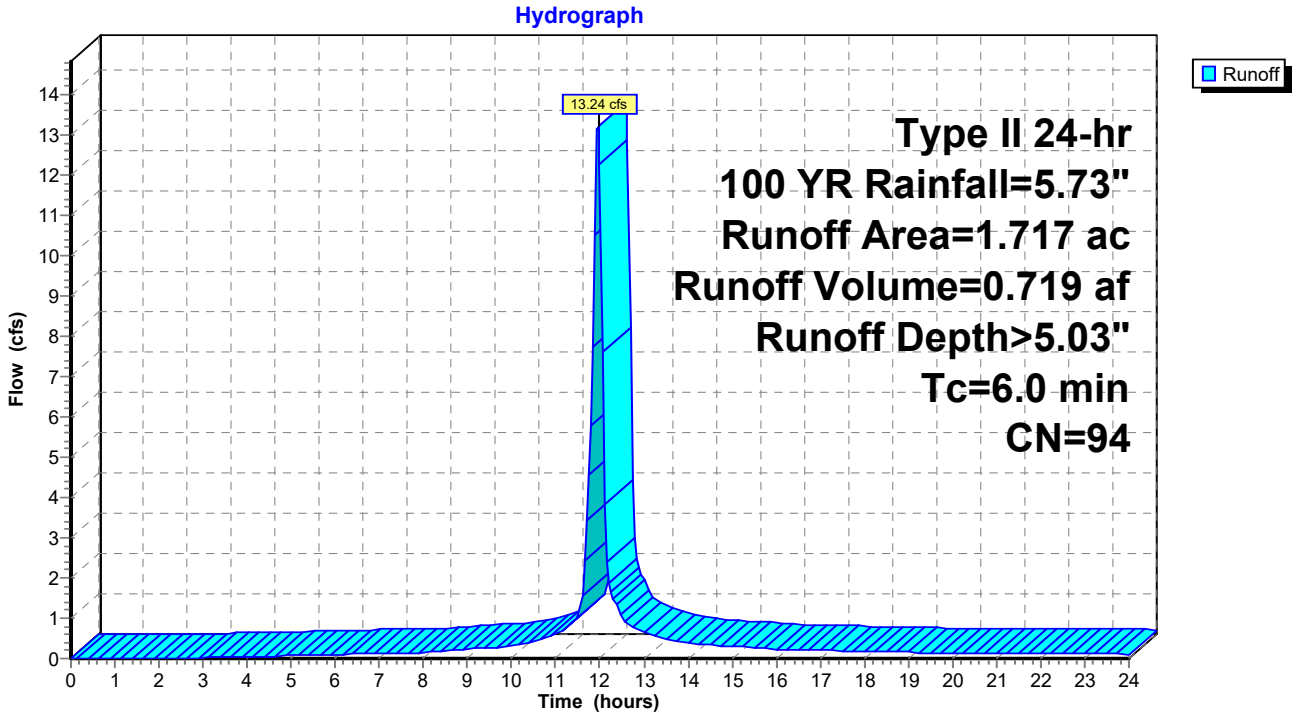
Runoff = 13.24 cfs @ 11.96 hrs, Volume= 0.719 af, Depth> 5.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=5.73"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.404 | 98 | Impervious |
| * | 0.313 | 74 | Open |
| | 1.717 | 94 | Weighted Average |
| | 0.313 | | 18.23% Pervious Area |
| | 1.404 | | 81.77% Impervious Area |

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

## Subcatchment 2S: POST DEVELOPMENT DRAINAGE AREA TO UNDERGROUND STORAGE



## Summary for Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA

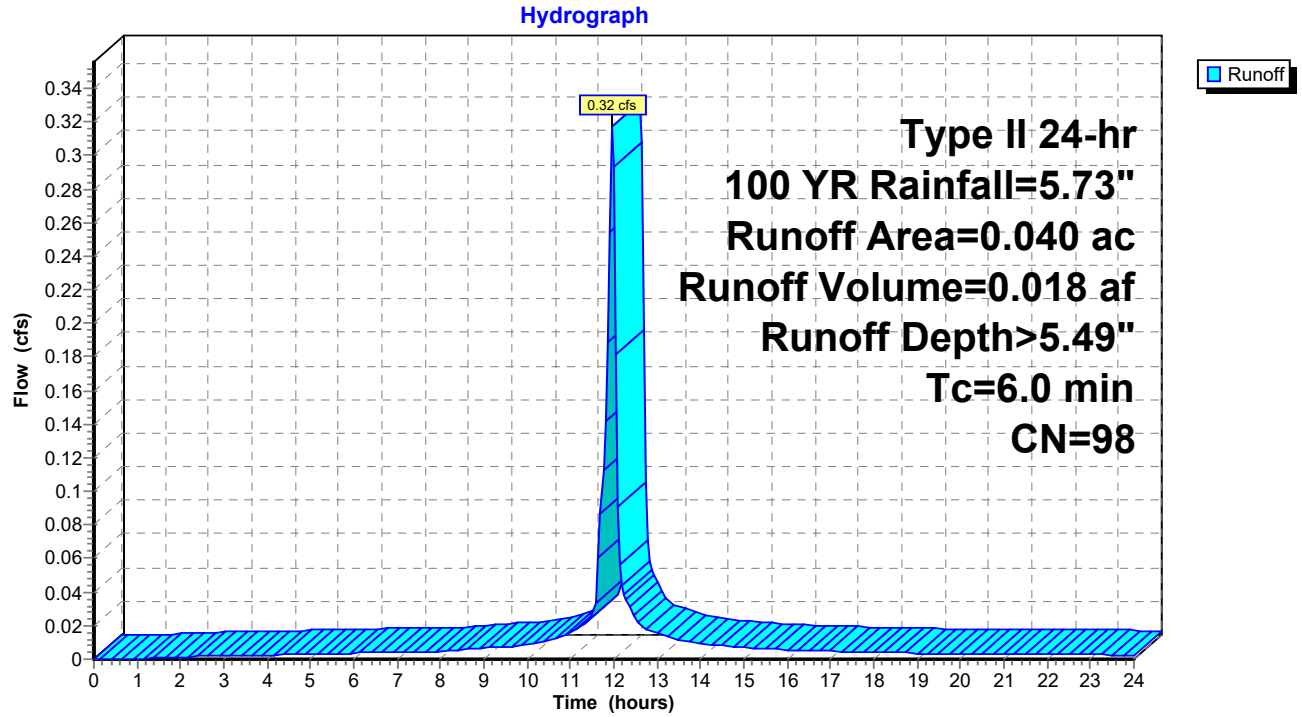
Runoff = 0.32 cfs @ 11.96 hrs, Volume= 0.018 af, Depth> 5.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 YR Rainfall=5.73"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 0.040 | 98 | Impervious |
| | 0.040 | | 100.00% Impervious Area |

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

### Subcatchment 4S: POST DEVELOPMENT UNDETAINED PAVEMENT AREA



## Summary for Pond 3P: UNDERGROUND STORAGE

Inflow Area = 1.717 ac, 81.77% Impervious, Inflow Depth > 5.03" for 100 YR event
Inflow = 13.24 cfs @ 11.96 hrs, Volume= 0.719 af
Outflow = 6.29 cfs @ 12.06 hrs, Volume= 0.611 af, Atten= 53%, Lag= 6.0 min
Primary = 6.29 cfs @ 12.06 hrs, Volume= 0.611 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 1,125.99' @ 12.07 hrs Surf.Area= 0.056 ac Storage= 0.290 af

Plug-Flow detention time= 123.5 min calculated for 0.610 af (85% of inflow)
Center-of-Mass det. time= 56.7 min ( 822.2 - 765.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 1,119.00' | 0.079 af | **29.00'W x 84.00'L x 7.50'H Field A**<br>0.419 af Overall - 0.223 af Embedded = 0.197 af x 40.0% Voids |
| #2A | 1,119.00' | 0.223 af | **CMP Round 84** x 12 Inside #1<br>Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf<br>Overall Size= 84.0"W x 84.0"H x 20.00'L<br>Row Length Adjustment= -5.00' x 38.48 sf x 3 rows<br>27.00' Header x 38.48 sf x 1 = 1,039.1 cf Inside |
| | | 0.301 af | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 1,119.00' | **18.0" Round Culvert**<br>L= 200.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 1,119.00' / 1,117.00' S= 0.0100 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.77 sf |
| #2 | Device 1 | 1,119.00' | **1.3" Vert. Orifice/Grate** C= 0.600 |
| #3 | Device 1 | 1,121.60' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #4 | Device 1 | 1,123.20' | **8.0" Vert. Orifice/Grate** C= 0.600 |
| #5 | Device 1 | 1,125.90' | **6.0' long x 0.5' breadth Broad-Crested Rectangular Weir**<br>Head (feet) 0.20 0.40 0.60 0.80 1.00<br>Coef. (English) 2.80 2.92 3.08 3.30 3.32 |

