Drainage Calculations for

Cedar Crossing Development
Bio-Retention Design
Knox County, TN

PRELIMINARY
FOR REVIEW
ONLY

PREPARED FOR:

Institute for a Secure
and Sustainable Environment
600 Henley Street
Suite 311 Conference Center Building
Knoxville, TN 37996
Tel No. (865) 974-3098

PREPARED BY:

Cannon & Cannon, Inc.
8550 Kingston Pike
Knoxville, TN 37919
Tel: 865.670.8555

CCI Project No. 01042-0000

February 2013

Cannon&Cannon,Inc.
Consulting Engineers • Field Surveyors

APPENDICES

REVISIONS

02/26/2013 Original Issue

Bio-Retention Pond

Calculate the peak runoff rate for the subject property resulting from the 1-, 2-, 5-, 10-, and 100-year, 24-hour storms for existing developed conditions. Design a bio-retention facility to provide water quality and channel protection in accordance with Knox County Stormwater requirements. Route the existing developed condition storms through the bio-retention pond and compare peak runoff rates leaving the site.

GIVEN:

1. Use SCS Type II distribution with AMC II conditions;
2. P_1= 2.5 inches, P_2= 3.3 inches; P_5= 4.1 inches; P_{10}= 4.8 inches; P_{25}= 5.5 inches; P_{50}= 6.1 inches; P_{100}= 6.6 inches
3. The existing site is fully developed.

REFERENCES:

1. SCS, 1986. "Urban Hydrology for Small Watersheds", TR-55;
2. CCI Cedar Crossing Development Plans dated 02/26/2013;
3. Knox County Tennessee Stormwater Management Manual;
4. Urban Waterways Bio-Retention Design Publications.

CALCULATIONS:

The soils information on the USDA/NRCS Web Soil Survey indicates that the site soils consist primarily of the following:

Soil Type:	HSG
FuC2 – Fullerton gravelly silt loam, 5 to 12 percent slopes, eroded	B
FvC – Fullerton-Minvale complex, 5 to 12 percent slopes	B
EvB – Etowah-Minvale complex, 2 to 5 percent slopes	B

Soil is predominately FvC – HSG B (Reference Attachment 2: Soils Map)

Subbasin SB-1 (Existing Conditions)

1. *Calculate the Drainage Area*
   The drainage area for Subbasin SB-1 includes the area north of Cedar Crossing Road along Leclay Drive. The subbasin flows in a southerly direction and collects at an existing storm sewer system that discharges at the P.O.I. (Ref. Attachment 3). The drainage area taken from the survey is approximately 6.23 ac.

2. *Calculate the Existing Curve Number:*

Cover Type	Curve Number
1/3 ac. Lots (30% Imp.)	72

   Curve number for SB-1, CN = 72

3. *Calculate the Time of Concentration, T_C*
   Use the SCS Travel Time Method:

   150 LF sheet flow @ 0.050 ft/ft (grass, short) — T_c = 9.3 min.

   950 LF shallow concentrated flow @ 0.080 ft/ft (unpaved) — T_c = 3.5 min.

   T_C = 12.8 min.

4. *Calculate the Peak Runoff, Q(cfs)*
   Reference the enclosed HydroCAD output data for a summary of peak runoff for this subbasin.

Subbasin SB-2 (Existing Conditions)

1. *Calculate the Drainage Area*
   The drainage area for Subbasin SB-2 includes the common area lot at the southeast corner of the intersection of Cedar Crossing Road and Twin Maple Drive. The subbasin flows southeast across the lot and collects at the end of the storm sewer system as noted in Subbasin SB-1 at the P.O.I. (Ref. Attachment 3). The drainage area taken from the survey is approximately 0.92 ac.

2. *Calculate the Existing Curve Number:*

Cover Type	Curve Number
Open Space, Good Condition	61

   Curve number for SB-2, CN = 61

3. *Calculate the Time of Concentration, T_C*
   Use the SCS Travel Time Method:

   200 LF sheet flow @ 0.040 ft/ft (grass, short) T_c = 12.7 min.

4. *Calculate the Peak Runoff, Q(cfs)*
   Reference the enclosed HydroCAD output data for a summary of peak runoff for this subbasin.

Calculate the Design Parameters for the Bio-Retention Facility

A. Water Quality Volume

Using the volumetric Runoff Coefficient and water quality volume equations:

$R_v = 0.015 + 0.0092(I)$; $WQ_v = (1.1R_vA) / 12$

Where:

I	= percent of impervious cover (%)
WQ_v	= water quality volume (acre-feet)
1.1	= the 85th percentile rainfall depth in Knox County (inches)
R_v	= volumetric runoff coefficient
A	= total drainage area (acres)

I = 30% (1/3 ac. lots CN)

$R_v = 0.015 + 0.0092(30) = 0.291$

$WQ_v = \frac{1.1R_vA}{12} = \frac{1.1(0.291)(7.15 \text{ ac.})}{12} = 0.19$ ac-ft

Water Quality Volume occurs at elevation 1176.90 (see HydroCAD Input Data below)

B. Channel Protection Volume

Overall Curve Number = [(6.23 ac. x 72) + (0.92 ac. x 61)] / 7.15 ac. = 71

Initial Abstraction (I_a) = 0.817 (Knox County Table 3-13, CN = 71)

$I_a / P = 0.817 / 2.5$ in. = 0.33

Using the accumulated direct runoff equation $Q_d = \frac{(P - I_a)^2}{(P - I_a) + S}$

Where:

Q_d	= accumulated direct runoff (in)
P	= accumulated rainfall or potential maximum runoff (in)
I_a	= initial abstraction including surface storage, interception, evaporation, and infiltration prior to runoff (in)
S	= potential maximum soil retention (in) = (1000/CN)-10

$Q_d = \frac{(P - I_a)^2}{(P - I_a) + S} = \frac{(2.5 - 0.817)^2}{(2.5 - 0.817) + [(1000/71)-10]} = 0.491$ in.

