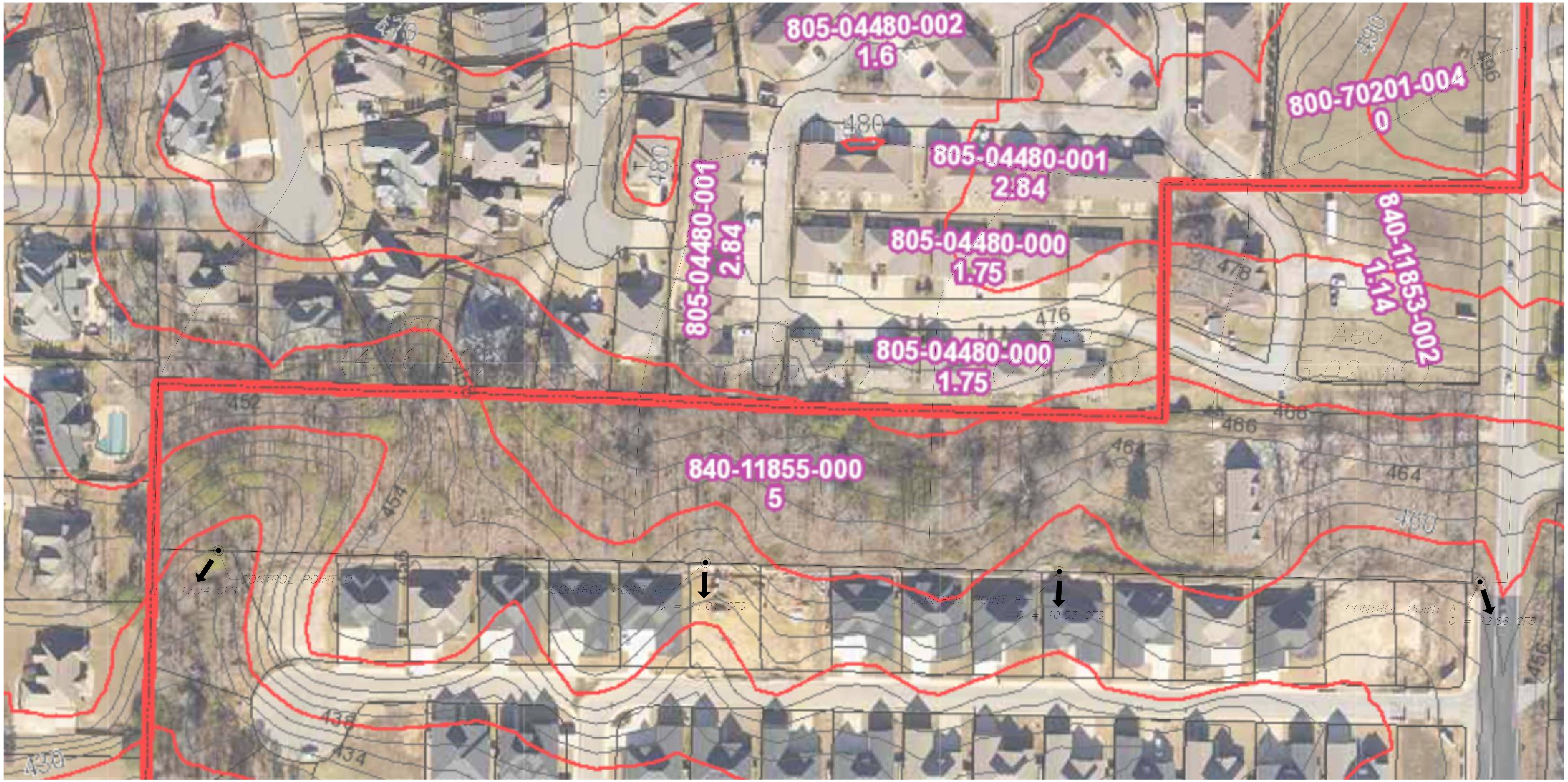

ALL FLOWRATES – 25 YR STORM EVENT

SCALE: 1" = 50'

LEMONS ENGINEERING CONSULTANTS, INC.
204 CHERRY STREET
CABOT, ARKANSAS 72023
(501) 843-5081 • Fax (501) 941-0959
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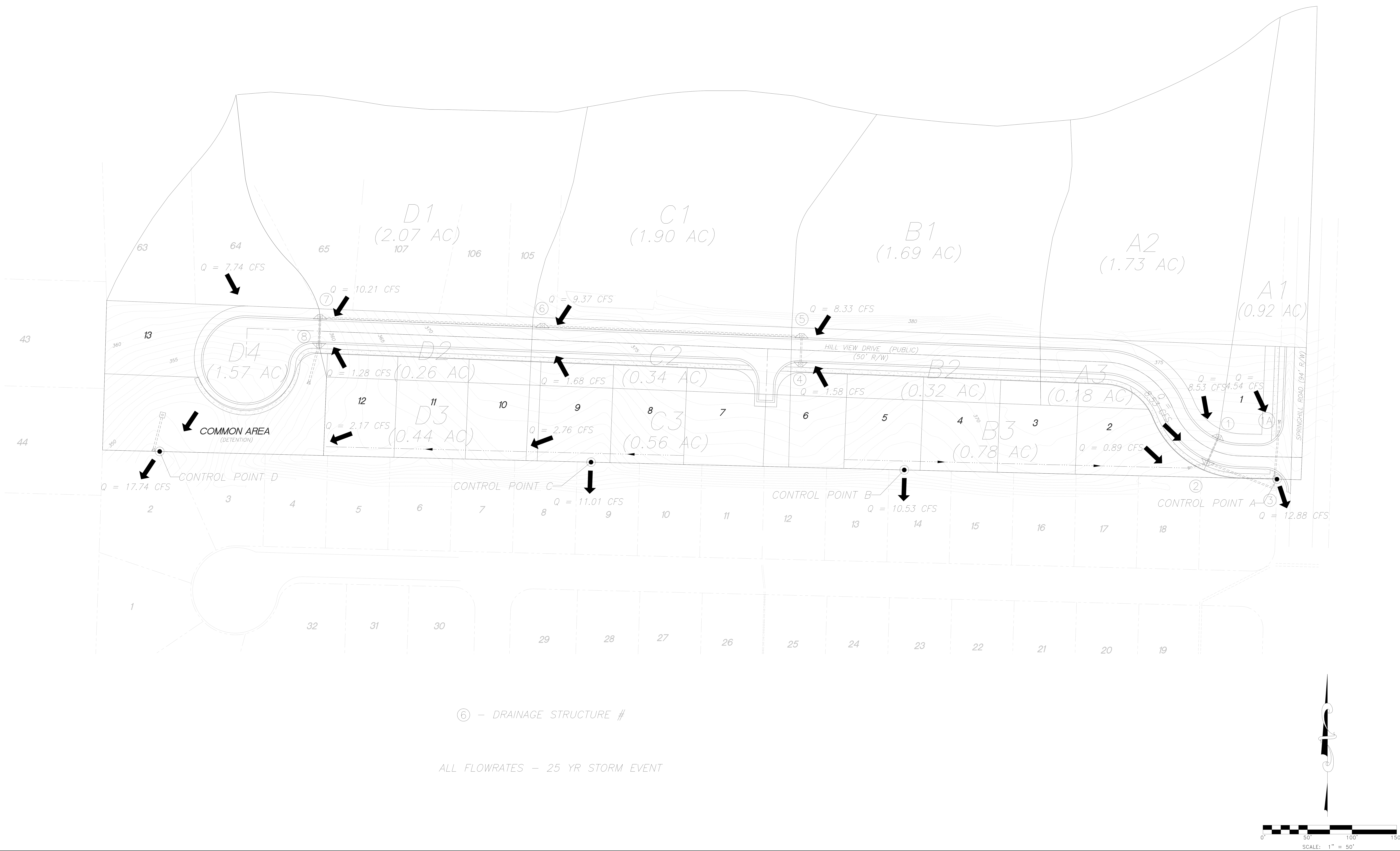
DRAINAGE MAP – PRECONSTRUCTION
HILLCREST ADDITION
PART OF THE SE 1/4 OF SECTION 17, T-1-S, R-14-W
CITY OF BRYANT, SALINE COUNTY, ARKANSAS

Prepared For:
Springhill HWY 5
Development, LLC
816 E. Oak Street
Conway, Arkansas 72032

No.	Revisions	Date	By

Project No.: 24-018
Date: OCTOBER 22, 2024
File: Drainage Precon
Scale: 1" = 50'
Sheet: 1 of 1
Drawn By: B. Judd



⑥ – DRAINAGE STRUCTURE #

ALL FLOWRATES – 25 YR STORM EVENT

SCALE: 1" = 50'

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DRAINAGE MAP – POST CONSTRUCTION
HILLCREST ADDITION
PART OF THE SE 1/4 OF SECTION 17, T-1-S, R-14-W
CITY OF BRYANT, SALINE COUNTY, ARKANSAS

Prepared For:
Springhill HWY 5
Development, LLC
816 E. Oak Street
Conway, Arkansas 72032

No.	Revisions	Date	By

Date: OCTOBER 22, 2024
Scale: 1" = 50'
Drawn By: B. Judd
Project No.: 24-018
File: Drainage Post Con
Sheet: 1 of 1

Drainage Report

For

Hillcrest Addition

Springhill Road
Bryant, Arkansas

Revised: October 21, 2024

Prepared By:

Lemons Engineering Consultants, Inc.
204 West Cherry Street
Cabot, Arkansas 72023
(501) 605-7565
arstrep43@gmail.com

Index

Project Information

Project Title:	Hillcrest Addition
Project Description:	13 lot single family development located on the West side of Springhill Road, North of and adjacent to Hurricane Gardens, Bryant, Arkansas (address: 3927 Springhill Road)
Owner/Developer:	Springhill – Hwy 5 Development, LLC 816 East Oak Street Conway, Arkansas 72032
Engineer of Record:	Lemons Engineering Consultants, Inc. Tim Lemons, PE 204 Cherry Street Cabot, Arkansas 72023 (501) 605-7565

General Information

This proposed development shall include 13 single family lots. This property is essentially the Northern Most tract of land within the city limits of Bryant as it presently exist. The property to the North of the subject site is developed with duplex style residential structures existing outside the City limits of Bryant. The property to the South is an established subdivision (Hurricane Gardens). The property drains North to South. There have been several reports of drainage issues by the residents of Hurricane Gardens. At present, the drainage from the subject property, and that to the north of the subject property, flows onto Hurricane Gardens. No detention exists on the property located north of the subject property.

The objectives of this report are as follows:

1) Determine the estimated increase in runoff due to the development of Hillcrest Addition.
2) Provide design computations for a detention facility to bring the runoff from said tract to pre-construction rate.
3) Based on comments expressed by the residents, divert as much flow as possible away from the rear of the Northern most lots within Hurricane Gardens. As previously stated, the majority of the property to the North of Hurricane Gardens flows into the rear of the Northern most lots, creating an issue for the property owners.
4) Size the infrastructure in the development using the City's Drainage Code.
5) Compare the estimated Pre and Post flowrates at specific control points to show that the overall runoff from Hillcrest is at or less than the pre-construction flowrate.

The control points (A-D) to be used in this analysis are shown on the following vicinity map, and throughout this report.

Project Vicinity Map

Source: ARCOUNTYDATA.com

Hydrological Computations

For this analysis, we will use the Rational Method in determining culvert sizes, culvert capacity computations, and other related issues on site. The total watershed size for this development is estimated at 12.40 acres. Attention is called to the Watershed Map included in this report. As per the Rational Method, the following equation is used:

$$Q = C \times I \times A$$, where:

Q = Flowrate (cfs)
C = Runoff Coefficient
I = Intensity (from tables)
A = area (acres)

The selection of the appropriate intensity is based on the estimated time of concentration (tc).

Determination of Runoff Coefficients "C"

In determining the Pre Construction C, we must consider the property to the North that is developed, and discharging onto the subject property. The C factor for Pre and Post Conditions are based on Table 400-1 "Runoff Coefficients for Surface Types" as provided in the Bryant Drainage Manual. A factored (weighted) value of C is determined in the following tables:

Pre Construction Conditions

Storm Event	Off Site C1	Off Site A1 (acres)	Off Site C2	Off Site A2 (acres)	On Site C3	On Site A3 (acres)	On Site C4	On Site A4 (acres)	Weighted C Factor
2	0.75	3.04	0.29	4.73	0.75	0.19	0.29	4.59	0.41
5	0.8	3.04	0.32	4.73	0.8	0.19	0.32	4.59	0.44
10	0.83	3.04	0.35	4.73	0.83	0.19	0.35	4.59	0.47
25	0.88	3.04	0.39	4.73	0.88	0.19	0.39	4.59	0.52
50	0.92	3.04	0.42	4.73	0.92	0.19	0.42	4.59	0.55
100	0.97	3.04	0.46	4.73	0.97	0.19	0.46	4.59	0.59

C1 (off site for homes, streets, etc.)
C2 (off site for grass, landscaping, etc.)
C3 (on site for homes, streets, etc.)
C4 (on site for grass. Landscaping, etc.)