**Primary OutFlow** Max=6.15 cfs @ 12.06 hrs HW=1,125.93' (Free Discharge)
└**1=Culvert** (Passes 6.15 cfs of 17.99 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.12 cfs @ 12.62 fps)
  ├**3=Orifice/Grate** (Orifice Controls 3.36 cfs @ 9.62 fps)
  ├**4=Orifice/Grate** (Orifice Controls 2.60 cfs @ 7.45 fps)
  └**5=Broad-Crested Rectangular Weir** (Weir Controls 0.08 cfs @ 0.46 fps)

## Pond 3P: UNDERGROUND STORAGE - Chamber Wizard Field A

**Chamber Model = CMP Round 84 (Round Corrugated Metal Pipe)**
Effective Size= 84.0"W x 84.0"H => 38.48 sf x 20.00'L = 769.7 cf
Overall Size= 84.0"W x 84.0"H x 20.00'L
Row Length Adjustment= -5.00' x 38.48 sf x 3 rows

84.0" Wide + 36.0" Spacing = 120.0" C-C Row Spacing

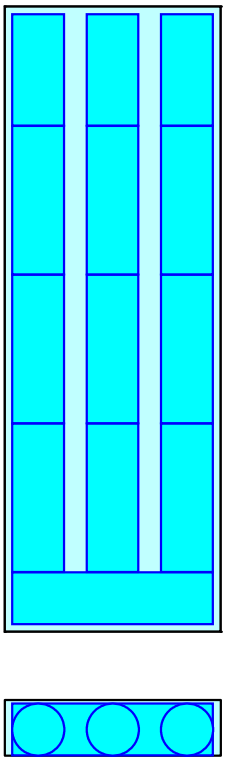
4 Chambers/Row x 20.00' Long -5.00' Row Adjustment +7.00' Header x 1 = 82.00' Row Length +12.0" End Stone x 2 = 84.00' Base Length
3 Rows x 84.0" Wide + 36.0" Spacing x 2 + 12.0" Side Stone x 2 = 29.00' Base Width
84.0" Chamber Height + 6.0" Cover = 7.50' Field Height

12 Chambers x 769.7 cf -5.00' Row Adjustment x 38.48 sf x 3 Rows + 27.00' Header x 38.48 sf = 9,698.1 cf Chamber Storage

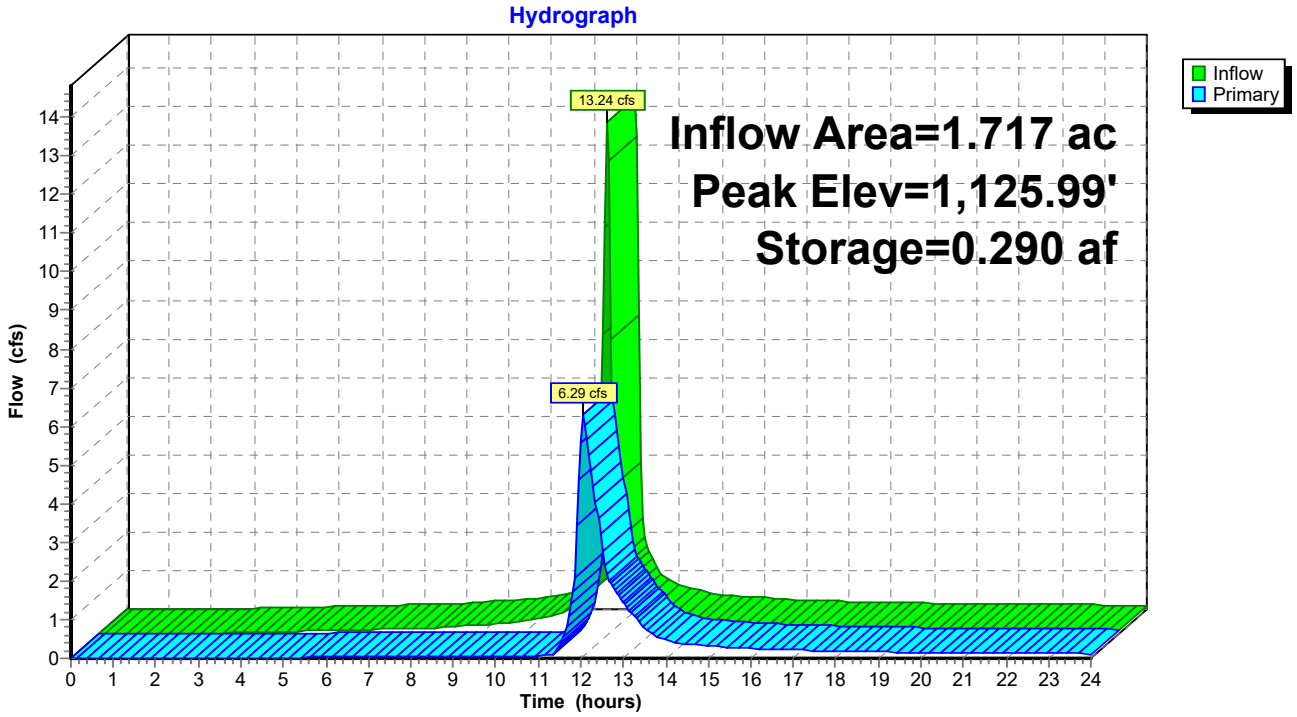
18,270.0 cf Field - 9,698.1 cf Chambers = 8,571.9 cf Stone x 40.0% Voids = 3,428.8 cf Stone Storage

Chamber Storage + Stone Storage = 13,126.9 cf = 0.301 af
Overall Storage Efficiency = 71.8%
Overall System Size = 84.00' x 29.00' x 7.50'

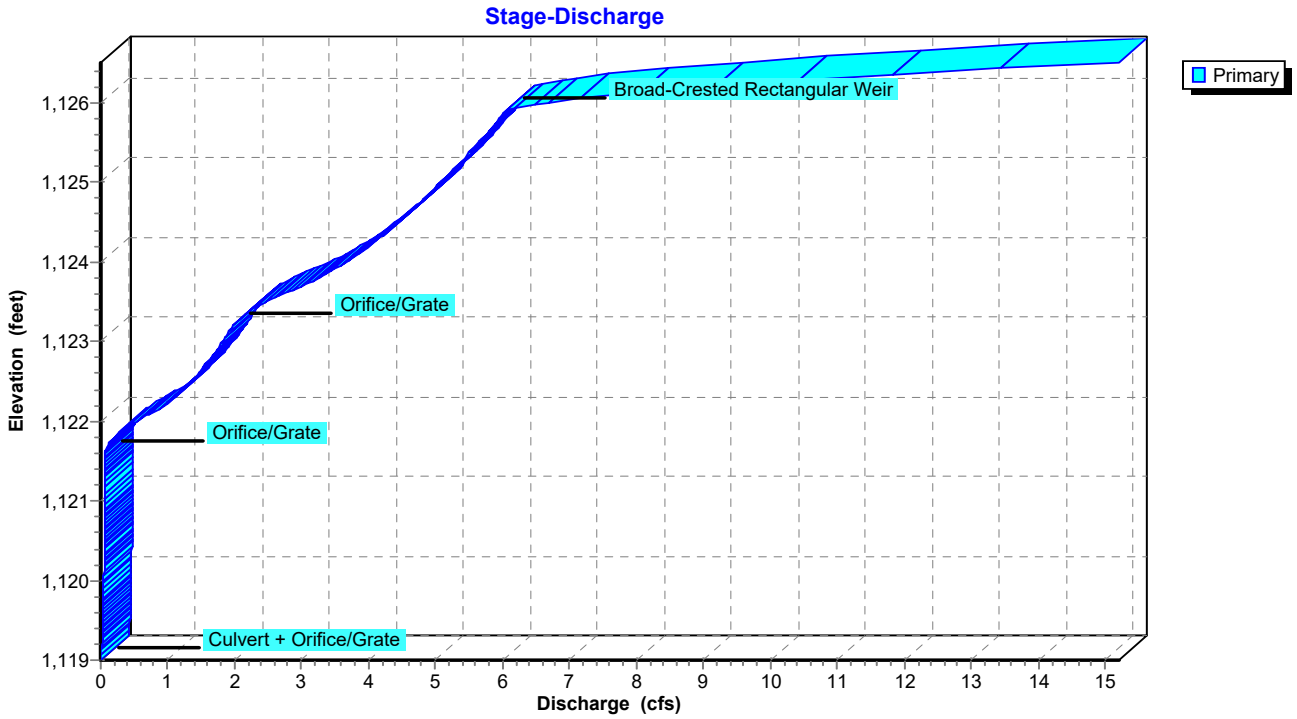
12 Chambers
676.7 cy Field
317.5 cy Stone