Unit peak discharge, q_u = 675 csm/in (Knox County Figure 3-6, Tc = 12.8 min)

q_o/q_i ratio (peak outflow /peak inflow) = 0.025 (Knox County Figure 3-15)

$V_s/V_r = 0.682 – 1.43(q_o/q_i) +1.64(q_o/q_i)^2 – 0.804(q_o/q_i)^3$

Where:

V_s = required storage volume (acre-feet)
V_r = runoff volume (acre-feet)
q_o = peak outflow discharge (cfs)
q_i = peak inflow discharge (cfs)

$V_s/V_r = 0.682 – 1.43(q_o/q_i) +1.64(q_o/q_i)^2 – 0.804(q_o/q_i)^3$
$= 0.682 – 1.43(0.025) + 1.64(0.025)^2 – 0.804(0.025)^3$
$= 0.682$

$V_s = \frac{(V_s/V_r) \times Q_d \times A}{12} = \frac{0.682 \times 0.491 \text{ in.} \times 7.15 \text{ ac.}}{12} = 0.20$ ac-ft

$CP_v = Vs = 0.20$ ac-ft

Channel Protection Volume occurs at elevation 1177.65
(See HydroCAD Input Data below)

HydroCAD Input Data

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

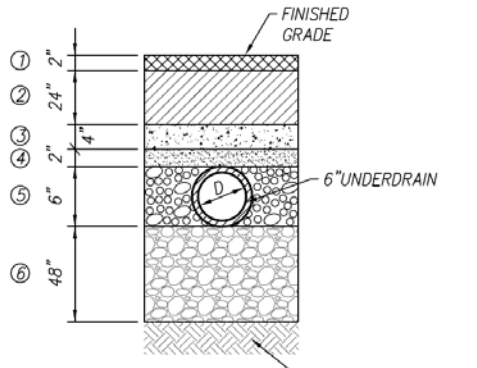
Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

C. Underdrain Pipe Sizing

Peak Inflow (Q) = [(hydraulic conductivity x height of water) / media depth] x area
= [(2 in/hr x 3.5 feet) / 2.5 feet] x 8,207 s.f. = 0.53 cfs x 10 = 5.3 cfs

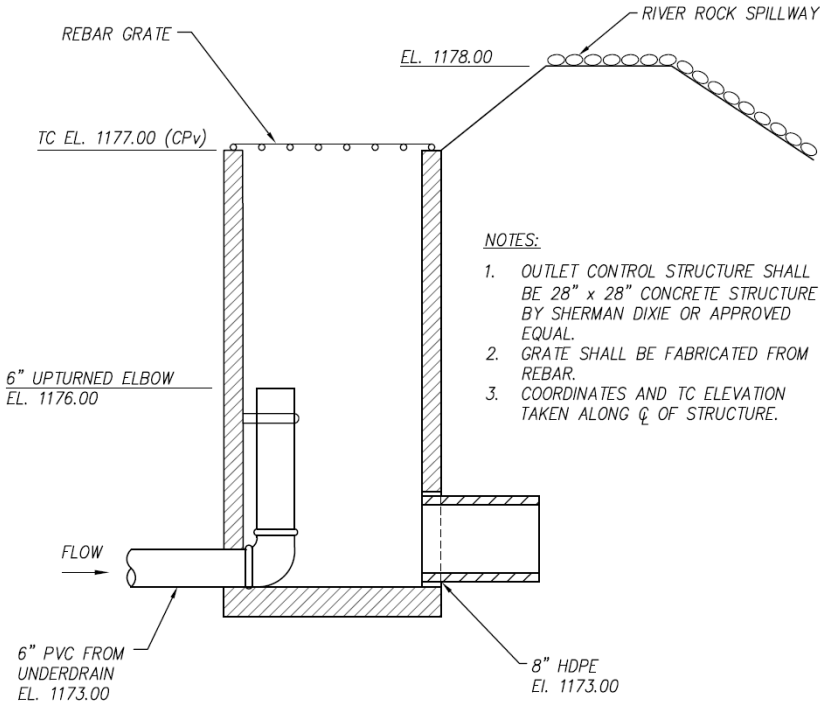
$N \times D = 16 \times (Q \times n / s^{0.5})^{3/8}$
$N \times D = 16 \times (5.3 \times 0.013 / 0.005^{0.5})^{3/8}$
$N \times D = 15.85$ inches (use 3 – 6" pipes)

Bio-Retention Media Cross-Section Detail



① MULCH LAYER
② FILL SOIL MEDIA: 85–88% WASHED SAND
8–12% FINES (SILT & CLAY)
3–5% ORGANIC MATTER
③ WASHED SAND
④ CHOKING STONE: #8 OR #89 WASHED STONE
⑤ #57 STONE–WASHED WITH 6" UNDERDRAIN PIPE
⑥ #57 STONE–INTERNAL WATER STORAGE

Bio-Retention Outlet Structure Detail



Pre-developed vs Post-developed Tables

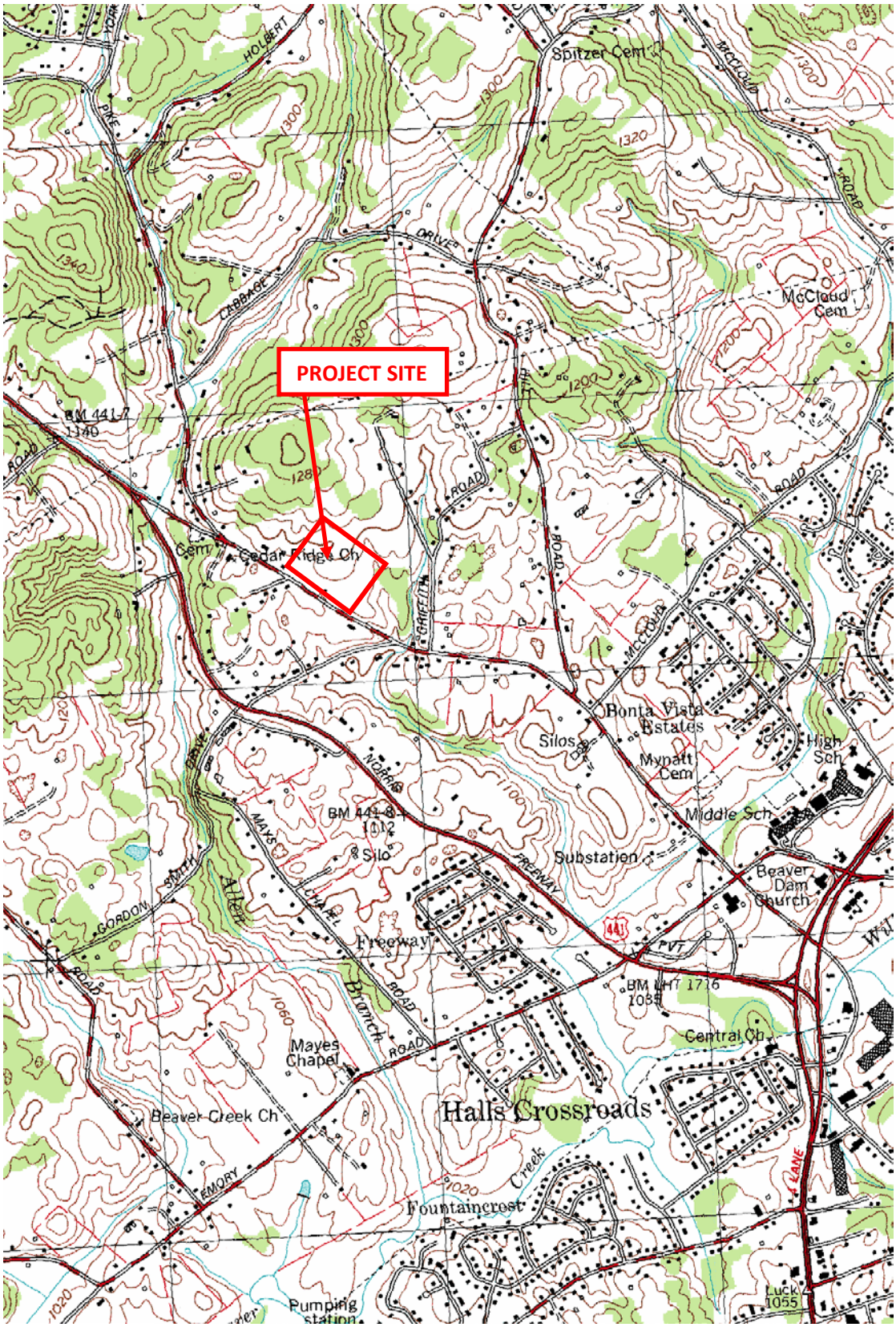
P.O.I.