A1 (off site area for C1)
A2 (off site area for C2)
A3 (on site area for C3)
A4 (on site area for C4)

Post Construction Conditions

Storm Event	Off Site C1	Off Site A1 (acres)	Off Site C2	Off Site A2 (acres)	On Site C3	On Site A3 (acres)	On Site C4	On Site A4 (acres)	Weighted C Factor
2	0.75	3.04	0.29	4.73	0.75	1.81	0.29	3.07	0.47
5	0.8	3.04	0.32	4.73	0.8	1.81	0.32	3.07	0.50
10	0.83	3.04	0.35	4.73	0.83	1.81	0.35	3.07	0.53
25	0.88	3.04	0.39	4.73	0.88	1.81	0.39	3.07	0.58
50	0.92	3.04	0.42	4.73	0.92	1.81	0.42	3.07	0.61
100	0.97	3.04	0.46	4.73	0.97	1.81	0.46	3.07	0.66

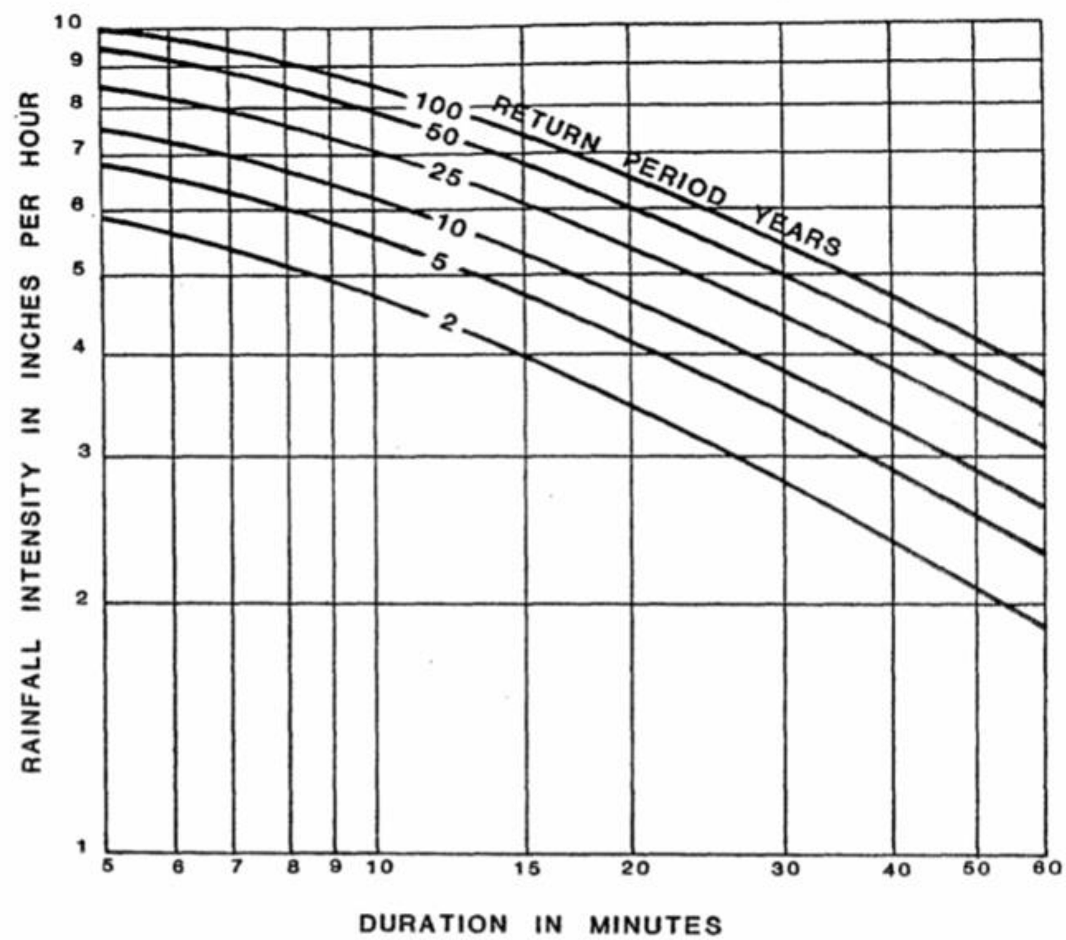
C1 (off site for homes, streets, etc.)
C2 (off site for grass, landscaping, etc.)
C3 (on site for homes, streets, etc.)
C4 (on site for grass. Landscaping, etc.)

A1 (off site area for C1)
A2 (off site area for C2)
A3 (on site area for C3)
A4 (on site area for C4)

The above variable values will be used in designing the Detention Facility. For culvert design, we will use the Post C values for the 25 year storm.

Determination of Intensity Values "I"

For this analysis, we will use the Intensity – Duration - Frequency Chart from the Little Rock Drainage Manual. Whereas the calculated value of I shall be used for Detention, we will use a tc (time of concentration) of 5 min for the culverts to also provide a conservative value.



INTENSITY - DURATION - FREQUENCY

LITTLE ROCK

SOURCE : HYDRO 35 & T.P. No. 40

Drainage Map (Pre-Construction)

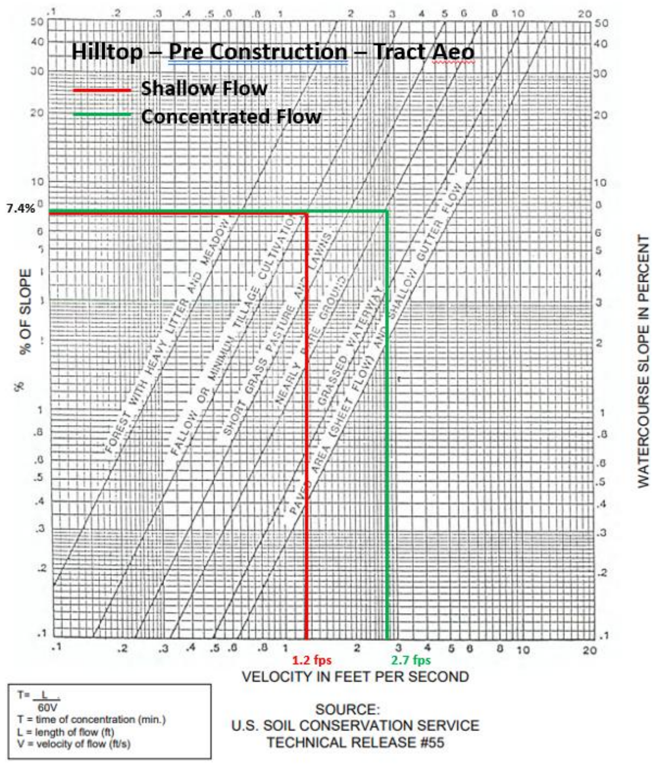
See attached map for additional information

Pre Construction Flowrates – Control Points

The estimated Pre Construction Flowrate for each Control Point is estimated as follows. These values will be used to compare to the Post Construction Flowrate later in this report:

Control Point A

The time of concentration is determined as follows:



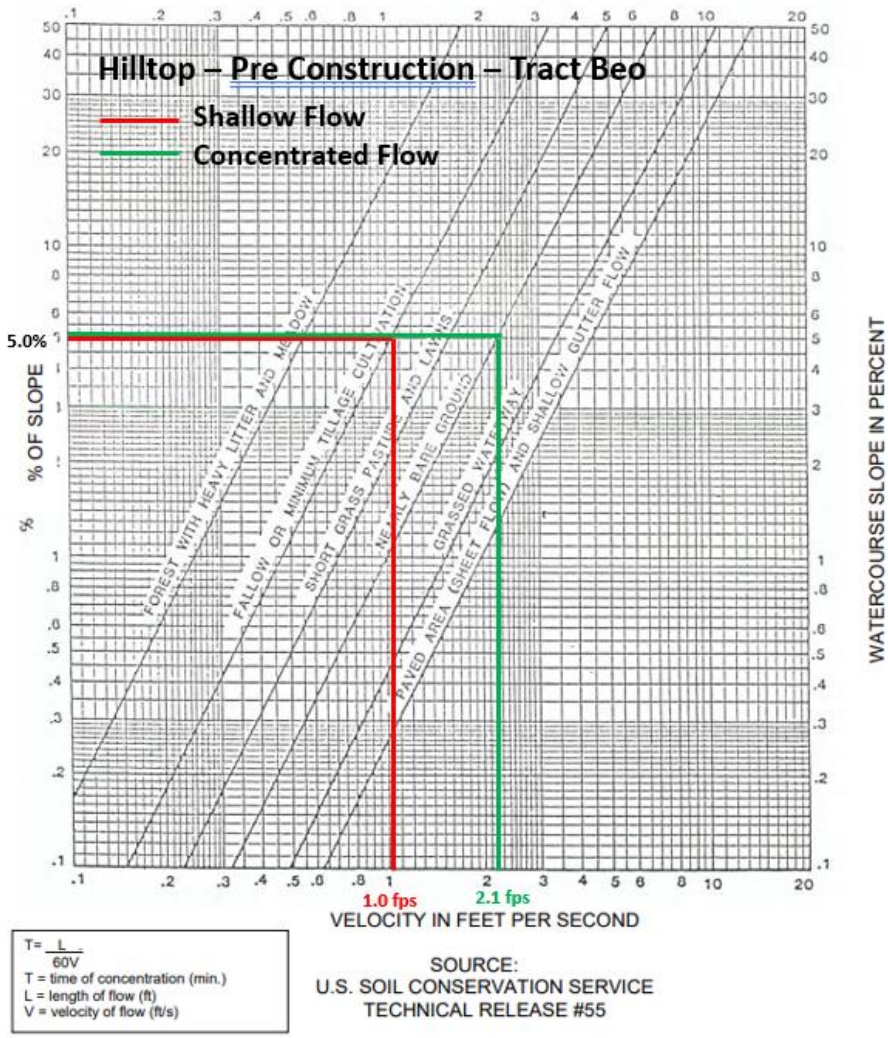
tc = ((300)/(60)(1.2)) + ((300)/(60)(2.7)) = 6 min

Flowrates for various Storm Events (Control Point A):

Storm Event	C	tc (min)	I (in/hour)	A (acres)	Q (cfs)
2	0.41	6	5.6	3.02	6.93
5	0.44	6	6.6	3.02	8.77
10	0.47	6	7.3	3.02	10.36
25	**0.52**	**6**	**8.2**	**3.02**	**12.88**
50	0.55	6	9.2	3.02	15.28
100	0.59	6	9.8	3.02	17.46

Control Point B

The time of concentration is determined as follows:



