



K&S ENGINEERING, INC.

Planning Engineering Surveying

Drainage Study

For

ACADIA HEALTH CARE

CUP No. _____

Prepared for:

ACADIA
HEALTHCARE

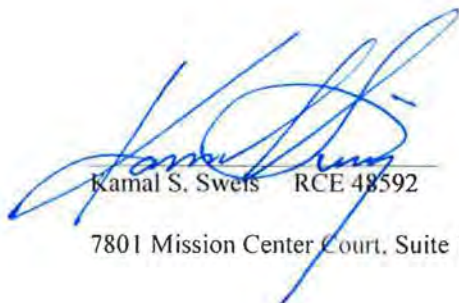
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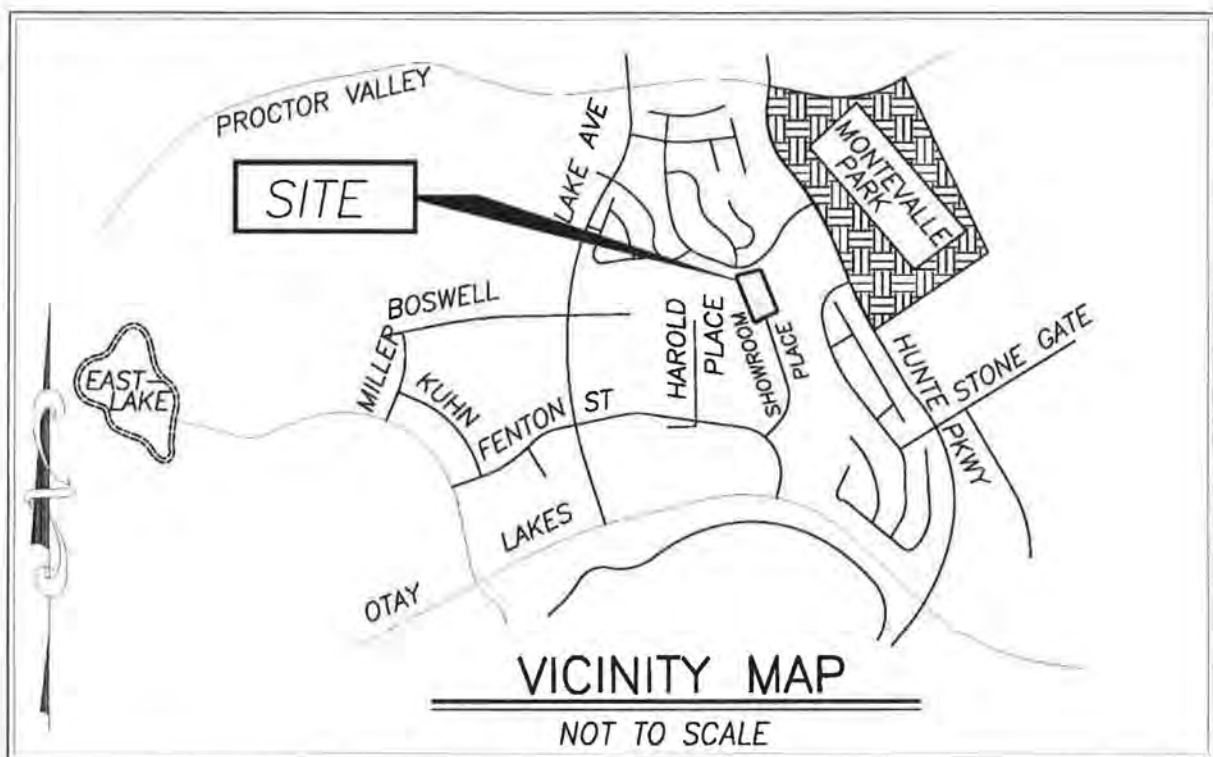
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1 VICINITY MAP



2 INTRODUCTION

The project consists of two existing undeveloped lots, i.e., Lots 7 & 8 of Map No. 14395.

The project proposes the construction of one medical building with parking and landscape areas. This site will drain to two proposed multipurpose bioretention BMP's for treatment, hydromodification and peak flow detention.

The subject report reflects the proposed precise grading and drainage as shown on precise grading plan Drawing No. _____.

3 PURPOSE OF THIS STUDY

The purpose of this study is to determine the proposed peak flows produced for the proposed driveway as shown on the grading plan for the Acadia Heath Care in Chula Vista as well as to determine the proposed pipe and inlet sizes.

4 PROJECT INFORMATION

4.1 Existing Condition

For the existing condition a runoff coefficient of 0.65 was used to determine the existing runoff flows. The existing $Q(50)$ at node 9 is 13.4 CFS. Likewise, The existing $Q(50)$ at node 16 is 18.8 CFS

4.2 Proposed Condition

The proposed land use for the proposed site will be commercial. A runoff coefficient of 0.85 was used to determine the proposed runoff flows. The proposed $Q(50)$ at node 16 before detention is 17.6 CFS and the proposed $Q(50)$ at node 31 before detention is 24.5 CFS

As required on City of Chula Vista, two detention basins were designed for this project. The purpose of these basins is to temporarily store the increased runoff and release it at a rate equal or less than the existing. Hydrographs were determined using Rational Method Hydrograph Program by Rick Engineering and routed for proposed (inflow) conditions using Hydraflow Software by Intelli SOLVE, respectively.

4.3 Summary

A proposed multipurpose Infiltration BMP is proposed to detain the increased proposed flows. The following is a summary of existing, before detention and detained flows, areas and C factors..

BASIN 1- PEAK FLOW TABLE (CFS) AT DETENTION BASIN

STORM EVENT	EXISTING CONDITION	PROPOSED CONDITION BEFORE DETENTION	PROPOSED CONDITION AFTER DETENTION
50-YEAR	13.4	24.5	10.7

BASIN 2- PEAK FLOW TABLE (CFS) AT DETENTION BASIN

STORM EVENT	EXISTING CONDITION	PROPOSED CONDITION BEFORE DETENTION	PROPOSED CONDITION AFTER DETENTION
50-YEAR	10.8	17.6	7.8

5 DESIGN CRITERIA AND METHODOLOGY

The proposed storm flow were determined using the Rational Method Hydrology Program CIVILCADD/CIVILDESIGN which is based on the City of Chula Vista Subdivision Manual. The pipes were sized using the 50 year storm event.

Hydrographs for these drainage basins were determined using Rational Method Hydrograph Program by Rick Engineering and routed for proposed (inflow) conditions using Hydraflow Software by Inteli SOLVE, respectively.

6. HYDROLOGY DESIGN MODELS

A. DESIGN METHODS

THE RATIONAL METHOD IS USED IN THIS HYDROLOGY STUDY; THE RATIONAL FORMULA IS AS FOLLOWS:

$Q = CIA$, WHERE : Q = PEAK DISCHARGE IN CUBIC FEET/SECOND *

C = RUNOFF COEFFICIENT (DIMENSIONLESS)

I = RAINFALL INTENSITY IN INCHES/HOUR

A = TRIBUTARY DRAINAGE AREA IN ACRES

*1 ACRE INCHES/HOUR = 1.008 CUBIC FEET/SEC

THE OVERLAND METHOD IS ALSO USED IN THIS HYDROLOGY STUDY;
THE URBAN AREAS OVERLAND FORMULA IS AS FOLLOWS:

$T = [1.8(1.1 - C)(L)^{0.5})] / [S(100)]^{333}$

L = LENGTH OF WATERSHED

C = COEFFICIENT OF RUNOFF

T = TIME IN MINUTES

S = DIFFERENCE IN ELEVATION DIVIDED BY DE LENGTH OF WATERSHED

B. DESIGN CRITERIA

- FREQUENCY 50 YEAR STORM.
- LAND USE PER SPECIFIC PLAN AND TENTATIVE MAP.
- RAIN FALL INTENSITY PER CITY OF SAN DIEGO DRAINAGE DESIGN MANUAL, DATED APRIL 1984.

C. REFERENCES

- CITY OF CHULA VISTA SUBDIVISION MANUAL, REVISED 03/13/2012
 - COUNTY OF SAN DIEGO HYDROLOGY MANUAL, JUNE 2003
 - HAND BOOK OF HYDRAULICS BY BRATER & KING, SIXTH EDITION.
-

7 HYDROLOGY CALCULATIONS

City of Chula Vista Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1992-2007 Version 7.3
Rational Hydrology Study Date: 03/25/19

***** Hydrology Study Control Information *****

Program License Serial Number 6303

Rational hydrology study storm event year is 50.0

Map data precipitation entered:
6 hour, precipitation(inches) = 2.450
24 hour precipitation(inches) = 5.000
Adjusted 6 hour precipitation (inches) = 2.450
P6/P24 = 49.0%
Runoff values by rational method

Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

[BARREN SLOPES - FLAT area type]
Initial subarea flow distance = 219.000(Ft.)
Highest elevation = 713.200(Ft.)
Lowest elevation = 709.750(Ft.)
Elevation difference = 3.450(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 10.30 min.
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5}] / (\% slope^{(1/3)})$
 $TC = [1.8 * (1.1 - 0.6500) * (219.000^{.5})] / (1.575^{(1/3)}) = 10.30$
Rainfall intensity $I = 7.44 P^6 * TC^{-0.645}$:
 $I = 7.44 (10.302) (2.450)^{-0.645}$:
Intensity = 4.050(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.650
Subarea runoff = 0.974(CFS)
Total initial stream area = 0.370(Ac.)

Process from Point/Station 1.000 to Point/Station 2.000
**** SUBAREA FLOW ADDITION ****

[BARREN SLOPES - FLAT area type]
Time of concentration = 10.30 min.
Rainfall intensity = 4.050(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.650
Subarea runoff = 2.474(CFS) for 0.940(Ac.)
Total runoff = 3.448(CFS) Total area = 1.31(Ac.)

Process from Point/Station 2.000 to Point/Station 3.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 710.00(Ft.)
Downstream point elevation = 703.00(Ft.)

Channel length thru subarea = 404.00(Ft.)
Channel base width = 0.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Manning's 'N' = 0.020
Maximum depth of channel = 0.500(Ft.)
Flow(q) thru subarea = 3.448(CFS)
Depth of flow = 0.143(Ft.), Average velocity = 1.685(Ft/s)
Channel flow top width = 28.610(Ft.)
Flow Velocity = 1.69(Ft/s)
Travel time = 4.00 min.
Time of concentration = 14.30 min.
Critical depth = 0.149(Ft.)

+++++
Process from Point/Station 3.000 to Point/Station 4.000
**** SUBAREA FLOW ADDITION ****

[BARREN SLOPES - FLAT area type]
Time of concentration = 14.30 min.
Rainfall intensity = 3.278(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.650
Subarea runoff = 6.520(CFS) for 3.060(Ac.)
Total runoff = 9.968(CFS) Total area = 4.37(Ac.)

+++++
Process from Point/Station 3.000 to Point/Station 4.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 703.00(Ft.)
Downstream point elevation = 700.00(Ft.)
Channel length thru subarea = 150.00(Ft.)
Channel base width = 3.500(Ft.)
Slope or 'Z' of left channel bank = 0.000
Slope or 'Z' of right channel bank = 0.000
Manning's 'N' = 0.015
Maximum depth of channel = 0.500(Ft.)
Flow(q) thru subarea = 9.968(CFS)
Depth of flow = 0.419(Ft.), Average velocity = 6.798(Ft/s)
Channel flow top width = 3.500(Ft.)
Flow Velocity = 6.80(Ft/s)
Travel time = 0.37 min.
Time of concentration = 14.67 min.
Critical depth = 0.633(Ft.)

+++++
Process from Point/Station 4.000 to Point/Station 16.000
**** SUBAREA FLOW ADDITION ****

[BARREN SLOPES - FLAT area type]
Time of concentration = 14.67 min.
Rainfall intensity = 3.225(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.650
Subarea runoff = 0.859(CFS) for 0.410(Ac.)
Total runoff = 10.827(CFS) Total area = 4.78(Ac.)

+++++
Process from Point/Station 16.000 to Point/Station 17.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 687.42(Ft.)
Downstream point/station elevation = 685.30(Ft.)
Pipe length = 77.00(Ft.) Manning's N = 0.012
No. of pipes = 1 Required pipe flow = 10.827(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 10.827(CFS)
Normal flow depth in pipe = 9.77(In.)
Flow top width inside pipe = 17.93(In.)
Critical Depth = 15.15(In.)
Pipe flow velocity = 11.05(Ft/s)
Travel time through pipe = 0.12 min.
Time of concentration (TC) = 14.78 min.

+++++
Process from Point/Station 5.000 to Point/Station 6.000
**** INITIAL AREA EVALUATION ****

[BARREN SLOPES - FLAT area type]
Initial subarea flow distance = 245.000(Ft.)
Highest elevation = 717.000(Ft.)
Lowest elevation = 712.000(Ft.)
Elevation difference = 5.000(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 10.00 min.
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5}] / (\% slope^{(1/3)})$
 $TC = [1.8 * (1.1 - 0.6500) * (245.000^{.5}) / (2.041^{(1/3)})] = 10.00$
Rainfall intensity $I = 7.44P^6 * TC^{-0.645}$:
 $I = 7.44(9.995)(2.450)^{-0.645}$:
Intensity = 4.129(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.650
Subarea runoff = 0.966(CFS)
Total initial stream area = 0.360(Ac.)

+++++
Process from Point/Station 5.000 to Point/Station 6.000
**** SUBAREA FLOW ADDITION ****

[BARREN SLOPES - FLAT area type]
Time of concentration = 10.00 min.
Rainfall intensity = 4.129(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.650
Subarea runoff = 5.690(CFS) for 2.120(Ac.)
Total runoff = 6.656(CFS) Total area = 2.48(Ac.)

+++++
Process from Point/Station 6.000 to Point/Station 7.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 712.00(Ft.)
Downstream point elevation = 704.50(Ft.)
Channel length thru subarea = 430.00(Ft.)
Channel base width = 0.000(Ft.)
Slope or 'Z' of left channel bank = 100.000
Slope or 'Z' of right channel bank = 100.000
Manning's 'N' = 0.020
Maximum depth of channel = 0.500(Ft.)
Flow(q) thru subarea = 6.656(CFS)
Depth of flow = 0.183(Ft.), Average velocity = 1.991(Ft/s)
Channel flow top width = 36.567(Ft.)

Flow Velocity = 1.99(Ft/s)
Travel time = 3.60 min.
Time of concentration = 13.59 min.
Critical depth = 0.193(Ft.)

+++++
Process from Point/Station 7.000 to Point/Station 8.000
**** IMPROVED CHANNEL TRAVEL TIME ****

Upstream point elevation = 704.50(Ft.)
Downstream point elevation = 702.50(Ft.)
Channel length thru subarea = 135.00(Ft.)
Channel base width = 3.500(Ft.)
Slope or 'Z' of left channel bank = 0.000
Slope or 'Z' of right channel bank = 0.000
Manning's 'N' = 0.015
Maximum depth of channel = 0.500(Ft.)
Flow(q) thru subarea = 6.656(CFS)
Depth of flow = 0.356(Ft.), Average velocity = 5.349(Ft/s)
Channel flow top width = 3.500(Ft.)
Flow Velocity = 5.35(Ft/s)
Travel time = 0.42 min.
Time of concentration = 14.02 min.
Critical depth = 0.484(Ft.)

+++++
Process from Point/Station 8.000 to Point/Station 9.000
**** SUBAREA FLOW ADDITION ****

[BARREN SLOPES - FLAT area type]
Time of concentration = 14.02 min.
Rainfall intensity = 3.320(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.650
Subarea runoff = 0.928(CFS) for 0.430(Ac.)
Total runoff = 7.584(CFS) Total area = 2.91(Ac.)

+++++
Process from Point/Station 8.000 to Point/Station 9.000
**** SUBAREA FLOW ADDITION ****

[BARREN SLOPES - FLAT area type]
Time of concentration = 14.02 min.
Rainfall intensity = 3.320(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.650
Subarea runoff = 5.784(CFS) for 2.680(Ac.)
Total runoff = 13.368(CFS) Total area = 5.59(Ac.)

+++++
Process from Point/Station 9.000 to Point/Station 36.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 690.00(Ft.)
Downstream point/station elevation = 685.40(Ft.)
Pipe length = 82.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 13.368(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 13.368(CFS)
Normal flow depth in pipe = 9.40(In.)
Flow top width inside pipe = 17.98(In.)