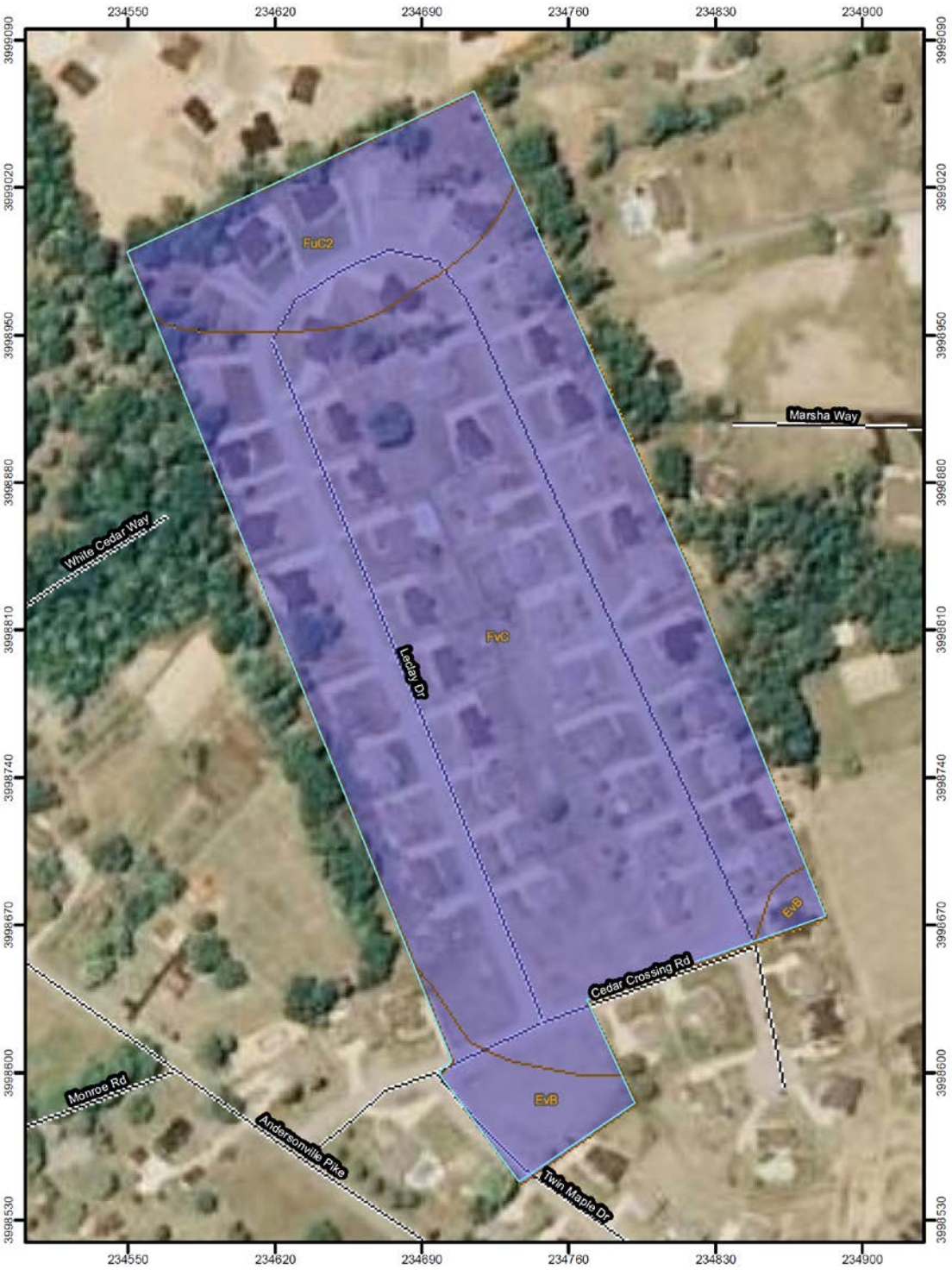
Frequency Storm	Pre-developed Peak Flow (cfs)		Post-developed Peak Flow (cfs)
1 yr	4.11	>	0.21
2 yr	8.70	>	0.46
5 yr	14.08	>	4.52
10 yr	19.20	>	9.15
25 yr	24.59	>	9.56
100 yr	32.61	>	16.44