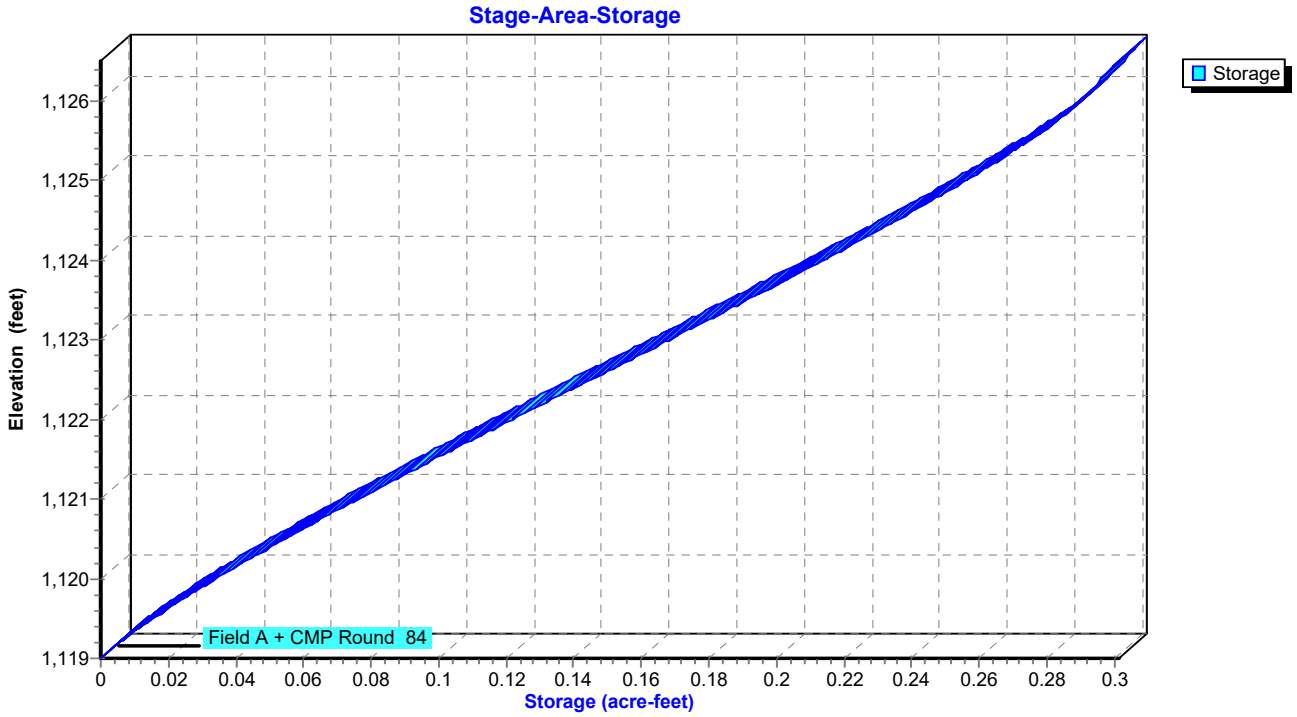
## Pond 3P: UNDERGROUND STORAGE




## Pond 3P: UNDERGROUND STORAGE



## Pond 3P: UNDERGROUND STORAGE

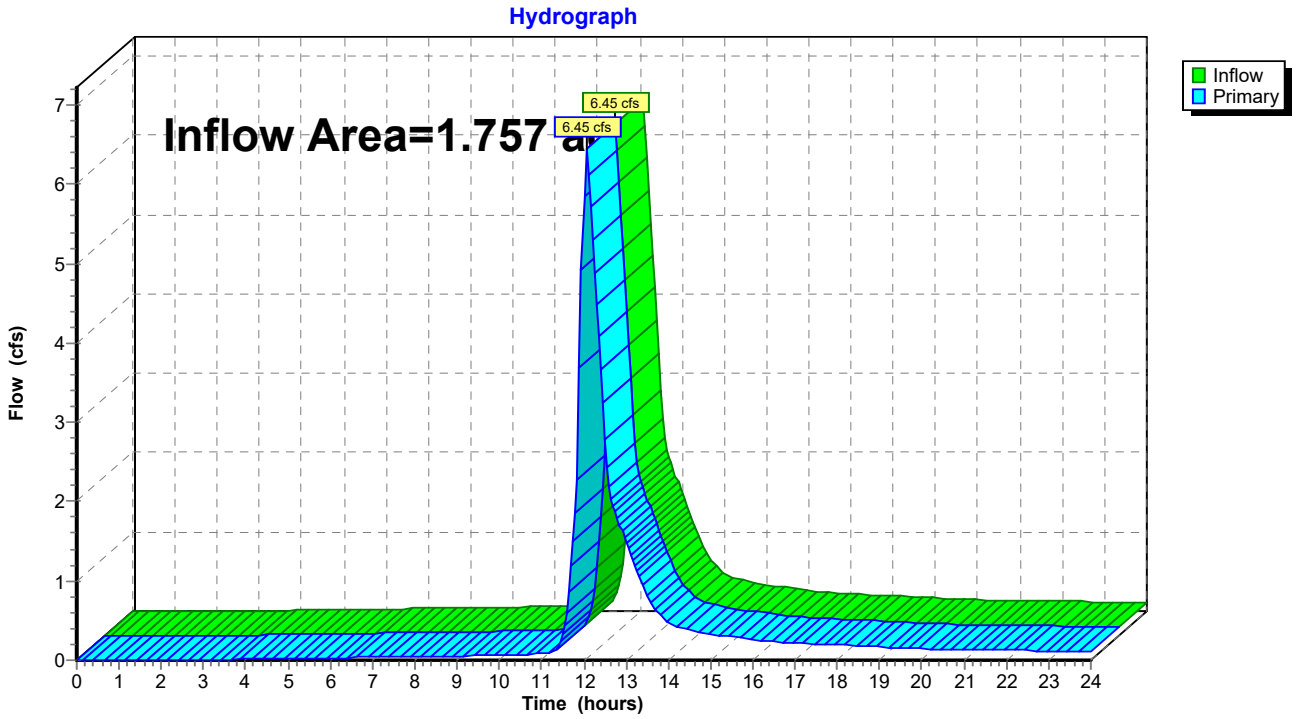


## Summary for Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE

Inflow Area = 1.757 ac, 82.19% Impervious, Inflow Depth > 4.30" for 100 YR event
Inflow = 6.45 cfs @ 12.06 hrs, Volume= 0.629 af
Primary = 6.45 cfs @ 12.06 hrs, Volume= 0.629 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Link 5L: TOTAL POST DEVELOPMENT RELEASE RATE



# Appendix D: Soil Information


Map Scale: 1:1,190 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 15 30 60 90

Feet
0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Lines**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Points**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Water Features**

Streams and Canals

**Transportation**

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

**Background**

Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Stark County, Ohio
Survey Area Data: Version 19, Sep 12, 2022

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

Date(s) aerial images were photographed: Jul 15, 2020—Aug 21, 2020

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

# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| CeB | Canfield-Urban land complex, 2 to 6 percent slopes | C/D | 3.7 | 98.8% |
| CeC | Canfield-Urban land complex, 6 to 12 percent slopes | C/D | 0.0 | 1.2% |
| **Totals for Area of Interest** | | | **3.7** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

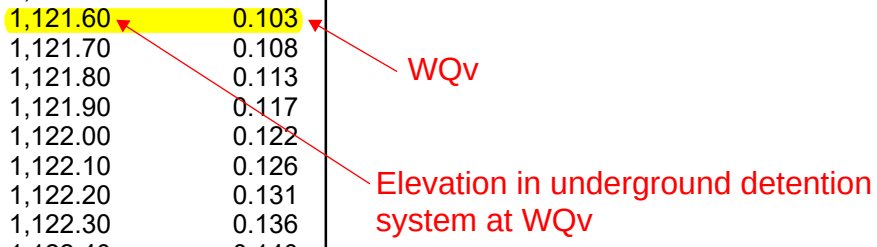
*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

# Appendix E: WQv/WQf Calculations

## Stage-Area-Storage for Pond 3P: UNDERGROUND STORAGE

| Elevation (feet) | Storage (acre-feet) | Elevation (feet) | Storage (acre-feet) |
|---|---|---|---|
| 1,119.00 | 0.000 | 1,124.20 | 0.223 |
| 1,119.10 | 0.003 | 1,124.30 | 0.227 |
| 1,119.20 | 0.006 | 1,124.40 | 0.231 |
| 1,119.30 | 0.009 | 1,124.50 | 0.236 |
| 1,119.40 | 0.012 | 1,124.60 | 0.240 |
| 1,119.50 | 0.015 | 1,124.70 | 0.244 |
| 1,119.60 | 0.019 | 1,124.80 | 0.248 |
| 1,119.70 | 0.023 | 1,124.90 | 0.252 |
| 1,119.80 | 0.026 | 1,125.00 | 0.256 |
| 1,119.90 | 0.030 | 1,125.10 | 0.260 |
| 1,120.00 | 0.034 | 1,125.20 | 0.264 |
| 1,120.10 | 0.038 | 1,125.30 | 0.268 |
| 1,120.20 | 0.042 | 1,125.40 | 0.271 |
| 1,120.30 | 0.046 | 1,125.50 | 0.275 |
| 1,120.40 | 0.050 | 1,125.60 | 0.278 |
| 1,120.50 | 0.055 | 1,125.70 | 0.281 |
| 1,120.60 | 0.059 | 1,125.80 | 0.285 |
| 1,120.70 | 0.063 | 1,125.90 | 0.288 |
| 1,120.80 | 0.067 | 1,126.00 | 0.290 |
| 1,120.90 | 0.072 | 1,126.10 | 0.292 |
| 1,121.00 | 0.076 | 1,126.20 | 0.295 |
| 1,121.10 | 0.081 | 1,126.30 | 0.297 |
| 1,121.20 | 0.085 | 1,126.40 | 0.299 |
| 1,121.30 | 0.090 | 1,126.50 | **0.301** |
| 1,121.40 | 0.094 | | |
| 1,121.50 | 0.099 | | |
| 1,121.60 | 0.103 | | |
| 1,121.70 | 0.108 | | |
| 1,121.80 | 0.113 | | |
| 1,121.90 | 0.117 | | |
| 1,122.00 | 0.122 | | |
| 1,122.10 | 0.126 | | |
| 1,122.20 | 0.131 | | |
| 1,122.30 | 0.136 | | |
| 1,122.40 | 0.140 | | |
| 1,122.50 | 0.145 | | |
| 1,122.60 | 0.150 | | |
| 1,122.70 | 0.154 | | |
| 1,122.80 | 0.159 | | |
| 1,122.90 | 0.164 | | |
| 1,123.00 | 0.168 | | |
| 1,123.10 | 0.173 | | |
| 1,123.20 | 0.178 | | |
| 1,123.30 | 0.182 | | |
| 1,123.40 | 0.187 | | |
| 1,123.50 | 0.191 | | |
| 1,123.60 | 0.196 | | |
| 1,123.70 | 0.201 | | |
| 1,123.80 | 0.205 | | |
| 1,123.90 | 0.209 | | |
| 1,124.00 | 0.214 | | |
| 1,124.10 | 0.218 | | |