Critical Depth = 16.35(In.)
Pipe flow velocity = 14.33(Ft/s)
Travel time through pipe = 0.10 min.
Time of concentration (TC) = 14.11 min.
End of computations, total study area = 10.370 (Ac.)

7.1 RATIONAL METHOD CALCULATIONS

City of Chula Vista Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1992-2007 Version 7.3
Rational Hydrology Study Date: 03/24/19

***** Hydrology Study Control Information *****

Program License Serial Number 6303

Rational hydrology study storm event year is 50.0

Map data precipitation entered:

6 hour, precipitation(inches) = 2.450

24 hour precipitation(inches) = 5.000

Adjusted 6 hour precipitation (inches) = 2.450

P6/P24 = 49.0%

Runoff values by rational method

+++++
Process from Point/Station 1.000 to Point/Station 2.000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type]
Initial subarea flow distance = 404.000(Ft.)
Highest elevation = 713.230(Ft.)
Lowest elevation = 710.350(Ft.)
Elevation difference = 2.880(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 10.13 min.
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5}] / (\% slope^{(1/3)})$
 $TC = [1.8 * (1.1 - 0.8500) * (404.000^{.5}) / (0.713^{(1/3)})] = 10.13$
Rainfall intensity $I = 7.44P6^{.07}TC^{-0.645}$:
 $I = 7.44(10.125)^{.07}(2.450)^{-0.645}$:
Intensity = 4.095(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850
Subarea runoff = 1.914(CFS)
Total initial stream area = 0.550(Ac.)

+++++
Process from Point/Station 2.000 to Point/Station 3.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 706.00(Ft.)
Downstream point/station elevation = 702.68(Ft.)
Pipe length = 90.97(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 1.914(CFS)
Given pipe size = 8.00(In.)
Calculated individual pipe flow = 1.914(CFS)
Normal flow depth in pipe = 5.56(In.)
Flow top width inside pipe = 7.37(In.)
Critical Depth = 7.44(In.)
Pipe flow velocity = 7.39(Ft/s)
Travel time through pipe = 0.21 min.
Time of concentration (TC) = 10.33 min.

+++++
Process from Point/Station 2,000 to Point/Station 3,000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 10.33 min.
Rainfall intensity = 4.042(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.649(CFS) for 0.480(Ac.)
Total runoff = 3.564(CFS) Total area = 1.03(Ac.)

+++++
Process from Point/Station 2,000 to Point/Station 3,000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 1.030(Ac.)
Runoff from this stream = 3.564(CFS)
Time of concentration = 10.33 min.
Rainfall intensity = 4.042(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	3.564	10.33	4.042

Qmax(1) = 1.000 * 1.000 * 3.564 + = 3.564

Total of 1 streams to confluence:
Flow rates before confluence point:
3.564
Maximum flow rates at confluence using above data:
3.564
Area of streams before confluence:
1.030
Results of confluence:
Total flow rate = 3.564(CFS)
Time of concentration = 10.330 min.
Effective stream area after confluence = 1.030(Ac.)

+++++
Process from Point/Station 4,000 to Point/Station 5,000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type]
Initial subarea flow distance = 75.530(Ft.)
Highest elevation = 707.870(Ft.)
Lowest elevation = 707.500(Ft.)
Elevation difference = 0.370(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 4.96 min.
TC = $[1.8 * (1.1 - C) * \text{distance}(\text{Ft.})^{.5}] / (\% \text{ slope}^{(1/3)})]$
TC = $[1.8 * (1.1 - 0.8500) * (75.530^{.5}) / (0.490^{(1/3)})] = 4.96$
Setting time of concentration to 5 minutes
Rainfall intensity I = $7.44P6 * TC^{-0.645}$:
I = $7.44(5.000) (2.450)^{-0.645}$:
Intensity = 6.455(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850
Subarea runoff = 1.207(CFS)

Total initial stream area = 0.220 (Ac.)

+++++
Process from Point/Station 5.000 to Point/Station 6.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 704.50 (Ft.)
Downstream point/station elevation = 704.05 (Ft.)
Pipe length = 89.00 (Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 1.207 (CFS)
Given pipe size = 10.00 (In.)
Calculated individual pipe flow = 1.207 (CFS)
Normal flow depth in pipe = 6.61 (In.)
Flow top width inside pipe = 9.47 (In.)
Critical Depth = 5.88 (In.)
Pipe flow velocity = 3.15 (Ft/s)
Travel time through pipe = 0.47 min.
Time of concentration (TC) = 5.47 min.

+++++
Process from Point/Station 6.000 to Point/Station 7.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 704.05 (Ft.)
Downstream point/station elevation = 703.58 (Ft.)
Pipe length = 95.00 (Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 1.207 (CFS)
Given pipe size = 10.00 (In.)
Calculated individual pipe flow = 1.207 (CFS)
Normal flow depth in pipe = 6.66 (In.)
Flow top width inside pipe = 9.43 (In.)
Critical Depth = 5.88 (In.)
Pipe flow velocity = 3.13 (Ft/s)
Travel time through pipe = 0.51 min.
Time of concentration (TC) = 5.98 min.

+++++
Process from Point/Station 6.000 to Point/Station 7.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 5.98 min.
Rainfall intensity = 5.753 (In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.440 (CFS) for 0.090 (Ac.)
Total runoff = 1.647 (CFS) Total area = 0.31 (Ac.)

+++++
Process from Point/Station 6.000 to Point/Station 7.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 5.98 min.
Rainfall intensity = 5.753 (In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.978 (CFS) for 0.200 (Ac.)
Total runoff = 2.625 (CFS) Total area = 0.51 (Ac.)

+++++
Process from Point/Station 7.000 to Point/Station 8.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 703.58(Ft.)
Downstream point/station elevation = 702.96(Ft.)
Pipe length = 124.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 2.625(CFS)
Given pipe size = 15.00(In.)
Calculated individual pipe flow = 2.625(CFS)
Normal flow depth in pipe = 8.16(In.)
Flow top width inside pipe = 14.94(In.)
Critical Depth = 7.79(In.)
Pipe flow velocity = 3.85(Ft/s)
Travel time through pipe = 0.54 min.
Time of concentration (TC) = 6.51 min.

+++++
Process from Point/Station 7.000 to Point/Station 8.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type 1]
Time of concentration = 6.51 min.
Rainfall intensity = 5.443(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, $Q=KCIA$, $C = 0.850$
Subarea runoff = 2.591(CFS) for 0.560(Ac.)
Total runoff = 5.216(CFS) Total area = 1.07(Ac.)

+++++
Process from Point/Station 8.000 to Point/Station 3.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 702.96(Ft.)
Downstream point/station elevation = 702.68(Ft.)
Pipe length = 38.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 5.216(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 5.216(CFS)
Normal flow depth in pipe = 9.82(In.)
Flow top width inside pipe = 17.93(In.)
Critical Depth = 10.56(In.)
Pipe flow velocity = 5.29(Ft/s)
Travel time through pipe = 0.12 min.
Time of concentration (TC) = 6.63 min.

+++++
Process from Point/Station 8.000 to Point/Station 3.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 1.070(Ac.)
Runoff from this stream = 5.216(CFS)
Time of concentration = 6.63 min.
Rainfall intensity = 5.379(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
------------	-----------------	----------	----------------------------

1	3.564	10.33	4.042	
2	5.216	6.63	5.379	
Qmax(1) =				
	1.000 *	1.000 *	3.564) +	
	0.751 *	1.000 *	5.216) + =	7.483
Qmax(2) =				
	1.000 *	0.642 *	3.564) +	
	1.000 *	1.000 *	5.216) + =	7.504

Total of 2 streams to confluence:
Flow rates before confluence point:
3.564 5.216
Maximum flow rates at confluence using above data:
7.483 7.504
Area of streams before confluence:
1.030 1.070
Results of confluence:
Total flow rate = 7.504(CFS)
Time of concentration = 6.633 min.
Effective stream area after confluence = 2.100(Ac.)

Process from Point/Station 3.000 to Point/Station 9.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 702.68(Ft.)
Downstream point/station elevation = 702.00(Ft.)
Pipe length = 96.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 7.504(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 7.504(CFS)
Normal flow depth in pipe = 12.73(In.)
Flow top width inside pipe = 16.38(In.)
Critical Depth = 12.73(In.)
Pipe flow velocity = 5.61(Ft/s)
Travel time through pipe = 0.29 min.
Time of concentration (TC) = 6.92 min.

Process from Point/Station 3.000 to Point/Station 9.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.92 min.
Rainfall intensity = 5.235(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.445(CFS) for 0.100(Ac.)
Total runoff = 7.949(CFS) Total area = 2.20(Ac.)

Process from Point/Station 9.000 to Point/Station 10.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 702.00(Ft.)
Downstream point/station elevation = 700.55(Ft.)
Pipe length = 146.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 7.949(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 7.949(CFS)
Normal flow depth in pipe = 11.73(In.)

Flow top width inside pipe = 17.15(In.)
Critical Depth = 13.11(In.)
Pipe flow velocity = 6.52(Ft/s)
Travel time through pipe = 0.37 min.
Time of concentration (TC) = 7.29 min.

+++++
Process from Point/Station 9.000 to Point/Station 10.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 2.200(Ac.)
Runoff from this stream = 7.949(CFS)
Time of concentration = 7.29 min.
Rainfall intensity = 5.061(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	7.949	7.29	5.061

Qmax(1) = 1.000 * 1.000 * 7.949 + = 7.949

Total of 1 streams to confluence:
Flow rates before confluence point:
7.949
Maximum flow rates at confluence using above data:
7.949
Area of streams before confluence:
2.200
Results of confluence:
Total flow rate = 7.949(CFS)
Time of concentration = 7.291 min.
Effective stream area after confluence = 2.200(Ac.)

+++++
Process from Point/Station 11.000 to Point/Station 12.000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type]
Initial subarea flow distance = 208.000(Ft.)
Highest elevation = 704.840(Ft.)
Lowest elevation = 703.800(Ft.)
Elevation difference = 1.040(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 8.18 min.
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5}] / (\% slope^{(1/3)})]$
 $TC = [1.8 * (1.1 - 0.8500) * (208.000^{.5})] / (0.500^{(1/3)}) = 8.18$
Rainfall intensity $I = 7.44P6 * TC^{-0.645}$:
 $I = 7.44(8.177) (2.450)^{-0.645}$:
Intensity = 4.700(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850
Subarea runoff = 1.438(CFS)
Total initial stream area = 0.360(Ac.)

+++++
Process from Point/Station 12.000 to Point/Station 13.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 703.80(Ft.)
 Downstream point/station elevation = 703.50(Ft.)
 Pipe length = 60.00(Ft.) Manning's N = 0.013
 No. of pipes = 1 Required pipe flow = 1.438(CFS)
 Given pipe size = 10.00(In.)
 Calculated individual pipe flow = 1.438(CFS)
 Normal flow depth in pipe = 7.62(In.)
 Flow top width inside pipe = 8.52(In.)
 Critical Depth = 6.45(In.)
 Pipe flow velocity = 3.23(Ft/s)
 Travel time through pipe = 0.31 min.
 Time of concentration (TC) = 8.49 min.

+++++
 Process from Point/Station 12.000 to Point/Station 13.000
 **** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
 Time of concentration = 8.49 min.
 Rainfall intensity = 4.589(In/Hr) for a 50.0 year storm
 Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
 Subarea runoff = 0.390(CFS) for 0.100(Ac.)
 Total runoff = 1.828(CFS) Total area = 0.46(Ac.)

+++++
 Process from Point/Station 13.000 to Point/Station 14.000
 **** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 703.50(Ft.)
 Downstream point/station elevation = 702.50(Ft.)
 Pipe length = 144.54(Ft.) Manning's N = 0.013
 No. of pipes = 1 Required pipe flow = 1.828(CFS)
 Given pipe size = 12.00(In.)
 Calculated individual pipe flow = 1.828(CFS)
 Normal flow depth in pipe = 6.82(In.)
 Flow top width inside pipe = 11.89(In.)
 Critical Depth = 6.91(In.)
 Pipe flow velocity = 3.97(Ft/s)
 Travel time through pipe = 0.61 min.
 Time of concentration (TC) = 9.09 min.

+++++
 Process from Point/Station 13.000 to Point/Station 14.000
 **** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
 Time of concentration = 9.09 min.
 Rainfall intensity = 4.389(In/Hr) for a 50.0 year storm
 Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
 Subarea runoff = 1.641(CFS) for 0.440(Ac.)
 Total runoff = 3.470(CFS) Total area = 0.90(Ac.)

+++++
 Process from Point/Station 14.000 to Point/Station 10.000
 **** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 702.50(Ft.)
 Downstream point/station elevation = 700.55(Ft.)

Pipe length = 131.65(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 3.470(CFS)
Given pipe size = 12.00(In.)
Calculated individual pipe flow = 3.470(CFS)
Normal flow depth in pipe = 8.12(In.)
Flow top width inside pipe = 11.23(In.)
Critical Depth = 9.55(In.)
Pipe flow velocity = 6.13(Ft/s)
Travel time through pipe = 0.36 min.
Time of concentration (TC) = 9.45 min.

Process from Point/Station 14.000 to Point/Station 10.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 0.900(Ac.)
Runoff from this stream = 3.470(CFS)
Time of concentration = 9.45 min.
Rainfall intensity = 4.281(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	7.949	7.29	5.061
2	3.470	9.45	4.281
Qmax(1) =			
	1.000 *	1.000 *	7.949) +
	1.000 *	0.771 *	3.470) + =
			10.626
Qmax(2) =			
	0.846 *	1.000 *	7.949) +
	1.000 *	1.000 *	3.470) + =
			10.194

Total of 2 streams to confluence:
Flow rates before confluence point:
7.949 3.470
Maximum flow rates at confluence using above data:
10.626 10.194
Area of streams before confluence:
2.200 0.900
Results of confluence:
Total flow rate = 10.626(CFS)
Time of concentration = 7.291 min.
Effective stream area after confluence = 3.100(Ac.)

Process from Point/Station 10.000 to Point/Station 15.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 700.55(Ft.)
Downstream point/station elevation = 697.96(Ft.)
Pipe length = 118.38(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 10.626(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 10.626(CFS)
Normal flow depth in pipe = 10.92(In.)
Flow top width inside pipe = 17.58(In.)
Critical Depth = 15.02(In.)
Pipe flow velocity = 9.46(Ft/s)

Travel time through pipe = 0.21 min.
Time of concentration (TC) = 7.50 min.

Process from Point/Station 10.000 to Point/Station 15.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.50 min.
Rainfall intensity = 4.970(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.225(CFS) for 0.290(Ac.)
Total runoff = 11.851(CFS) Total area = 3.39(Ac.)

Process from Point/Station 10.000 to Point/Station 15.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.50 min.
Rainfall intensity = 4.970(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 2.577(CFS) for 0.610(Ac.)
Total runoff = 14.428(CFS) Total area = 4.00(Ac.)

Process from Point/Station 15.000 to Point/Station 16.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 697.96(Ft.)
Downstream point/station elevation = 696.00(Ft.)
Pipe length = 98.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 14.428(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 14.428(CFS)
Normal flow depth in pipe = 14.30(In.)
Flow top width inside pipe = 14.55(In.)
Critical Depth = 16.71(In.)
Pipe flow velocity = 9.58(Ft/s)
Travel time through pipe = 0.17 min.
Time of concentration (TC) = 7.67 min.

Process from Point/Station 15.000 to Point/Station 16.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.67 min.
Rainfall intensity = 4.898(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.540(CFS) for 0.370(Ac.)
Total runoff = 15.969(CFS) Total area = 4.37(Ac.)

Process from Point/Station 15.000 to Point/Station 16.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]

Time of concentration = 7.67 min.
Rainfall intensity = 4.898(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.458(CFS) for 0.110(Ac.)
Total runoff = 16.427(CFS) Total area = 4.48(Ac.)

+++++
Process from Point/Station 15.000 to Point/Station 16.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.67 min.
Rainfall intensity = 4.898(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.207(CFS) for 0.290(Ac.)
Total runoff = 17.634(CFS) Total area = 4.77(Ac.)

+++++
Process from Point/Station 16.000 to Point/Station 17.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 687.42(Ft.)
Downstream point/station elevation = 685.30(Ft.)
Pipe length = 75.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 17.634(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 17.634(CFS)
Normal flow depth in pipe = 14.72(In.)
Flow top width inside pipe = 13.90(In.)
Critical depth could not be calculated.
Pipe flow velocity = 11.39(Ft/s)
Travel time through pipe = 0.11 min.
Time of concentration (TC) = 7.78 min.