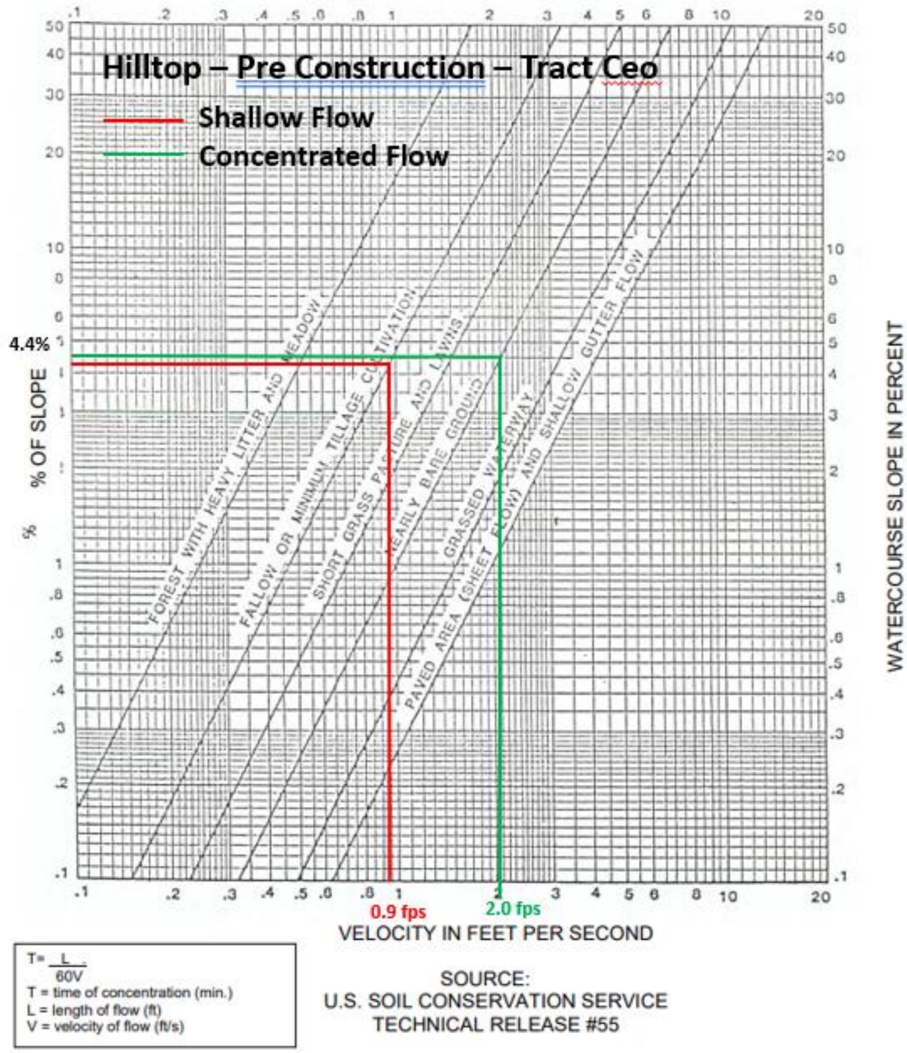
tc = ((300)/(60)(1.0)) + ((200)/(60)(2.1)) = 6.5 min

Flowrates for various Storm Events (Control Point B):

Storm Event	C	tc	I	A	Q
		(min)	(in/hour)	(acres)	(cfs)
2	0.41	6.5	5.6	2.47	5.67
5	0.44	6.5	6.6	2.47	7.17
10	0.47	6.5	7.3	2.47	8.47
25	**0.52**	**6.5**	**8.2**	**2.47**	**10.53**
50	0.55	6.5	9.2	2.47	12.50
100	0.59	6.5	9.8	2.47	14.28

Control Point C

The time of concentration is determined as follows:



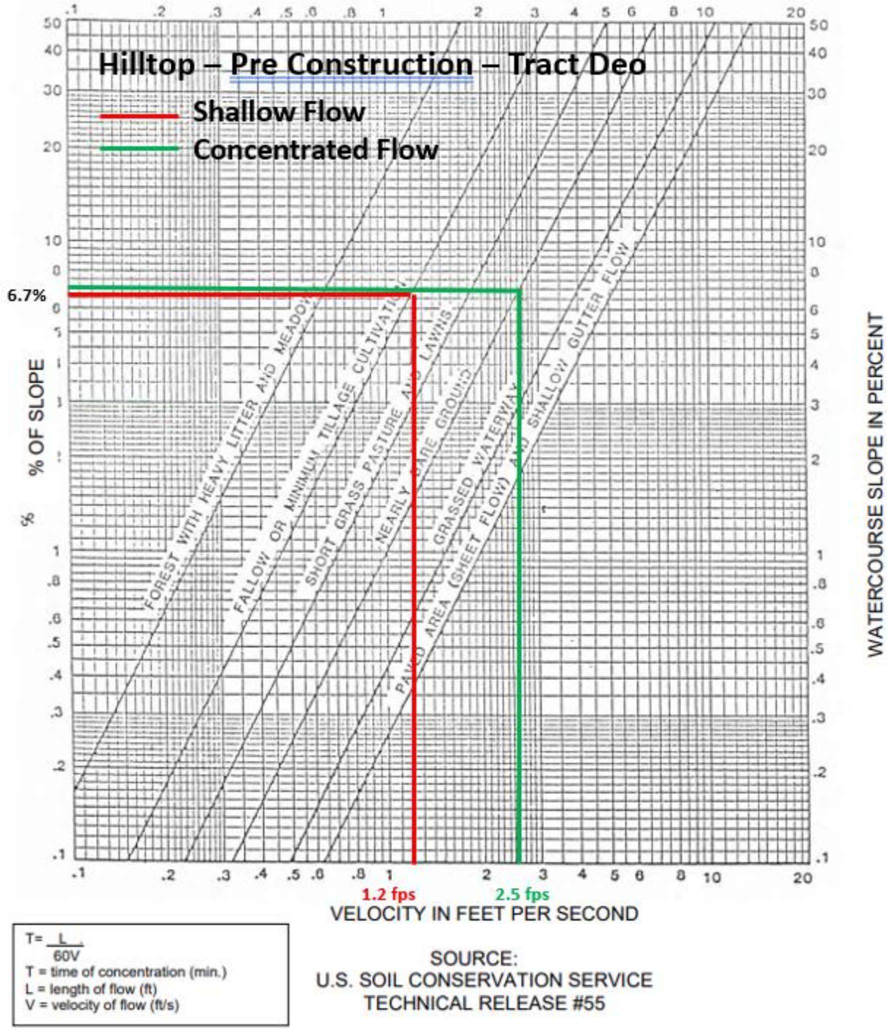
tc = ((300)/(60)(0.9)) + ((300)/(60)(2.0)) = 8 min

Flowrates for various Storm Events (Control Point C):

Storm Event	C	tc (min)	I (in/hour)	A (acres)	Q (cfs)
2	0.41	8	5.1	2.75	5.75
5	0.44	8	6	2.75	7.26
10	0.47	8	6.7	2.75	8.66
25	**0.52**	**8**	**7.7**	2.75	**11.01**
50	0.55	8	8.5	2.75	12.86
100	0.59	8	9.1	2.75	14.76

Control Point D

The time of concentration is determined as follows:



tc = ((300)/(60)(1.2)) + ((340)/(60)(2.5)) = 6.4 min

Flowrates for various Storm Events (Control Point D):

Storm Event	C	tc	I	A	Q
		(min)	(in/hour)	(acres)	(cfs)
2	0.41	6.5	5.6	4.16	9.55
5	0.44	6.5	6.6	4.16	12.08
10	0.47	6.5	7.3	4.16	14.27
25	**0.52**	**6.5**	**8.2**	4.16	**17.74**
50	0.55	6.5	9.2	4.16	21.05
100	0.59	6.5	9.8	4.16	24.05

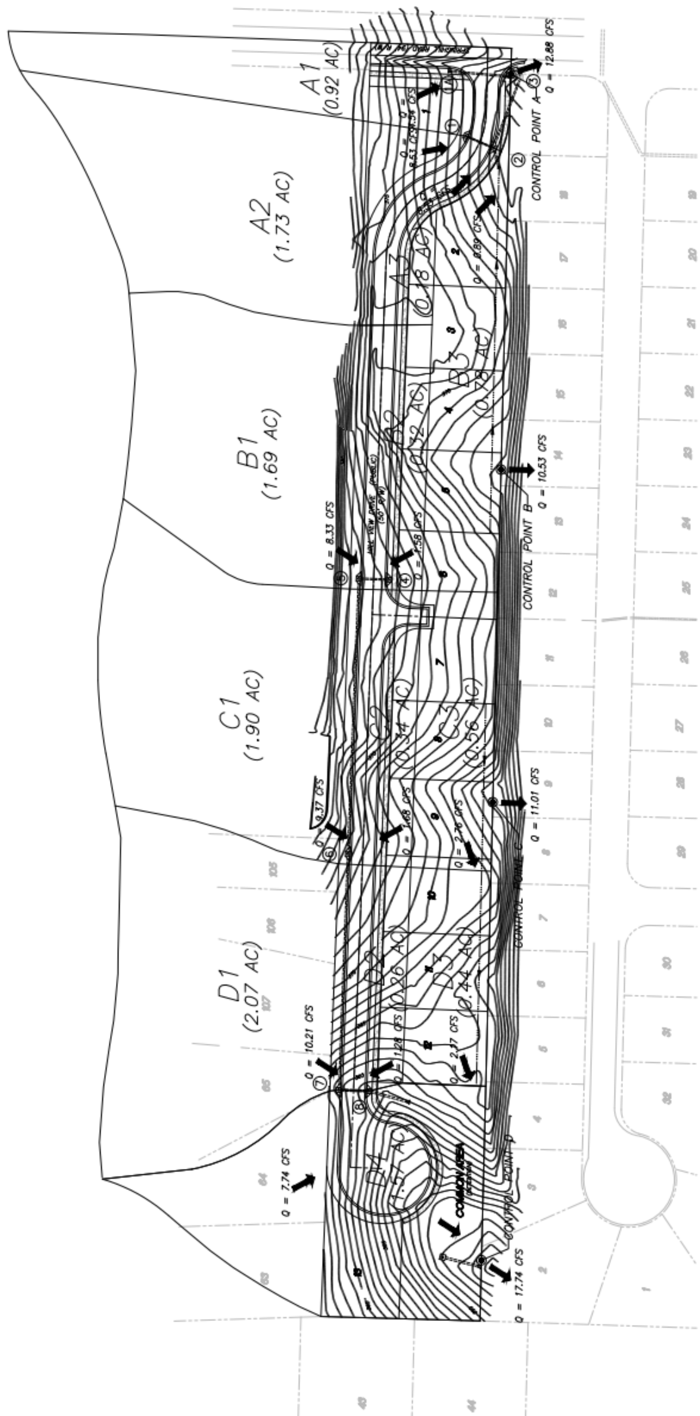
Determination of Flowrates for Culverts & Spreadflow

Attention is called to the following chart which provides C, Intensity, Area, and Flowrate (Q) of each Tract. Again, the Rational Method is being used for all basins. Attention is called to the Maps on the next two pages for a detailed drawings showing the various watershed tracts. The 25 year storm event will be used for culvert design. A conservative tc of 5 minutes is used for the culvert design.

Tract	C(Post)	I25	A	Q25
		(in/hr)	(ac)	(cfs)
A1	0.58	8.5	0.92	4.54
A2	0.58	8.5	1.73	8.53
A3	0.58	8.5	0.18	0.89
B1	0.58	8.5	1.69	8.33
B2	0.58	8.5	0.32	1.58
B3	0.58	8.5	0.78	3.85
C1	0.58	8.5	1.90	9.37
C2	0.58	8.5	0.34	1.68
C3	0.58	8.5	0.56	2.76
D1	0.58	8.5	2.07	10.21
D2	0.58	8.5	0.26	1.28
D3	0.58	8.5	0.44	2.17
D4	0.58	8.5	1.57	7.74

Drainage Map (Post Construction)

Revised 10/21/2024



See attached Map for additional information

Culvert Sizing

All culverts are sized to meet a 25 year storm, and the Rational Method is used. We will use a Manning's Coefficient of 0.012 shall be for all culverts (concrete and HDPE). The d/D ratio and velocity was computed using HawsEDC On-Line Calculator (hawsedc.com).