**WQv Calculation**

| | | |
|---|---|---|
| WQv = [P*Rv*A]/12 | | |
| P = average rainfall in inches | 0.90 | inches |
| I= Percent impervious | 0.82 | |
| Rv = volumetric runoff coefficient (0.05+0.9I) | 0.79 | |
| A = total area draining into the BMP | 1.72 | ac |
| WQv = | 0.1015 | ac-ft |
| | 4,420 | cu ft |

**Average Release Rate of WQv**

| | | |
|---|---|---|
| $Q_{WQ\_avg}$ = WQv/$t_{WQ}$ = Average release rate of the WQv | | |
| $t_{WQ}$ = the intended WQv detention time (24 hrs) | 86400 | seconds |
| WQv = | 4,420 | cu ft |
| $Q_{WQ\_avg}$ = | 0.05 | cfs |

**Average Hydraulic Head on Water Quality Outlet**

| | | |
|---|---|---|
| $h_{wq\_avg}$ = [ $E_{WQ}$ - $E_{Invert}$ ]/2 = average head on the water quality outlet | | |
| $E_{WQ}$ = Elevation with the WQv dropped into system | 1121.60 | ft |
| $E_{invert}$ = Invert Elevation of System | 1119 | ft |
| $h_{wq\_total}$ = Total head on water quality outlet | 2.60 | ft |
| $h_{wq\_avg}$ = | 1.30 | ft |

**Orifice Sizing Equation**

| | | |
|---|---|---|
| $Q_{WQ\_avg}$ = C*$A_{WQ}$ * SQRT(2*g*$h_{wq\_avg}$ ) | | |
| $Q_{WQ\_avg}$ = average release rate of the WQv | 0.0512 | cfs |
| C = orifice coefficient | 0.60 | |
| g = gravitational acceleration | 32.20 | ft/sec^2 |
| $h_{WQ\_avg}$ = average head on the water quality outlet | 1.30 | ft |
| $A_{WQ}$ = required orifice area | 0.01 | ft^2 |
| $d_{WQ}$ = orifice diameter | 0.11 | ft |
| | 1.31 | in |

**Actual Release Rate - Verfication**

| | | | | |
|---|---|---|---|---|
| $Q_{WQ}$ = C*$A_{WQ}$ * SQRT(2*g*$h_{wq\_avg}$ ) | | | | |
| $Q_{WQ}$= actual release rate of the WQv | 0.0506 | cfs | | |
| C = orifice coefficient | 0.6 | | | |
| g = gravitational acceleration | 32.20 | ft/sec^2 | | |
| $h_{WQ\_avg}$ = average head on the water quality outlet | 1.30 | ft | | |
| A = actual orifice area used | 0.0092 | ft | | |
| $d_{WQ}$ = orifice diameter | 1.3 | in | | |
| Volume Released @ 24 hr | 4372 | cu-ft | < | 4420 cu-ft |
| Volume Released @ 8 hr | 1457 | cu-ft | < | 2210 cu-ft |

**WQf Calculation**

| | | |
|---|---|---|
| WQf = CiA | | |
| C = rational method runoff coefficient for drainage area | 0.80 | |
| (1.404*0.95)+(0.313*0.15)/(1.404+0.313) | | |
| i= intensity per general permit App. C | 2.37 | in/hr |
| A = total area draining into the BMP | 1.72 | ac |
| WQf = | 3.27 | cfs |

Contech CS-6 Hydrodynamic Separator Required

# Appendix F: Storm Sewer Calculations

STORM PIPE BASIN 1:
0.316 AC TOTAL
0.306 AC IMPERVIOUS (C=0.95)
0.010 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 2:
0.080 AC TOTAL
0.065 AC IMPERVIOUS (C=0.95)
0.014 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 3:
0.052 AC TOTAL
0.052 AC IMPERVIOUS (C=0.95)
0.000 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 4:
0.323 AC TOTAL
0.190 AC IMPERVIOUS (C=0.95)
0.133 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 5:
0.304 AC TOTAL
0.273 AC IMPERVIOUS (C=0.95)
0.032 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 6:
0.084 AC TOTAL
0.061 AC IMPERVIOUS (C=0.95)
0.024 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 7:
0.062 AC TOTAL
0.062 AC IMPERVIOUS (C=0.95)
0.000 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 8:
0.057 AC TOTAL
0.045 AC IMPERVIOUS (C=0.95)
0.013 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

STORM PIPE BASIN 9:
0.438 AC TOTAL
0.351 AC IMPERVIOUS (C=0.95)
0.087 AC OPEN (C=0.15)
Tc = 5 MINUTES (MINIMUM)

# STORM SEWER BASIN MAP

NORTH

1"= 50'

50' 0 50' 100'

SCALE 1"=50' (11X17) FEET

Excel Engineering Project No. 2178020 Project Name Starbucks/Panda Development

| Pipe Data | | | | Pipe Capacity (100-yr) | | | | |
|---|---|---|---|---|---|---|---|---|
| Pipe Letter | Diameter (FT) | Slope (FT/FT) | Manning's n | Contributing Basin No. | Total Flow (cfs) | Total Flow (gpm) | Full Flow Capacity (cfs) | Full Flow Capacity (gpm) |
| A | 0.67 | 0.0256 | 0.012 | 2,3 | 0.99 | 444 | 2.13 | 955 |
| B | 1 | 0.0216 | 0.012 | 2,3,5,6,7,8 | 4.72 | 2118 | 5.69 | 2553 |
| C | 0.83 | 0.0150 | 0.012 | 1 | 2.54 | 1141 | 2.88 | 1294 |
| D | 1 | 0.0150 | 0.012 | 1,4 | 4.29 | 1924 | 4.74 | 2127 |
| E | 1 | 0.0155 | 0.012 | 9 | 3.02 | 1355 | 4.82 | 2162 |
| F1 | 0.5 | 0.0198 | 0.012 | 7 - HALF | 0.26 | 115 | 0.86 | 385 |
| F2 | 0.5 | 0.0373 | 0.012 | 7 - HALF | 0.26 | 115 | 1.18 | 528 |
| G | 0.67 | 0.0165 | 0.012 | 6,7 | 1.05 | 470 | 1.71 | 767 |
| H | 0.67 | 0.0165 | 0.012 | 6,7,8 | 1.43 | 643 | 1.71 | 767 |
| I | 1.5 | 0.0200 | 0.012 | 1,2,3,4,5,6,7,8,9 | 12.02 | 5397 | 16.14 | 7242 |
| J | 2 | 0.0000 | 0.012 | EQUALIZATION PIPE | | | | |
| K | 1.5 | 0.0147 | 0.012 | DETENTION BASIN OUTLET PIPE; SEE HYDROCAD REPORT | | | | |
| DS | 0.5 | 0.0100 | 0.012 | 3 | 0.43 | 193 | 0.61 | 274 |

| Pipe Drainage Basins-100-Year Design Storm | | | | | | |
|---|---|---|---|---|---|---|
| Pipe Basin | Area (sf) | Area (ac) | Avg 'C' Value | Time Concentration (min) | Rainfall Intensity (in/hr) | Peak Flow (cfs) |
| 1 | 13757 | 0.316 | 0.92 | 5 | 8.71 | 2.54 |
| 2 | 3478 | 0.080 | 0.81 | 5 | 8.71 | 0.56 |
| 3 | 2259 | 0.052 | 0.95 | 5 | 8.71 | 0.43 |
| 4 | 14090 | 0.323 | 0.62 | 5 | 8.71 | 1.75 |
| 5 | 13257 | 0.304 | 0.87 | 5 | 8.71 | 2.30 |
| 6 | 3670 | 0.084 | 0.73 | 5 | 8.71 | 0.53 |
| 7 | 2706 | 0.062 | 0.95 | 5 | 8.71 | 0.51 |
| 8 | 2486 | 0.057 | 0.77 | 5 | 8.71 | 0.39 |
| 9 | 19073 | 0.438 | 0.79 | 5 | 8.71 | 3.02 |

Full Flow Capacity based on Manning's Equation $Q = \frac{1.49}{n} R^{2/3} S^{1/2} a$

Where:
- Q = Full Flow Capacity of Pipe (cfs)
- n = manning's roughness coefficient
- R = hydraulic radius (ft) (D/4)
- s = hydraulic gradient, slope (ft/ft)
- a = flow area (sq. ft.)