+++++
Process from Point/Station 1.000 to Point/Station 18.000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type]
Initial subarea flow distance = 147.000(Ft.)
Highest elevation = 713.230(Ft.)
Lowest elevation = 712.220(Ft.)
Elevation difference = 1.010(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 6.18 min.
 $TC = [1.8 * (1.1 - C) * distance(Ft.)^{.5} / (\% slope^{(1/3)})]$
 $TC = [1.8 * (1.1 - 0.8500) * (147.000^{.5}) / (0.687^{(1/3)})] = 6.18$
Rainfall intensity $I = 7.44P^{.6}TC^{-0.645}$:
 $I = 7.44(6.183)^{.6}(2.450)^{-0.645}$:
Intensity = 5.629(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850
Subarea runoff = 1.005(CFS)
Total initial stream area = 0.210(Ac.)

+++++
Process from Point/Station 18.000 to Point/Station 19.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 708.20(Ft.)

Downstream point/station elevation = 702.54 (Ft.)
Pipe length = 133.00 (Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 1.005 (CFS)
Given pipe size = 8.00 (In.)
Calculated individual pipe flow = 1.005 (CFS)
Normal flow depth in pipe = 3.53 (In.)
Flow top width inside pipe = 7.95 (In.)
Critical Depth = 5.71 (In.)
Pipe flow velocity = 6.76 (Ft/s)
Travel time through pipe = 0.33 min.
Time of concentration (TC) = 6.51 min.

+++++
Process from Point/Station 18.000 to Point/Station 19.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.51 min.
Rainfall intensity = 5.444 (In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 5.275 (CFS) for 1.140 (Ac.)
Total runoff = 6.280 (CFS) Total area = 1.35 (Ac.)

+++++
Process from Point/Station 18.000 to Point/Station 19.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.51 min.
Rainfall intensity = 5.444 (In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.416 (CFS) for 0.090 (Ac.)
Total runoff = 6.697 (CFS) Total area = 1.44 (Ac.)

+++++
Process from Point/Station 18.000 to Point/Station 19.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.51 min.
Rainfall intensity = 5.444 (In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.185 (CFS) for 0.040 (Ac.)
Total runoff = 6.882 (CFS) Total area = 1.48 (Ac.)

+++++
Process from Point/Station 19.000 to Point/Station 20.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 702.54 (Ft.)
Downstream point/station elevation = 702.33 (Ft.)
Pipe length = 27.93 (Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 6.882 (CFS)
Given pipe size = 18.00 (In.)
Calculated individual pipe flow = 6.882 (CFS)
Normal flow depth in pipe = 11.70 (In.)
Flow top width inside pipe = 17.17 (In.)
Critical Depth = 12.19 (In.)
Pipe flow velocity = 5.67 (Ft/s)

Travel time through pipe = 0.08 min.
Time of concentration (TC) = 6.59 min.

Process from Point/Station 19.000 to Point/Station 20.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.59 min.
Rainfall intensity = 5.400(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.780(CFS) for 0.170(Ac.)
Total runoff = 7.662(CFS) Total area = 1.65(Ac.)

Process from Point/Station 20.000 to Point/Station 21.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 702.33(Ft.)
Downstream point/station elevation = 701.33(Ft.)
Pipe length = 118.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 7.662(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 7.662(CFS)
Normal flow depth in pipe = 12.09(In.)
Flow top width inside pipe = 16.90(In.)
Critical Depth = 12.87(In.)
Pipe flow velocity = 6.07(Ft/s)
Travel time through pipe = 0.32 min.
Time of concentration (TC) = 6.92 min.

Process from Point/Station 20.000 to Point/Station 21.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.92 min.
Rainfall intensity = 5.236(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.445(CFS) for 0.100(Ac.)
Total runoff = 8.107(CFS) Total area = 1.75(Ac.)

Process from Point/Station 21.000 to Point/Station 22.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 701.33(Ft.)
Downstream point/station elevation = 700.33(Ft.)
Pipe length = 127.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 8.107(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 8.107(CFS)
Normal flow depth in pipe = 12.98(In.)
Flow top width inside pipe = 16.14(In.)
Critical Depth = 13.23(In.)
Pipe flow velocity = 5.94(Ft/s)
Travel time through pipe = 0.36 min.
Time of concentration (TC) = 7.27 min.

+++++
Process from Point/Station 21.000 to Point/Station 22.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.27 min.
Rainfall intensity = 5.069(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.680(CFS) for 0.390(Ac.)
Total runoff = 9.787(CFS) Total area = 2.14(Ac.)

+++++
Process from Point/Station 21.000 to Point/Station 22.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 2.140(Ac.)
Runoff from this stream = 9.787(CFS)
Time of concentration = 7.27 min.
Rainfall intensity = 5.069(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	9.787	7.27	5.069

Qmax(1) = 1.000 * 1.000 * 9.787) + = 9.787

Total of 1 streams to confluence:
Flow rates before confluence point:
9.787
Maximum flow rates at confluence using above data:
9.787
Area of streams before confluence:
2.140
Results of confluence:
Total flow rate = 9.787(CFS)
Time of concentration = 7.274 min.
Effective stream area after confluence = 2.140(Ac.)

+++++
Process from Point/Station 23.000 to Point/Station 24.000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type]
Initial subarea flow distance = 57.170(Ft.)
Highest elevation = 708.880(Ft.)
Lowest elevation = 707.740(Ft.)
Elevation difference = 1.140(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 2.70 min.
TC = $[1.8 * (1.1 - C) * \text{distance}(\text{Ft.})^{.5}] / (\% \text{ slope}^{(1/3)})]$
TC = $[1.8 * (1.1 - 0.8500) * (57.170^{.5}) / (1.994^{(1/3)})] = 2.70$
Setting time of concentration to 5 minutes
Rainfall intensity I = $7.44P6 * TC^{-0.645}$:
I = $7.44(5.000) (2.450)^{-0.645}$:
Intensity = 6.455(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850

Subarea runoff = 0.549(CFS)
Total initial stream area = 0.100(Ac.)

+++++
Process from Point/Station 24.000 to Point/Station 25.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 706.24(Ft.)
Downstream point/station elevation = 705.50(Ft.)
Pipe length = 148.77(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 0.549(CFS)
Given pipe size = 8.00(In.)
Calculated individual pipe flow = 0.549(CFS)
Normal flow depth in pipe = 4.66(In.)
Flow top width inside pipe = 7.89(In.)
Critical Depth = 4.17(In.)
Pipe flow velocity = 2.59(Ft/s)
Travel time through pipe = 0.96 min.
Time of concentration (TC) = 5.96 min.

+++++
Process from Point/Station 25.000 to Point/Station 26.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 705.50(Ft.)
Downstream point/station elevation = 704.09(Ft.)
Pipe length = 112.12(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 0.549(CFS)
Given pipe size = 12.00(In.)
Calculated individual pipe flow = 0.549(CFS)
Normal flow depth in pipe = 3.01(In.)
Flow top width inside pipe = 10.40(In.)
Critical Depth = 3.68(In.)
Pipe flow velocity = 3.57(Ft/s)
Travel time through pipe = 0.52 min.
Time of concentration (TC) = 6.48 min.

+++++
Process from Point/Station 25.000 to Point/Station 26.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.48 min.
Rainfall intensity = 5.461(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 3.110(CFS) for 0.670(Ac.)
Total runoff = 3.659(CFS) Total area = 0.77(Ac.)

+++++
Process from Point/Station 26.000 to Point/Station 22.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 704.09(Ft.)
Downstream point/station elevation = 700.31(Ft.)
Pipe length = 138.32(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 3.659(CFS)
Given pipe size = 12.00(In.)
Calculated individual pipe flow = 3.659(CFS)
Normal flow depth in pipe = 6.84(In.)

Flow top width inside pipe = 11.88(In.)
Critical Depth = 9.79(In.)
Pipe flow velocity = 7.90(Ft/s)
Travel time through pipe = 0.29 min.
Time of concentration (TC) = 6.77 min.

+++++
Process from Point/Station 26.000 to Point/Station 22.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 0.770(Ac.)
Runoff from this stream = 3.659(CFS)
Time of concentration = 6.77 min.
Rainfall intensity = 5.308(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	9.787	7.27	5.069
2	3.659	6.77	5.308
Qmax(1) =			
	1.000 *	1.000 *	9.787) +
	0.955 *	1.000 *	3.659) + = 13.281
Qmax(2) =			
	1.000 *	0.931 *	9.787) +
	1.000 *	1.000 *	3.659) + = 12.771

Total of 2 streams to confluence:
Flow rates before confluence point:
9.787 3.659
Maximum flow rates at confluence using above data:
13.281 12.771
Area of streams before confluence:
2.140 0.770
Results of confluence:
Total flow rate = 13.281(CFS)
Time of concentration = 7.274 min.
Effective stream area after confluence = 2.910(Ac.)

+++++
Process from Point/Station 22.000 to Point/Station 30.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 700.31(Ft.)
Downstream point/station elevation = 698.52(Ft.)
Pipe length = 118.67(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 13.281(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 13.281(CFS)
Normal flow depth in pipe = 18.00(In.)
Flow top width inside pipe = 0.00(In.)
Critical Depth = 16.33(In.)
Pipe flow velocity = 7.30(Ft/s)
Travel time through pipe = 0.27 min.
Time of concentration (TC) = 7.54 min.

+++++

Process from Point/Station 22.000 to Point/Station 30.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 1
Stream flow area = 2.910(Ac.)
Runoff from this stream = 13.281(CFS)
Time of concentration = 7.54 min.
Rainfall intensity = 4.951(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	13.281	7.54	4.951

Qmax(1) = 1.000 * 1.000 * 13.281) + = 13.281

Total of 1 streams to confluence:
Flow rates before confluence point:
13.281
Maximum flow rates at confluence using above data:
13.281
Area of streams before confluence:
2.910
Results of confluence:
Total flow rate = 13.281(CFS)
Time of concentration = 7.544 min.
Effective stream area after confluence = 2.910(Ac.)

Process from Point/Station 27.000 to Point/Station 28.000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type 1
Initial subarea flow distance = 218.000(Ft.)
Highest elevation = 708.390(Ft.)
Lowest elevation = 705.670(Ft.)
Elevation difference = 2.720(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 6.17 min.
TC = $[1.8 * (1.1 - C) * \text{distance}(\text{Ft.})^{.5}] / (\% \text{ slope}^{(1/3)})$
TC = $[1.8 * (1.1 - 0.8500) * (218.000^{.5})] / (1.248^{(1/3)}) = 6.17$
Rainfall intensity I = $7.44 P^6 * TC^{-0.645}$:
I = $7.44 (6.172) (2.450)^{-0.645}$:
Intensity = 5.635(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850
Subarea runoff = 1.581(CFS)
Total initial stream area = 0.330(Ac.)

Process from Point/Station 28.000 to Point/Station 29.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 701.67(Ft.)
Downstream point/station elevation = 699.63(Ft.)
Pipe length = 49.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 1.581(CFS)
Given pipe size = 8.00(In.)
Calculated individual pipe flow = 1.581(CFS)
Normal flow depth in pipe = 4.66(In.)

Flow top width inside pipe = 7.89(In.)
Critical Depth = 7.01(In.)
Pipe flow velocity = 7.50(Ft/s)
Travel time through pipe = 0.11 min.
Time of concentration (TC) = 6.28 min.

+++++
Process from Point/Station 28.000 to Point/Station 29.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 6.28 min.
Rainfall intensity = 5.572(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, $Q=KCIA$, $C = 0.850$
Subarea runoff = 0.663(CFS) for 0.140(Ac.)
Total runoff = 2.244(CFS) Total area = 0.47(Ac.)

+++++
Process from Point/Station 29.000 to Point/Station 30.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 699.63(Ft.)
Downstream point/station elevation = 698.52(Ft.)
Pipe length = 21.50(Ft.) Manning's $N = 0.013$
No. of pipes = 1 Required pipe flow = 2.244(CFS)
Given pipe size = 8.00(In.)
Calculated individual pipe flow = 2.244(CFS)
Normal flow depth in pipe = 5.50(In.)
Flow top width inside pipe = 7.42(In.)
Critical depth could not be calculated.
Pipe flow velocity = 8.77(Ft/s)
Travel time through pipe = 0.04 min.
Time of concentration (TC) = 6.32 min.

+++++
Process from Point/Station 29.000 to Point/Station 30.000
**** CONFLUENCE OF MINOR STREAMS ****

Along Main Stream number: 1 in normal stream number 2
Stream flow area = 0.470(Ac.)
Runoff from this stream = 2.244(CFS)
Time of concentration = 6.32 min.
Rainfall intensity = 5.549(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	13.281	7.54	4.951
2	2.244	6.32	5.549
Qmax(1) =			
	1.000 *	1.000 *	13.281) +
	0.892 *	1.000 *	2.244) + = 15.283
Qmax(2) =			
	1.000 *	0.838 *	13.281) +
	1.000 *	1.000 *	2.244) + = 13.372

Total of 2 streams to confluence:
Flow rates before confluence point:

13.281 2.244
Maximum flow rates at confluence using above data:
15.283 13.372
Area of streams before confluence:
2.910 0.470
Results of confluence:
Total flow rate = 15.283(CFS)
Time of concentration = 7.544 min.
Effective stream area after confluence = 3.380(Ac.)

Process from Point/Station 30.000 to Point/Station 31.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 698.52(Ft.)
Downstream point/station elevation = 697.00(Ft.)
Pipe length = 82.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 15.283(CFS)
Given pipe size = 24.00(In.)
Calculated individual pipe flow = 15.283(CFS)
Normal flow depth in pipe = 11.95(In.)
Flow top width inside pipe = 24.00(In.)
Critical Depth = 16.91(In.)
Pipe flow velocity = 9.79(Ft/s)
Travel time through pipe = 0.14 min.
Time of concentration (TC) = 7.68 min.

Process from Point/Station 30.000 to Point/Station 31.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.68 min.
Rainfall intensity = 4.892(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.663(CFS) for 0.400(Ac.)
Total runoff = 16.947(CFS) Total area = 3.78(Ac.)

Process from Point/Station 30.000 to Point/Station 31.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.68 min.
Rainfall intensity = 4.892(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.081(CFS) for 0.260(Ac.)
Total runoff = 18.028(CFS) Total area = 4.04(Ac.)

Process from Point/Station 30.000 to Point/Station 31.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.68 min.
Rainfall intensity = 4.892(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.125(CFS) for 0.030(Ac.)
Total runoff = 18.153(CFS) Total area = 4.07(Ac.)

+++++
Process from Point/Station 30.000 to Point/Station 31.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 7.68 min.
Rainfall intensity = 4.892(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.539(CFS) for 0.370(Ac.)
Total runoff = 19.691(CFS) Total area = 4.44(Ac.)

+++++
Process from Point/Station 30.000 to Point/Station 31.000
**** CONFLUENCE OF MAIN STREAMS ****

The following data inside Main Stream is listed:

In Main Stream number: 1
Stream flow area = 4.440(Ac.)
Runoff from this stream = 19.691(CFS)
Time of concentration = 7.68 min.
Rainfall intensity = 4.892(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	19.691	7.68	4.892

Qmax(1) = 1.000 * 1.000 * 19.691 + = 19.691

Total of 1 main streams to confluence:
Flow rates before confluence point:
19.691
Maximum flow rates at confluence using above data:
19.691
Area of streams before confluence:
4.440

Results of confluence:
Total flow rate = 19.691(CFS)
Time of concentration = 7.684 min.
Effective stream area after confluence = 4.440(Ac.)

+++++
Process from Point/Station 27.000 to Point/Station 32.000
**** INITIAL AREA EVALUATION ****

[COMMERCIAL area type]
Initial subarea flow distance = 210.000(Ft.)
Highest elevation = 708.390(Ft.)
Lowest elevation = 704.830(Ft.)
Elevation difference = 3.560(Ft.)
Time of concentration calculated by Page 12 Section 3-400
developed areas with overland flow = 5.47 min.
TC = $[1.8 * (1.1 - C) * \text{distance}(\text{Ft.})^{.5} / (\% \text{ slope}^{(1/3)})]$
TC = $[1.8 * (1.1 - 0.8500) * (210.000^{.5}) / (1.695^{(1/3)})] = 5.47$
Rainfall intensity I = $7.44P6 * TC^{-0.645}$:

$I = 7.44(5.469)(2.450)^{-0.645}$
Intensity = 6.092(In/Hr) for a 50.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.850
Subarea runoff = 1.812(CFS)
Total initial stream area = 0.350(Ac.)