FES 1a
Q = Qa1 = 4.54 cfs
Use 18" @ 3.5%
Q capacity = 21.94 cfs
V actual = 9.68 fps (d/D = 0.32)

Inlet 1
Q = Qa2 = 8.53 cfs
Use 18" @ 1.1%
Q capacity = 12.30 cfs
V actual = 7.36 fps (d/D = 0.63)

Inlet 2
Q = Inlet 1 + Qa3 = 8.53 + 0.89 = 9.42 cfs
Use 24" @ 0.3%
Q capacity = 13.84 cfs
V actual = 4.63 fps (d/D = 0.62)

Junction Box 3 (verify capacity)
Q = Inlet 2 + Qb3 + Exist 18" in Hurricane Gardens
(Culvert in Hurricane Gardens is an 18" ADS at 0.46%, Capacity = 7.95 cfs at d/D=0.85)
Q = 9.42 + 3.85 + 7.95 = 21.22 cfs
Existing 24" Discharging from Junc Box is 24" ADS @ 5.20%
Q capacity = 57.58 cfs ***Capacity appears to exist***
V actual = 16.61 fps (d/D = 0.43)

Inlet 4
Q = Qb2 = 1.58 cfs
Use 18" @ 0.5%
Q capacity = 8.29 cfs
V actual = 3.53 fps (d/D = 0.30)

Inlet 5
Q = Inlet 4 + Qb1 = 1.58 + 8.33 = 9.91 cfs
Use 18" @ 1.0%
Q capacity = 11.73 cfs
V actual = 7.25 fps (d/D = 0.72)

Inlet 6
Q = Inlet 5 + Qc1 = 9.91 + 9.37 = 19.28 cfs
Use 18" @ 4.60%
Q capacity = 25.15 cfs
V actual = 15.30 fps (d/D = 0.67)

Inlet 7
Q = Inlet 6 + Qd1 = 19.28 + 10.21 = 29.49 cfs
Use 24" @ 2.0%
Q capacity = 35.71 cfs
V actual = 12.38 fps (d/D = 0.71)

Inlet 8
Q = Inlet 7 + Qc2 + Qd2 = 29.49 + 1.68 + 1.28 = 32.45 cfs
Use 24" @ 2.25%
Q capacity = 37.87 cfs
V actual = 13.28 fps (d/D = 0.73)

Street Spreadflow Analysis & Inlet Capture

In this Section of the Report, we will examine how the stormwater in the street gutters may impact in proposed inlets. We will use our 27' street width (back of curb to back of curb), while giving allowances for the vertical portion of the curb on each side. The crown on the street shall be 3.0%. The available street width, to handle the stormwater, has a width of 26'. Our goal is to provide a minimum "non submerged" street width ("clear space") of 8 feet. We will use the following equation (as provided in "Urban Drainage and Flood Control District – Urban

Storm Drainage Manual, Volume 1, dated January, 2016) to determine the required length of throat to capture 100% of the stormwater:

Lt = 0.38 (Q^0.51)(Sl^0.058)(1/nSx)^0.46, where:
Lt = required length of throat to capture 100%
Q = flowrate (cfs)
Sl = slope of gutter
N = manning's coef. = 0.012
Sx = cross slope of street = 0.03

Since n and Sx are constant, the equation can be reduced to:
Lt = 0.38 (Q^0.51)(Sl^0.058)(38.38)
Lt = 14.58 (Q^0.51) (Sl^0.058)

Attention is called to the Appendix for the spreadsheets used to evaluate these areas.

Check Inlet 1 & 2 – Hillcrest Drive (Spreadflow Analysis)

Inlet 1
Q = Qa2 = 8.53 cfs
Gutter Slope = 1.50%
Height of water (from gutter) = 0.33'
Width of water (from gutter) = 11.0'
Clear space (half street) = 13.0 – 11.0' = 2.0'
Inlet 2
Q = Qa3 = 0.89 cfs
Gutter Slope = 1.50%
Height of water (from gutter) = 0.14'
Width of water (from gutter) = 4.5'
Clear space (half street) = 13.0 – 4.5' = 8.5'
Total Clear Space = 2.0 + 8.5 = 10.5'

Stormwater Capture – Inlet 1
Lt = 14.58 (8.53^0.51)(0.015^0.058) = 34.10 feet
Using a 20' throat:
Q captured = 5.01 cfs (58.7%)
Q bypass = 3.52 cfs (41.3%)

Stormwater Capture – Inlet 2
Lt = 14.58 (0.89^0.51)(0.015^0.058) = 10.77 feet
Using a 12' throat:
Q captured = 0.89 cfs (100%)
Q bypass = 0.00 cfs (0%)

Check Inlet 4 & 5 – Hillcrest Drive (Spreadflow Analysis)

Inlet 4

Q = Qb2 = 1.58 cfs
Gutter Slope = 0.5%
Height of water (from gutter) = 0.21'
Width of water (from gutter) = 7.0'
Clear space (half street) = 13.0 – 7.0 = 6.0'

Inlet 5

Q = Qb1 = 8.33 fps
Gutter Slope = 0.5%
Height of water (from gutter) = 0.39'
Width of water (from gutter) = 13.0'
Clear space (half street) = 13.0 – 13.0' = 0.0'

Total Clear Space = 6.0 + 0.0 = 6.0'

TRY 10 YEAR STORM

Inlet 4

Q = Qb2 = 1.26 cfs
Gutter Slope = 0.5%
Height of water (from gutter) = 0.20'
Width of water (from gutter) = 6.5'
Clear space (half street) = 13.0 – 6.5' = 6.5'

Inlet 5

Q = Qb1 = 6.66 cfs
Gutter Slope = 0.5%
Height of water (from gutter) = 0.36'
Width of water (from gutter) = 12.0'
Clear space (half street) = 13.0 – 12.0' = 1.0'

Total Clear Space = 6.5 + 1.0 = 7.5'

Stormwater Capture – Inlet 4

Lt = 14.58 (1.26^0.51)(0.005^0.058) = 12.06 feet
Using a 13' throat:
Q captured = 1.26 cfs (100%)
Q bypass = 0.00 cfs (0%)

Stormwater Capture – Inlet 5

Lt = 14.58 (6.66^0.51)(0.005^0.058) = 28.20 feet
Using a 24' throat:
Q captured = 5.67 cfs (85.1%)
Q bypass = 0.99 cfs (14.9%)

Check Inlet 6 & Across Street – Hillcrest Drive (Spreadflow Analysis)

Inlet 6

Q = Qc1 = 9.37 cfs

Gutter Slope = 2.67%

Height of water (from gutter) = 0.30'

Width of water (from gutter) = 10.0'

Clear space (half street) = 13.0 – 10.0' = 3.0'

Across from Inlet 6

Q = Qc2 = 1.68 cfs

Gutter Slope = 2.67%

Height of water (from gutter) = 0.17'

Width of water (from gutter) = 5.5'

Clear space (half street) = 13.0 – 5.5 = 7.5'

Total Clear Space = 3.0 + 7.5 = 10.5'

Stormwater Capture – Inlet 6

Q = 9.37 + 0.99 (bypass from Inlet 5) = 10.36 cfs

Lt = 14.58 (10.36^0.51)(0.0267^0.058) = 38.93 feet

Using a 30' throat:

Q captured = 7.99 cfs (77.1%)

Q bypass = 2.37 cfs (22.9%)

Check Inlet 7 & 8 – Hillcrest (Spreadflow Analysis)

Inlet 7

Q = Qd1 = 10.21 cfs

Gutter Slope = 4.88%

Height of water (from gutter) = 0.29'

Width of water (from gutter) = 9.5'

Clear space (half street) = 13.0 – 9.5' = 2.5'

Inlet 8

Q = Qc2 + Qd2 = 2.42 + 2.17 = 2.96 cfs

Gutter Slope = 4.88%

Height of water (from gutter) = 0.18'

Width of water (from gutter) = 6.0'

Clear space (half street) = 13.0 – 6.0' = 7.0'

Total Clear Space = 2.5 + 7.0 = 9.5'

Stormwater Capture – Inlet 7

Q = 10.21 + 2.37 (bypass from Inlet 6) = 12.58 cfs

Lt = 14.58 (12.58^0.51)(0.0488^0.058) = 44.5 feet

Using a 30' throat:

Q captured = 8.48 cfs (67.4%)

Q bypass = 4.10 cfs (0%)

Stormwater Capture – Inlet 8
Lt = 14.58 (2.96^0.51)(0.0488^0.058) = 21.28 feet
Using a 22' throat:
Q captured = 21.28 cfs (100%)
Q bypass = 0.00 cfs (0%)

Curb Cut on Street at North side of Detention Pond
Q = Qd4 + 4.10 (bypass from Inlet 7) = 7.74 + 4.10 = 11.84 cfs
Use a 6" x 8' Curb Cut with a slope of 3%:
Q = (1.49/n)(A)(R^2/3)(S^1/2) = (1.49/0.012)(4)(4.33)(0.17) = 22.44 cfs

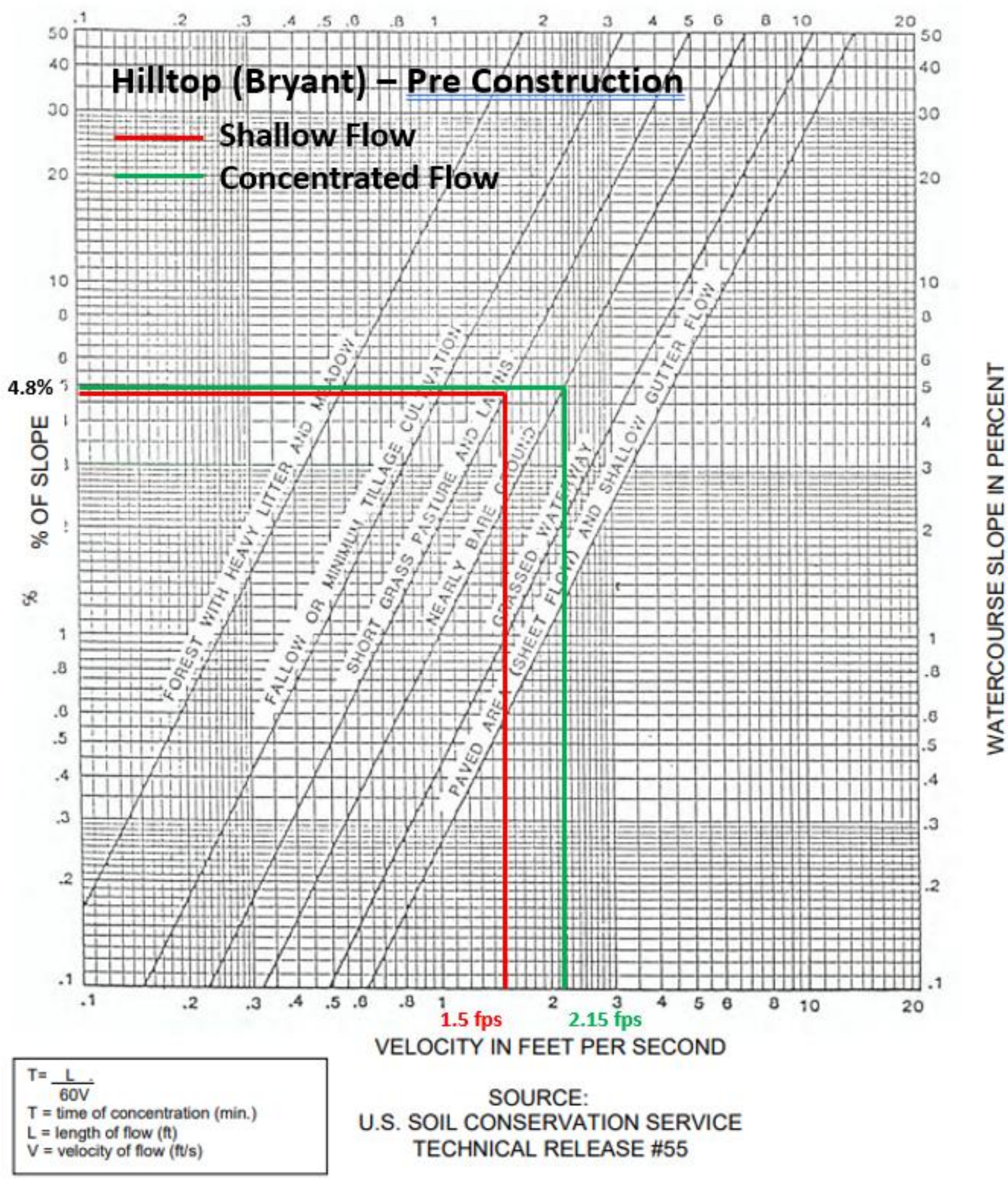
Detention Facility Computations

In this section, we will size the detention facility located in the Common Area (West side of the project). At the completion of this section, a summary of pre and post flows will be provided. Whereas the time of concentration will be used to determine the intensity (I), the runoff coefficient (C) for each storm analysis shall be based on that determined on pages 5 and 6 of this report.