Typical Manning's n

| | |
|---|---|
| HDPE | 0.012 |
| PVC | 0.012 |
| Concrete | 0.013 |
| CMP | 0.024 |

Note: Total flow calculated via rational method hydrologic calculations for the 100-year storm event. Reference Storm Pipe Basin Map and spreadsheet calculations. Rainfall intensity per NOAA Atlas 14

# Appendix G: Rainfall Data

**NOAA Atlas 14, Volume 2, Version 3**
**Location name: Massillon, Ohio, USA***
**Latitude: 40.7975°, Longitude: -81.4889°**
**Elevation: 1129.43 ft****
* source: ESRI Maps
** source: USGS

**POINT PRECIPITATION FREQUENCY ESTIMATES**

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.322 (0.294-0.354) | 0.385 (0.351-0.421) | 0.466 (0.424-0.511) | 0.528 (0.480-0.578) | 0.607 (0.550-0.664) | 0.668 (0.602-0.729) | 0.726 (0.652-0.792) | 0.786 (0.703-0.857) | 0.865 (0.770-0.941) | 0.923 (0.817-1.00) |
| 10-min | 0.501 (0.458-0.550) | 0.601 (0.548-0.658) | 0.725 (0.659-0.794) | 0.816 (0.741-0.892) | 0.929 (0.841-1.02) | 1.01 (0.912-1.11) | 1.09 (0.982-1.19) | 1.17 (1.05-1.28) | 1.27 (1.13-1.38) | 1.34 (1.19-1.46) |
| 15-min | 0.614 (0.561-0.674) | 0.734 (0.670-0.804) | 0.890 (0.810-0.975) | 1.00 (0.911-1.10) | 1.15 (1.04-1.25) | 1.25 (1.13-1.37) | 1.36 (1.22-1.48) | 1.46 (1.31-1.59) | 1.59 (1.41-1.73) | 1.68 (1.49-1.83) |
| 30-min | 0.812 (0.742-0.892) | 0.983 (0.897-1.08) | 1.22 (1.11-1.34) | 1.39 (1.26-1.53) | 1.62 (1.47-1.77) | 1.79 (1.61-1.96) | 1.96 (1.76-2.14) | 2.13 (1.90-2.32) | 2.35 (2.09-2.56) | 2.52 (2.23-2.74) |
| 60-min | 0.992 (0.906-1.09) | 1.21 (1.10-1.32) | 1.53 (1.39-1.68) | 1.77 (1.61-1.94) | 2.10 (1.90-2.30) | 2.36 (2.13-2.58) | 2.62 (2.35-2.86) | 2.89 (2.58-3.15) | 3.25 (2.89-3.54) | 3.54 (3.13-3.85) |
| 2-hr | 1.14 (1.03-1.25) | 1.38 (1.25-1.52) | 1.78 (1.61-1.96) | 2.10 (1.90-2.31) | 2.57 (2.31-2.81) | 2.96 (2.66-3.24) | 3.38 (3.03-3.69) | 3.84 (3.42-4.18) | 4.50 (3.98-4.89) | 5.06 (4.45-5.50) |
| 3-hr | 1.21 (1.09-1.34) | 1.46 (1.32-1.62) | 1.88 (1.70-2.07) | 2.22 (2.00-2.45) | 2.72 (2.44-2.99) | 3.14 (2.81-3.44) | 3.61 (3.21-3.94) | 4.11 (3.64-4.49) | 4.84 (4.25-5.27) | 5.46 (4.77-5.94) |
| 6-hr | 1.46 (1.32-1.63) | 1.76 (1.59-1.96) | 2.24 (2.02-2.49) | 2.64 (2.38-2.93) | 3.24 (2.90-3.59) | 3.75 (3.35-4.15) | 4.31 (3.83-4.75) | 4.94 (4.35-5.43) | 5.86 (5.11-6.42) | 6.65 (5.75-7.27) |
| 12-hr | 1.73 (1.57-1.94) | 2.08 (1.89-2.32) | 2.61 (2.37-2.92) | 3.08 (2.78-3.43) | 3.77 (3.38-4.19) | 4.37 (3.90-4.84) | 5.04 (4.47-5.56) | 5.78 (5.09-6.35) | 6.88 (6.01-7.55) | 7.84 (6.79-8.58) |
| 24-hr | 2.03 (1.86-2.24) | 2.44 (2.23-2.69) | 3.04 (2.77-3.35) | 3.56 (3.24-3.91) | 4.33 (3.91-4.75) | 5.00 (4.49-5.47) | 5.73 (5.11-6.27) | 6.54 (5.77-7.16) | 7.76 (6.74-8.48) | 8.80 (7.54-9.62) |
| 2-day | 2.35 (2.16-2.58) | 2.81 (2.58-3.09) | 3.46 (3.18-3.81) | 4.02 (3.67-4.41) | 4.85 (4.40-5.31) | 5.54 (5.00-6.07) | 6.31 (5.65-6.91) | 7.15 (6.33-7.83) | 8.37 (7.31-9.18) | 9.41 (8.10-10.3) |
| 3-day | 2.51 (2.31-2.75) | 3.00 (2.76-3.28) | 3.68 (3.38-4.02) | 4.24 (3.89-4.63) | 5.08 (4.63-5.54) | 5.78 (5.23-6.29) | 6.53 (5.88-7.12) | 7.35 (6.55-8.01) | 8.55 (7.52-9.33) | 9.57 (8.32-10.5) |
| 4-day | 2.68 (2.47-2.91) | 3.19 (2.94-3.47) | 3.89 (3.59-4.23) | 4.47 (4.11-4.85) | 5.31 (4.86-5.76) | 6.01 (5.46-6.51) | 6.75 (6.10-7.33) | 7.55 (6.77-8.19) | 8.72 (7.74-9.49) | 9.73 (8.54-10.6) |
| 7-day | 3.21 (2.97-3.47) | 3.81 (3.53-4.12) | 4.60 (4.26-4.98) | 5.26 (4.86-5.69) | 6.21 (5.71-6.70) | 6.99 (6.39-7.54) | 7.81 (7.10-8.42) | 8.67 (7.84-9.37) | 9.90 (8.86-10.7) | 10.9 (9.67-11.8) |
| 10-day | 3.69 (3.44-3.97) | 4.38 (4.07-4.71) | 5.24 (4.87-5.63) | 5.93 (5.51-6.38) | 6.91 (6.39-7.42) | 7.69 (7.08-8.25) | 8.49 (7.79-9.12) | 9.33 (8.51-10.0) | 10.5 (9.48-11.3) | 11.4 (10.2-12.3) |
| 20-day | 5.15 (4.83-5.50) | 6.09 (5.71-6.50) | 7.18 (6.72-7.67) | 8.03 (7.51-8.57) | 9.16 (8.54-9.78) | 10.0 (9.33-10.7) | 10.9 (10.1-11.6) | 11.7 (10.9-12.6) | 12.9 (11.8-13.8) | 13.7 (12.6-14.7) |
| 30-day | 6.46 (6.06-6.88) | 7.62 (7.15-8.11) | 8.88 (8.32-9.45) | 9.84 (9.21-10.5) | 11.1 (10.4-11.8) | 12.1 (11.2-12.8) | 13.0 (12.1-13.8) | 13.9 (12.9-14.8) | 15.0 (13.9-16.1) | 15.9 (14.6-17.0) |
| 45-day | 8.27 (7.79-8.77) | 9.70 (9.14-10.3) | 11.1 (10.5-11.8) | 12.2 (11.5-13.0) | 13.6 (12.8-14.5) | 14.6 (13.7-15.5) | 15.6 (14.6-16.6) | 16.5 (15.4-17.6) | 17.7 (16.5-18.8) | 18.5 (17.2-19.7) |
| 60-day | 9.99 (9.45-10.6) | 11.7 (11.1-12.4) | 13.3 (12.6-14.1) | 14.5 (13.8-15.4) | 16.1 (15.2-17.0) | 17.2 (16.2-18.1) | 18.2 (17.1-19.2) | 19.1 (18.0-20.2) | 20.3 (19.0-21.5) | 21.0 (19.7-22.3) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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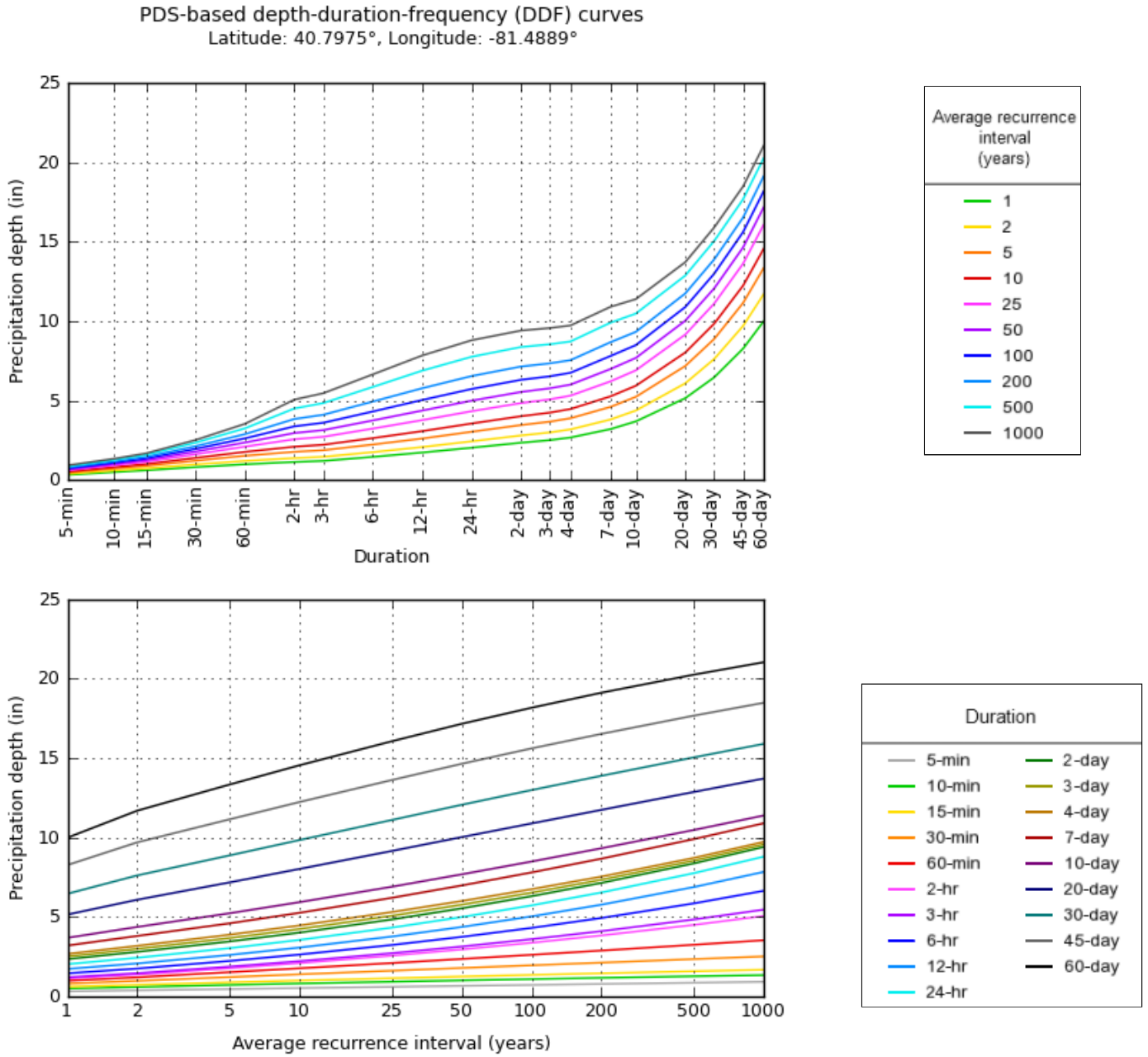
## PF graphical