+++++
Process from Point/Station 32.000 to Point/Station 33.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 701.02(Ft.)
Downstream point/station elevation = 698.14(Ft.)
Pipe length = 38.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 1.812(CFS)
Given pipe size = 12.00(In.)
Calculated individual pipe flow = 1.812(CFS)
Normal flow depth in pipe = 3.49(In.)
Flow top width inside pipe = 10.90(In.)
Critical Depth = 6.87(In.)
Pipe flow velocity = 9.53(Ft/s)
Travel time through pipe = 0.07 min.
Time of concentration (TC) = 5.54 min.

+++++
Process from Point/Station 32.000 to Point/Station 33.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 5.54 min.
Rainfall intensity = 6.045(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 0.617(CFS) for 0.120(Ac.)
Total runoff = 2.429(CFS) Total area = 0.47(Ac.)

+++++
Process from Point/Station 32.000 to Point/Station 33.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 5.54 min.
Rainfall intensity = 6.045(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, Q=KCIA, C = 0.850
Subarea runoff = 1.953(CFS) for 0.380(Ac.)
Total runoff = 4.382(CFS) Total area = 0.85(Ac.)

+++++
Process from Point/Station 33.000 to Point/Station 34.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 698.14(Ft.)
Downstream point/station elevation = 697.18(Ft.)
Pipe length = 76.30(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 4.382(CFS)
Given pipe size = 15.00(In.)
Calculated individual pipe flow = 4.382(CFS)
Normal flow depth in pipe = 8.41(In.)
Flow top width inside pipe = 14.89(In.)
Critical Depth = 10.18(In.)
Pipe flow velocity = 6.18(Ft/s)

Travel time through pipe = 0.21 min.
Time of concentration (TC) = 5.74 min.

+++++
Process from Point/Station 33.000 to Point/Station 34.000
**** SUBAREA FLOW ADDITION ****

[COMMERCIAL area type]
Time of concentration = 5.74 min.
Rainfall intensity = 5.904(In/Hr) for a 50.0 year storm
Runoff coefficient used for sub-area, Rational method, $Q=KCIA$, $C = 0.850$
Subarea runoff = 1.405(CFS) for 0.280(Ac.)
Total runoff = 5.787(CFS) Total area = 1.13(Ac.)

+++++
Process from Point/Station 34.000 to Point/Station 31.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 697.18(Ft.)
Downstream point/station elevation = 697.00(Ft.)
Pipe length = 14.92(Ft.) Manning's $N = 0.013$
No. of pipes = 1 Required pipe flow = 5.787(CFS)
Given pipe size = 15.00(In.)
Calculated individual pipe flow = 5.787(CFS)
Normal flow depth in pipe = 10.29(In.)
Flow top width inside pipe = 13.92(In.)
Critical Depth = 11.68(In.)
Pipe flow velocity = 6.44(Ft/s)
Travel time through pipe = 0.04 min.
Time of concentration (TC) = 5.78 min.

+++++
Process from Point/Station 34.000 to Point/Station 31.000
**** CONFLUENCE OF MAIN STREAMS ****

The following data inside Main Stream is listed:

In Main Stream number: 2
Stream flow area = 1.130(Ac.)
Runoff from this stream = 5.787(CFS)
Time of concentration = 5.78 min.
Rainfall intensity = 5.879(In/Hr)
Summary of stream data:

Stream No.	Flow rate (CFS)	TC (min)	Rainfall Intensity (In/Hr)
1	19.691	7.68	4.892
2	5.787	5.78	5.879
Qmax(1) =			
	1.000 *	1.000 *	19.691) +
	0.832 *	1.000 *	5.787) + = 24.507
Qmax(2) =			
	1.000 *	0.752 *	19.691) +
	1.000 *	1.000 *	5.787) + = 20.598

Total of 2 main streams to confluence:

Flow rates before confluence point:

19.691 5.787

Maximum flow rates at confluence using above data:

24.507 20.598
Area of streams before confluence:
4.440 1.130

Results of confluence:

Total flow rate = 24.507 (CFS)
Time of concentration = 7.684 min.
Effective stream area after confluence = 5.570 (Ac.)

Process from Point/Station 31.000 to Point/Station 35.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 692.97 (Ft.)
Downstream point/station elevation = 689.12 (Ft.)
Pipe length = 70.00 (Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 24.507 (CFS)
Given pipe size = 18.00 (In.)
Calculated individual pipe flow = 24.507 (CFS)
Normal flow depth in pipe = 14.67 (In.)
Flow top width inside pipe = 13.98 (In.)
Critical depth could not be calculated.
Pipe flow velocity = 15.89 (Ft/s)
Travel time through pipe = 0.07 min.
Time of concentration (TC) = 7.76 min.

Process from Point/Station 35.000 to Point/Station 36.000
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 698.12 (Ft.)
Downstream point/station elevation = 685.40 (Ft.)
Pipe length = 60.00 (Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 24.507 (CFS)
Given pipe size = 18.00 (In.)
Calculated individual pipe flow = 24.507 (CFS)
Normal flow depth in pipe = 9.07 (In.)
Flow top width inside pipe = 18.00 (In.)
Critical depth could not be calculated.
Pipe flow velocity = 27.46 (Ft/s)
Travel time through pipe = 0.04 min.
Time of concentration (TC) = 7.79 min.
End of computations, total study area = 10.340 (Ac.)

7.2 HYDROGRAPH CALCULATIONS

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

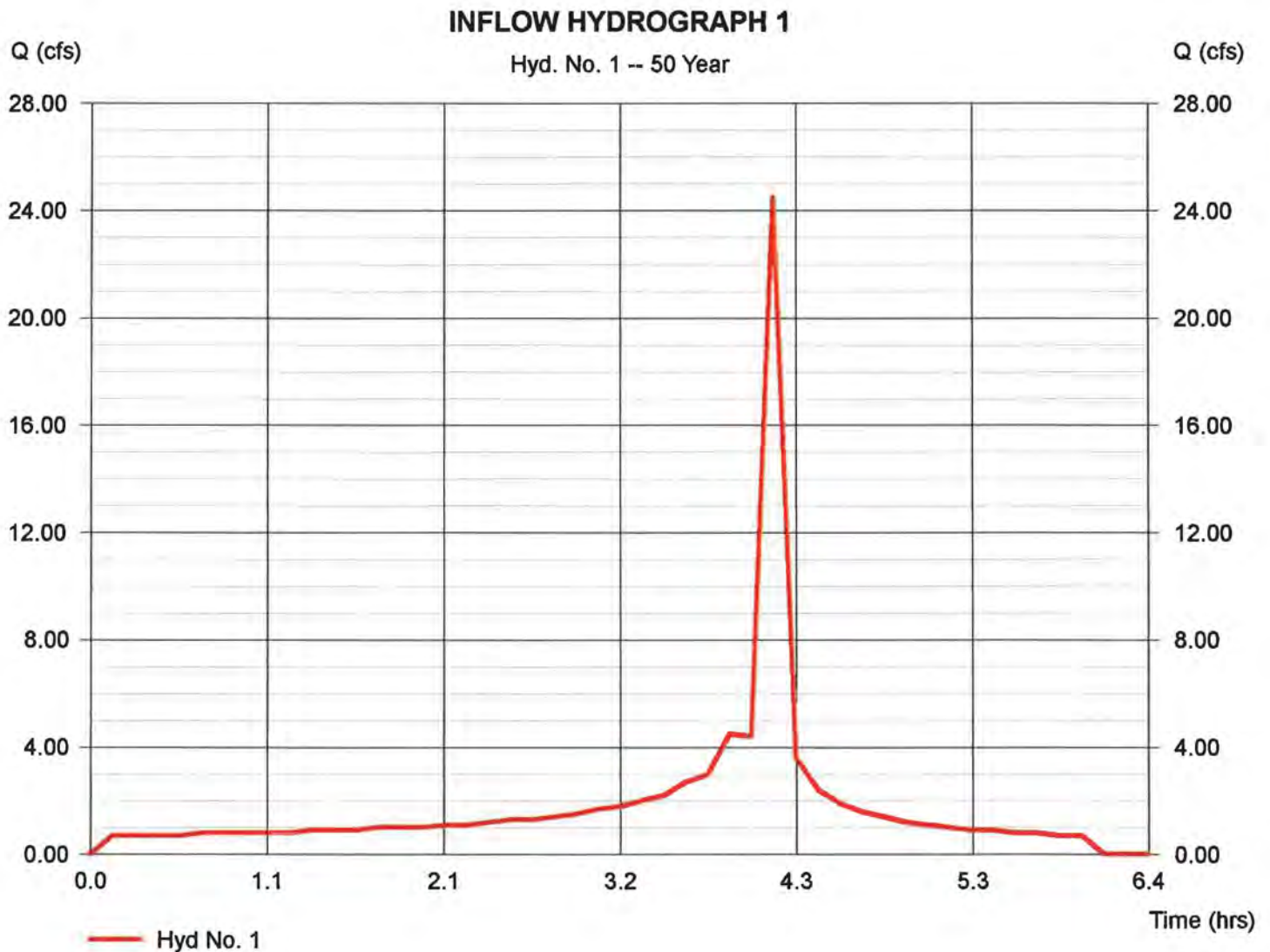
Monday, Mar 25, 2019

Hyd. No. 1

INFLOW HYDROGRAPH 1

Hydrograph type = Manual
Storm frequency = 50 yrs
Time interval = 8 min

Peak discharge = 24.50 cfs
Time to peak = 248 min
Hyd. volume = 41,856 cuft



BASIN # 1

RUN DATE 3/25/2019
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 8 MIN.
6 HOUR RAINFALL 2.45 INCHES
BASIN AREA 5.57 ACRES
RUNOFF COEFFICIENT 0.85
PEAK DISCHARGE 24.5 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 8	DISCHARGE (CFS) = 0.7
TIME (MIN) = 16	DISCHARGE (CFS) = 0.7
TIME (MIN) = 24	DISCHARGE (CFS) = 0.7
TIME (MIN) = 32	DISCHARGE (CFS) = 0.7
TIME (MIN) = 40	DISCHARGE (CFS) = 0.8
TIME (MIN) = 48	DISCHARGE (CFS) = 0.8
TIME (MIN) = 56	DISCHARGE (CFS) = 0.8
TIME (MIN) = 64	DISCHARGE (CFS) = 0.8
TIME (MIN) = 72	DISCHARGE (CFS) = 0.8
TIME (MIN) = 80	DISCHARGE (CFS) = 0.9
TIME (MIN) = 88	DISCHARGE (CFS) = 0.9
TIME (MIN) = 96	DISCHARGE (CFS) = 0.9
TIME (MIN) = 104	DISCHARGE (CFS) = 1
TIME (MIN) = 112	DISCHARGE (CFS) = 1
TIME (MIN) = 120	DISCHARGE (CFS) = 1
TIME (MIN) = 128	DISCHARGE (CFS) = 1.1
TIME (MIN) = 136	DISCHARGE (CFS) = 1.1
TIME (MIN) = 144	DISCHARGE (CFS) = 1.2
TIME (MIN) = 152	DISCHARGE (CFS) = 1.3
TIME (MIN) = 160	DISCHARGE (CFS) = 1.3
TIME (MIN) = 168	DISCHARGE (CFS) = 1.4
TIME (MIN) = 176	DISCHARGE (CFS) = 1.5
TIME (MIN) = 184	DISCHARGE (CFS) = 1.7
TIME (MIN) = 192	DISCHARGE (CFS) = 1.8
TIME (MIN) = 200	DISCHARGE (CFS) = 2
TIME (MIN) = 208	DISCHARGE (CFS) = 2.2
TIME (MIN) = 216	DISCHARGE (CFS) = 2.7
TIME (MIN) = 224	DISCHARGE (CFS) = 3
TIME (MIN) = 232	DISCHARGE (CFS) = 4.5
TIME (MIN) = 240	DISCHARGE (CFS) = 4.4
TIME (MIN) = 248	DISCHARGE (CFS) = 24.5
TIME (MIN) = 256	DISCHARGE (CFS) = 3.6
TIME (MIN) = 264	DISCHARGE (CFS) = 2.4
TIME (MIN) = 272	DISCHARGE (CFS) = 1.9
TIME (MIN) = 280	DISCHARGE (CFS) = 1.6
TIME (MIN) = 288	DISCHARGE (CFS) = 1.4
TIME (MIN) = 296	DISCHARGE (CFS) = 1.2
TIME (MIN) = 304	DISCHARGE (CFS) = 1.1
TIME (MIN) = 312	DISCHARGE (CFS) = 1
TIME (MIN) = 320	DISCHARGE (CFS) = 0.9
TIME (MIN) = 328	DISCHARGE (CFS) = 0.9
TIME (MIN) = 336	DISCHARGE (CFS) = 0.8
TIME (MIN) = 344	DISCHARGE (CFS) = 0.8
TIME (MIN) = 352	DISCHARGE (CFS) = 0.7
TIME (MIN) = 360	DISCHARGE (CFS) = 0.7
TIME (MIN) = 368	DISCHARGE (CFS) = 0

BASIN # 2

RUN DATE 3/25/2019
HYDROGRAPH FILE NAME Text1
TIME OF CONCENTRATION 8 MIN
6 HOUR RAINFALL 2.45 INCHES
BASIN AREA 4.77 ACRES
RUNOFF COEFFICIENT 0.85
PEAK DISCHARGE 17.63 CFS

TIME (MIN) = 0	DISCHARGE (CFS) = 0
TIME (MIN) = 8	DISCHARGE (CFS) = 0.6
TIME (MIN) = 16	DISCHARGE (CFS) = 0.6
TIME (MIN) = 24	DISCHARGE (CFS) = 0.6
TIME (MIN) = 32	DISCHARGE (CFS) = 0.6
TIME (MIN) = 40	DISCHARGE (CFS) = 0.7
TIME (MIN) = 48	DISCHARGE (CFS) = 0.7
TIME (MIN) = 56	DISCHARGE (CFS) = 0.7
TIME (MIN) = 64	DISCHARGE (CFS) = 0.7
TIME (MIN) = 72	DISCHARGE (CFS) = 0.7
TIME (MIN) = 80	DISCHARGE (CFS) = 0.7
TIME (MIN) = 88	DISCHARGE (CFS) = 0.8
TIME (MIN) = 96	DISCHARGE (CFS) = 0.8
TIME (MIN) = 104	DISCHARGE (CFS) = 0.8
TIME (MIN) = 112	DISCHARGE (CFS) = 0.8
TIME (MIN) = 120	DISCHARGE (CFS) = 0.9
TIME (MIN) = 128	DISCHARGE (CFS) = 0.9
TIME (MIN) = 136	DISCHARGE (CFS) = 1
TIME (MIN) = 144	DISCHARGE (CFS) = 1
TIME (MIN) = 152	DISCHARGE (CFS) = 1.1
TIME (MIN) = 160	DISCHARGE (CFS) = 1.1
TIME (MIN) = 168	DISCHARGE (CFS) = 1.2
TIME (MIN) = 176	DISCHARGE (CFS) = 1.3
TIME (MIN) = 184	DISCHARGE (CFS) = 1.4
TIME (MIN) = 192	DISCHARGE (CFS) = 1.5
TIME (MIN) = 200	DISCHARGE (CFS) = 1.7
TIME (MIN) = 208	DISCHARGE (CFS) = 1.9
TIME (MIN) = 216	DISCHARGE (CFS) = 2.3
TIME (MIN) = 224	DISCHARGE (CFS) = 2.6
TIME (MIN) = 232	DISCHARGE (CFS) = 3.8
TIME (MIN) = 240	DISCHARGE (CFS) = 7.1
TIME (MIN) = 248	DISCHARGE (CFS) = 17.63
TIME (MIN) = 256	DISCHARGE (CFS) = 3.1
TIME (MIN) = 264	DISCHARGE (CFS) = 2.1
TIME (MIN) = 272	DISCHARGE (CFS) = 1.6
TIME (MIN) = 280	DISCHARGE (CFS) = 1.3
TIME (MIN) = 288	DISCHARGE (CFS) = 1.2
TIME (MIN) = 296	DISCHARGE (CFS) = 1
TIME (MIN) = 304	DISCHARGE (CFS) = 0.9
TIME (MIN) = 312	DISCHARGE (CFS) = 0.9
TIME (MIN) = 320	DISCHARGE (CFS) = 0.8
TIME (MIN) = 328	DISCHARGE (CFS) = 0.8
TIME (MIN) = 336	DISCHARGE (CFS) = 0.7
TIME (MIN) = 344	DISCHARGE (CFS) = 0.7
TIME (MIN) = 352	DISCHARGE (CFS) = 0.6
TIME (MIN) = 360	DISCHARGE (CFS) = 0.6
TIME (MIN) = 368	DISCHARGE (CFS) = 0