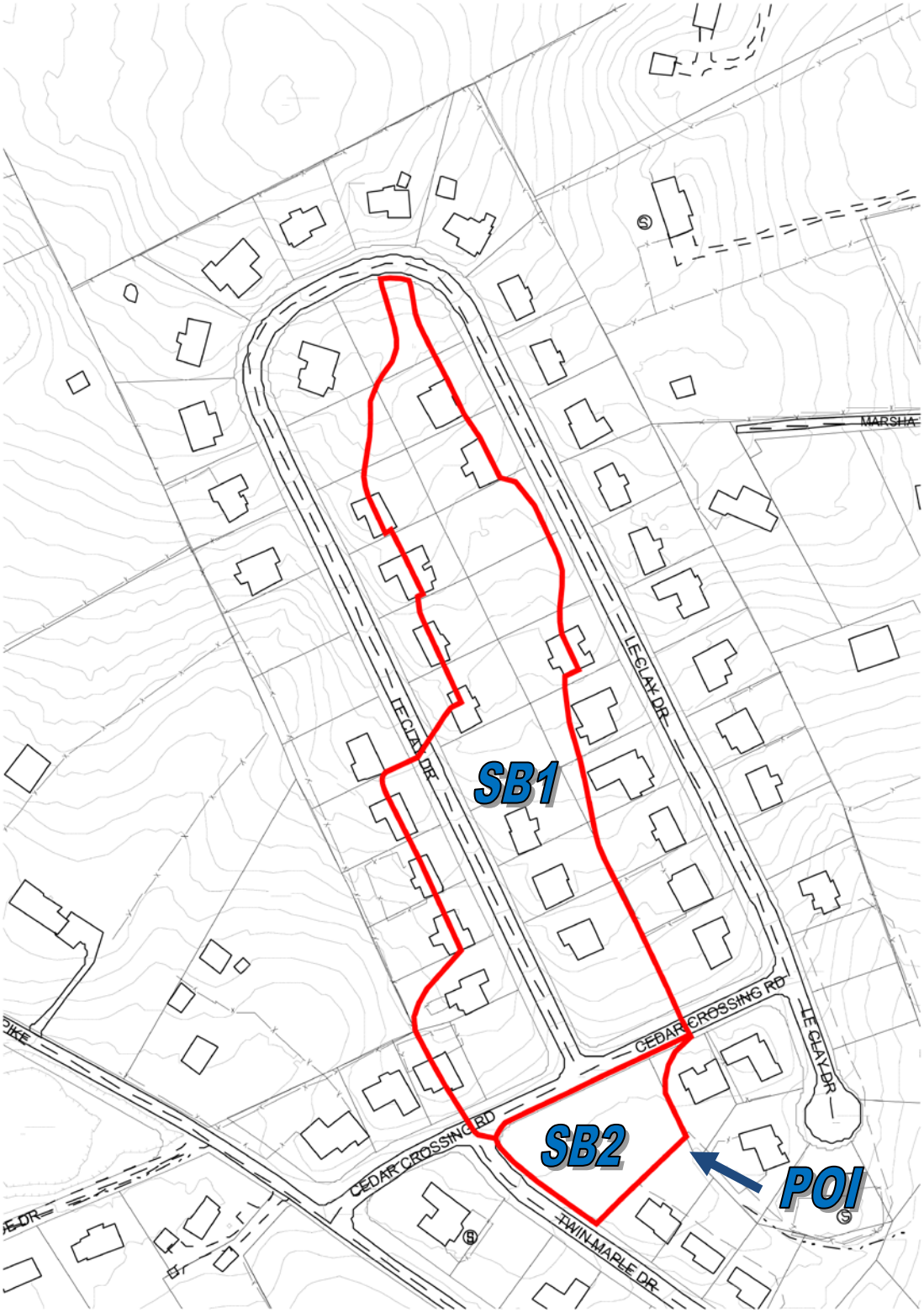
Bio-Retention Pond					Top of berm elevation = 1179.00
Rainfall Frequency	Inflow to Pond	Outflow Thru Exfiltration	Outflow from Overflow	Max. Water Surface Elevation	Maximum Storage Volume (Above Ground)
	(cfs)		(cfs)	---	(cubic feet)
WQv	-	-	-	1176.90	8,276.4
CPv	-	-	-	1177.65	16,988.4
1-year	4.11	0.43	0	1176.47	4,153
2-year	8.70	0.49	0.39	1177.05	9,934
5-year	14.08	0.52	4.52	1177.27	12,290
10-year	19.20	0.55	9.15	1177.47	14,661
25-year	24.59	0.59	9.56	1177.83	18,986
100-year	32.61	0.67	16.44	1178.26	24,771