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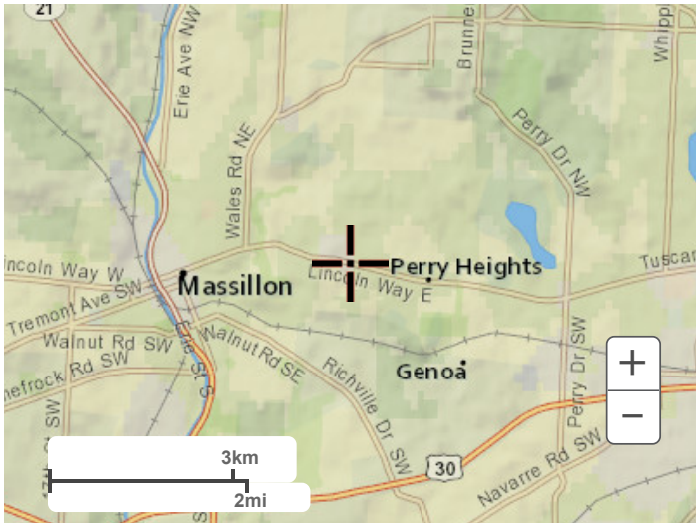
## Maps & aerials

**Small scale terrain**

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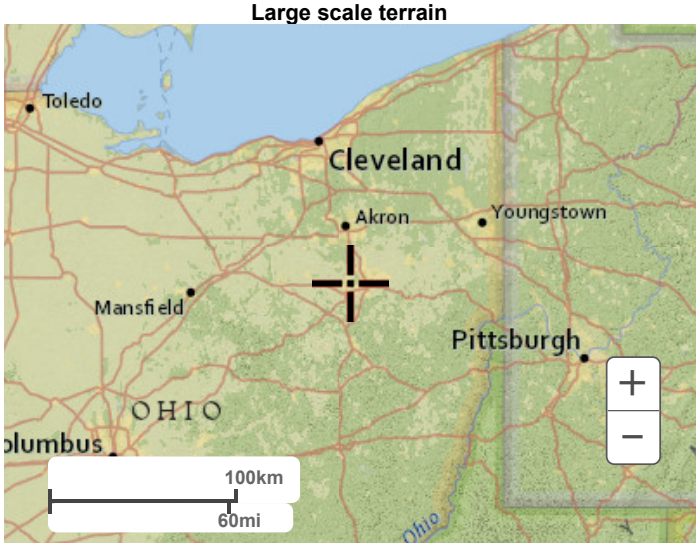


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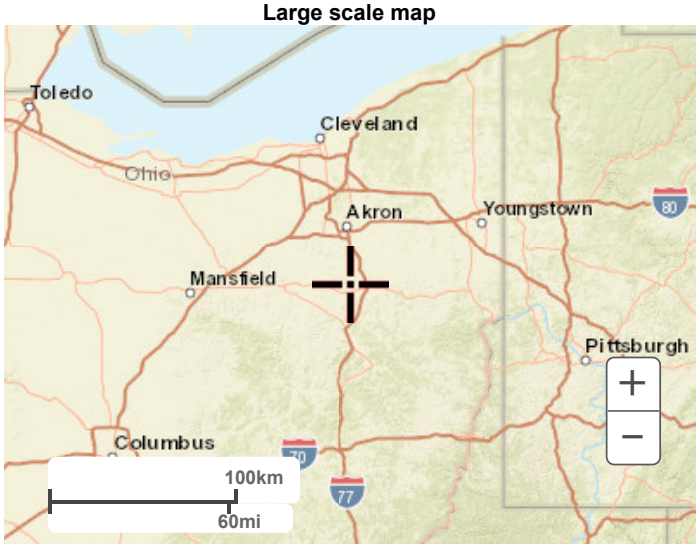
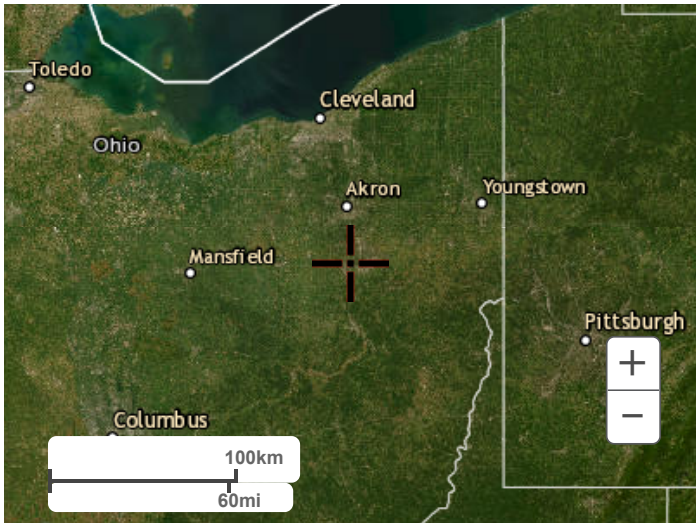



**Large scale aerial**

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

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**NOAA Atlas 14, Volume 2, Version 3**
**Location name: Massillon, Ohio, USA***
**Latitude: 40.7975°, Longitude: -81.4889°**
**Elevation: 1129.43 ft****
* source: ESRI Maps
** source: USGS