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

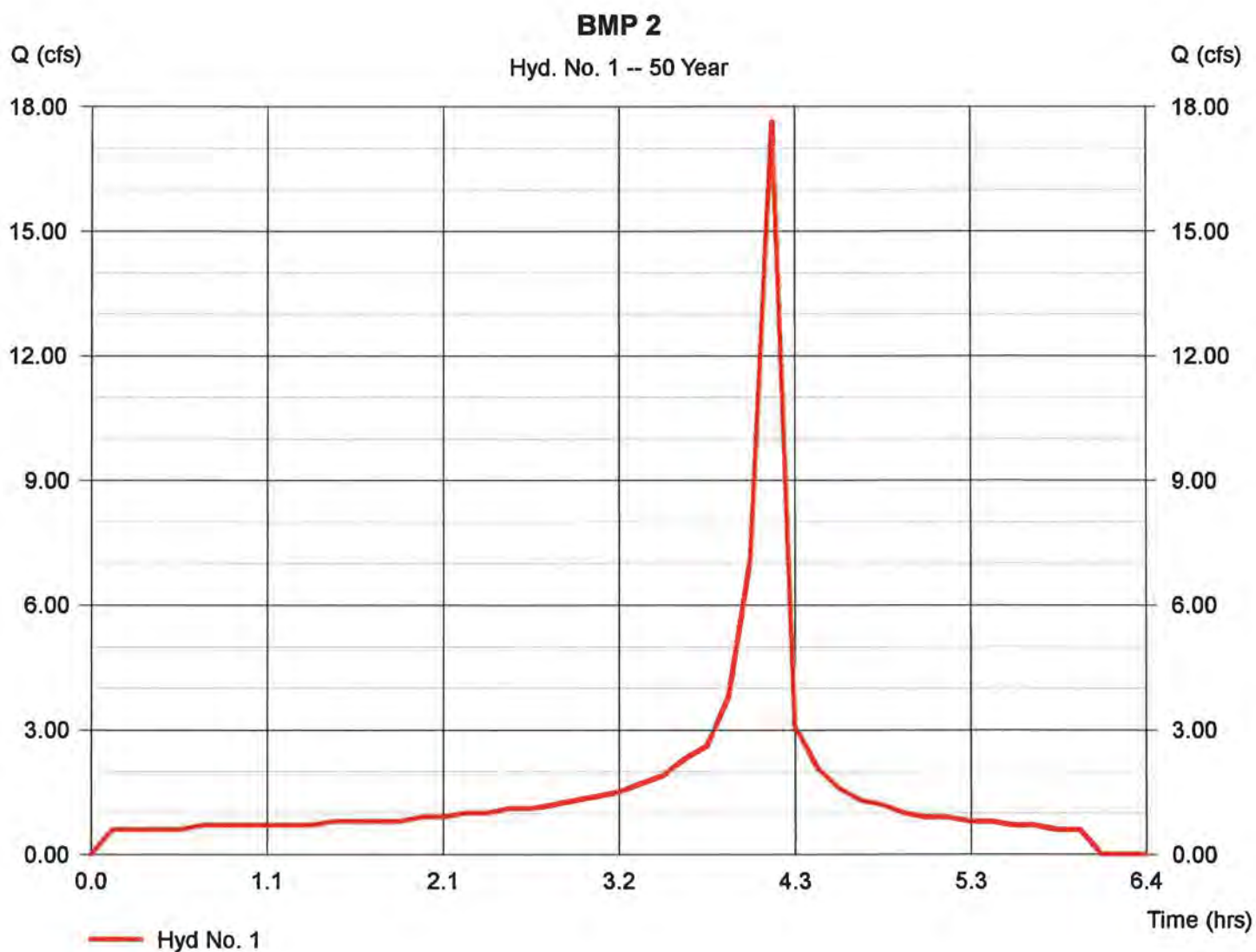
Monday, Mar 25, 2019

Hyd. No. 1

BMP 2

Hydrograph type = Manual
Storm frequency = 50 yrs
Time interval = 8 min

Peak discharge = 17.63 cfs
Time to peak = 248 min
Hyd. volume = 35,774 cuft



7.3 DETENTION BASIN CALCULATIONS

Watershed Model Schematic

Hydraflow Hydrographs by Intelisolve v9.23



Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	Manual	24.50	8	248	41,856	—	-----	-----	INFLOW HYDROGRAPH 1
2	Reservoir	10.72	8	256	41,135	1	699.86	30,194	OUTFLOW HYDROGRAPH 1
18-062 BMP1.gpw					Return Period: 50 Year			Monday, Mar 25, 2019	

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

Hyd. No. 1

INFLOW HYDROGRAPH 1

Hydrograph type = Manual
 Storm frequency = 50 yrs
 Time interval = 8 min

Peak discharge = 24.50 cfs
 Time to peak = 248 min
 Hyd. volume = 41,856 cuft

Hydrograph Discharge Table

(Printed values >= 1.00% of Qp.)

Time -- Outflow (min) cfs)	Time -- Outflow (min) cfs)
8 0.700	344 0.800
16 0.700	352 0.700
24 0.700	360 0.700
32 0.700	...
40 0.800	End
48 0.800	
56 0.800	
64 0.800	
72 0.800	
80 0.900	
88 0.900	
96 0.900	
104 1.000	
112 1.000	
120 1.000	
128 1.100	
136 1.100	
144 1.200	
152 1.300	
160 1.300	
168 1.400	
176 1.500	
184 1.700	
192 1.800	
200 2.000	
208 2.200	
216 2.700	
224 3.000	
232 4.500	
240 4.400	
248 24.50 <<	
256 3.600	
264 2.400	
272 1.900	
280 1.600	
288 1.400	
296 1.200	
304 1.100	
312 1.000	
320 0.900	
328 0.900	
336 0.800	

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

Hyd. No. 2

OUTFLOW HYDROGRAPH 1

Hydrograph type	= Reservoir	Peak discharge	= 10.72 cfs
Storm frequency	= 50 yrs	Time to peak	= 256 min
Time interval	= 8 min	Hyd. volume	= 41,135 cuft
Inflow hyd. No.	= 1 - INFLOW HYDROGRAPH 1	Reservoir name	= BMP 1
Max. Elevation	= 699.86 ft	Max. Storage	= 30,194 cuft

Storage Indication method used.

Hydrograph Discharge Table

(Printed values >= 1.00% of Qp)

Time (min)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
248	24.50 <<	699.09	1.215	0.069	----	----	0.624	----	----	----	----	0.693
256	3.600	699.63 <<	10.65	0.071	----	----	10.65	----	----	----	----	10.72 <<
264	2.400	699.34	4.245	0.070	----	----	4.232	----	----	----	----	4.302
272	1.900	699.25	2.654	0.069	----	----	2.646	----	----	----	----	2.715
280	1.600	699.20	2.230	0.069	----	----	2.066	----	----	----	----	2.136
288	1.400	699.18	1.952	0.069	----	----	1.685	----	----	----	----	1.754
296	1.200	699.16	1.753	0.069	----	----	1.412	----	----	----	----	1.481
304	1.100	699.14	1.607	0.069	----	----	1.213	----	----	----	----	1.282
312	1.000	699.13	1.506	0.069	----	----	1.074	----	----	----	----	1.143
320	0.900	699.12	1.421	0.069	----	----	0.958	----	----	----	----	1.027
328	0.900	699.12	1.365	0.069	----	----	0.882	----	----	----	----	0.951
336	0.800	699.11	1.321	0.069	----	----	0.822	----	----	----	----	0.890
344	0.800	699.11	1.281	0.069	----	----	0.767	----	----	----	----	0.836
352	0.700	699.10	1.244	0.069	----	----	0.716	----	----	----	----	0.784
360	0.700	699.10	1.215	0.069	----	----	0.672	----	----	----	----	0.741
368	0.000	699.08	1.215	0.068	----	----	0.573	----	----	----	----	0.641
376	0.000	699.04	1.215	0.068	----	----	0.410	----	----	----	----	0.478
384	0.000	699.01	1.215	0.068	----	----	0.289	----	----	----	----	0.357
392	0.000	698.99	1.215	0.068	----	----	0.198	----	----	----	----	0.266
400	0.000	698.98	1.215	0.068	----	----	0.131	----	----	----	----	0.199
408	0.000	698.97	1.215	0.068	----	----	0.080	----	----	----	----	0.148
416	0.000	698.96	1.215	0.068	----	----	0.043	----	----	----	----	0.110

...End

Hydrograph Report

4

Hydraflow Hydrographs by Intelisolve v9.23

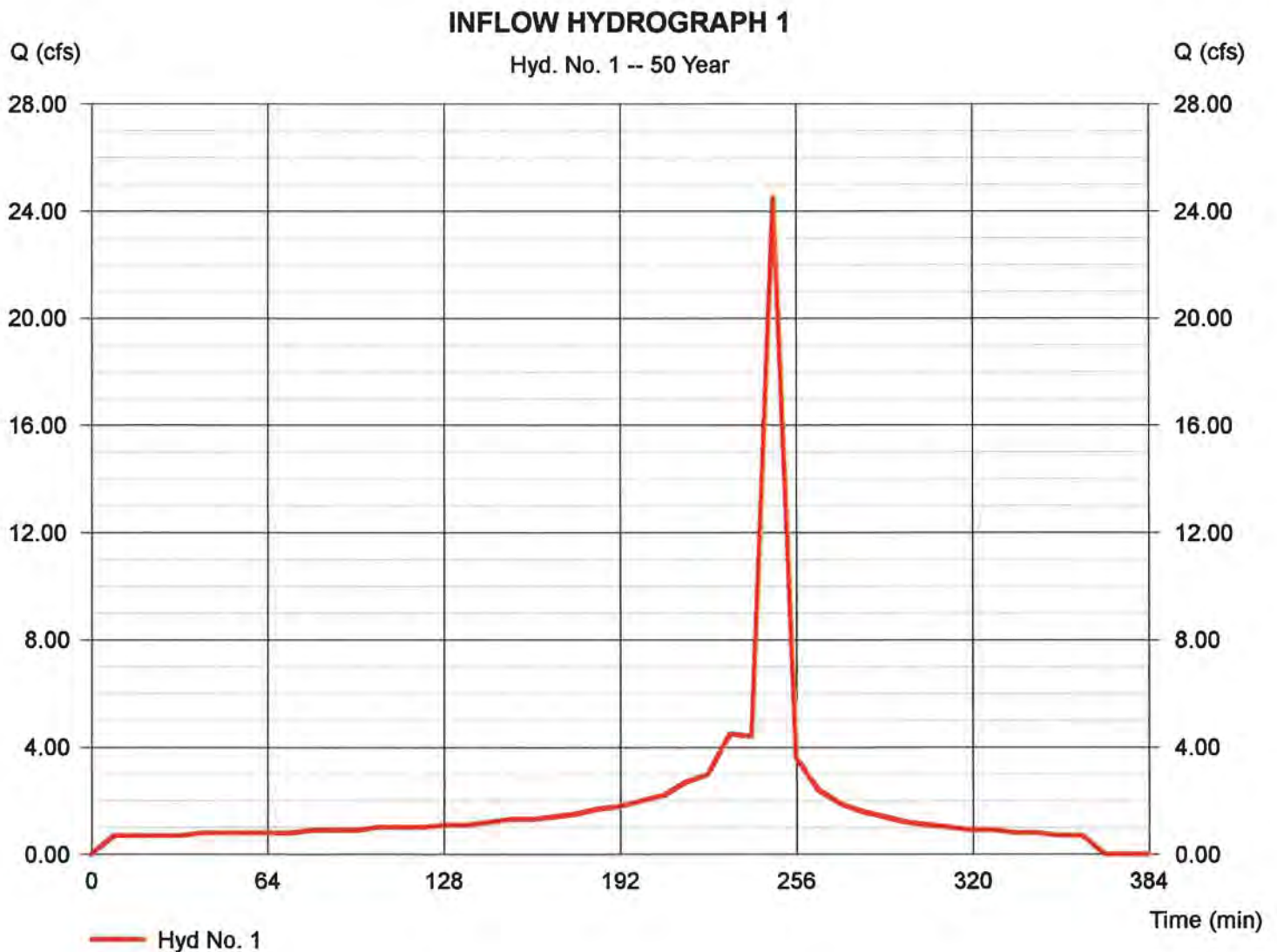
Monday, Mar 25, 2019

Hyd. No. 1

INFLOW HYDROGRAPH 1

Hydrograph type = Manual
Storm frequency = 50 yrs
Time interval = 8 min

Peak discharge = 24.50 cfs
Time to peak = 248 min
Hyd. volume = 41,856 cuft



Hydrograph Report

5

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

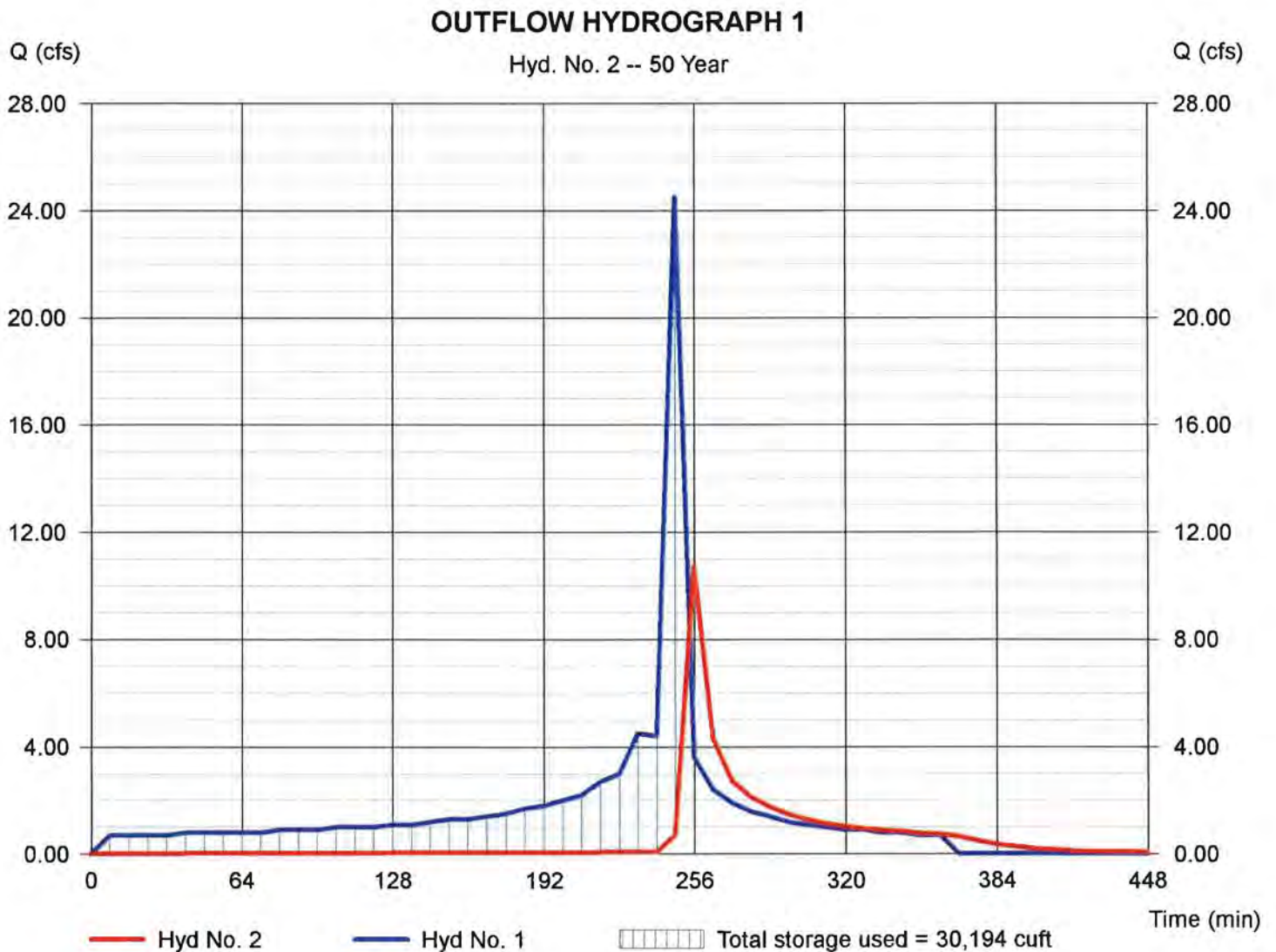
Hyd. No. 2

OUTFLOW HYDROGRAPH 1

Hydrograph type = Reservoir
Storm frequency = 50 yrs
Time interval = 8 min
Inflow hyd. No. = 1 - INFLOW HYDROGRAPH 1
Reservoir name = BMP 1

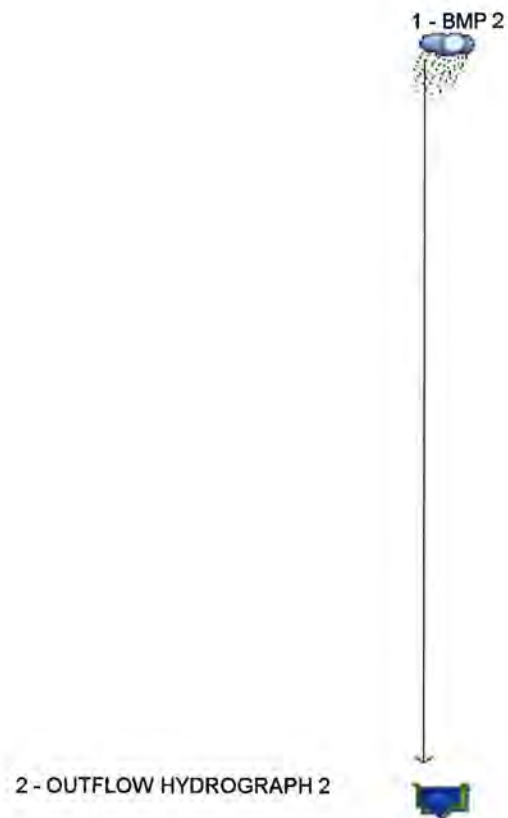
Peak discharge = 10.72 cfs
Time to peak = 256 min
Hyd. volume = 41,135 cuft
Max. Elevation = 699.86 ft
Max. Storage = 30,194 cuft

Storage Indication method used.