Time of Concentration (tc)

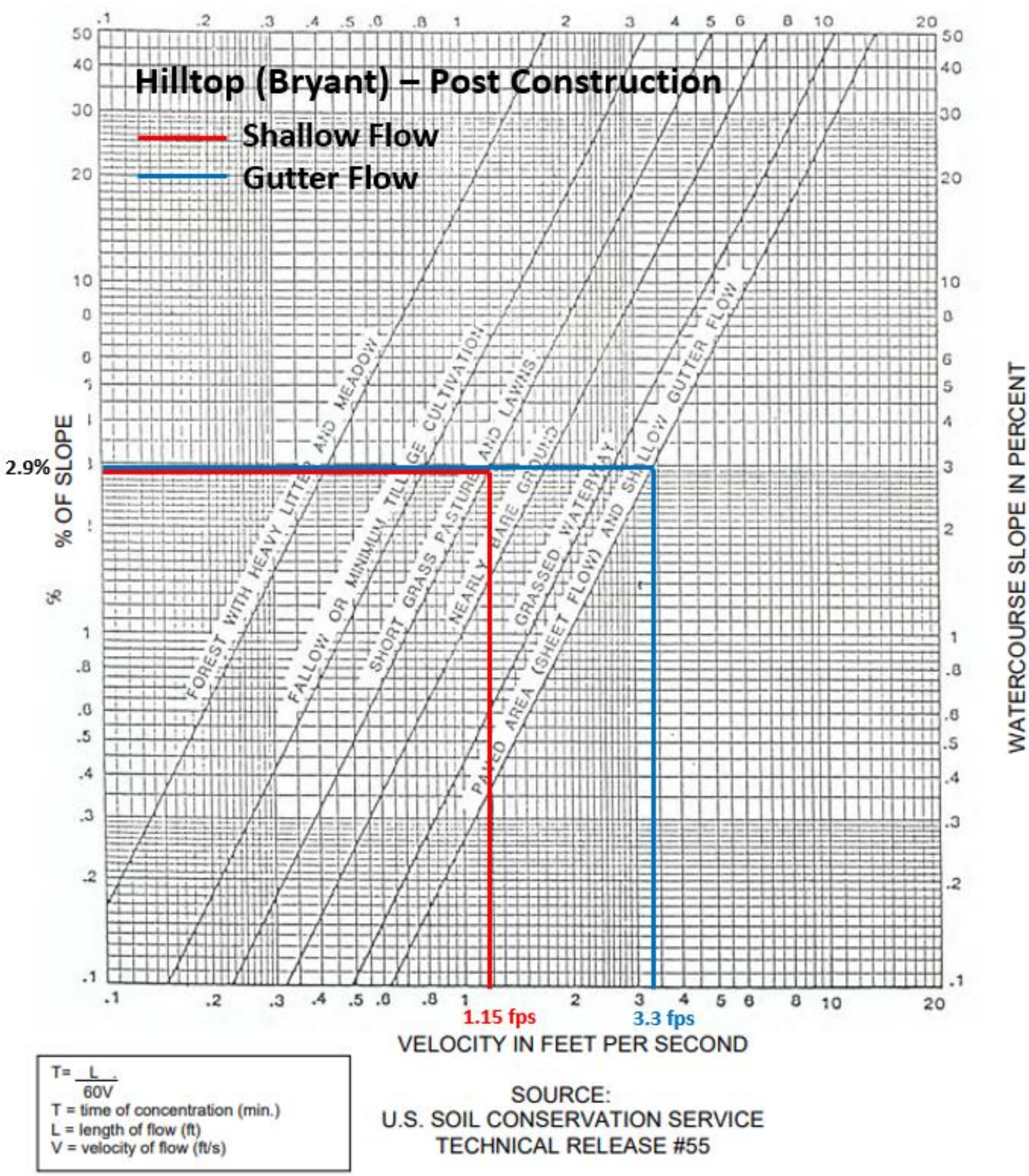
In determining the time of concentration, we must first determine the velocity of the runoff based on the type of ground cover and type of flow. The total tc is a sum of the tc for overland flow, the tc for shallow concentrated flow, and the tc for channelized flow. For this analysis, we will use the US Soil Conservation Service Technical Release #55, “Watercourse Slope vs Velocity” graph. A Pre Construction and Post Construction graph for each watershed is provided on the following pages.

Pre Construction Time of Concentration (tc)



Pre-Construction tc = Σ(L/(60)(V)) = 6 min

Post Construction Time of Concentration (tc)



Post-Construction tc = Σ(L/(60)(V)) = 9 min

Stage – Storage Table

The following Stage Storage Table is provided, based on the grading plan contained in the Civil Plans. The accumulative storage is provided in the right most column.

TYPE 3			
Stage - Storage for Irregular Detention Basin			
Top Elev	Bottom Elev	Increment	
353.5	345.5	1	
Stage	Area	∆ Volume	Volume
msl	sf	cf	cf
345.50	1	0	0
346.50	1853.50	927.25	927.25
347.50	2951.40	2402.45	3329.70
348.50	4240.13	3595.77	6925.47
349.50	5637.46	4938.80	11864.26
350.50	7118.75	6378.11	18242.37
351.50	8673.71	7896.23	26138.60
352.50	10265.99	9469.85	35608.45
353.50	11858.27	11062.13	46670.58

Stage – Discharge Table

The following Stage Discharge Table is provided, based on the grading plan contained in the Civil Plans. The discharge structure planned for this facility is shown later in this report.

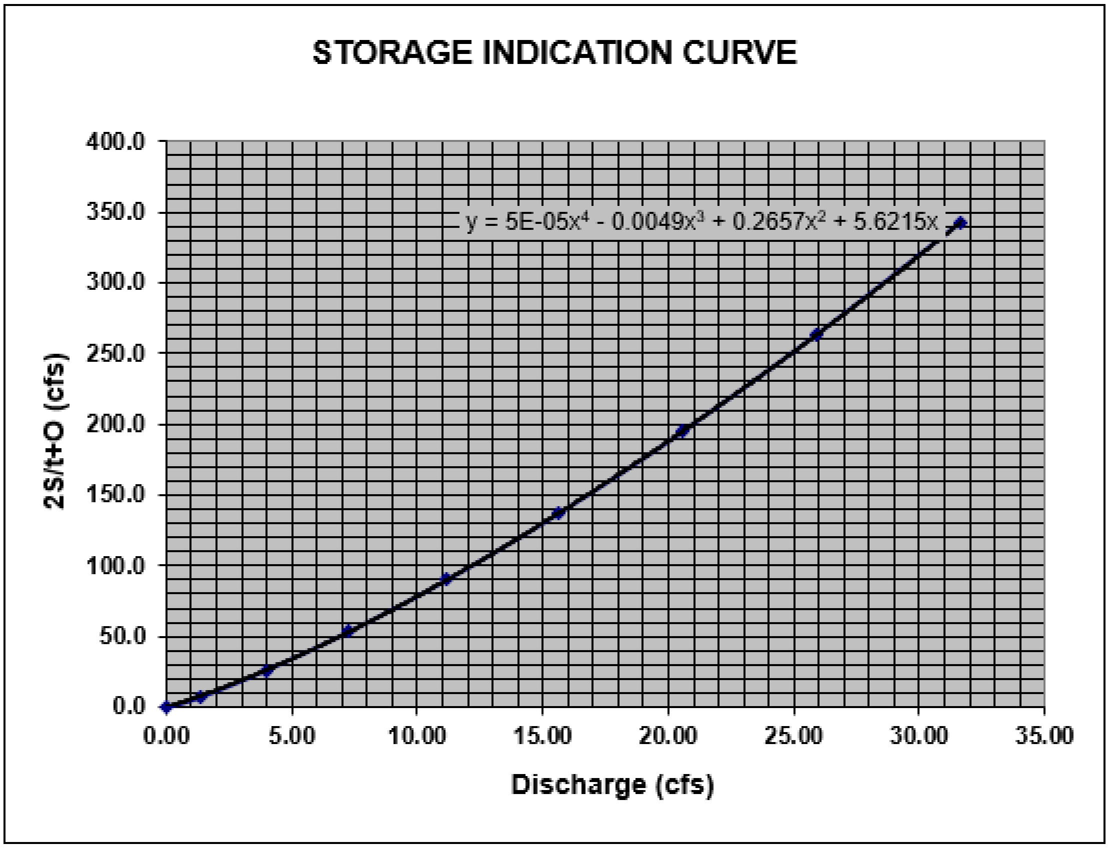
TYPE 2

Stage - Discharge for Rectangular Weir

FL Discharge	Beginning Elevation	Elevation Increment	Top of Basin
345.50	345.50	1.00	353.50

Stage	Head (H)	Weir Length (L)	Area (A)	Orifice Coefficient (C)	Velocity	Discharge (Q)
msl	ft	ft	sf		ft/s	cfs
345.50	0.00	0.42	0.00	3.33	0.00	0.00
346.50	1.00	0.42	0.42	3.33	3.33	1.40
347.50	2.00	0.42	0.84	3.33	4.71	3.96
348.50	3.00	0.42	1.26	3.33	5.77	7.27
349.50	4.00	0.42	1.68	3.33	6.66	11.19
350.50	5.00	0.42	2.10	3.33	7.45	15.64
351.50	6.00	0.42	2.52	3.33	8.16	20.56
352.50	7.00	0.42	2.94	3.33	8.81	25.90
353.50	8.00	0.42	3.36	3.33	9.42	31.65

Storage Indication Curve



Alternate Routing Time

The following spreadsheets represent the Hydrograph Routing for the various storm events. In each case, the Routing Storm Duration time was adjusted to provide the maximum storage required. Also, runoff coefficients C have been adjusted for each storm event:

Storm Event	Pre C	Post C
2	0.41	0.47
5	0.44	0.50
10	0.47	0.53
25	0.52	0.58
50	0.55	0.61
100	0.59	0.66

2 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0001	-0.0049	0.2657	5.6215

HYDROGRAPH ROUTING FOR 2 YEAR DESIGN STORM

Routing Storm Duration

20 **minutes**

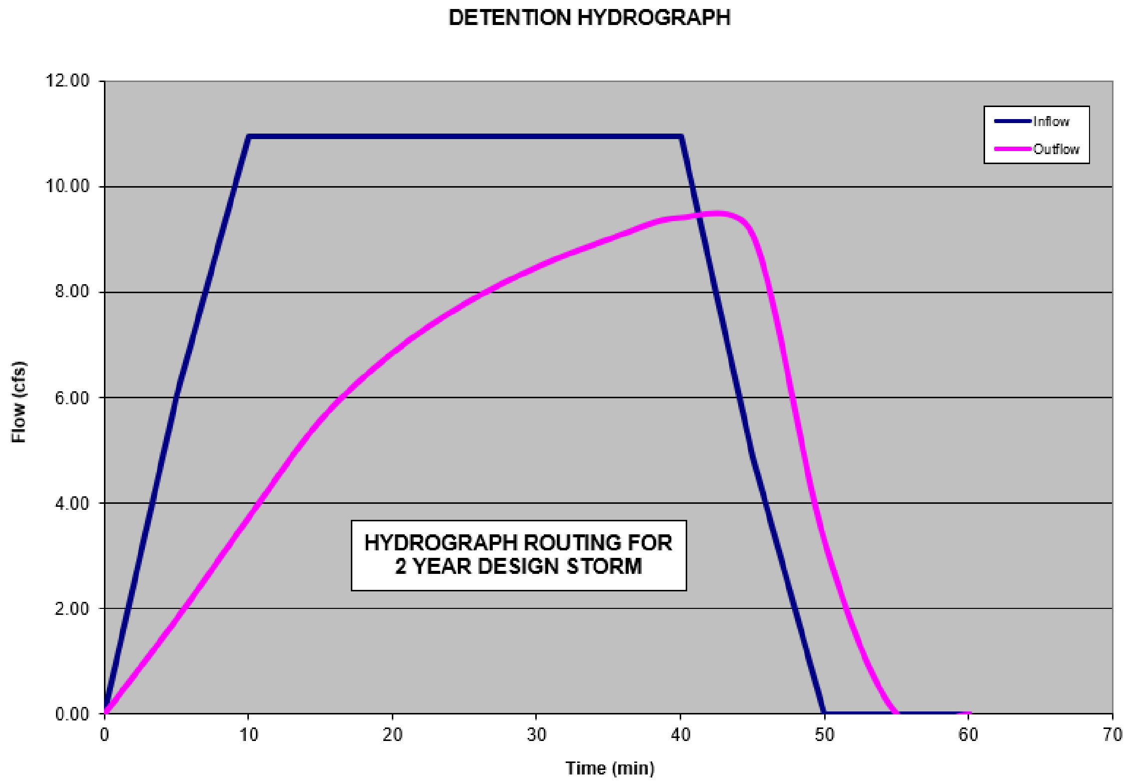
	1	2	3	4	5	6	7	8
Time	I_1	I_1+I_2	$2S_1/t-Q_1$	$2S_2/t+Q_2$	Q_2	S_2	2S/t-Q	Col 4 - 7
min	cfs	cfs	cfs	cfs	cfs	cf	from eqn.	
0	0.00	15.97	0	15.973	0	0	15.972	0.001
5	8.87	24.85	10.876	35.723	2.548	2013.7	35.724	-0.001
10	15.97	31.95	25.334	57.280	5.194	4579.3	57.280	0.000
15	15.97	31.95	41.818	73.764	7.731	7432.4	73.764	-0.001
20	15.97	23.07	54.737	77.809	9.513	9637.5	77.810	-0.001
25	7.10	7.10	57.939	65.038	9.935	10181.1	8.503	56.535
30	0.00	0.00	62.199	62.199	1.520	9527.8	0.000	62.199
35	0.00	0.00	50.999	50.999	0.000	9329.8	0.000	50.999
40	0.00	0.00	51.199	51.199	0.000	7649.8	0.000	51.199
45	0.00	0.00	51.399	51.399	0.000	7679.8	0.000	51.399
50	0.00	0.00	51.599	51.599	0.000	7709.8	0.000	51.599
55	0.00	0.00	51.799	51.799	0.000	7739.8	0.000	51.799
60	0.00	0.00	51.999	51.999	0.000	7769.8	0.000	51.999