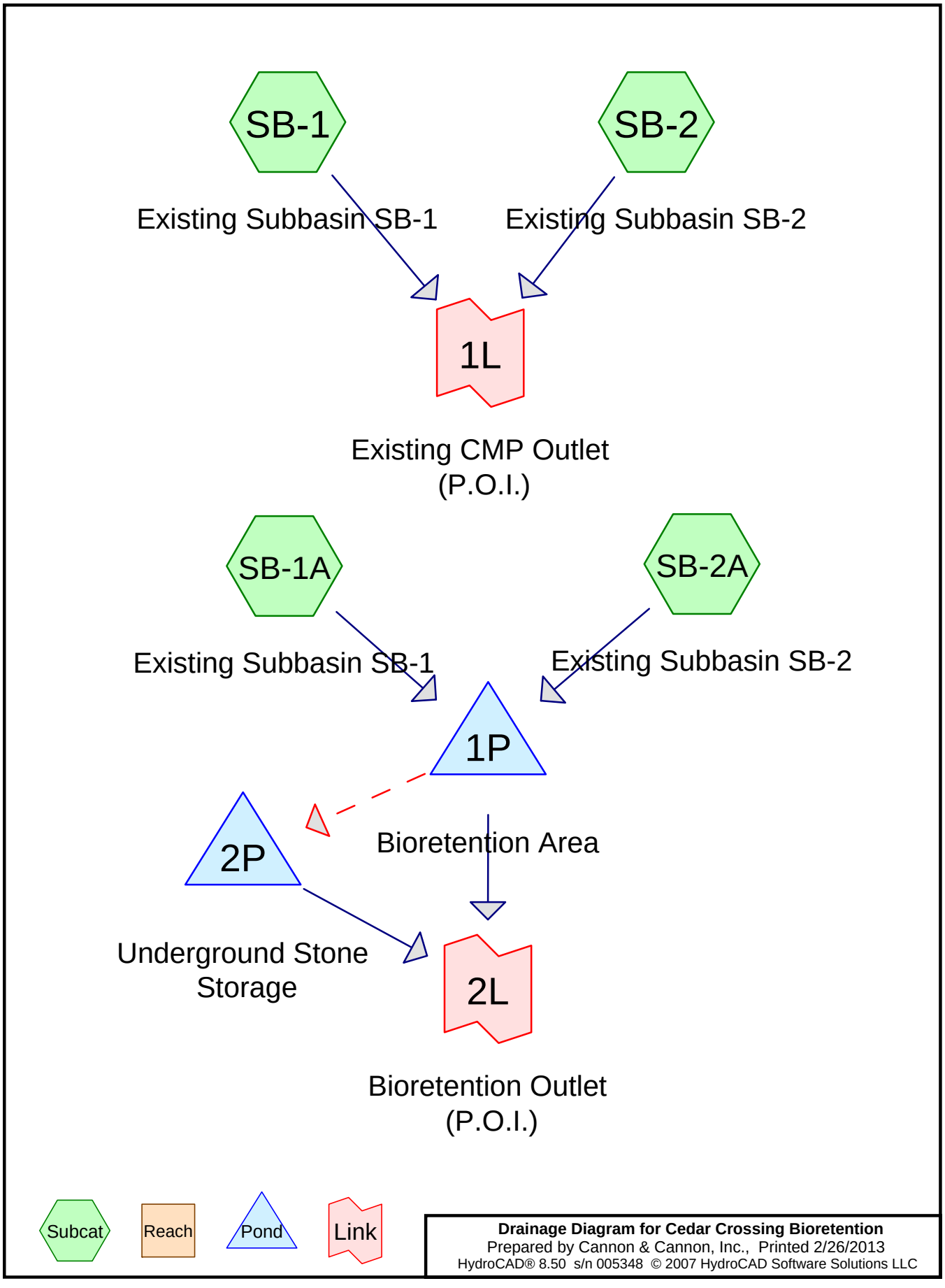
Bio-Retention Pond

For the 100 yr frequency storm, the water surface elevation in the proposed bio-retention pond is at elevation 1178.26. For the 100 yr frequency storm, 0.74 ft of freeboard is provided between the maximum water surface elevation and the berm elevation of 1179.


PROJECT SITE
Spitzer Cem
McCloud Cem
Cedar Ridge Ch
Cem
Bonta Vista Estates
Silos
Mynatt Cem
High Sch
Middle Sch
BM 441-8
1012
Silo
Substation
Beaver Dam Church
Freeway
BM LHT 1716
1035
Central Ch
Mayes Chapel
Beaver Creek Ch
Halls Crossroads
Fountaincrest
Creek
Pumping station
Luck
1055
HOLBERT
PIKE
CABBAGE
DRIVE
ROAD
GAREETH
McCLOUD
NORRIS
MAYS
CHAPEL
SMITH
ALLEN
GORDON
BRANCH
EMORY
LANE
PVT
441


234550
234620
234690
234760
234830
234900
3999090
3999020
3998950
3998880
3998810
3998740
3998670
3998600
3998530
FuC2
FvC
EvB
EvB
Marsha Way
White Cedar Way
Lesley Dr
Cedar Crossing Rd
Monroe Rd
Andersonville Pike
Twin Maple Dr


SB1
SB2
POI
CEDAR CROSSING RD
CEDAR CROSSING RD
LE CLAY DR
LE CLAY DR
TWIN MAPLE DR
MARSHA


SB-1
SB-2
Existing Subbasin SB-1
Existing Subbasin SB-2
1L
Existing CMP Outlet
(P.O.I.)
SB-1A
SB-2A
Existing Subbasin SB-1
Existing Subbasin SB-2
1P
2P
Bioretention Area
Underground Stone
Storage
2L
Bioretention Outlet
(P.O.I.)
Subcat
Reach
Pond
Link
Drainage Diagram for Cedar Crossing Bioretention
Prepared by Cannon & Cannon, Inc., Printed 2/26/2013
HydroCAD® 8.50 s/n 005348 © 2007 HydroCAD Software Solutions LLC

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 4.02 cfs @ 12.07 hrs, Volume= 0.274 af, Depth= 0.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 1-YR, 24-HR Rainfall=2.50"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 4.02 cfs @ 12.07 hrs, Volume= 0.274 af, Depth= 0.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 1-YR, 24-HR Rainfall=2.50"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 0.10 cfs @ 12.11 hrs, Volume= 0.015 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 1-YR, 24-HR Rainfall=2.50"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 0.10 cfs @ 12.11 hrs, Volume= 0.015 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 1-YR, 24-HR Rainfall=2.50"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 0.49" for 1-YR, 24-HR event
Inflow = 4.11 cfs @ 12.07 hrs, Volume= 0.289 af
Outflow = 0.43 cfs @ 13.14 hrs, Volume= 0.289 af, Atten= 89%, Lag= 64.4 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 0.43 cfs @ 13.14 hrs, Volume= 0.289 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,176.47' @ 13.14 hrs Surf.Area= 9,317 sf Storage= 4,153 cf

Plug-Flow detention time= 88.3 min calculated for 0.289 af (100% of inflow)
Center-of-Mass det. time= 88.3 min (983.6 - 895.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=1,176.00' (Free Discharge)
- **1=Culvert** (Passes 0.00 cfs of 7.19 cfs potential flow)
  - **2=Orifice/Grate** (Controls 0.00 cfs)
- **3=Emergency Spillway** (Controls 0.00 cfs)

Secondary OutFlow Max=0.43 cfs @ 13.14 hrs HW=1,176.47' (Free Discharge)
- **4=Exfiltration** (Exfiltration Controls 0.43 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.43 cfs @	13.14 hrs, Volume=	0.289 af
Outflow	=	0.21 cfs @	18.96 hrs, Volume=	0.063 af, Atten= 51%, Lag= 348.9 min
Primary	=	0.21 cfs @	18.96 hrs, Volume=	0.063 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.15' @ 18.96 hrs Surf.Area= 8,207 sf Storage= 10,227 cf