Watershed Model Schematic

Hydraflow Hydrographs by Intelisolve v9.23



Legend

<u>Hyd.</u>	<u>Origin</u>	<u>Description</u>
1	Manual	BMP 2
2	Reservoir	OUTFLOW HYDROGRAPH 2

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.23

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph description
1	Manual	17.63	8	248	35,774	----	-----	-----	BMP 2
2	Reservoir	7.834	8	256	35,742	1	698.54	26,037	OUTFLOW HYDROGRAPH 2
18-062 BMP2.gpw					Return Period: 50 Year			Monday, Mar 25, 2019	

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

Hyd. No. 1

BMP 2

Hydrograph type	= Manual	Peak discharge	= 17.63 cfs
Storm frequency	= 50 yrs	Time to peak	= 4.13 hrs
Time interval	= 8 min	Hyd. volume	= 35,774 cuft

Hydrograph Discharge Table

(Printed values >= 1.00% of Qp)

Time -- Outflow		Time -- Outflow	
(hrs	cfs)	(hrs	cfs)
0.13	0.600	5.73	0.700
0.27	0.600	5.87	0.600
0.40	0.600	6.00	0.600
0.53	0.600		
0.67	0.700	...End	
0.80	0.700		
0.93	0.700		
1.07	0.700		
1.20	0.700		
1.33	0.700		
1.47	0.800		
1.60	0.800		
1.73	0.800		
1.87	0.800		
2.00	0.900		
2.13	0.900		
2.27	1.000		
2.40	1.000		
2.53	1.100		
2.67	1.100		
2.80	1.200		
2.93	1.300		
3.07	1.400		
3.20	1.500		
3.33	1.700		
3.47	1.900		
3.60	2.300		
3.73	2.600		
3.87	3.800		
4.00	7.100		
4.13	17.63 <<		
4.27	3.100		
4.40	2.100		
4.53	1.600		
4.67	1.300		
4.80	1.200		
4.93	1.000		
5.07	0.900		
5.20	0.900		
5.33	0.800		
5.47	0.800		
5.60	0.700		

Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

Hyd. No. 2

OUTFLOW HYDROGRAPH 2

Hydrograph type = Reservoir
 Storm frequency = 50 yrs
 Time interval = 8 min
 Inflow hyd. No. = 1 - BMP 2
 Max. Elevation = 698.54 ft

Peak discharge = 7.834 cfs
 Time to peak = 4.27 hrs
 Hyd. volume = 35,742 cuft
 Reservoir name = BMP 2
 Max. Storage = 26,037 cuft

Storage Indication method used. Outflow includes exfiltration.

(Printed values >= 1.00% of Qp)

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
3.73	2.600	696.02	9.660	0.057	----	----	----	----	----	----	0.023	0.080
3.87	3.800	696.34	9.660	0.059	----	----	----	----	----	----	0.023	0.082
4.00	7.100	696.88	9.660	0.062	----	----	----	----	----	----	0.023	0.085
4.13	17.63 <<	697.98	9.660	0.068	----	----	----	----	----	----	0.023	0.091
4.27	3.100	698.39 <<	9.660	0.070	----	----	7.741	----	----	----	0.023	7.834 <<
4.40	2.100	698.21	9.660	0.069	----	----	3.008	----	----	----	0.023	3.101
4.53	1.600	698.15	9.660	0.069	----	----	2.167	----	----	----	0.023	2.259
4.67	1.300	698.12	9.660	0.069	----	----	1.665	----	----	----	0.023	1.756
4.80	1.200	698.10	9.660	0.068	----	----	1.349	----	----	----	0.023	1.441
4.93	1.000	698.08	9.660	0.068	----	----	1.137	----	----	----	0.023	1.229
5.07	0.900	698.07	9.660	0.068	----	----	0.964	----	----	----	0.023	1.055
5.20	0.900	698.06	9.660	0.068	----	----	0.867	----	----	----	0.023	0.959
5.33	0.800	698.06	9.660	0.068	----	----	0.800	----	----	----	0.023	0.891
5.47	0.800	698.05	9.660	0.068	----	----	0.743	----	----	----	0.023	0.834
5.60	0.700	698.05	9.660	0.068	----	----	0.691	----	----	----	0.023	0.782
5.73	0.700	698.05	9.660	0.068	----	----	0.640	----	----	----	0.023	0.731
5.87	0.600	698.04	9.660	0.068	----	----	0.589	----	----	----	0.023	0.681
6.00	0.600	698.04	9.660	0.068	----	----	0.539	----	----	----	0.023	0.630
6.13	0.000	698.02	9.660	0.068	----	----	0.334	----	----	----	0.023	0.425
6.27	0.000	698.00	9.660	0.068	----	----	0.069	----	----	----	0.023	0.161
6.40	0.000	698.00	9.660	0.068	----	----	----	----	----	----	0.023	0.091
6.53	0.000	697.99	9.660	0.068	----	----	----	----	----	----	0.023	0.091
6.67	0.000	697.98	9.660	0.068	----	----	----	----	----	----	0.023	0.091
6.80	0.000	697.97	9.660	0.068	----	----	----	----	----	----	0.023	0.091
6.93	0.000	697.97	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.07	0.000	697.96	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.20	0.000	697.95	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.33	0.000	697.95	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.47	0.000	697.94	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.60	0.000	697.93	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.73	0.000	697.93	9.660	0.068	----	----	----	----	----	----	0.023	0.091
7.87	0.000	697.92	9.660	0.068	----	----	----	----	----	----	0.023	0.091
8.00	0.000	697.91	9.660	0.068	----	----	----	----	----	----	0.023	0.091
8.13	0.000	697.90	9.660	0.068	----	----	----	----	----	----	0.023	0.091
8.27	0.000	697.90	9.660	0.067	----	----	----	----	----	----	0.023	0.090
8.40	0.000	697.89	9.660	0.067	----	----	----	----	----	----	0.023	0.090
8.53	0.000	697.88	9.660	0.067	----	----	----	----	----	----	0.023	0.090
8.67	0.000	697.88	9.660	0.067	----	----	----	----	----	----	0.023	0.090
8.80	0.000	697.87	9.660	0.067	----	----	----	----	----	----	0.023	0.090
8.93	0.000	697.86	9.660	0.067	----	----	----	----	----	----	0.023	0.090

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OUTFLOW HYDROGRAPH 2

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
9.07	0.000	697.86	9.660	0.067	----	----	----	----	----	----	0.023	0.090
9.20	0.000	697.85	9.660	0.067	----	----	----	----	----	----	0.023	0.090
9.33	0.000	697.84	9.660	0.067	----	----	----	----	----	----	0.023	0.090
9.47	0.000	697.83	9.660	0.067	----	----	----	----	----	----	0.023	0.090
9.60	0.000	697.83	9.660	0.067	----	----	----	----	----	----	0.023	0.090
9.73	0.000	697.82	9.660	0.067	----	----	----	----	----	----	0.023	0.090
9.87	0.000	697.81	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.00	0.000	697.81	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.13	0.000	697.80	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.27	0.000	697.79	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.40	0.000	697.79	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.53	0.000	697.78	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.67	0.000	697.77	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.80	0.000	697.76	9.660	0.067	----	----	----	----	----	----	0.023	0.090
10.93	0.000	697.76	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.07	0.000	697.75	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.20	0.000	697.74	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.33	0.000	697.74	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.47	0.000	697.73	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.60	0.000	697.72	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.73	0.000	697.72	9.660	0.067	----	----	----	----	----	----	0.023	0.090
11.87	0.000	697.71	9.660	0.067	----	----	----	----	----	----	0.023	0.090
12.00	0.000	697.70	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.13	0.000	697.69	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.27	0.000	697.69	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.40	0.000	697.68	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.53	0.000	697.67	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.67	0.000	697.67	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.80	0.000	697.66	9.660	0.066	----	----	----	----	----	----	0.023	0.089
12.93	0.000	697.65	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.07	0.000	697.65	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.20	0.000	697.64	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.33	0.000	697.63	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.47	0.000	697.63	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.60	0.000	697.62	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.73	0.000	697.61	9.660	0.066	----	----	----	----	----	----	0.023	0.089
13.87	0.000	697.60	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.00	0.000	697.60	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.13	0.000	697.59	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.27	0.000	697.58	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.40	0.000	697.58	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.53	0.000	697.57	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.67	0.000	697.56	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.80	0.000	697.56	9.660	0.066	----	----	----	----	----	----	0.023	0.089
14.93	0.000	697.55	9.660	0.066	----	----	----	----	----	----	0.023	0.089
15.07	0.000	697.54	9.660	0.066	----	----	----	----	----	----	0.023	0.089
15.20	0.000	697.54	9.660	0.066	----	----	----	----	----	----	0.023	0.089
15.33	0.000	697.53	9.660	0.066	----	----	----	----	----	----	0.023	0.089
15.47	0.000	697.52	9.660	0.066	----	----	----	----	----	----	0.023	0.089
15.60	0.000	697.51	9.660	0.066	----	----	----	----	----	----	0.023	0.089
15.73	0.000	697.51	9.660	0.065	----	----	----	----	----	----	0.023	0.088
15.87	0.000	697.50	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.00	0.000	697.49	9.660	0.065	----	----	----	----	----	----	0.023	0.088

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OUTFLOW HYDROGRAPH 2

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
16.13	0.000	697.48	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.27	0.000	697.47	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.40	0.000	697.47	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.53	0.000	697.46	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.67	0.000	697.45	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.80	0.000	697.44	9.660	0.065	----	----	----	----	----	----	0.023	0.088
16.93	0.000	697.43	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.07	0.000	697.42	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.20	0.000	697.41	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.33	0.000	697.40	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.47	0.000	697.39	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.60	0.000	697.39	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.73	0.000	697.38	9.660	0.065	----	----	----	----	----	----	0.023	0.088
17.87	0.000	697.37	9.660	0.065	----	----	----	----	----	----	0.023	0.088
18.00	0.000	697.36	9.660	0.065	----	----	----	----	----	----	0.023	0.088
18.13	0.000	697.35	9.660	0.065	----	----	----	----	----	----	0.023	0.088
18.27	0.000	697.34	9.660	0.065	----	----	----	----	----	----	0.023	0.088
18.40	0.000	697.33	9.660	0.065	----	----	----	----	----	----	0.023	0.088
18.53	0.000	697.32	9.660	0.064	----	----	----	----	----	----	0.023	0.087
18.67	0.000	697.32	9.660	0.064	----	----	----	----	----	----	0.023	0.087
18.80	0.000	697.31	9.660	0.064	----	----	----	----	----	----	0.023	0.087
18.93	0.000	697.30	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.07	0.000	697.29	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.20	0.000	697.28	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.33	0.000	697.27	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.47	0.000	697.26	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.60	0.000	697.25	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.73	0.000	697.24	9.660	0.064	----	----	----	----	----	----	0.023	0.087
19.87	0.000	697.24	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.00	0.000	697.23	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.13	0.000	697.22	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.27	0.000	697.21	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.40	0.000	697.20	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.53	0.000	697.19	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.67	0.000	697.18	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.80	0.000	697.17	9.660	0.064	----	----	----	----	----	----	0.023	0.087
20.93	0.000	697.17	9.660	0.064	----	----	----	----	----	----	0.023	0.087
21.07	0.000	697.16	9.660	0.064	----	----	----	----	----	----	0.023	0.087
21.20	0.000	697.15	9.660	0.064	----	----	----	----	----	----	0.023	0.087
21.33	0.000	697.14	9.660	0.063	----	----	----	----	----	----	0.023	0.086
21.47	0.000	697.13	9.660	0.063	----	----	----	----	----	----	0.023	0.086
21.60	0.000	697.12	9.660	0.063	----	----	----	----	----	----	0.023	0.086
21.73	0.000	697.11	9.660	0.063	----	----	----	----	----	----	0.023	0.086
21.87	0.000	697.10	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.00	0.000	697.10	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.13	0.000	697.09	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.27	0.000	697.08	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.40	0.000	697.07	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.53	0.000	697.06	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.67	0.000	697.05	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.80	0.000	697.04	9.660	0.063	----	----	----	----	----	----	0.023	0.086
22.93	0.000	697.04	9.660	0.063	----	----	----	----	----	----	0.023	0.086
23.07	0.000	697.03	9.660	0.063	----	----	----	----	----	----	0.023	0.086

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OUTFLOW HYDROGRAPH 2

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
23.20	0.000	697.02	9.660	0.063	----	----	----	----	----	----	0.023	0.086
23.33	0.000	697.01	9.660	0.063	----	----	----	----	----	----	0.023	0.086
23.47	0.000	697.00	9.660	0.063	----	----	----	----	----	----	0.023	0.086
23.60	0.000	696.99	9.660	0.063	----	----	----	----	----	----	0.023	0.086
23.73	0.000	696.98	9.660	0.063	----	----	----	----	----	----	0.023	0.086
23.87	0.000	696.97	9.660	0.063	----	----	----	----	----	----	0.023	0.086
24.00	0.000	696.97	9.660	0.063	----	----	----	----	----	----	0.023	0.086
24.13	0.000	696.96	9.660	0.063	----	----	----	----	----	----	0.023	0.086
24.27	0.000	696.95	9.660	0.062	----	----	----	----	----	----	0.023	0.085
24.40	0.000	696.94	9.660	0.062	----	----	----	----	----	----	0.023	0.085
24.53	0.000	696.93	9.660	0.062	----	----	----	----	----	----	0.023	0.085
24.67	0.000	696.92	9.660	0.062	----	----	----	----	----	----	0.023	0.085
24.80	0.000	696.91	9.660	0.062	----	----	----	----	----	----	0.023	0.085
24.93	0.000	696.91	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.07	0.000	696.90	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.20	0.000	696.89	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.33	0.000	696.88	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.47	0.000	696.87	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.60	0.000	696.86	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.73	0.000	696.85	9.660	0.062	----	----	----	----	----	----	0.023	0.085
25.87	0.000	696.85	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.00	0.000	696.84	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.13	0.000	696.83	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.27	0.000	696.82	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.40	0.000	696.81	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.53	0.000	696.80	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.67	0.000	696.79	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.80	0.000	696.79	9.660	0.062	----	----	----	----	----	----	0.023	0.085
26.93	0.000	696.78	9.660	0.061	----	----	----	----	----	----	0.023	0.085
27.07	0.000	696.77	9.660	0.061	----	----	----	----	----	----	0.023	0.084
27.20	0.000	696.76	9.660	0.061	----	----	----	----	----	----	0.023	0.084
27.33	0.000	696.75	9.660	0.061	----	----	----	----	----	----	0.023	0.084
27.47	0.000	696.74	9.660	0.061	----	----	----	----	----	----	0.023	0.084
27.60	0.000	696.73	9.660	0.061	----	----	----	----	----	----	0.023	0.084
27.73	0.000	696.73	9.660	0.061	----	----	----	----	----	----	0.023	0.084
27.87	0.000	696.72	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.00	0.000	696.71	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.13	0.000	696.70	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.27	0.000	696.69	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.40	0.000	696.68	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.53	0.000	696.68	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.67	0.000	696.67	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.80	0.000	696.66	9.660	0.061	----	----	----	----	----	----	0.023	0.084
28.93	0.000	696.65	9.660	0.061	----	----	----	----	----	----	0.023	0.084
29.07	0.000	696.64	9.660	0.061	----	----	----	----	----	----	0.023	0.084
29.20	0.000	696.63	9.660	0.061	----	----	----	----	----	----	0.023	0.084
29.33	0.000	696.62	9.660	0.061	----	----	----	----	----	----	0.023	0.084
29.47	0.000	696.62	9.660	0.061	----	----	----	----	----	----	0.023	0.084
29.60	0.000	696.61	9.660	0.061	----	----	----	----	----	----	0.023	0.084
29.73	0.000	696.60	9.660	0.060	----	----	----	----	----	----	0.023	0.083
29.87	0.000	696.59	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.00	0.000	696.58	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.13	0.000	696.57	9.660	0.060	----	----	----	----	----	----	0.023	0.083