Actual Maximum Storage needed is 10181.1 cubic feet

Maximum Storage required is achieved at an elev. = 349.32

Maximum Allowable (undeveloped) Discharge is 11.99 cfs

Maximum Discharge for the above storm is 9.93 cfs



5 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0001	-0.0049	0.2657	5.6215

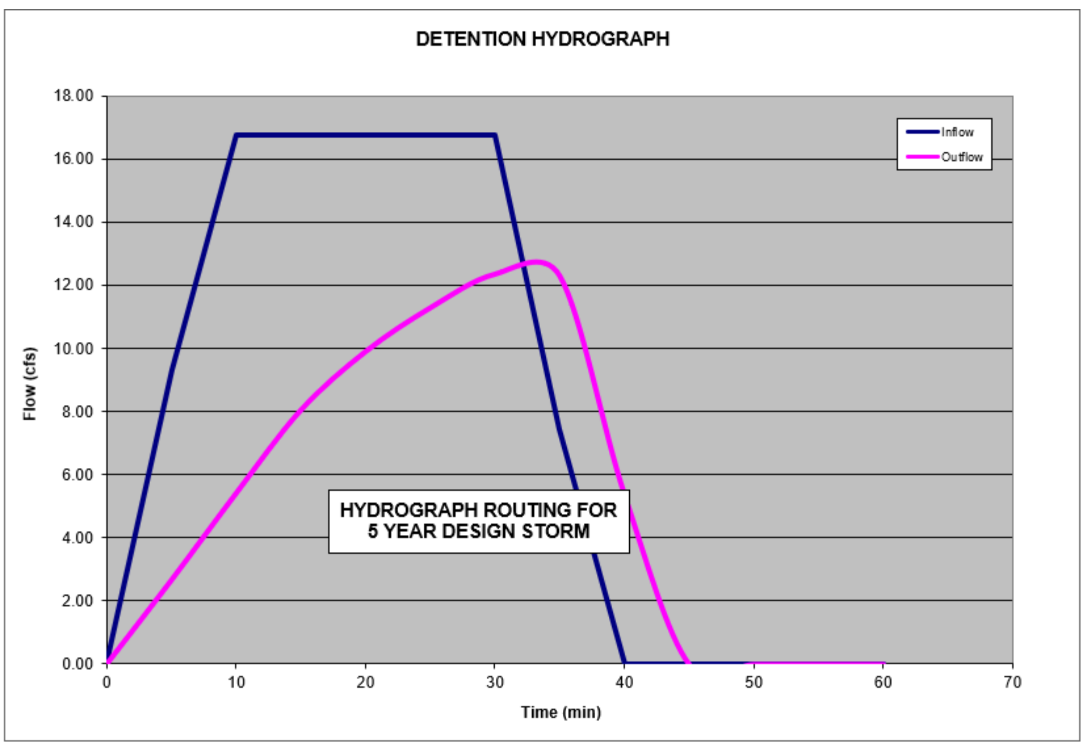
HYDROGRAPH ROUTING FOR 5 YEAR DESIGN STORM

Routing Storm Duration

30 **minutes**

	1	2	3	4	5	6	7	8
Time	I_1	I_1+I_2	$2S_1/t-Q_1$	$2S_2/t+Q_2$	Q_2	S_2	2S/t-Q	Col 4 - 7
min	cfs	cfs	cfs	cfs	cfs	cf	from eqn.	
0	0.00	16.75	0	16.750	0	0	16.749	0.001
5	9.31	26.06	11.428	37.484	2.661	2113.4	37.485	-0.001
10	16.75	33.50	26.658	60.157	5.413	4810.6	60.158	-0.001
15	16.75	33.50	44.056	77.555	8.051	7816.0	77.555	0.001
20	16.75	33.50	57.739	91.238	9.908	10147.0	91.236	0.002
25	16.75	33.50	68.648	102.147	11.295	11991.4	102.146	0.001
30	16.75	24.19	77.420	101.614	12.364	13467.5	101.615	-0.001
35	7.44	7.44	76.989	84.434	12.312	13395.2	36.484	47.950
40	0.00	0.00	73.856	73.856	5.389	11856.7	0.000	73.856
45	0.00	0.00	74.056	74.056	0.000	11078.4	0.000	74.056
50	0.00	0.00	74.256	74.256	0.000	11108.4	0.000	74.256
55	0.00	0.00	74.456	74.456	0.000	11138.4	0.000	74.456
60	0.00	0.00	74.656	74.656	0.000	11168.4	0.000	74.656

Actual Maximum Storage needed is 13467.5 cubic feet
Maximum Storage required is achieved at an elev. = 349.89
Maximum Allowable (undeveloped) Discharge is 14.9 cfs
Maximum Discharge for the above storm is 12.36 cfs



10 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0001	-0.0049	0.2657	5.6215

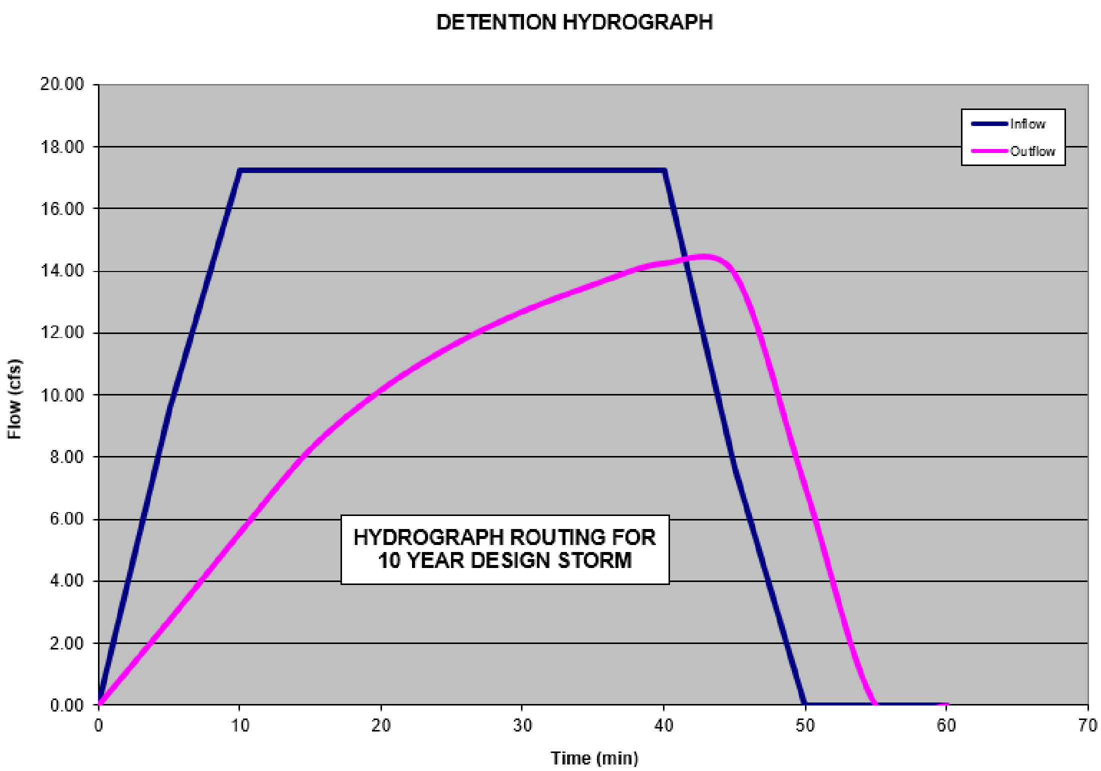
HYDROGRAPH ROUTING FOR 10 YEAR DESIGN STORM

Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	17.24	0	17.240	0	0	17.239	0.001
5	9.58	26.82	11.778	38.596	2.731	2176.3	38.597	-0.001
10	17.24	34.48	27.496	61.977	5.550	4956.9	61.976	0.001
15	17.24	34.48	45.475	79.956	8.251	8058.9	79.956	0.000
20	17.24	34.48	59.644	94.124	10.156	10469.9	94.123	0.001
25	17.24	34.48	70.962	105.442	11.581	12381.4	105.442	0.000
30	17.24	34.48	80.081	114.561	12.681	13914.2	114.560	0.001
35	17.24	34.48	87.472	121.953	13.544	15152.5	121.953	0.000
40	17.24	24.90	93.489	118.391	14.232	16158.1	118.390	0.001
45	7.66	7.66	90.587	98.249	13.902	15673.3	50.238	48.011
50	0.00	0.00	84.384	84.384	7.032	13682.5	0.000	84.384
55	0.00	0.00	84.584	84.584	0.000	12657.6	0.000	84.584
60	0.00	0.00	84.784	84.784	0.000	12687.6	0.000	84.784

Actual Maximum Storage needed is 16158.1 cubic feet
Maximum Storage required is achieved at an elev. = 350.25
Maximum Allowable (undeveloped) Discharge is 17.36 cfs
Maximum Discharge for the above storm is 14.23 cfs



25 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0001	-0.0049	0.2657	5.6215

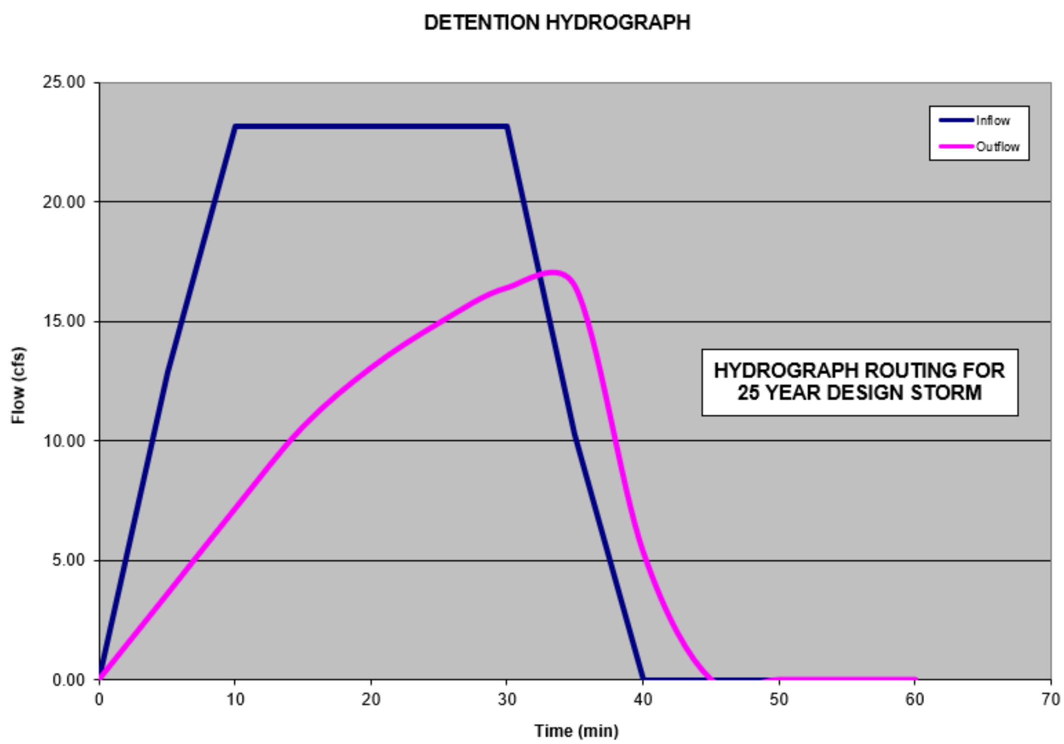
HYDROGRAPH ROUTING FOR 25 YEAR DESIGN STORM