Plug-Flow detention time= 526.7 min calculated for 0.063 af (22% of inflow)
Center-of-Mass det. time= 310.8 min (1,294.4 - 983.6)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.21 cfs @ 18.96 hrs HW=1,173.15' (Free Discharge)
- **1=Exfiltration** (Exfiltration Controls 0.00 cfs)
- **2=Underdrain System** (Orifice Controls 0.21 cfs @ 1.34 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 0.49" for 1-YR, 24-HR event
Inflow = 4.11 cfs @ 12.07 hrs, Volume= 0.289 af
Primary = 4.11 cfs @ 12.07 hrs, Volume= 0.289 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 0.11" for 1-YR, 24-HR event
Inflow = 0.21 cfs @ 18.96 hrs, Volume= 0.063 af
Primary = 0.21 cfs @ 18.96 hrs, Volume= 0.063 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 8.25 cfs @ 12.06 hrs, Volume= 0.515 af, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR, 24-HR Rainfall=3.30"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 8.25 cfs @ 12.06 hrs, Volume= 0.515 af, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR, 24-HR Rainfall=3.30"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 0.46 cfs @ 12.08 hrs, Volume= 0.037 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR, 24-HR Rainfall=3.30"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 0.46 cfs @ 12.08 hrs, Volume= 0.037 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR, 24-HR Rainfall=3.30"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 0.93" for 2-YR, 24-HR event
Inflow = 8.70 cfs @ 12.06 hrs, Volume= 0.552 af
Outflow = 0.89 cfs @ 12.91 hrs, Volume= 0.552 af, Atten= 90%, Lag= 50.8 min
Primary = 0.39 cfs @ 12.91 hrs, Volume= 0.036 af
Secondary = 0.49 cfs @ 12.91 hrs, Volume= 0.517 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,177.05' @ 12.91 hrs Surf.Area= 10,685 sf Storage= 9,934 cf

Plug-Flow detention time= 209.0 min calculated for 0.552 af (100% of inflow)
Center-of-Mass det. time= 209.0 min (1,081.8 - 872.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.39 cfs @ 12.91 hrs HW=1,177.05' (Free Discharge)
└**1=Culvert** (Passes 0.39 cfs of 8.64 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.39 cfs @ 0.75 fps)
└**3=Emergency Spillway** (Controls 0.00 cfs)

Secondary OutFlow Max=0.49 cfs @ 12.91 hrs HW=1,177.05' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.49 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.49 cfs @	12.91 hrs, Volume=	0.517 af
Outflow	=	0.46 cfs @	18.69 hrs, Volume=	0.291 af, Atten= 7%, Lag= 347.3 min
Primary	=	0.46 cfs @	18.69 hrs, Volume=	0.291 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.24' @ 18.69 hrs Surf.Area= 8,207 sf Storage= 10,433 cf

Plug-Flow detention time= 379.6 min calculated for 0.291 af (56% of inflow)
Center-of-Mass det. time= 200.5 min (1,301.9 - 1,101.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.46 cfs @ 18.69 hrs HW=1,173.24' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Underdrain System** (Orifice Controls 0.46 cfs @ 1.66 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 0.93" for 2-YR, 24-HR event
Inflow = 8.70 cfs @ 12.06 hrs, Volume= 0.552 af
Primary = 8.70 cfs @ 12.06 hrs, Volume= 0.552 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 0.55" for 2-YR, 24-HR event
Inflow = 0.46 cfs @ 18.69 hrs, Volume= 0.326 af
Primary = 0.46 cfs @ 18.69 hrs, Volume= 0.326 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 13.12 cfs @ 12.05 hrs, Volume= 0.795 af, Depth= 1.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR, 24-HR Rainfall=4.10"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 13.12 cfs @ 12.05 hrs, Volume= 0.795 af, Depth= 1.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR, 24-HR Rainfall=4.10"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 0.97 cfs @ 12.07 hrs, Volume= 0.066 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR, 24-HR Rainfall=4.10"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 0.97 cfs @ 12.07 hrs, Volume= 0.066 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR, 24-HR Rainfall=4.10"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 1.44" for 5-YR, 24-HR event
Inflow = 14.08 cfs @ 12.05 hrs, Volume= 0.861 af
Outflow = 5.04 cfs @ 12.25 hrs, Volume= 0.861 af, Atten= 64%, Lag= 11.9 min
Primary = 4.52 cfs @ 12.25 hrs, Volume= 0.256 af
Secondary = 0.52 cfs @ 12.25 hrs, Volume= 0.605 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,177.27' @ 12.25 hrs Surf.Area= 11,241 sf Storage= 12,290 cf

Plug-Flow detention time= 172.3 min calculated for 0.861 af (100% of inflow)
Center-of-Mass det. time= 172.3 min (1,031.3 - 859.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=4.52 cfs @ 12.25 hrs HW=1,177.27' (Free Discharge)
└**1=Culvert** (Passes 4.52 cfs of 8.90 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 4.52 cfs @ 1.69 fps)
└**3=Emergency Spillway** (Controls 0.00 cfs)

Secondary OutFlow Max=0.52 cfs @ 12.25 hrs HW=1,177.27' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.52 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.52 cfs @	12.25 hrs, Volume=	0.605 af
Outflow	=	0.48 cfs @	18.40 hrs, Volume=	0.379 af, Atten= 8%, Lag= 369.1 min
Primary	=	0.48 cfs @	18.40 hrs, Volume=	0.379 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.24' @ 18.40 hrs Surf.Area= 8,207 sf Storage= 10,446 cf

Plug-Flow detention time= 371.7 min calculated for 0.379 af (63% of inflow)
Center-of-Mass det. time= 195.6 min (1,337.0 - 1,141.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.48 cfs @ 18.40 hrs HW=1,173.24' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Underdrain System** (Orifice Controls 0.48 cfs @ 1.68 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 1.44" for 5-YR, 24-HR event
Inflow = 14.08 cfs @ 12.05 hrs, Volume= 0.861 af
Primary = 14.08 cfs @ 12.05 hrs, Volume= 0.861 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 1.07" for 5-YR, 24-HR event
Inflow = 4.52 cfs @ 12.25 hrs, Volume= 0.635 af
Primary = 4.52 cfs @ 12.25 hrs, Volume= 0.635 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 17.71 cfs @ 12.05 hrs, Volume= 1.062 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR, 24-HR Rainfall=4.80"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 17.71 cfs @ 12.05 hrs, Volume= 1.062 af, Depth= 2.05"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR, 24-HR Rainfall=4.80"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 1.50 cfs @ 12.06 hrs, Volume= 0.096 af, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR, 24-HR Rainfall=4.80"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 1.50 cfs @ 12.06 hrs, Volume= 0.096 af, Depth= 1.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR, 24-HR Rainfall=4.80"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 1.94" for 10-YR, 24-HR event
Inflow = 19.20 cfs @ 12.05 hrs, Volume= 1.158 af
Outflow = 9.70 cfs @ 12.19 hrs, Volume= 1.158 af, Atten= 49%, Lag= 8.4 min
Primary = 9.15 cfs @ 12.19 hrs, Volume= 0.488 af
Secondary = 0.55 cfs @ 12.19 hrs, Volume= 0.669 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,177.47' @ 12.19 hrs Surf.Area= 11,773 sf Storage= 14,661 cf