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OUTFLOW HYDROGRAPH 2

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
30.27	0.000	696.57	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.40	0.000	696.56	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.53	0.000	696.55	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.67	0.000	696.54	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.80	0.000	696.53	9.660	0.060	----	----	----	----	----	----	0.023	0.083
30.93	0.000	696.52	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.07	0.000	696.52	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.20	0.000	696.51	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.33	0.000	696.50	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.47	0.000	696.49	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.60	0.000	696.48	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.73	0.000	696.47	9.660	0.060	----	----	----	----	----	----	0.023	0.083
31.87	0.000	696.47	9.660	0.060	----	----	----	----	----	----	0.023	0.083
32.00	0.000	696.46	9.660	0.060	----	----	----	----	----	----	0.023	0.083
32.13	0.000	696.45	9.660	0.060	----	----	----	----	----	----	0.023	0.083
32.27	0.000	696.44	9.660	0.060	----	----	----	----	----	----	0.023	0.083
32.40	0.000	696.43	9.660	0.060	----	----	----	----	----	----	0.023	0.083
32.53	0.000	696.42	9.660	0.059	----	----	----	----	----	----	0.023	0.082
32.67	0.000	696.42	9.660	0.059	----	----	----	----	----	----	0.023	0.082
32.80	0.000	696.41	9.660	0.059	----	----	----	----	----	----	0.023	0.082
32.93	0.000	696.40	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.07	0.000	696.39	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.20	0.000	696.38	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.33	0.000	696.37	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.47	0.000	696.37	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.60	0.000	696.36	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.73	0.000	696.35	9.660	0.059	----	----	----	----	----	----	0.023	0.082
33.87	0.000	696.34	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.00	0.000	696.33	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.13	0.000	696.32	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.27	0.000	696.32	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.40	0.000	696.31	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.53	0.000	696.30	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.67	0.000	696.29	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.80	0.000	696.28	9.660	0.059	----	----	----	----	----	----	0.023	0.082
34.93	0.000	696.27	9.660	0.059	----	----	----	----	----	----	0.023	0.082
35.07	0.000	696.27	9.660	0.059	----	----	----	----	----	----	0.023	0.082
35.20	0.000	696.26	9.660	0.059	----	----	----	----	----	----	0.023	0.082
35.33	0.000	696.25	9.660	0.058	----	----	----	----	----	----	0.023	0.081
35.47	0.000	696.24	9.660	0.058	----	----	----	----	----	----	0.023	0.081
35.60	0.000	696.23	9.660	0.058	----	----	----	----	----	----	0.023	0.081
35.73	0.000	696.23	9.660	0.058	----	----	----	----	----	----	0.023	0.081
35.87	0.000	696.22	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.00	0.000	696.21	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.13	0.000	696.20	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.27	0.000	696.19	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.40	0.000	696.18	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.53	0.000	696.18	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.67	0.000	696.17	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.80	0.000	696.16	9.660	0.058	----	----	----	----	----	----	0.023	0.081
36.93	0.000	696.15	9.660	0.058	----	----	----	----	----	----	0.023	0.081
37.07	0.000	696.14	9.660	0.058	----	----	----	----	----	----	0.023	0.081
37.20	0.000	696.14	9.660	0.058	----	----	----	----	----	----	0.023	0.081

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OUTFLOW HYDROGRAPH 2

Hydrograph Discharge Table

Time (hrs)	Inflow cfs	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	Outflow cfs
37.33	0.000	696.13	9.660	0.058	----	----	----	----	----	----	0.023	0.081
37.47	0.000	696.12	9.660	0.058	----	----	----	----	----	----	0.023	0.081
37.60	0.000	696.11	9.660	0.058	----	----	----	----	----	----	0.023	0.081
37.73	0.000	696.10	9.660	0.058	----	----	----	----	----	----	0.023	0.081
37.87	0.000	696.09	9.660	0.058	----	----	----	----	----	----	0.023	0.081
38.00	0.000	696.09	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.13	0.000	696.08	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.27	0.000	696.07	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.40	0.000	696.06	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.53	0.000	696.05	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.67	0.000	696.05	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.80	0.000	696.04	9.660	0.057	----	----	----	----	----	----	0.023	0.080
38.93	0.000	696.03	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.07	0.000	696.02	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.20	0.000	696.01	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.33	0.000	696.01	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.47	0.000	696.00	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.60	0.000	695.99	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.73	0.000	695.98	9.660	0.057	----	----	----	----	----	----	0.023	0.080
39.87	0.000	695.97	9.660	0.057	----	----	----	----	----	----	0.023	0.080
40.00	0.000	695.96	9.660	0.057	----	----	----	----	----	----	0.023	0.080
40.13	0.000	695.94	9.660	0.057	----	----	----	----	----	----	0.023	0.080
40.27	0.000	695.93	9.660	0.057	----	----	----	----	----	----	0.023	0.080
40.40	0.000	695.92	9.660	0.057	----	----	----	----	----	----	0.023	0.080
40.53	0.000	695.91	9.660	0.056	----	----	----	----	----	----	0.023	0.079
40.67	0.000	695.90	9.660	0.056	----	----	----	----	----	----	0.023	0.079
40.80	0.000	695.89	9.660	0.056	----	----	----	----	----	----	0.023	0.079
40.93	0.000	695.88	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.07	0.000	695.87	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.20	0.000	695.86	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.33	0.000	695.85	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.47	0.000	695.84	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.60	0.000	695.83	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.73	0.000	695.82	9.660	0.056	----	----	----	----	----	----	0.023	0.079
41.87	0.000	695.81	9.660	0.056	----	----	----	----	----	----	0.023	0.079
42.00	0.000	695.80	9.660	0.056	----	----	----	----	----	----	0.023	0.079
42.13	0.000	695.79	9.660	0.056	----	----	----	----	----	----	0.023	0.079
42.27	0.000	695.78	9.660	0.056	----	----	----	----	----	----	0.023	0.079
42.40	0.000	695.77	9.660	0.056	----	----	----	----	----	----	0.023	0.079
42.53	0.000	695.76	9.660	0.056	----	----	----	----	----	----	0.023	0.079
42.67	0.000	695.75	9.660	0.055	----	----	----	----	----	----	0.023	0.078
42.80	0.000	695.74	9.660	0.055	----	----	----	----	----	----	0.023	0.078

...End

Pond Report

11

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

Pond No. 1 - BMP 2

Pond Data

Trapezoid - Bottom L x W = 184.0 x 20.0 ft, Side slope = 0.00:1, Bottom elev. = 689.50 ft, Depth = 5.00 ft, Voids = 40.00%

Contours - User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 696.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	689.50	3,680	0	0
0.50	690.00	3,680	736	736
1.00	690.50	3,680	736	1,472
1.50	691.00	3,680	736	2,208
2.00	691.50	3,680	736	2,944
2.50	692.00	3,680	736	3,680
3.00	692.50	3,680	736	4,416
3.50	693.00	3,680	736	5,152
4.00	693.50	3,680	736	5,888
4.50	694.00	3,680	736	6,624
5.00	694.50	3,680	736	7,360
6.50	696.00	3,688	5,525	12,885
8.00	697.50	5,918	7,138	20,024
8.50	698.00	6,431	3,086	23,110
10.50	700.00	8,541	14,921	38,030

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 18.00	1.00	0.00	0.00
Span (in)	= 18.00	1.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 687.42	691.25	0.00	0.00
Length (ft)	= 10.00	0.00	0.00	0.00
Slope (%)	= 2.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 9.42	0.00	0.00	0.00
Crest El. (ft)	= 698.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Riser	---	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.270 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	689.50	0.00	0.00	---	---	0.00	---	---	---	0.000	---	0.000
0.50	736	690.00	9.66 oc	0.00	---	---	0.00	---	---	---	0.023	---	0.023
1.00	1,472	690.50	9.66 oc	0.00	---	---	0.00	---	---	---	0.023	---	0.023
1.50	2,208	691.00	9.66 oc	0.00	---	---	0.00	---	---	---	0.023	---	0.023
2.00	2,944	691.50	9.66 oc	0.01 ic	---	---	0.00	---	---	---	0.023	---	0.035
2.50	3,680	692.00	9.66 oc	0.02 ic	---	---	0.00	---	---	---	0.023	---	0.045
3.00	4,416	692.50	9.66 oc	0.03 ic	---	---	0.00	---	---	---	0.023	---	0.052
3.50	5,152	693.00	9.66 oc	0.03 ic	---	---	0.00	---	---	---	0.023	---	0.057
4.00	5,888	693.50	9.66 oc	0.04 ic	---	---	0.00	---	---	---	0.023	---	0.062
4.50	6,624	694.00	9.66 oc	0.04 ic	---	---	0.00	---	---	---	0.023	---	0.066
5.00	7,360	694.50	9.66 oc	0.05 ic	---	---	0.00	---	---	---	0.023	---	0.070
6.50	12,885	696.00	9.66 oc	0.06 ic	---	---	0.00	---	---	---	0.023	---	0.080
8.00	20,024	697.50	9.66 oc	0.07 ic	---	---	0.00	---	---	---	0.023	---	0.088
8.50	23,110	698.00	9.66 oc	0.07 ic	---	---	0.00	---	---	---	0.023	---	0.091
10.50	38,030	700.00	29.17 ic	0.08 ic	---	---	29.16 s	---	---	---	0.023	---	29.26

Hydrograph Report

4

Hydraflow Hydrographs by Intelisolve v9.23

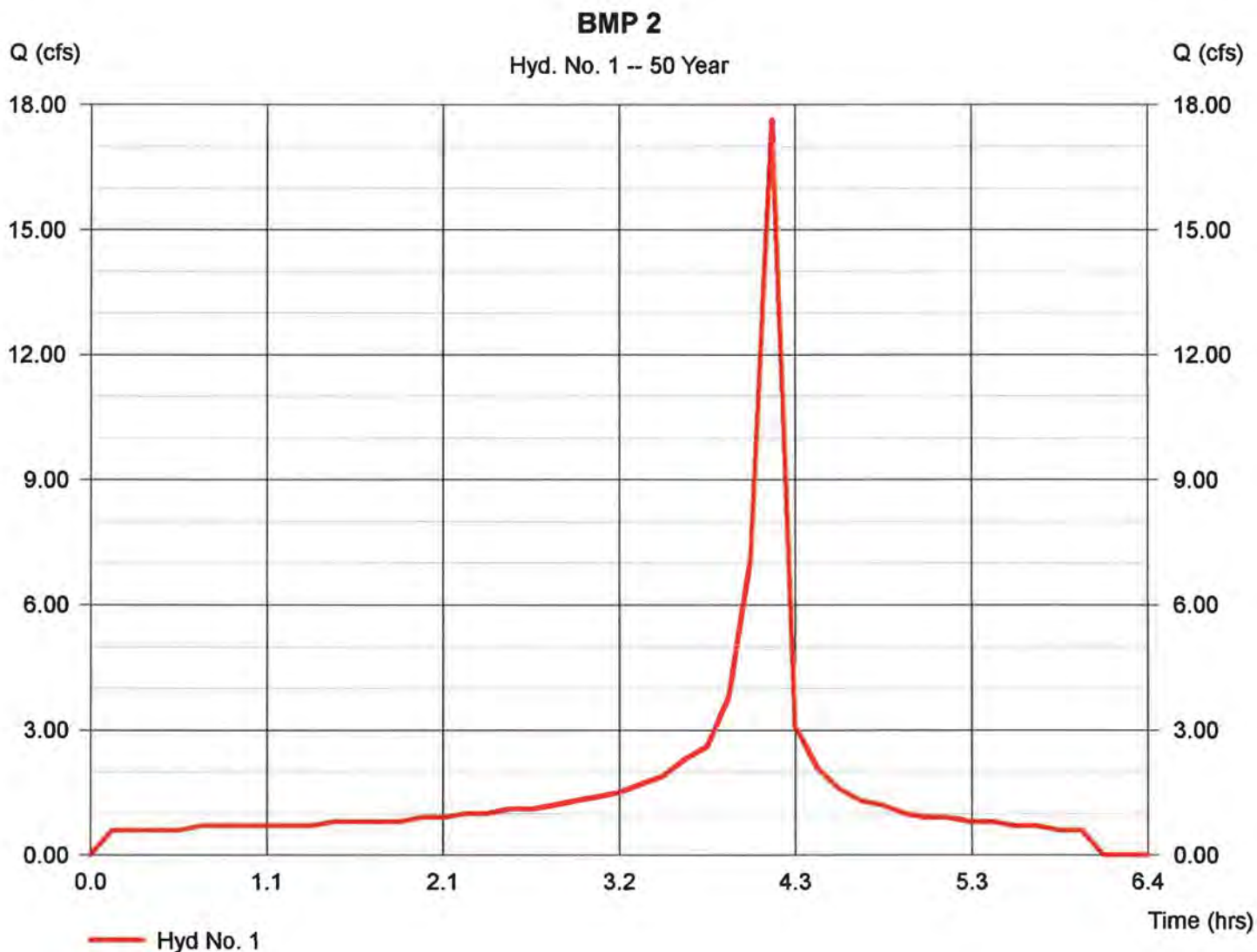
Monday, Mar 25, 2019

Hyd. No. 1

BMP 2

Hydrograph type = Manual
Storm frequency = 50 yrs
Time interval = 8 min

Peak discharge = 17.63 cfs
Time to peak = 4.13 hrs
Hyd. volume = 35,774 cuft



Hydrograph Report

5

Hydraflow Hydrographs by Intelisolve v9.23

Monday, Mar 25, 2019

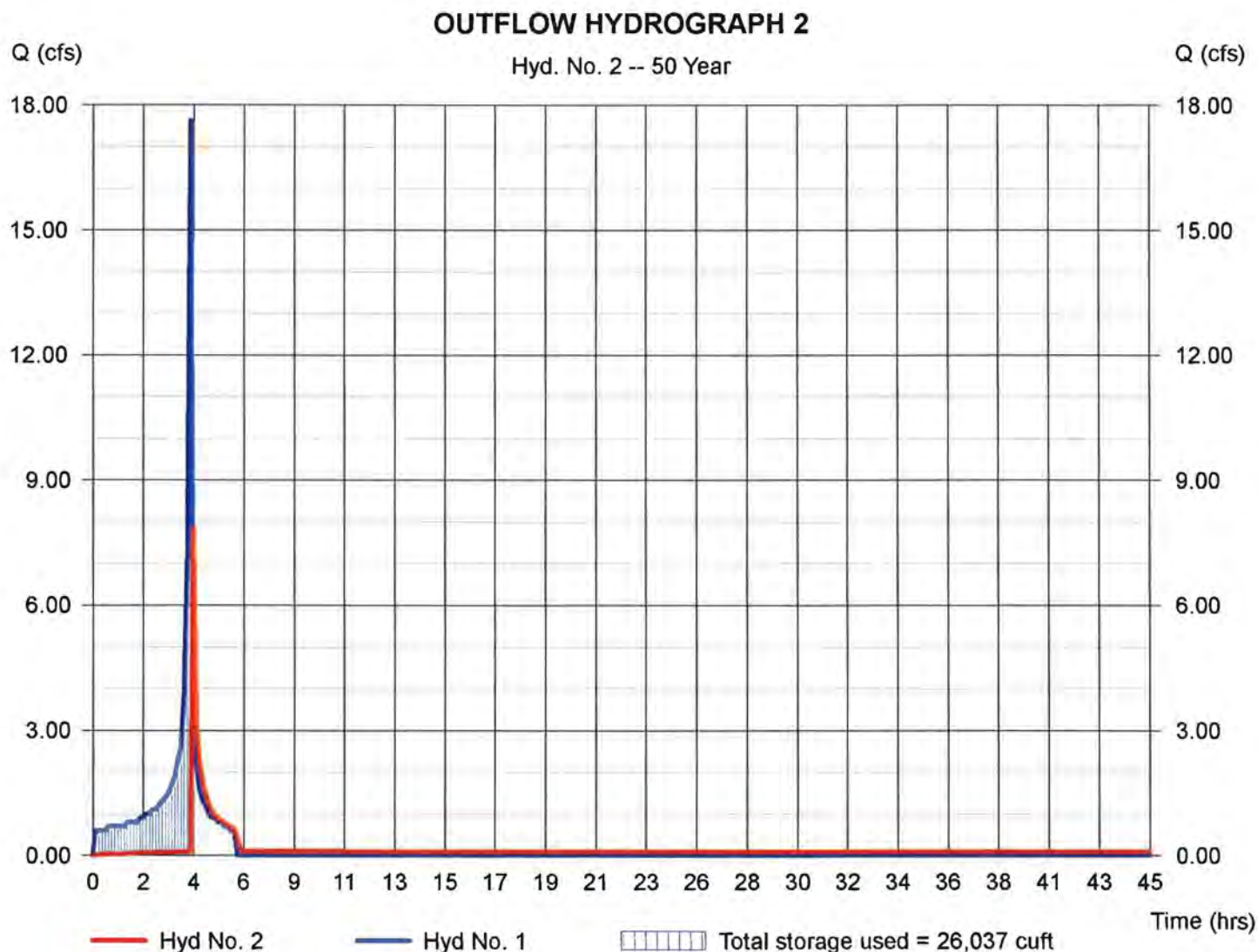
Hyd. No. 2

OUTFLOW HYDROGRAPH 2

Hydrograph type = Reservoir
Storm frequency = 50 yrs
Time interval = 8 min
Inflow hyd. No. = 1 - BMP 2
Reservoir name = BMP 2

Peak discharge = 7.834 cfs
Time to peak = 4.27 hrs
Hyd. volume = 35,742 cuft
Max. Elevation = 698.54 ft
Max. Storage = 26,037 cuft

Storage Indication method used. Outflow includes exfiltration.



APPENDIX A – TABLES AND CHARTS

HANDBOOK OF HYDRAULICS

For the Solution of Hydraulic Engineering Problems

$$Q = \frac{K'}{n} d^{n/3} S^{1/3}$$
[illegible]

3-203 Hydrology

Developers draining to a river or stream will be required to use the latest adopted County Hydrology Manual to determine the flows expected at a given frequency (Q10, Q50, Q100, etc.) Infill developments will use the following Hydrology requirements. The City Engineer will determine which projects may be considered "infill" projects.

3-203.1 Previously Approved Reports

Runoff quantities; as set forth or derived from the report prepared by Lawrence, Fogg, Florer and Smith titled "A Special Study of Storm Drain Facilities" on file in the office of the City Engineer may be used in the design of drainage facilities in Chula Vista. A hydrologic study prepared and approved at General Development Plan (GDP) or Specific Planning Area (SPA) plan may be used as determined by the City Engineer.

3-203.2

For local drainage basins, storm discharge flow may be estimated based on the Rational Method or the Modified Rational Method. For all lateral and major drainage basins the SCS method, U.S. Army Corps of Engineers HEC-1 computer method or other tabular or computer method may be used upon City Engineer approval.

3-203.3 Rational and Modified Rational Methods

- (1) The rational method equation relates storm rainfall intensity (I), a selected runoff coefficient (C) and drainage area (A) to the peak runoff rate (Q):

$$Q = CIA \text{ (Empirical Units)}$$

where:

Q = Peak runoff in cubic feet per second
C = Runoff coefficient
I = Intensity, inches per hours
A = Drainage basin area in acres

Or

$$Q = 0.278CIA \text{ (Metric Units)}$$

where:

Q = Peak runoff in cubic meters per second
C = Runoff coefficient
I = Intensity in millimeters per second
A = Drainage area in square kilometers

- (2) Coefficient of Runoff: Consider probable development. Use highest number of the following values:

a)	Paved Surface	0.90
b)	Commercial Area	0.85
c)	Dense Residential (R2, R3)	0.75

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Revised 03-13-2012

d)	Normal Residential (R1)	0.65
e)	Suburban Property (RE)	0.55
f)	Barren Slopes Steep	0.80
g)	Barren Slopes Hilly	0.75
h)	" " Rolling	0.70
i)	" " Flat	0.65
j)	Vegetated Slopes Steep	0.60
k)	" " Hilly	0.55
l)	" " Rolling	0.50
m)	" " Flat	0.45
n)	Farm Land	0.35
o)	Parks, Golf Courses	0.30

NOTES: Steep = Steep, rugged terrain with average slopes generally above 30%.
Hilly = Hilly terrain with average slopes of 10% to 30%.
Rolling = Rolling terrain with average slopes of 5% to 10%.
Flat = Relatively flat land, with average slopes of 0% to 5%.
Composite = Where drainage areas are composed of parts having different runoff characteristics, a weighted coefficient for the total drainage area may be used.

The runoff coefficient for a basin should be a composite coefficient made of the many different runoff coefficients for the sub-areas of the basin per equation:

$$CA_T = \frac{C_1A_1 + C_2A_2 + \dots + C_nA_n}{n}$$

- (3) Time of Concentration (t_c = minutes) is the time required for runoff to flow from the most remote part of the watershed to the outlet point under consideration. With exceptions for limited natural watersheds, the time of concentration shall be calculated as follows:

a) $t_c = t_i + t_r$ where:

t_i = Initial time or overland flow time of concentration, the time required for runoff to flow to the first inlet or to the street gutter

t_r = Travel time of concentration, the time required for runoff to flow within street gutters to inlets, with channels or within storm drain pipes.

- b) t_i may be calculated using the following natural watershed flow formula:

$$t_i = 60 \times [(11.9L^3)/H]^{0.385}$$

L = Length of water shed (miles)

H = Difference in elevation from furthestmost point to the design point (feet).

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calculations. The following guidelines shall be used for work in the City of Chula Vista.

(1) The following Manning "n" factors are to be used:

- | | | |
|----|--|---|
| a) | <u>Pipe</u>
CMP, fully bituminous coated

CMP, fully asphalt paved

CMP, invert asphalt paved

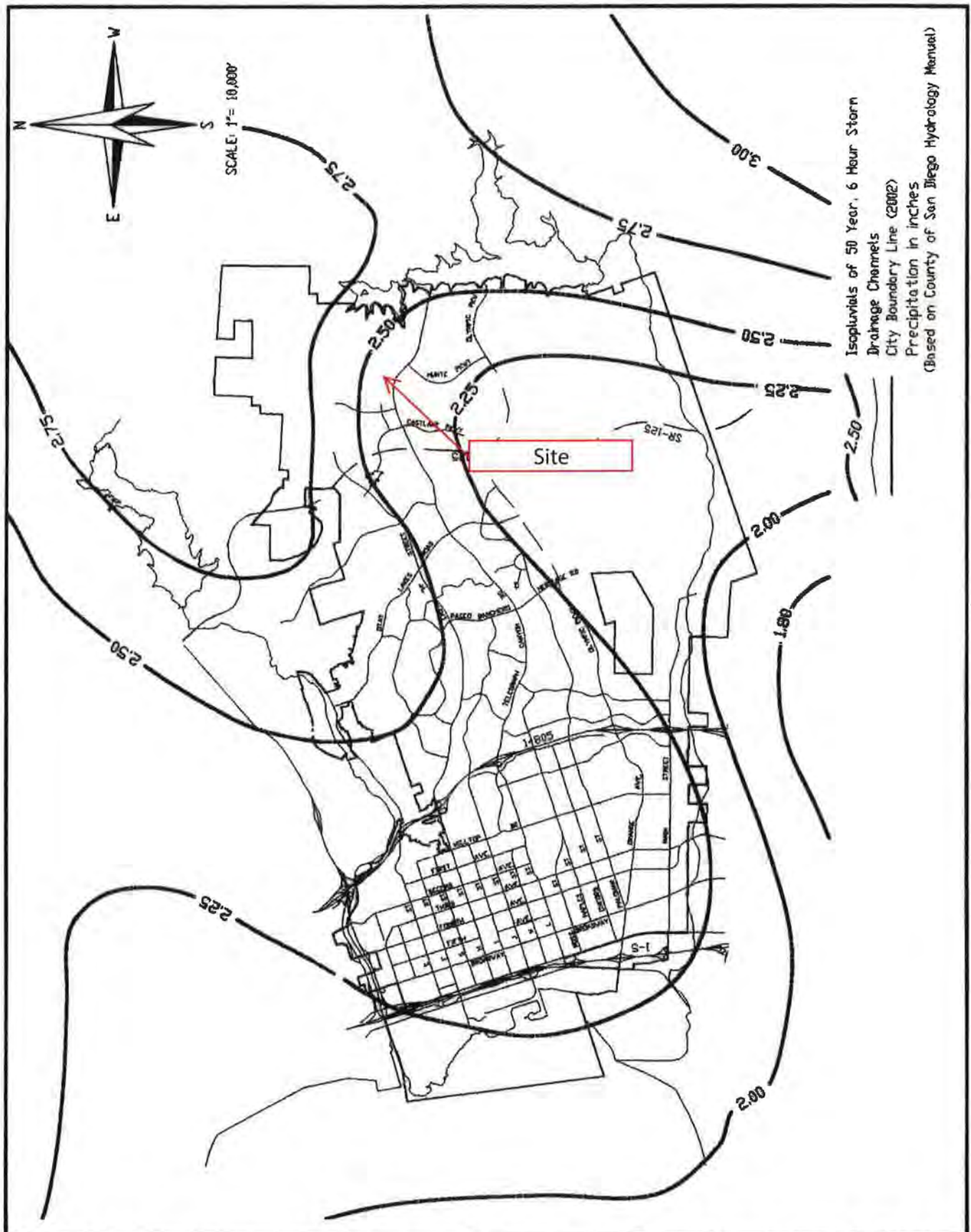
RCP, All
Cast in place
PVC & HDPE, ALL | <u>n</u>
0.024 (Not allowed in City
maintained system)

0.018 (Not allowed in City
maintained system)

0.023 (Not allowed in City
maintained system)

0.013
0.014
0.012 |
| b) | <u>Channel</u>
P.C.C., formed, no finish
P.C.C., trowel finish
P.C.C., float finish
Gunitite, no finish
Gunitite, trowel finish | <u>n</u>
0.015
0.013
0.014
0.019
0.015 |
| c) | "n" factors for other materials or type of construction shall be as approved by the City Engineer. | |

- (2) Public storm drain pipes shall be reinforced concrete pipe (RCP) unless otherwise stated below or approved by the City Engineer. Corrugated metal pipe (CMP) shall not be used unless specifically approved by the City Engineer.
- (3) Minimum pipe diameter shall be 18" (46cm), minimum "D" load rating for RCP within the right of way shall be 1500.
- (4) Storm drainage must be enclosed within a closed conduit for design runoff within a street right of way or City easement that can be carried in a 42" (107cm) diameter pipe or less.
- (5) Minimum grade of storm drains and culverts shall be 0.5%.
- (6) Maximum grade for RCP storm drains shall be 40%. PVC pipe may be used for grades greater than 40%.
- (7) Type A storm drain cleanouts shall have a minimum 6" clearance between the outside wall of pipe and inside of cleanout structure. Also, the maximum allowable skew shall not exceed 20 degrees and limit the size of pipe to 39" without an engineering detail. Any pipes that are 39" or larger shall have an engineering detail.



Revised:	Original approval date: 01-29-02		CITY OF CHULA VISTA	
M.P.M 2-02	Redrawn By: M.P.M	Date: 01-29-02	PUBLIC WORKS DEPARTMENT	
			50 YEAR, 6 HOUR	
	CITY ENGINEER Date: 11-7-02		PRECIPITATION	
				CVD-DR04

County of San Diego Hydrology Manual



Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

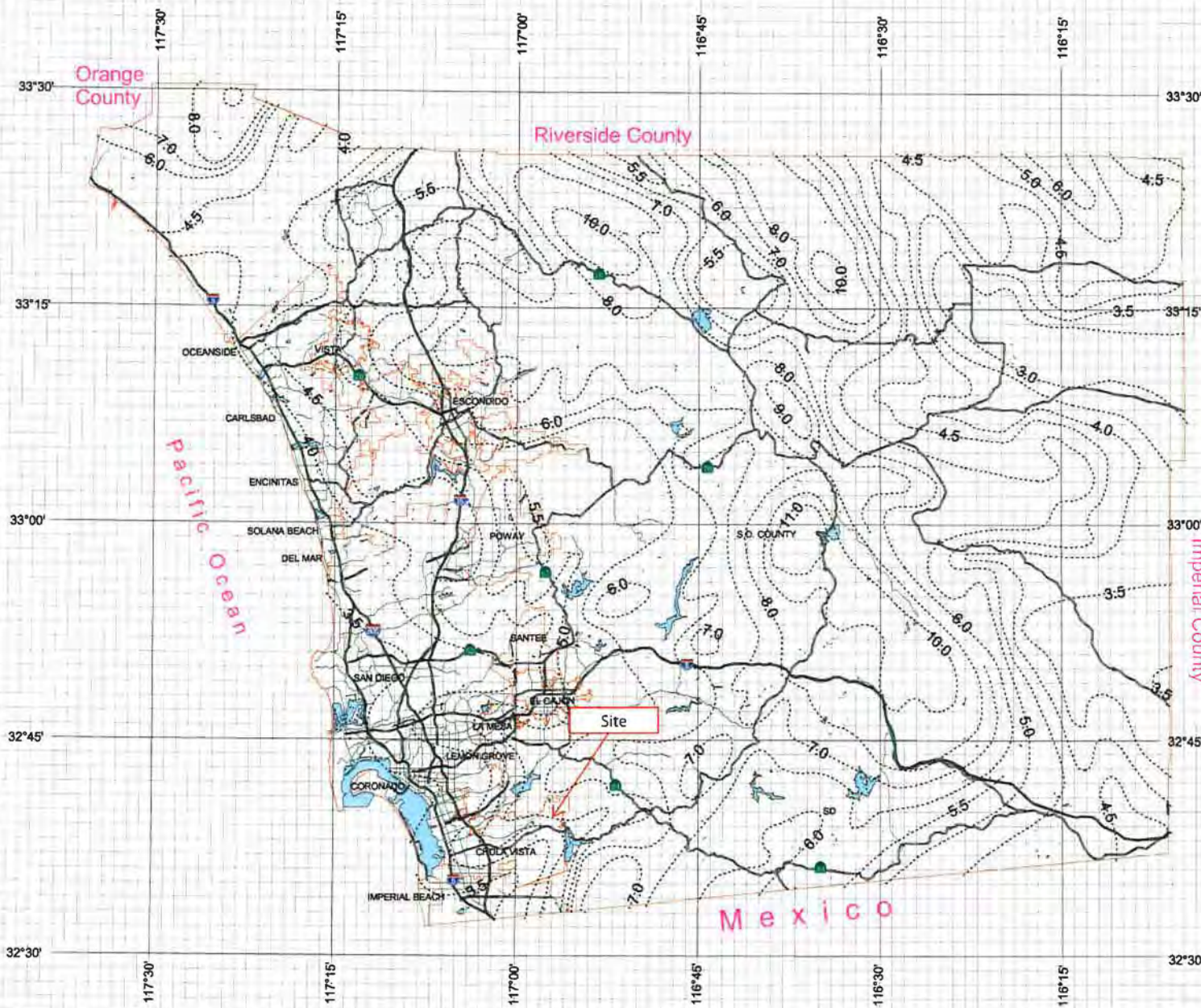
----- Isopluvial (Inches)



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APPENDIX B – DRAINAGE EXHIBIT