Routing Storm Duration

30 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	23.16	0	23.158	0	0	23.159	-0.001
5	12.87	36.02	16.041	52.065	3.559	2939.9	52.066	-0.001
10	23.16	46.32	37.780	84.097	7.142	6738.4	84.098	-0.001
15	23.16	46.32	62.939	109.256	10.579	11027.7	109.256	0.000
20	23.16	46.32	83.168	129.485	13.044	14431.8	129.484	0.001
25	23.16	46.32	99.641	145.958	14.922	17184.4	145.957	0.001
30	23.16	33.45	113.166	146.617	16.396	19434.3	146.616	0.001
35	10.29	10.29	113.708	124.001	16.454	19524.4	36.239	87.762
40	0.00	0.00	113.484	113.484	5.359	17796.3	0.000	113.484
45	0.00	0.00	113.684	113.684	0.000	17022.6	0.000	113.684
50	0.00	0.00	113.884	113.884	0.000	17052.6	0.000	113.884
55	0.00	0.00	114.084	114.084	0.000	17082.6	0.000	114.084
60	0.00	0.00	114.284	114.284	0.000	17112.6	0.000	114.284

Actual Maximum Storage needed is 19524.4 cubic feet
Maximum Storage required is achieved at an elev. = 350.65
Maximum Allowable (undeveloped) Discharge is 19.53 cfs
Maximum Discharge for the above storm is 16.45 cfs



50 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0001	-0.0049	0.2657	5.6215

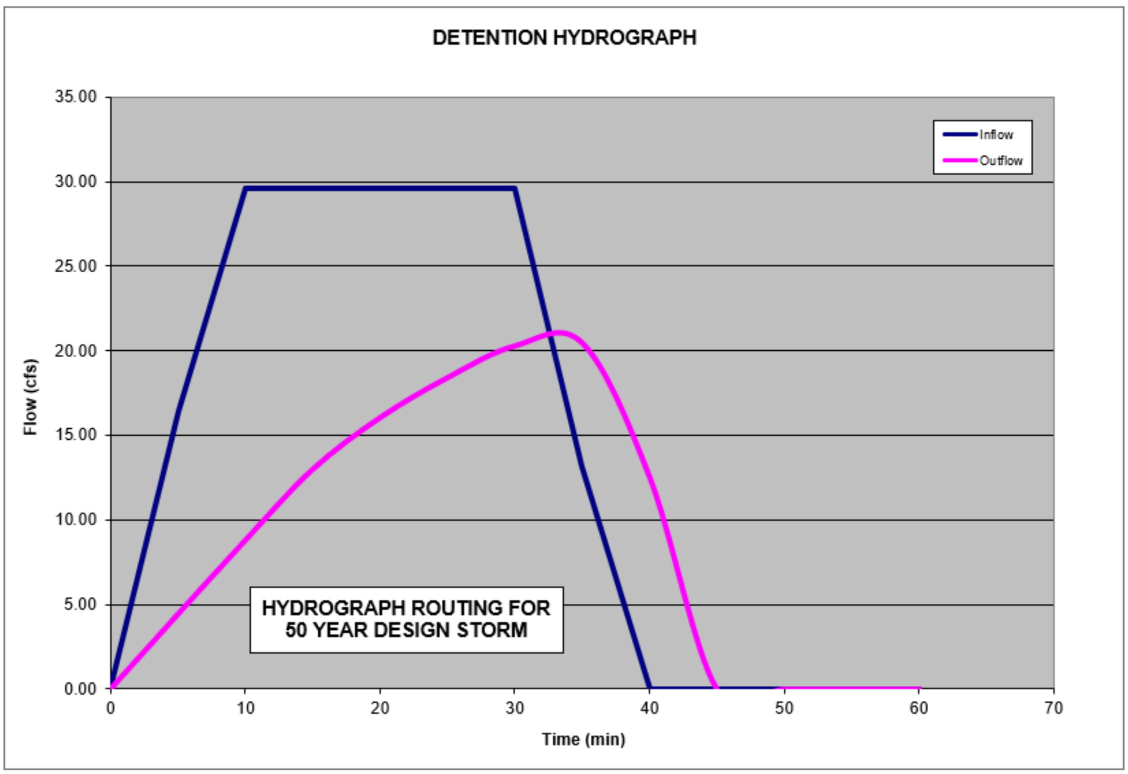
HYDROGRAPH ROUTING FOR 50 YEAR DESIGN STORM

Routing Storm Duration

30 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	29.62	0	29.616	0	0	29.615	0.001
5	16.45	46.07	20.781	66.850	4.417	3779.8	66.850	0.000
10	29.62	59.23	49.291	108.522	8.779	8710.6	108.523	-0.001
15	29.62	59.23	82.573	141.804	12.974	14332.1	141.804	0.000
20	29.62	59.23	109.747	168.978	16.029	18866.3	168.978	0.000
25	29.62	59.23	132.202	191.433	18.388	22588.5	191.434	0.000
30	29.62	42.78	150.904	193.682	20.265	25675.3	193.683	-0.001
35	13.16	13.16	152.783	165.945	20.449	25984.8	102.860	63.085
40	0.00	0.00	141.080	141.080	12.532	23011.9	0.000	141.080
45	0.00	0.00	141.280	141.280	0.000	21162.0	0.000	141.280
50	0.00	0.00	141.480	141.480	0.000	21192.0	0.000	141.480
55	0.00	0.00	141.680	141.680	0.000	21222.0	0.000	141.680
60	0.00	0.00	141.880	141.880	0.000	21252.0	0.000	141.880

Actual Maximum Storage needed is 25984.8 cubic feet
Maximum Storage required is achieved at an elev. = 351.37
Maximum Allowable (undeveloped) Discharge is 25.68 cfs
Maximum Discharge for the above storm is 20.45 cfs



100 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0001	-0.0049	0.2657	5.6215

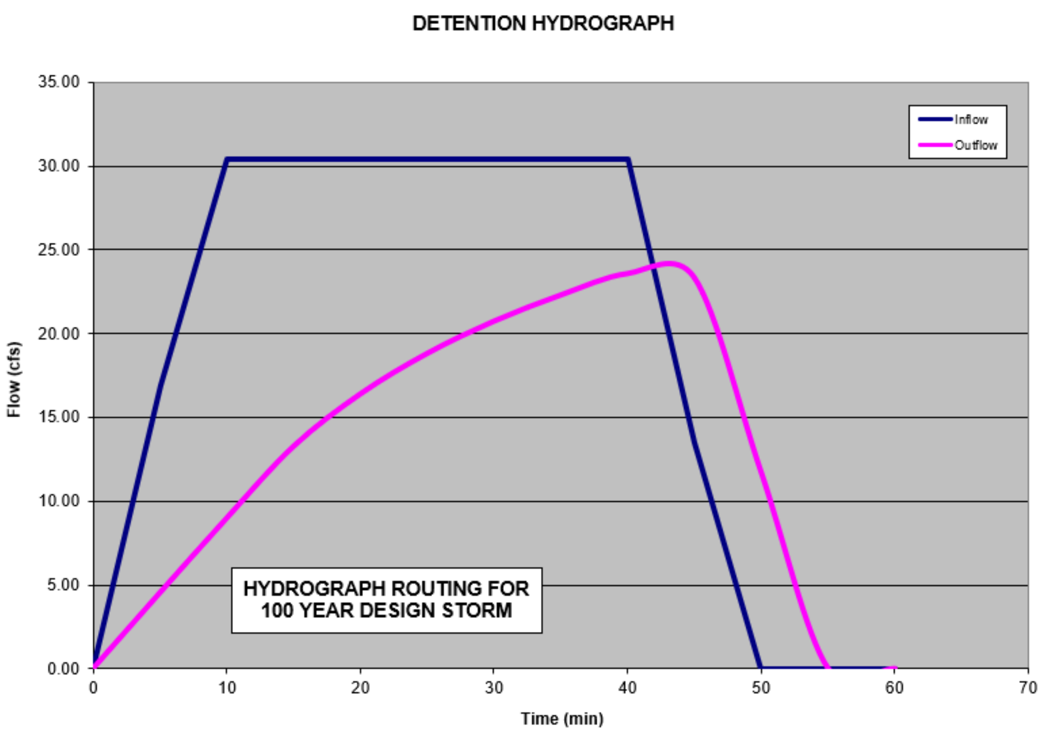
HYDROGRAPH ROUTING FOR 100 YEAR DESIGN STORM

Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time	I_1	I_1+I_2	$2S_1/t-Q_1$	$2S_2/t+Q_2$	Q_2	S_2	2S/t-Q	Col 4 - 7
min	cfs	cfs	cfs	cfs	cfs	cf	from eqn.	
0	0.00	30.44	0	30.441	0	0	30.440	0.001
5	16.91	47.35	21.393	68.745	4.524	3887.5	68.746	-0.001
10	30.44	60.88	50.780	111.662	8.983	8964.4	111.661	0.001
15	30.44	60.88	85.119	146.000	13.272	14758.5	146.001	-0.001
20	30.44	60.88	113.200	174.082	16.400	19440.0	174.083	-0.001
25	30.44	60.88	136.442	197.324	18.820	23289.3	197.323	0.001
30	30.44	60.88	155.829	216.711	20.747	26486.5	216.710	0.001
35	30.44	60.88	172.091	232.972	22.310	29160.1	232.973	-0.001
40	30.44	43.97	185.788	229.759	23.592	31407.1	229.758	0.001
45	13.53	13.53	183.077	196.607	23.341	30962.7	94.375	102.232
50	0.00	0.00	173.395	173.395	11.706	27735.1	0.000	173.395
55	0.00	0.00	173.595	173.595	0.000	26009.2	0.000	173.595
60	0.00	0.00	173.795	173.795	0.000	26039.2	0.000	173.795

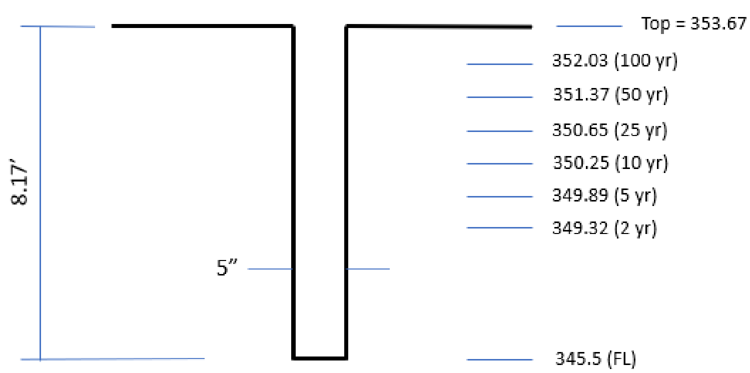
Actual Maximum Storage needed is 31407.1 cubic feet
Maximum Storage required is achieved at an elev. = 352.03
Maximum Allowable (undeveloped) Discharge is 29.36 cfs
Maximum Discharge for the above storm is 23.59 cfs



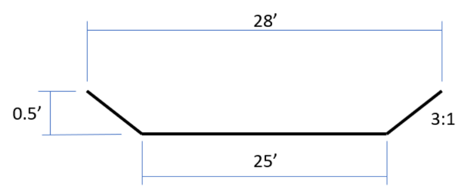
Summary – Detention

Storm Event	Volume Needed (cf)	WSE	Max Discharge Allowed (cfs)	Max Discharge Model (cfs)
2	10181.1	349.32	11.99	9.93
5	13467.5	349.89	14.90	12.36
10	16158.1	350.25	17.36	14.23
25	19524.4	350.65	19.53	16.45
50	25984.8	351.37	25.68	20.45
100	31407.1	352.03	29.36	23.59

Discharge Structure Detail



Overflow Structure Detail

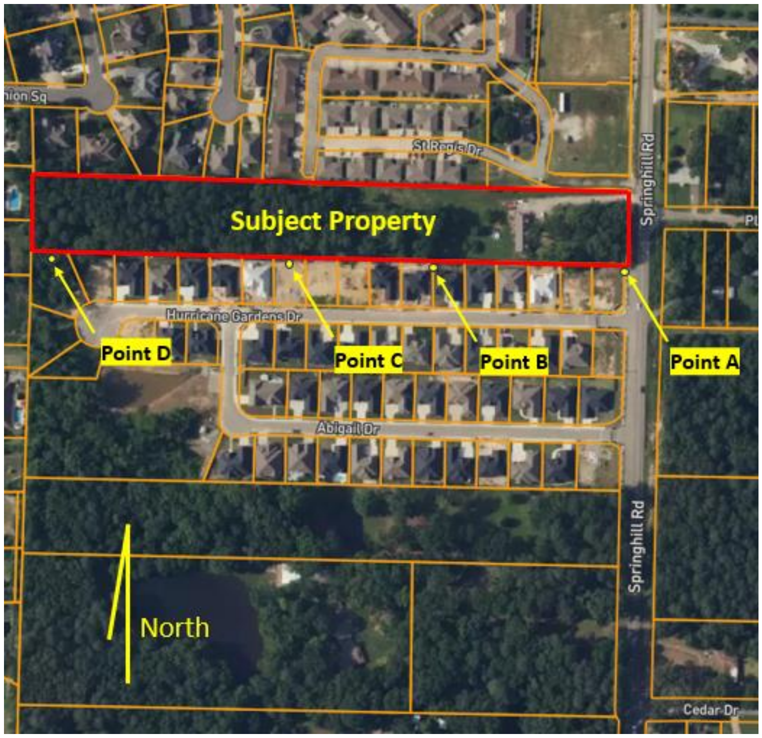


Q = (1.49/n)(A)(R^2/3)(S^0.5)

Q = (1.49/0.025)(13.25)(0.60)(0.1) = 47.38 cfs

Required Capacity = 23.59 cfs (2) = 47.18 cfs

Study Point Summary (25 yr Storm)



Study Point	Pre Construction Q (cfs)	Post Construction Q (no detention) (cfs)	Post Construction Q (with detention) (cfs)	Change - Pre to Post (with detention) (cfs)
A	12.88	16.81	16.81	3.93
B	10.53	0	0	-10.53
C	11.01	0	0	-11.01
D	17.74	38.08	16.45	-1.29
TOTAL	52.16	54.89	33.26	-18.9

** Existing culvert originating at the Junction Box near the NE corner of Hurricane Gardens has adequate capacity to accept this slight increase in flow.*

Downstream Considerations

The discharge from the proposed Detention Facility will enter into an existing ditch that drains to the West, into Hurricane Lake, Phase 3. The ditch exists between Lots 47 and 48 of said development (based on Saline County GIS map). A 54" CMP (Helical) culvert exists under Worth Ave, at a grade of 0.7% (as shot in the field). Using an n of 0.012, the capacity of this culvert is computed at 183.65 cfs at d/D of 0.85 (velocity = 12.75 fps). It should be noted that the estimated post construction discharge is 1.29 cfs less than the estimated existing runoff from the same area. Therefore, this development should not have a negative impact on the downstream properties.

Source: Saline County GIS

Engineering Certification

I, Tim Lemons, Arkansas Registered Professional Engineer No. 7373, hereby certify that the drainage reports, and calculations contained in this report, have been prepared in accordance with sound engineering practice and principles, and based on best known available data. Improvements as outlined in this report and depicted on the preliminary plat and design drawings should not increase the risk of endangerment to life or have negative impacts on adjacent or downstream property or watersheds.

Timothy B. Lemons, PE
Arkansas Professional Engineer, #7373

Appendix

GUTTER CAPACITY OF STREETS - 27' BC to BC								
Slope = 0.5%, n = 0.012								
Width (ft)	Slope	Height (ft)	Area (sf)	R	R^2/3	S	S^1/2	Q (cfs)
0.5	0.030	0.02	0.00	0.01	0.04	0.00500	0.0707	0.00
1	0.030	0.03	0.02	0.01	0.06	0.00500	0.0707	0.01
1.5	0.030	0.05	0.03	0.02	0.08	0.00500	0.0707	0.02
2	0.030	0.06	0.06	0.03	0.10	0.00500	0.0707	0.05
2.5	0.030	0.08	0.09	0.04	0.11	0.00500	0.0707	0.09
3	0.030	0.09	0.14	0.04	0.13	0.00500	0.0707	0.15
3.5	0.030	0.11	0.18	0.05	0.14	0.00500	0.0707	0.22
4	0.030	0.12	0.24	0.06	0.15	0.00500	0.0707	0.32
4.5	0.030	0.14	0.30	0.07	0.16	0.00500	0.0707	0.44
5	0.030	0.15	0.38	0.07	0.18	0.00500	0.0707	0.58
5.5	0.030	0.17	0.45	0.08	0.19	0.00500	0.0707	0.75
6	0.030	0.18	0.54	0.09	0.20	0.00500	0.0707	0.94
6.5	0.030	0.20	0.63	0.10	0.21	0.00500	0.0707	1.17
7	0.030	0.21	0.74	0.10	0.22	0.00500	0.0707	1.43
7.5	0.030	0.23	0.84	0.11	0.23	0.00500	0.0707	1.71
8.5	0.030	0.26	1.08	0.13	0.25	0.00500	0.0707	2.39
9	0.030	0.27	1.22	0.13	0.26	0.00500	0.0707	2.79
9.5	0.030	0.29	1.35	0.14	0.27	0.00500	0.0707	3.22
10	0.030	0.30	1.50	0.15	0.28	0.00500	0.0707	3.69
10.5	0.030	0.32	1.65	0.16	0.29	0.00500	0.0707	4.21
11	0.030	0.33	1.82	0.16	0.30	0.00500	0.0707	4.76
11.5	0.030	0.35	1.98	0.17	0.31	0.00500	0.0707	5.36
12	0.030	0.36	2.16	0.18	0.32	0.00500	0.0707	6.01
12.5	0.030	0.38	2.34	0.19	0.33	0.00500	0.0707	6.70
13	0.030	0.39	2.54	0.19	0.33	0.00500	0.0707	7.44

GUTTER CAPACITY OF STREETS - 27' BC to BC								
Slope = 1.50%, n = 0.012								
Width	**Slope**	**Height**	**Area**	**R**	**R^2/3**	**S**	**S^1/2**	**Q**
(ft)		**(ft)**	**(sf)**					**(cfs)**
0.5	0.030	0.02	0.00	0.01	0.04	0.01500	0.1225	0.00
1	0.030	0.03	0.02	0.01	0.06	0.01500	0.1225	0.01
1.5	0.030	0.05	0.03	0.02	0.08	0.01500	0.1225	0.04
2	0.030	0.06	0.06	0.03	0.10	0.01500	0.1225	0.09
2.5	0.030	0.08	0.09	0.04	0.11	0.01500	0.1225	0.16
3	0.030	0.09	0.14	0.04	0.13	0.01500	0.1225	0.26
3.5	0.030	0.11	0.18	0.05	0.14	0.01500	0.1225	0.39
4	0.030	0.12	0.24	0.06	0.15	0.01500	0.1225	0.55
4.5	0.030	0.14	0.30	0.07	0.16	0.01500	0.1225	0.76
5	0.030	0.15	0.38	0.07	0.18	0.01500	0.1225	1.01
5.5	0.030	0.17	0.45	0.08	0.19	0.01500	0.1225	1.30
6	0.030	0.18	0.54	0.09	0.20	0.01500	0.1225	1.64
6.5	0.030	0.20	0.63	0.10	0.21	0.01500	0.1225	2.03
7	0.030	0.21	0.74	0.10	0.22	0.01500	0.1225	2.47
7.5	0.030	0.23	0.84	0.11	0.23	0.01500	0.1225	2.97
8.5	0.030	0.26	1.08	0.13	0.25	0.01500	0.1225	4.15
9	0.030	0.27	1.22	0.13	0.26	0.01500	0.1225	4.83
9.5	0.030	0.29	1.35	0.14	0.27	0.01500	0.1225	5.58
10	0.030	0.30	1.50	0.15	0.28	0.01500	0.1225	6.40
10.5	0.030	0.32	1.65	0.16	0.29	0.01500	0.1225	7.29
11	0.030	0.33	1.82	0.16	0.30	0.01500	0.1225	8.25
11.5	0.030	0.35	1.98	0.17	0.31	0.01500	0.1225	9.29
12	0.030	0.36	2.16	0.18	0.32	0.01500	0.1225	10.41
12.5	0.030	0.38	2.34	0.19	0.33	0.01500	0.1225	11.61
13	0.030	0.39	2.54	0.19	0.33	0.01500	0.1225	12.89

GUTTER CAPACITY OF STREETS - 27' BC to BC								
Slope = 2.67%, n = 0.012								
Width	**Slope**	**Height**	**Area**	**R**	**R^2/3**	**S**	**S^1/2**	**Q**
(ft)		**(ft)**	**(sf)**					**(cfs)**
0.5	0.030	0.02	0.00	0.01	0.04	0.02670	0.1634	0.00
1	0.030	0.03	0.02	0.01	0.06	0.02670	0.1634	0.02
1.5	0.030	0.05	0.03	0.02	0.08	0.02670	0.1634	0.05
2	0.030	0.06	0.06	0.03	0.10	0.02670	0.1634	0.12
2.5	0.030	0.08	0.09	0.04	0.11	0.02670	0.1634	0.21
3	0.030	0.09	0.14	0.04	0.13	0.02670	0.1634	0.34
3.5	0.030	0.11	0.18	0.05	0.14	0.02670	0.1634	0.52
4	0.030	0.12	0.24	0.06	0.15	0.02670	0.1634	0.74
4.5	0.030	0.14	0.30	0.07	0.16	0.02670	0.1634	1.01
5	0.030	0.15	0.38	0.07	0.18	0.02670	0.1634	1.34
5.5	0.030	0.17	0.45	0.08	0.19	0.02670	0.1634	1.73
6	0.030	0.18	0.54	0.09	0.20	0.02670	0.1634	2.18
6.5	0.030	0.20	0.63	0.10	0.21	0.02670	0.1634	2.70
7	0.030	0.21	0.74	0.10	0.22	0.02670	0.1634	3.29
7.5	0.030	0.23	0.84	0.11	0.23	0.02670	0.1634	3.96
8.5	0.030	0.26	1.08	0.13	0.25	0.02670	0.1634	5.53
9	0.030	0.27	1.22	0.13	0.26	0.02670	0.1634	6.44
9.5	0.030	0.29	1.35	0.14	0.27	0.02670	0.1634	7.44
10	0.030	0.30	1.50	0.15	0.28	0.02670	0.1634	8.53
10.5	0.030	0.32	1.65	0.16	0.29	0.02670	0.1634	9.72
11	0.030	0.33	1.82	0.16	0.30	0.02670	0.1634	11.01
11.5	0.030	0.35	1.98	0.17	0.31	0.02670	0.1634	12.40
12	0.030	0.36	2.16	0.18	0.32	0.02670	0.1634	13.89
12.5	0.030	0.38	2.34	0.19	0.33	0.02670	0.1634	15.49
13	0.030	0.39	2.54	0.19	0.33	0.02670	0.1634	17.20

GUTTER CAPACITY OF STREETS - 27' BC to BC								
Slope = 4.88%, n = 0.012								
Width (ft)	**Slope**	**Height (ft)**	**Area (sf)**	**R**	**R^2/3**	**S**	**S^1/2**	**Q (cfs)**
0.5	0.030	0.02	0.00	0.01	0.04	0.04880	0.2209	0.00
1	0.030	0.03	0.02	0.01	0.06	0.04880	0.2209	0.02
1.5	0.030	0.05	0.03	0.02	0.08	0.04880	0.2209	0.07
2	0.030	0.06	0.06	0.03	0.10	0.04880	0.2209	0.16
2.5	0.030	0.08	0.09	0.04	0.11	0.04880	0.2209	0.28
3	0.030	0.09	0.14	0.04	0.13	0.04880	0.2209	0.46
3.5	0.030	0.11	0.18	0.05	0.14	0.04880	0.2209	0.70
4	0.030	0.12	0.24	0.06	0.15	0.04880	0.2209	1.00
4.5	0.030	0.14	0.30	0.07	0.16	0.04880	0.2209	1.37
5	0.030	0.15	0.38	0.07	0.18	0.04880	0.2209	1.81
5.5	0.030	0.17	0.45	0.08	0.19	0.04880	0.2209	2.34
6	0.030	0.18	0.54	0.09	0.20	0.04880	0.2209	2.95
6.5	0.030	0.20	0.63	0.10	0.21	0.04880	0.2209	3.65
7	0.030	0.21	0.74	0.10	0.22	0.04880	0.2209	4.45
7.5	0.030	0.23	0.84	0.11	0.23	0.04880	0.2209	5.35
8.5	0.030	0.26	1.08	0.13	0.25	0.04880	0.2209	7.48
9	0.030	0.27	1.22	0.13	0.26	0.04880	0.2209	8.71
9.5	0.030	0.29	1.35	0.14	0.27	0.04880	0.2209	10.06
10	0.030	0.30	1.50	0.15	0.28	0.04880	0.2209	11.54
10.5	0.030	0.32	1.65	0.16	0.29	0.04880	0.2209	13.14
11	0.030	0.33	1.82	0.16	0.30	0.04880	0.2209	14.88
11.5	0.030	0.35	1.98	0.17	0.31	0.04880	0.2209	16.76
12	0.030	0.36	2.16	0.18	0.32	0.04880	0.2209	18.77
12.5	0.030	0.38	2.34	0.19	0.33	0.04880	0.2209	20.94
13	0.030	0.39	2.54	0.19	0.33	0.04880	0.2209	23.25