Plug-Flow detention time= 148.2 min calculated for 1.158 af (100% of inflow)
Center-of-Mass det. time= 148.2 min (998.4 - 850.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=9.15 cfs @ 12.19 hrs HW=1,177.47' (Free Discharge)
└**1=Culvert** (Inlet Controls 9.15 cfs @ 7.46 fps)
└**2=Orifice/Grate** (Passes 9.15 cfs of 10.64 cfs potential flow)
└**3=Emergency Spillway** (Controls 0.00 cfs)

Secondary OutFlow Max=0.55 cfs @ 12.19 hrs HW=1,177.47' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.55 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.55 cfs @	12.19 hrs, Volume=	0.669 af
Outflow	=	0.49 cfs @	18.24 hrs, Volume=	0.443 af, Atten= 10%, Lag= 363.2 min
Primary	=	0.49 cfs @	18.24 hrs, Volume=	0.443 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.24' @ 18.24 hrs Surf.Area= 8,207 sf Storage= 10,451 cf

Plug-Flow detention time= 367.2 min calculated for 0.443 af (66% of inflow)
Center-of-Mass det. time= 193.1 min (1,356.5 - 1,163.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.48 cfs @ 18.24 hrs HW=1,173.24' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Underdrain System** (Orifice Controls 0.48 cfs @ 1.68 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 1.94" for 10-YR, 24-HR event
Inflow = 19.20 cfs @ 12.05 hrs, Volume= 1.158 af
Primary = 19.20 cfs @ 12.05 hrs, Volume= 1.158 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 1.56" for 10-YR, 24-HR event
Inflow = 9.15 cfs @ 12.19 hrs, Volume= 0.931 af
Primary = 9.15 cfs @ 12.19 hrs, Volume= 0.931 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 22.52 cfs @ 12.05 hrs, Volume= 1.344 af, Depth= 2.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR, 24-HR Rainfall=5.50"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 22.52 cfs @ 12.05 hrs, Volume= 1.344 af, Depth= 2.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR, 24-HR Rainfall=5.50"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 2.08 cfs @ 12.06 hrs, Volume= 0.129 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR, 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 2.08 cfs @ 12.06 hrs, Volume= 0.129 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR, 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.47" for 25-YR, 24-HR event
Inflow = 24.59 cfs @ 12.05 hrs, Volume= 1.473 af
Outflow = 10.15 cfs @ 12.22 hrs, Volume= 1.473 af, Atten= 59%, Lag= 10.2 min
Primary = 9.56 cfs @ 12.22 hrs, Volume= 0.751 af
Secondary = 0.59 cfs @ 12.22 hrs, Volume= 0.722 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,177.83' @ 12.22 hrs Surf.Area= 12,687 sf Storage= 18,986 cf

Plug-Flow detention time= 129.8 min calculated for 1.473 af (100% of inflow)
Center-of-Mass det. time= 129.8 min (973.0 - 843.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=9.56 cfs @ 12.22 hrs HW=1,177.83' (Free Discharge)
└**1=Culvert** (Inlet Controls 9.56 cfs @ 7.79 fps)
└**2=Orifice/Grate** (Passes 9.56 cfs of 24.59 cfs potential flow)
└**3=Emergency Spillway** (Controls 0.00 cfs)

Secondary OutFlow Max=0.59 cfs @ 12.22 hrs HW=1,177.83' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.59 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.59 cfs @	12.22 hrs, Volume=	0.722 af
Outflow	=	0.49 cfs @	17.92 hrs, Volume=	0.496 af, Atten= 16%, Lag= 341.9 min
Primary	=	0.49 cfs @	17.92 hrs, Volume=	0.496 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.25' @ 17.92 hrs Surf.Area= 8,207 sf Storage= 10,453 cf

Plug-Flow detention time= 364.1 min calculated for 0.496 af (69% of inflow)
Center-of-Mass det. time= 191.5 min (1,366.4 - 1,174.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.49 cfs @ 17.92 hrs HW=1,173.25' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Underdrain System** (Orifice Controls 0.49 cfs @ 1.69 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.47" for 25-YR, 24-HR event
Inflow = 24.59 cfs @ 12.05 hrs, Volume= 1.473 af
Primary = 24.59 cfs @ 12.05 hrs, Volume= 1.473 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.09" for 25-YR, 24-HR event
Inflow = 9.56 cfs @ 12.22 hrs, Volume= 1.247 af
Primary = 9.56 cfs @ 12.22 hrs, Volume= 1.247 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 26.76 cfs @ 12.05 hrs, Volume= 1.597 af, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR, 24-HR Rainfall=6.10"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 26.76 cfs @ 12.05 hrs, Volume= 1.597 af, Depth= 3.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR, 24-HR Rainfall=6.10"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 2.60 cfs @ 12.06 hrs, Volume= 0.159 af, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR, 24-HR Rainfall=6.10"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 2.60 cfs @ 12.06 hrs, Volume= 0.159 af, Depth= 2.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR, 24-HR Rainfall=6.10"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.95" for 50-YR, 24-HR event
Inflow = 29.36 cfs @ 12.05 hrs, Volume= 1.755 af
Outflow = 12.89 cfs @ 12.21 hrs, Volume= 1.755 af, Atten= 56%, Lag= 9.6 min
Primary = 12.25 cfs @ 12.21 hrs, Volume= 0.995 af
Secondary = 0.64 cfs @ 12.21 hrs, Volume= 0.761 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,178.13' @ 12.21 hrs Surf.Area= 13,788 sf Storage= 22,996 cf

Plug-Flow detention time= 117.7 min calculated for 1.755 af (100% of inflow)
Center-of-Mass det. time= 117.7 min (955.9 - 838.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=12.25 cfs @ 12.21 hrs HW=1,178.13' (Free Discharge)
└**1=Culvert** (Inlet Controls 9.90 cfs @ 8.07 fps)
└**2=Orifice/Grate** (Passes 9.90 cfs of 32.01 cfs potential flow)
└**3=Emergency Spillway** (Weir Controls 2.34 cfs @ 1.19 fps)