**POINT PRECIPITATION FREQUENCY ESTIMATES**

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NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 3.86 (3.53-4.25) | 4.62 (4.21-5.05) | 5.59 (5.09-6.13) | 6.34 (5.76-6.94) | 7.28 (6.60-7.97) | 8.02 (7.22-8.75) | 8.71 (7.82-9.50) | 9.43 (8.44-10.3) | 10.4 (9.24-11.3) | 11.1 (9.80-12.0) |
| 10-min | 3.01 (2.75-3.30) | 3.61 (3.29-3.95) | 4.35 (3.95-4.76) | 4.90 (4.45-5.35) | 5.57 (5.05-6.10) | 6.08 (5.47-6.64) | 6.56 (5.89-7.15) | 7.04 (6.29-7.67) | 7.63 (6.79-8.30) | 8.06 (7.13-8.77) |
| 15-min | 2.46 (2.24-2.70) | 2.94 (2.68-3.22) | 3.56 (3.24-3.90) | 4.02 (3.64-4.39) | 4.59 (4.15-5.02) | 5.02 (4.52-5.47) | 5.43 (4.88-5.92) | 5.83 (5.22-6.36) | 6.35 (5.65-6.91) | 6.72 (5.94-7.31) |
| 30-min | 1.62 (1.48-1.78) | 1.97 (1.79-2.15) | 2.44 (2.22-2.67) | 2.79 (2.53-3.05) | 3.24 (2.93-3.54) | 3.58 (3.23-3.91) | 3.92 (3.52-4.28) | 4.26 (3.81-4.64) | 4.70 (4.18-5.12) | 5.04 (4.46-5.48) |
| 60-min | 0.992 (0.906-1.09) | 1.21 (1.10-1.32) | 1.53 (1.39-1.68) | 1.77 (1.61-1.94) | 2.10 (1.90-2.30) | 2.36 (2.13-2.58) | 2.62 (2.35-2.86) | 2.89 (2.58-3.15) | 3.25 (2.89-3.54) | 3.54 (3.13-3.85) |
| 2-hr | 0.569 (0.516-0.626) | 0.690 (0.626-0.762) | 0.888 (0.806-0.978) | 1.05 (0.949-1.15) | 1.28 (1.16-1.41) | 1.48 (1.33-1.62) | 1.69 (1.51-1.84) | 1.92 (1.71-2.09) | 2.25 (1.99-2.45) | 2.53 (2.23-2.75) |
| 3-hr | 0.402 (0.364-0.445) | 0.487 (0.441-0.539) | 0.625 (0.565-0.690) | 0.740 (0.667-0.816) | 0.906 (0.814-0.997) | 1.05 (0.936-1.15) | 1.20 (1.07-1.31) | 1.37 (1.21-1.49) | 1.61 (1.42-1.76) | 1.82 (1.59-1.98) |
| 6-hr | 0.243 (0.220-0.272) | 0.293 (0.266-0.328) | 0.373 (0.337-0.416) | 0.441 (0.397-0.490) | 0.541 (0.485-0.600) | 0.626 (0.559-0.693) | 0.720 (0.639-0.793) | 0.825 (0.727-0.906) | 0.978 (0.853-1.07) | 1.11 (0.960-1.21) |
| 12-hr | 0.144 (0.130-0.161) | 0.172 (0.156-0.193) | 0.217 (0.196-0.242) | 0.255 (0.231-0.284) | 0.313 (0.281-0.347) | 0.363 (0.324-0.402) | 0.418 (0.371-0.461) | 0.479 (0.423-0.527) | 0.571 (0.499-0.627) | 0.651 (0.563-0.712) |
| 24-hr | 0.085 (0.078-0.093) | 0.102 (0.093-0.112) | 0.127 (0.116-0.140) | 0.148 (0.135-0.163) | 0.180 (0.163-0.198) | 0.208 (0.187-0.228) | 0.239 (0.213-0.261) | 0.273 (0.241-0.298) | 0.323 (0.281-0.353) | 0.367 (0.314-0.401) |
| 2-day | 0.049 (0.045-0.054) | 0.058 (0.054-0.064) | 0.072 (0.066-0.079) | 0.084 (0.076-0.092) | 0.101 (0.092-0.111) | 0.115 (0.104-0.126) | 0.131 (0.118-0.144) | 0.149 (0.132-0.163) | 0.174 (0.152-0.191) | 0.196 (0.169-0.215) |
| 3-day | 0.035 (0.032-0.038) | 0.042 (0.038-0.046) | 0.051 (0.047-0.056) | 0.059 (0.054-0.064) | 0.071 (0.064-0.077) | 0.080 (0.073-0.087) | 0.091 (0.082-0.099) | 0.102 (0.091-0.111) | 0.119 (0.105-0.130) | 0.133 (0.116-0.145) |
| 4-day | 0.028 (0.026-0.030) | 0.033 (0.031-0.036) | 0.041 (0.037-0.044) | 0.047 (0.043-0.051) | 0.055 (0.051-0.060) | 0.063 (0.057-0.068) | 0.070 (0.064-0.076) | 0.079 (0.071-0.085) | 0.091 (0.081-0.099) | 0.101 (0.089-0.111) |
| 7-day | 0.019 (0.018-0.021) | 0.023 (0.021-0.025) | 0.027 (0.025-0.030) | 0.031 (0.029-0.034) | 0.037 (0.034-0.040) | 0.042 (0.038-0.045) | 0.046 (0.042-0.050) | 0.052 (0.047-0.056) | 0.059 (0.053-0.064) | 0.065 (0.058-0.070) |
| 10-day | 0.015 (0.014-0.017) | 0.018 (0.017-0.020) | 0.022 (0.020-0.023) | 0.025 (0.023-0.027) | 0.029 (0.027-0.031) | 0.032 (0.029-0.034) | 0.035 (0.032-0.038) | 0.039 (0.035-0.042) | 0.044 (0.039-0.047) | 0.047 (0.043-0.051) |
| 20-day | 0.011 (0.010-0.011) | 0.013 (0.012-0.014) | 0.015 (0.014-0.016) | 0.017 (0.016-0.018) | 0.019 (0.018-0.020) | 0.021 (0.019-0.022) | 0.023 (0.021-0.024) | 0.024 (0.023-0.026) | 0.027 (0.025-0.029) | 0.029 (0.026-0.031) |
| 30-day | 0.009 (0.008-0.010) | 0.011 (0.010-0.011) | 0.012 (0.012-0.013) | 0.014 (0.013-0.015) | 0.015 (0.014-0.016) | 0.017 (0.016-0.018) | 0.018 (0.017-0.019) | 0.019 (0.018-0.021) | 0.021 (0.019-0.022) | 0.022 (0.020-0.024) |
| 45-day | 0.008 (0.007-0.008) | 0.009 (0.008-0.010) | 0.010 (0.010-0.011) | 0.011 (0.011-0.012) | 0.013 (0.012-0.013) | 0.014 (0.013-0.014) | 0.014 (0.014-0.015) | 0.015 (0.014-0.016) | 0.016 (0.015-0.017) | 0.017 (0.016-0.018) |
| 60-day | 0.007 (0.007-0.007) | 0.008 (0.008-0.009) | 0.009 (0.009-0.010) | 0.010 (0.010-0.011) | 0.011 (0.011-0.012) | 0.012 (0.011-0.013) | 0.013 (0.012-0.013) | 0.013 (0.012-0.014) | 0.014 (0.013-0.015) | 0.015 (0.014-0.016) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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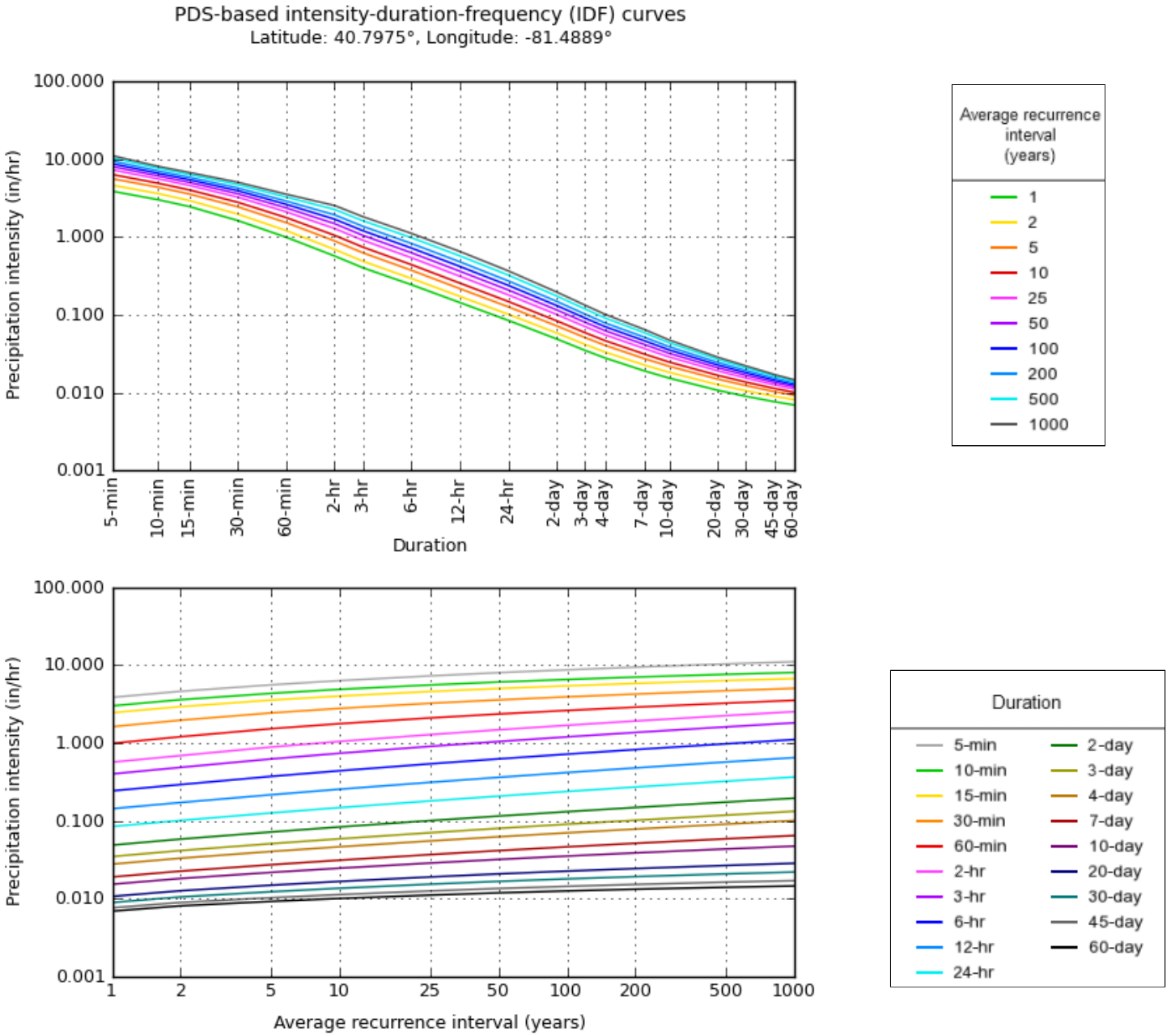
## PF graphical

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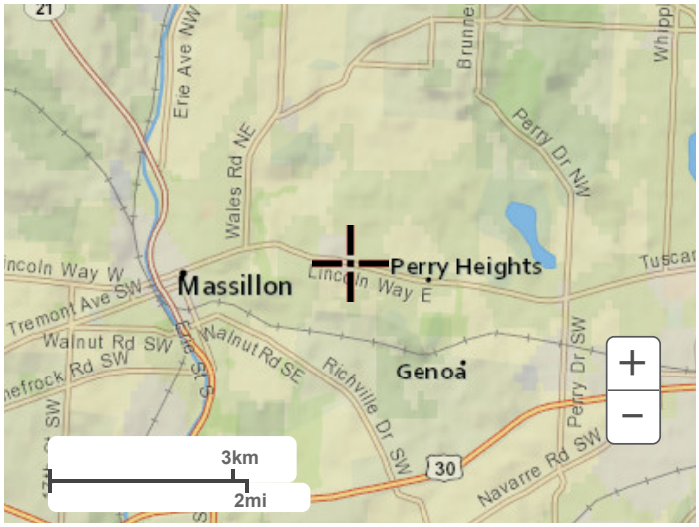
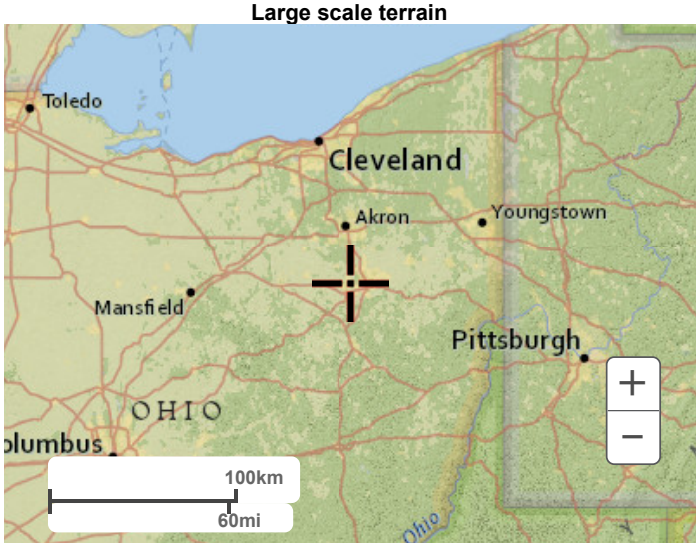
## Maps & aerials

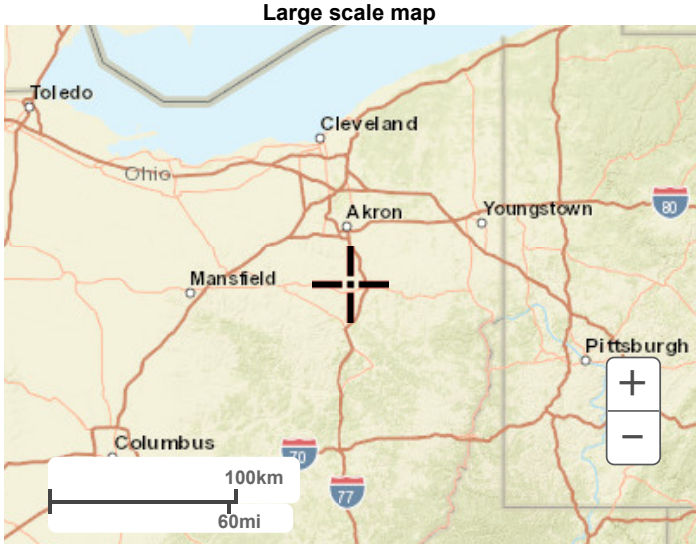
**Small scale terrain**



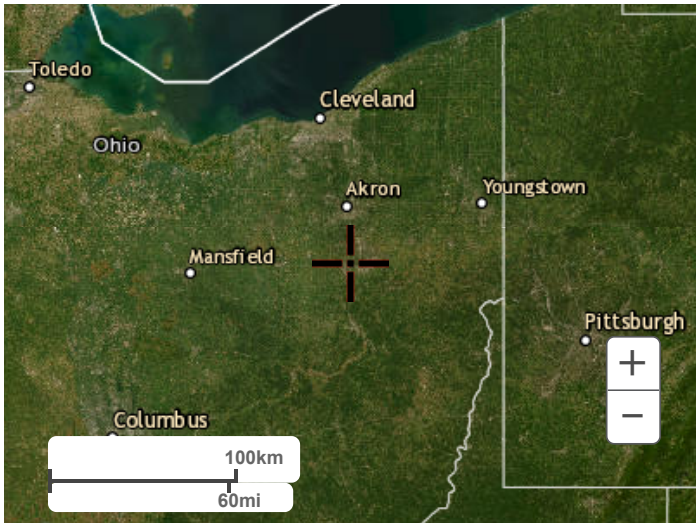

**Large scale terrain**




**Large scale map**




**Large scale aerial**

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

# Appendix H: Post Construction Operation and Maintenance Plan

| The owner of the property affected shall inspect and maintain the following stormwater management systems frequently, especially after heavy rainfalls, but at least on an annual basis unless otherwise specified. | |
|---|---|
| **STORMWATER FACILITY** | **TYPE OF ACTION** |
| 1. Lawn and Landscaped Areas | All lawn areas shall be kept clear of any materials that block the flow of stormwater. Rills and small gullies shall immediately be filled and seeded or have sod placed in them. The lawn shall be kept mowed, tree seedlings shall be removed, and litter shall be removed from landscaped areas. |
| 2. Swales | All grassed swales showing signs of erosion, scour, or channelization shall be repaired, reinforced, and revegetated immediately. All swales shall be repaired to the original plan requirements. Mowing shall take place no less than twice per year at a height of no less than three inches. Grasses shall not be allowed to grow to a height that permits branching or bending. Mowing shall only take place when the ground is dry and able to support machinery. |
| 3. Catch Basin/Curb Inlet Grates | The grate openings to these structures must be kept clear of any clogging or the blocking of stormwater flow. |
| 4. Catch Basin/Curb Inlet Sumps | Sumps shall visually be inspected every 3 months. Siltation shall be removed and disposed of offsite when the sump depth is within 3" of the outlet pipe invert elevation. The removal of siltation should occur a minimum of once per year. |
| 5. Underground Stormwater System | Standpipes, outlet structures, inlet and outlet pipes, and chambers shall be kept clear of debris at all times. Non-structurally sound devices shall be replaced. Special attention shall be given to the system outlet structure to ensure that orifice openings are clear of debris. These appurtenances shall be inspected semi-annually, in the spring and fall seasons. Follow underground detention system manufacturer's specifications for maintenance procedures. Contractor to remove all sediment and debris from the system prior to completing the storm system installation. Sediment shall be regularly removed from the system in accordance with manufacturers recommendations. Cleaning, removal, and deposit of silt from the underground stormwater quality system shall be done by means and methods acceptable to the local jurisdiction. |
| 6. Contech Cascade Hydrodynamic Separator | Inspection of the structure shall be completed annually at a minimum by qualified maintenance personnel. Sediment in the bottom of the structure shall be inspected to verify sediment is less than 16" deep. If sediment is greater than 16" deep, the sediment shall be removed per Contech guidelines and the structure shall be inspected by qualified personnel. |
| 7. Record of Maintenance | The operation and maintenance plan shall remain onsite and be available for inspection when requested by the local governing agency. When requested, the owner shall make available for inspection all maintenance records to the department or agent for the life of the system. |