Secondary OutFlow Max=0.64 cfs @ 12.21 hrs HW=1,178.13' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.64 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.64 cfs @	12.21 hrs, Volume=	0.761 af
Outflow	=	0.49 cfs @	17.50 hrs, Volume=	0.535 af, Atten= 23%, Lag= 317.3 min
Primary	=	0.49 cfs @	17.50 hrs, Volume=	0.535 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.25' @ 17.50 hrs Surf.Area= 8,207 sf Storage= 10,454 cf

Plug-Flow detention time= 361.9 min calculated for 0.535 af (70% of inflow)
Center-of-Mass det. time= 190.4 min (1,369.7 - 1,179.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.49 cfs @ 17.50 hrs HW=1,173.25' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Underdrain System** (Orifice Controls 0.49 cfs @ 1.69 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.95" for 50-YR, 24-HR event
Inflow = 29.36 cfs @ 12.05 hrs, Volume= 1.755 af
Primary = 29.36 cfs @ 12.05 hrs, Volume= 1.755 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.57" for 50-YR, 24-HR event
Inflow = 12.25 cfs @ 12.21 hrs, Volume= 1.529 af
Primary = 12.25 cfs @ 12.21 hrs, Volume= 1.529 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Subcatchment SB-1: Existing Subbasin SB-1

Runoff = 29.64 cfs @ 12.05 hrs, Volume= 1.769 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=6.50"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-1A: Existing Subbasin SB-1

Runoff = 29.64 cfs @ 12.05 hrs, Volume= 1.769 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=6.50"

Area (ac)	CN	Description
6.230	72	1/3 acre lots, 30% imp, HSG B
4.361		Pervious Area
1.869		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	150	0.0500	0.27		**Sheet Flow, Grassland Sheet Flow**
					Grass: Short n= 0.150 P2= 3.30"
3.5	950	0.0800	4.55		**Shallow Concentrated Flow, Grassland Shallow Conc.**
					Unpaved Kv= 16.1 fps
12.8	1,100	Total			

Summary for Subcatchment SB-2: Existing Subbasin SB-2

Runoff = 2.97 cfs @ 12.05 hrs, Volume= 0.180 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=6.50"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Subcatchment SB-2A: Existing Subbasin SB-2

Runoff = 2.97 cfs @ 12.05 hrs, Volume= 0.180 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR, 24-HR Rainfall=6.50"

Area (ac)	CN	Description
0.920	61	>75% Grass cover, Good, HSG B
0.920		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.7	200	0.0400	0.26		**Sheet Flow, Overland Sheet Flow** Grass: Short n= 0.150 P2= 3.30"

Summary for Pond 1P: Bioretention Area

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 3.27" for 100-YR, 24-HR event
Inflow = 32.61 cfs @ 12.05 hrs, Volume= 1.949 af
Outflow = 17.11 cfs @ 12.18 hrs, Volume= 1.949 af, Atten= 48%, Lag= 8.1 min
Primary = 16.44 cfs @ 12.18 hrs, Volume= 1.165 af
Secondary = 0.67 cfs @ 12.18 hrs, Volume= 0.783 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,178.26' @ 12.18 hrs Surf.Area= 14,412 sf Storage= 24,771 cf

Plug-Flow detention time= 110.2 min calculated for 1.948 af (100% of inflow)
Center-of-Mass det. time= 110.2 min (945.5 - 835.3)

Volume	Invert	Avail.Storage	Storage Description
#1	1,176.00'	36,833 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,176.00	8,207	0	0
1,177.00	10,550	9,379	9,379
1,178.00	13,135	11,843	21,221
1,179.00	18,089	15,612	36,833

Device	Routing	Invert	Outlet Devices
#1	Primary	1,173.00'	**15.0" x 423.0' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 1,156.51' S= 0.0390 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior
#2	Device 1	1,177.00'	**2.50' x 2.50' Horiz. Orifice/Grate** Limited to weir flow C= 0.600
#3	Primary	1,178.00'	**15.0' long Emergency Spillway** 2 End Contraction(s)
#4	Secondary	1,176.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=16.42 cfs @ 12.18 hrs HW=1,178.26' (Free Discharge)
└**1=Culvert** (Inlet Controls 10.04 cfs @ 8.18 fps)
└**2=Orifice/Grate** (Passes 10.04 cfs of 33.74 cfs potential flow)
└**3=Emergency Spillway** (Weir Controls 6.38 cfs @ 1.66 fps)

Secondary OutFlow Max=0.67 cfs @ 12.18 hrs HW=1,178.26' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.67 cfs)

Summary for Pond 2P: Underground Stone Storage

Inflow	=	0.67 cfs @	12.18 hrs, Volume=	0.783 af
Outflow	=	0.49 cfs @	17.23 hrs, Volume=	0.557 af, Atten= 26%, Lag= 303.0 min
Primary	=	0.49 cfs @	17.23 hrs, Volume=	0.557 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 1,173.25' @ 17.23 hrs Surf.Area= 8,207 sf Storage= 10,455 cf

Plug-Flow detention time= 360.8 min calculated for 0.557 af (71% of inflow)
Center-of-Mass det. time= 189.8 min (1,370.3 - 1,180.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,169.00'	11,079 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,169.00	8,207	30.0	0	0
1,173.50	8,207	30.0	11,079	11,079
1,173.51	8,207	0.0	0	11,079
1,176.00	8,207	0.0	0	11,079

Device	Routing	Invert	Outlet Devices
#1	Primary	1,169.00'	**0.100 in/hr Exfiltration over Surface area above invert** Excluded Surface area = 8,207 sf
#2	Primary	1,173.00'	**6.0" Vert. Underdrain System X 3.00** C= 0.600

Primary OutFlow Max=0.49 cfs @ 17.23 hrs HW=1,173.25' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.00 cfs)
└**2=Underdrain System** (Orifice Controls 0.49 cfs @ 1.69 fps)

Summary for Link 1L: Existing CMP Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 3.27" for 100-YR, 24-HR event
Inflow = 32.61 cfs @ 12.05 hrs, Volume= 1.949 af
Primary = 32.61 cfs @ 12.05 hrs, Volume= 1.949 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs

Summary for Link 2L: Bioretention Outlet (P.O.I.)

Inflow Area = 7.150 ac, 26.14% Impervious, Inflow Depth = 2.89" for 100-YR, 24-HR event
Inflow = 16.44 cfs @ 12.18 hrs, Volume= 1.723 af
Primary = 16.44 cfs @ 12.18 hrs, Volume= 1.723 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs