

# Cover Sheet

<b>Document Title:</b>	<b>Final Compliant Drainage Study</b>
<b>Prepared By:</b>	San Bernardino County
<b>Date:</b>	02/12/2024
<b>Version:</b>	Permit DRNSTY-2021-00054
<b>Project Name:</b>	PPHCSD Civic Center Phase 1
<b>Client/Stakeholder:</b>	PPHCSD
<b>Confidentiality:</b>	[Public/Internal/Confidential]

## Document Overview

This specification document outlines the requirements, standards, and key details for the project or product described above. The cover sheet provides a summary of essential information to identify and track the document throughout its lifecycle.

## Contact Information

- Preparer David W Larson, P.E., 801-331-8900, [david@rbcea.com](mailto:david@rbcea.com)
- Steeno Design Studio Inc, 760-244-5001, [sophie@steenodesign.com](mailto:sophie@steenodesign.com)

## Revision History

Version	Date	Description	Author



## Land Use Services Department



## Plan Review Comments

<b>Project Description:</b>		<b>Sheep Creek Road - PHELAN</b>		<b>Application #:</b>	<b>DRNSTY-2021-00054</b>
<b>Site Address/Tract No:</b>				<b>APN:</b>	<b>3066-261-10 3066-251-18</b>
<b>Applicant/Contact:</b>		<b>David Larson Redbrick Solution, LLC 19153 Town Center Drive Suite 203 Apple Valley, CA 92308</b>		<b>Application Date:</b>	
				<b>Expiration Date:</b>	
<b>Applicant Phone:</b>		<b>(661) 816-5179</b>		<b>Applicant Email:</b>	
<b>Plans Reviewer:</b>		<b>Scott Lyle (NV5)</b>	<b>Phone:</b>	<b>(858) 385-0500</b>	
		<b>Email:</b>	<b><a href="mailto:scott.lyle@nv5.com">scott.lyle@nv5.com</a> (Preferred contact)</b>		
<input type="checkbox"/> <b>1<sup>st</sup> Review:</b>		<input type="checkbox"/> <b>2<sup>nd</sup> Review:</b>		<input type="checkbox"/> <b>3<sup>rd</sup> Review:</b>	
<input checked="" type="checkbox"/> <b>4<sup>th</sup> Review</b>	<b>1/31/2024</b>				

No further comments.

[END of COMMENTS]

I hereby declare that I have exercised responsible charge of the review of this project as defined in Section 6703 of the Business and Professions Code. The comments expressed herein are confined to a review only and do not relieve the Engineer of Work of their responsibilities for project design.

Tamara O'Neal  
Name

1/31/2024  
Date:



01/31/2024

# RED BRICK SOLUTION

# FINAL On-Site Hydrology Study

January 11, 2024  
JN 200039

**APN: 3066-261-10 &  
3066-251-18**

# Sheep Creek Road PHELAN

**San Bernardino  
County, California**



**County of San Bernardino**  
**BUILDING AND SAFETY**

THE PLANS AND DETAILS HAVE BEEN

**REVIEWED**

**FOR CODE COMPLIANCE**

THE REVIEW OF THESE PLANS SHALL NOT BE  
CONSTRUED TO BE A PERMIT FOR ANY  
VIOLATION OF ANY CODE OR ORDINANCE OF  
THIS COA

By Jorge C. [Signature]

Date 02/06/2024

THESE PLANS SHALL BE ON THE JOB FOR ALL  
REQUIRED INSPECTIONS

timothy\_cheng@usa.business.gov  
(909) 387-4096 (909) 629-0566

### PROFESSIONAL ENGINEER'S AFFIRMATIVE STATEMENT

I have examined and am familiar with the information in this document and all appendices, and based on my inquiries of individuals immediately responsible for obtaining the information in this document, I believe that the information is true, accurate, and complete AAA

Prepared by

**REDBRICK SOLUTION, LLC**

Consulting Engineers &amp; Architects

www.redbricksolution.com

Salt Lake City Office

331 South Rio Grande Street | Suite 203  
Salt Lake City, Utah 84101  
T: 801.244.5335

Apple Valley Office

19153 Town Center Dr. | Suite 101-A  
Apple Valley, CA 92308  
T: 661.816.5179

## Table of Contents

I.	Introduction	
A.	Location of Property	
B.	Property Description	
C.	Purpose and Scope	1
D.	Methodology	1
E.	Compliance with Regulations	1
F.	Floodplain Information	1
II.	Off-site Tributary Flows	2
III.	On-site Hydrology	2
A.	Onsite Drainage Description	2
B.	Pre-Developed Conditions	2
C.	Post-Developed Conditions	3
D.	Street Capacity and Catch Basin Inlet Capacities	4
E.	Storm Drain Pipe Sizing	4
D.	Retarding Basin Sizing	5
IV.	Conclusions	5
V.	References	5

## Appendix

### Appendix A -Exhibits

- A- Location / Land Use Map
- B- FEMA MAP
- C- NOAA 14 Precipitation
- D- USGS Soil Type
- E- Off-Site Tributary Watershed Map
- F- Pre-Development Hydrology Map
- G- G2 Post-Development Hydrology Map
- H- Pipe Capacity Calculation\
- I- Off-Site Flow By-Pass Channel
- J- Proposed Slope Channel
- K- Retarding Basin Design

### Appendix B- Hydrologic Calculations

- Pre-Developed 25-year Rational Method Analysis
- Pre-Developed 100-year Rational Method Analysis
- Post-Developed 100-year Rational Method Analysis
- Post-developed 100-year Unit Hydrograph

### Appendix C- Retarding Basin Calculations



**A. LOCATION OF PROPERTY**

Appendix A, Exhibit A shows the 23.96-acre overall project site is located north and east of the Phelan Pinion Hills Community Service District offices and is bounded by Sheep Creek Road on the West, Comercial Development and School fields on the North, residential homes on the East an Warbler Road on the South.

**B. DESCRIPTION OF PROPERTY**

The project consists of Class A soils (see Exhibit D1) with Poor Cover consisting of Annual grass CN 67 (see Exhibit D2) and Barren graded land CN 78. Graval and Decomposed Granite are to be considered 20-percent impevious CN 98 and 80-percent Commercial Landscaping CN 32. The overall project will expand the existing 3.11-acre PPHCSD site into a 23.96-acre development comprised of APN 3066-261-10 that encompasses the existing 3.11 acre site, and the northerly 5.02-acre commercial site; APN 3066-251-18 a proposed 14.6-acre park; a quick claim of the southern 0.42- acre portion of Sahara Road; the easterly 0.72-acre extention of Warbler Road; a 0.49-acre reciprical access road on the north; the removal of the 0.40 dedication of Sheep Creek Road, and the existing 0.90-acre developed commercial site west of the existing PPHCSD site. Total project acreage is then  $3.11+5.02+14.60+0.42+0.72+0.49-0.40+0.90=24.86$ -acres.

The overall tributary area is then reduced by the slope areas that drain off-site and areas conveying off-site tributary flows through the site that do not confluence with on-site flows prior to exiting the site. This area was identified as the slopes on Sheep Creek Road, the north and east slopes of the basin, and the eastern by-pass channel totaling 1.09-acres for a total project area ( $24.86-1.09=$ ) 23.77-acres.

**C. PURPOSE AND SCOPE**

The purpose of this study is to determine the commercial developments effect on hydrology and mitigate the developed storm flows to protect downstream developments from an increase in flows.

**D. METHODOLOGY**

This study is based on using the San Bernardino County Hydrology Manual 1986 Revision, the April 6, 2010 Addendum for Arid Regions, the September 4, 1987 Detention Basin Design Criteria Memo, and CivilDesign Rational Method and Unit Hydrograph Software to model the storm channel flows.

The following criteria were used for the off-site tributary flows:

- |                          |  |
|--------------------------|--|
| 1. Current land use:     | Private Unincorporated   |
| 2. Pervious ratio        | Pre-10% Post-85%   |
| 3. Intended Use:         | Private Unincorporated   |
| 4. NOAA 14 Precipitation | 100-year 1-hour=1.28 in. Post-Developed<br>100-year 24-hour=5.53 in.<br>25-year 1-hour = 0.927 in. Pre-Developed |
| 5. Soil Type             | Group A  |

## **E. COMPLIANCE WITH REGULATIONS**

All calculations are based on generally accepted engineering practices in accordance with the San Bernardino County Hydrology Manual's Hydrologic Criteria and Drainage Design including the April 6, 2010 Addendum that addresses the Antecedent Moisture Condition (AMC) for arid regions of the County and the September 4, 1987 Detention Basin Design Criteria Memorandum.

## **F. FLOODPLAIN INFORMATION**

The project site is located within the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map Panel 06071C6450H effective August 28, 2008. This panel indicates that the site is in "Zone AO". Zone AO (hatching) is defined by FEMA as "flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined." (See Appendix A, Exhibit B) for the San Bernardino County.

## **II. OFF-SITE TRIBUTARY FLOWS**

Research shows that a FEMA FIS (06071CV001D) was performed on this general area, but the Horse Canyon area was not listed as one of the 'Flooding Sources Studied by Detailed Methods'. We infer from this that it was studied by 'Approximate Methods' although again it is not listed under this heading. Page 46 of the FEMA FIS report, Table 7 -Summary of Discharges, lists Horse Canyon as having a 1-percent peak discharge of 1,219 cfs.

Red Brick Solution, LLC (RBS) prepared a separate off-site hydrology study titled "Off-Site Tributary Storm Flows APN: 3066-261-10 Sheep Creek Road Phelan" that reanalyzed the data from BSI Consultants, Inc. Detailed Study of Zone 6 – Phelan Area Hydrology Study dated November 20, 1989 that determined a base flow at the mouth of Horse Canyon to be 4070 cfs. Using the 4070 cfs flow at the mouth of Horse Canyon, RBS determined that the flows split several times before reaching the project and that portion of the off-site storm flow that reaches the Dip-Section in Sheep Creek Road is 1434 cfs (See Exhibit E). If the 1,219 cfs listed in the FEMA FIS report were analyzed similarly by RBS it would determine that the entire 1,219 cfs would reach the Dip-Section in Sheep Creek Road where it would combine with an additional 209 cfs tributary along the path of travel. The combined  $(1219+209 =)$  1428 cfs. In RBS's separate report at this point 1434 cfs combines with the additional 209 cfs for a combined flow rate of  $(1434+209=)$  1644 cfs with a street dip section capacity of 1095 flowing northeasterly in a natural channel capable of conveying 1330 cfs. In Addition, the flow paths depicted in Exhibit E as a 2<sup>nd</sup> crossing of Sheep Creek Road just south of Warbler Road were proven to be diverted north with any local tributary flows to Sheep Creek Road captured and conveyed north within Sheep Creek Road past Warbler Road via a cross-gutter and elevated high point to the east on Warbler Road.

Thus, the remaining off-site tributary flow of  $(1644-1095=)$  549 cfs identified in the RBS separate report at the Dip-Section in Sheep Creek are directed northeasterly as sheet flows toward the northeast and enter the future park site from the south, east of the existing PPHCSD campus. Considering that this 549 cfs sheet flows are historically travelling across the easterly topography of the site that will not be disturbed, no improvements are deemed necessary until the final phase of the parks development plan. At that time these flows need to be captured and diverted easterly along Warbler Road to the eastern boundary where a separate channel system will divert these flows north to the northeast corner of the site and release them into their historic conveyance.

A by-pass channel design is presented in Appendix A, Exhibit I, that shows a 15-foot base width channel with 5:1 side slopes flowing 9.77 feet per second at a slope of 2.24 % approximately 2.17 deep and 37-feet wide. This results in a capacity of 549 cfs, which will contain these flows. The channel as shown will have (3.17 channel depth-2.17 W.S.E=1) 1-ft of freeboard. This will prevent flooding of the 100-year storm as defined by FEMA Special Flood Hazard Zone AO from the offsite flows.

### **III. ON-SITE HYDROLOGY**

#### **A. ON-SITE DRAINAGE DESCRIPTION-PHASE 1**

According to the USGS topographic survey of the area, the tributary drainage area consists of the proposed commercial property, including the PPHCSD offices, a community park and vacant land. Drainage flows from all these areas are generally to the northeast. The vegetation on the undeveloped areas of the project site is considered to be of poor to average cover.

#### **B. PRE-DEVELOPED CONDITIONS**

The assessor's map of the area shows the project consists of an initial parcel which contains the PPHCSD offices to the southwest, a small community park to the southeast and vacant land to the north. The site is also impacted by a 0.90-acre commercial parcel surrounded on 3 sides by the site, the fourth side borders Sheep Creek Road. To the east of the initial parcel are 2 additional undeveloped parcels which are included in the drainage area. An existing ridgeline bisects the site running from the southwest corner of the site to the northeast corner of the site. Using the San Bernardino County Hydrology Manual and CivilDesign software to perform a Rational method analysis, the single drainage area (DA1) pre-developed site was divided into two drainage management areas (DMA-A & DMA-B) each consisting of three (3) subareas (1A-3A & 4B-6B respectively) that ultimately confluence at the northeast corner of the site. The pre-developed site (see Appendix A, Exhibit F) was analyzed using the point rainfall of 0.927 for a 25-year AMC II storm event that determined that the undeveloped storm flows are approximately 38.08 cfs and a 100-year AMC III storm event of 65.04 cfs.

## C. POST-DEVELOPED CONDITIONS

The 100-year storm condition outlined in the San Bernardino Hydrology Manual considers a 3-day storm event where the ground is saturated, and no ground water percolation occurs. This is accomplished by considering the Antecedent Moisture Condition case III (AMC-III) for our study. Using the point rainfall of 1.28 inches for the 100-year-one-hour storm event.

The developed site drainage area is somewhat smaller due to street improvements along Sheep Creed Road, which direct some flows onto Sheep Creek Road and then north past the project.

The developed site considers that the drainage will travel through entire site through various conveyances contained in three (3) Drainage Management Areas (DMA-A,B,&C). All three DMA's lead to the northeast corner of the project where a single retention basin will mitigate the 100-year storm flows (see Appendix A, Exhibit hydrology G).

Drainage Management Area DA1-DMA-A (subareas 1A-19A; nodes 1-22) consists of 6.46-acres which includes a portion of the existing two sites and the proposed new development to the north.

8.97 ac?

Drainage Management Area DA1-DMA-B (subareas 20G-31A; nodes 23-37) consists of 9.02-acres along the southerly access road and the proposed play areas west of the existing site. This contains a soccer field and a multi-purpose turf area that convey the storm flows via perimeter channel having a base width of 10-foot, 10:1 side slopes, flowing less than 0.4-ft deep.

Drainage Management Area DA1-DMA-C (subareas 32K-34K; nodes 38-41) consists of the easterly undeveloped 8.30-acres along the southern and eastern property lines flowing north to the northeast corner of the site.

Converting the Rational method analysis data to the Unit Hydrograph Method, it was determined that this combined 23.77-acre area will generate a 100-year 24-hour storm flow of 68.04 cfs.(see Appendix B, 100-year Unit Hydrograph)

## D. CURB AND GUTTER CAPACITY / CATCH BASIN SIZING

The project is designed with 6-inch curbs and 2-percent surface slopes that have a maximum capacity to convey 7.79 cfs at curb height. A maximum storm flow of 6.73 cfs flow occurs at Node 18 which is less than the 7.79 capacity and only rises to 4.5 inches above the flowline. These calculations are based on using an LA County grated catch basin configuration shown on Figure D-14 at the end of this report.

## E. STORM DRAINSIZING

Although Pipe sizes are calculated while utilizing the CivilDesign Rational Method Software we have provided two scenarios in Appendix A as Exhibit H. One scenario shows the worst case piped flows between nodes 21 & 22 (Ap7) where a 24-inch diameter pipe conveys 32 cfs at a 4.09% slope half full. The minimum slope needed to carry this flow was determined to be 2.00%. The second scenario

shows the capacity of an 18-inch diameter pipe at a minimum slope of 0.5% to be 7.99 cfs. These flows will exit as a free outlet into a ten (10) foot base width channel with 10:1 side slope flowing less than 0.4-feet deep. To mitigate the velocity changes at the exit of the pipe systems a rip-rap pad will need to be sized by the site engineer.

## **F. DETENTION BASIN SIZING**

The San Bernardino County Hydrology Manual Detention Basin Design Criteria memorandum requires that the developed 100-year storm flow of 68.04 cfs (DA1) be mitigated to 90% of the pre-developed storm flow ( $38.08 \times 0.9 =$ ) 34.27 cfs. The required detention basin volume was then determined by running CivilDesign Route Software that analyzes the 68.04 cfs unit hydrograph against an outflow that varies with the depth of water in the basin that is limited to 34.27 cfs.

A retarding basin is detailed in Appendix A, Exhibit K which shows a 6-foot deep 1.07 ac-ft basin with five (5) 12-inch diameter storm drain discharge pipes under the spillway set at an outlet elevation of 4117.5 that retains 3.5 feet of storm water equal to a volume of 0.402 Ac-Ft. These pipes are set at a 1% (0.5 ft elevation drop in 50 lf) slope. After analyzing the 100-year storm event (see Appendix C) it was determined that the water surface elevation reaches a depth of 6.0-ft (elevation 4120) with a maximum discharge rate of 33.6 cfs which is below the 34.27 cfs maximum allowed.

The spillway elevation is set at elevation 4120 with the embankment at 4122 that gives us 2-foot of freeboard. The 15-ft base width and 5:1 embankment spillway is designed to carry the  $Q_{1000} = 1.35 \times Q_{100} = 92$  cfs at a depth of 0.72-feet with 1.28-feet of freeboard.

The drawdown time to drain the 0.402 Ac-Ft of retained volume at a depth of 3.5 feet is determined by the percolation rate that is reported to be 4.24 in/hr. Using a factor of safety of 2 (FS=2) the percolation rate is reduced to a value of 2.12 in/hr. Thus, the drawdown time is equal to  $(3.5 \times 12)$  42-inches divided by 2.12-in/hr that equates to 19.74 hrs which is less than the 48-hrs required.

## **IV. CONCLUSIONS**

Based on the separate report entitled “Off-Site Tributary Storm Flows APN: 3066-261-10 Sheep Creek Road Phelan” that the uses data from the BSI Consultants, Inc. Detailed Study of Zone 6 – Phelan Area Hydrology Study dated November 20, 1989 to determine the projects off-site tributary flow rate of 549 cfs and how it can be safely around the site with no impact to the project. New data from the FEMA Flood Insurance Study (06071CV001D) was reviewed for this general area, that shows the tributary watershed producing only 1,219 cfs which can be fully contained within the existing off-site channel system without any tributary flows on to the currently designed project site.

The proposed project will also mitigate the on-site 68.04 cfs 100 -year 24-hour storm event to below the 90% pre-developed storm event flows of 34.27 cfs tributary to the downstream neighbors. In addition, 0.402 ac-ft of storm water will be retained for infiltration to meet the Mojave River WQMP

requirements. The drawdown time was determined to be 19.74 hrs which is less than the required 48-hrs. All improvements will be required to be maintained by the property owner or assigns. All building Pad Elevations should be elevated one (1) foot above the highest adjacent proposed drainage grade and at a minimum elevation of 4121.0 being one (1) foot above the water surface elevation of the proposed basin. The site design engineer shall also size headwalls and rip-rap areas based on the velocities and pipe sizes calculated in the rational study provided herein.

## REFERENCES:

County of San Bernardino Public Works Hydrology Manual. Created in August 1986.

<http://cms.sbcounty.gov/Portals/50/floodcontrol/HydrologyManual.pdf>

San Bernardino County Detention Basin Design Guidelines Criteria dated September 4, 1987

<http://www.sbcounty.gov/Uploads/lus/PW/DETENTIONBASINDESIGN.pdf>

San Bernardino County Hydrology Manual Addendum for Arid Regions dated April 6, 2010.

[https://cms.sbcounty.gov/Portals/50/floodcontrol/20100412\\_addendum.pdf](https://cms.sbcounty.gov/Portals/50/floodcontrol/20100412_addendum.pdf)

Federal Emergency Management Agency website: <https://msc.fema.gov/portal> accessed December 2016.

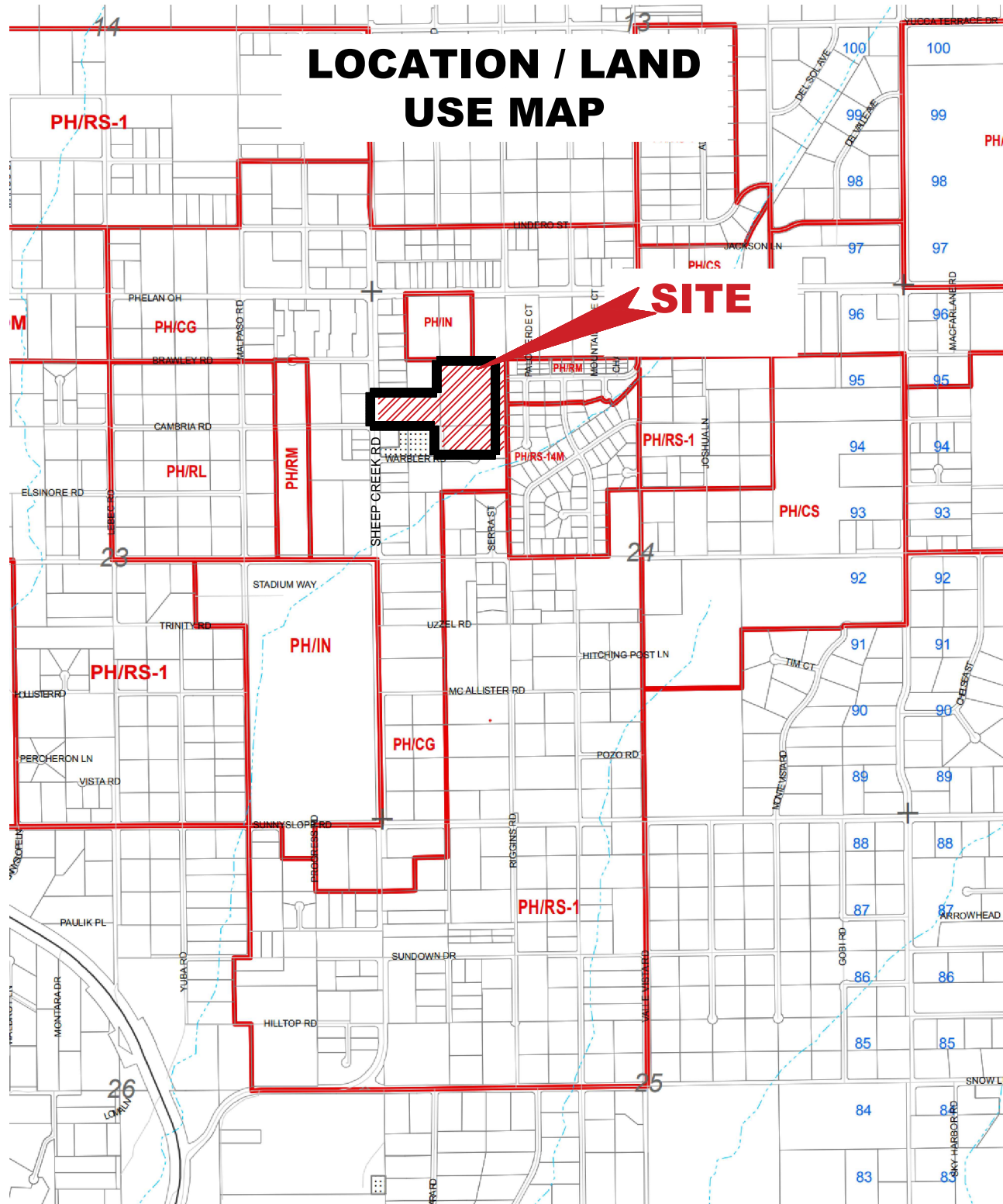
NOAA Atlas 14, Volume 6, Version 2 POINT PRECIPITATION FREQUENCY (PF) ESTIMATES WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION. Accessed December 2016.

NRCS Soils Data from Soil Map; San Bernardino County, California, Mojave River Area; Version 8, Sep 12, 2016 Accessed December 2016.

## **APPENDIX A - Exhibits:**

Location / Land Use Map – A  
FEMA Map – B  
NOAA 14 Precipitation – C  
USGS Soil Type – D  
Off-Site Tributary Watershed Map - E  
Pre-Development Hydrology Map - F  
Post-Development Hydrology Map - G  
Pipe Capacity Calculation - H  
Off-Site Flow By-Pass Channel - I  
Proposed Slope Channel - J  
Retarding Basin Design -K

# LOCATION / LAND USE MAP



**DATE: 03/15/2022**

**DRAWN BY: DWL**

**CHECKED BY: DWL**

**SCALE: NTS**

## EXHIBIT A

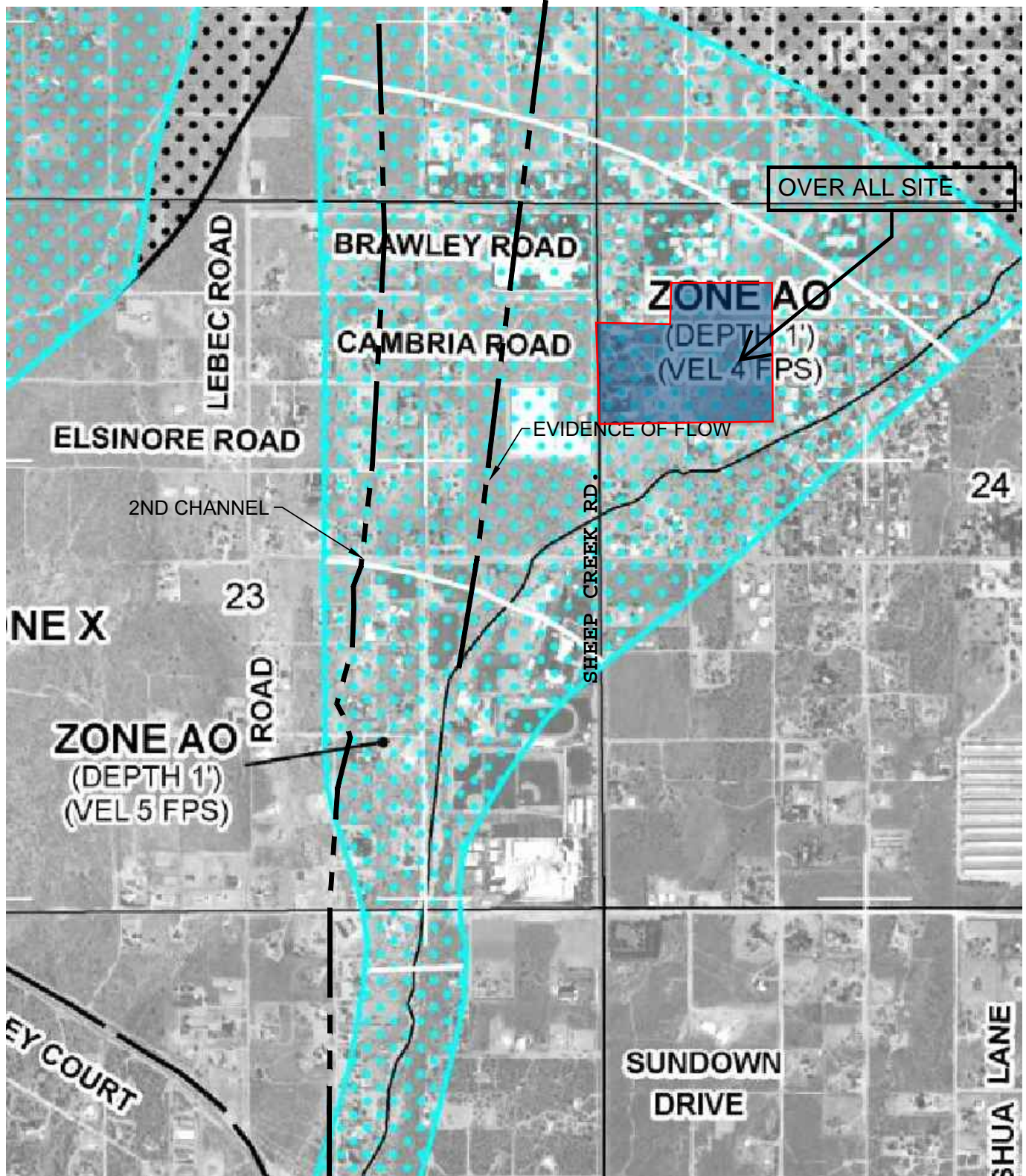
**PPHCSD-COMMUNITY CENTER  
PHELAN - SAN BERNARDINO, CA  
COUNTY, CA**



**APN: 3066-261-08,10  
3066-251-14**

**RED  
BRICK**  
SOLUTION

CONSULTING ENGINEERS  
& ARCHITECTS





	<p>JOB: 20039</p> <p>SCALE: 1" = 1000'</p> <p>FILE:</p> <p>DATE:</p>	<p>EXHIBIT B</p>	
		<p>PROJECT</p> <p>PHELAN PINION HILLS PARK</p> <p>HYDROLOGY STUDY</p>	



## POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps & aeriels](#)

### PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) <sup>1</sup>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.083 (0.069-0.101)	0.118 (0.098-0.144)	0.167 (0.138-0.205)	0.209 (0.171-0.259)	0.270 (0.214-0.345)	0.320 (0.248-0.417)	0.373 (0.282-0.498)	0.430 (0.316-0.591)	0.510 (0.360-0.732)	0.576 (0.392-0.855)
10-min	0.119 (0.099-0.145)	0.170 (0.140-0.207)	0.240 (0.198-0.294)	0.300 (0.246-0.371)	0.388 (0.307-0.495)	0.459 (0.355-0.598)	0.534 (0.404-0.714)	0.616 (0.452-0.847)	0.732 (0.515-1.05)	0.826 (0.562-1.23)
15-min	0.144 (0.120-0.176)	0.205 (0.170-0.250)	0.290 (0.239-0.355)	0.363 (0.297-0.448)	0.469 (0.371-0.598)	0.555 (0.430-0.723)	0.646 (0.488-0.864)	0.745 (0.547-1.02)	0.885 (0.623-1.27)	0.998 (0.679-1.48)
30-min	0.207 (0.172-0.252)	0.294 (0.243-0.359)	0.416 (0.343-0.509)	0.521 (0.426-0.643)	0.672 (0.532-0.858)	0.796 (0.616-1.04)	0.927 (0.701-1.24)	1.07 (0.785-1.47)	1.27 (0.894-1.82)	1.43 (0.974-2.13)
60-min	0.285 (0.236-0.348)	0.405 (0.335-0.495)	0.574 (0.473-0.702)	0.718 (0.587-0.886)	0.927 (0.733-1.18)	1.10 (0.849-1.43)	1.28 (0.966-1.71)	1.47 (1.08-2.02)	1.75 (1.23-2.51)	1.97 (1.34-2.93)
2-hr	0.420 (0.348-0.512)	0.576 (0.476-0.703)	0.791 (0.653-0.969)	0.975 (0.798-1.20)	1.24 (0.980-1.58)	1.45 (1.13-1.89)	1.68 (1.27-2.24)	1.92 (1.41-2.64)	2.26 (1.59-3.24)	2.53 (1.72-3.75)
3-hr	0.523 (0.433-0.637)	0.707 (0.585-0.863)	0.960 (0.792-1.18)	1.18 (0.962-1.45)	1.48 (1.17-1.89)	1.73 (1.34-2.26)	1.99 (1.51-2.66)	2.27 (1.67-3.12)	2.66 (1.88-3.82)	2.97 (2.02-4.41)
6-hr	0.750 (0.621-0.914)	1.00 (0.832-1.23)	1.35 (1.12-1.66)	1.65 (1.35-2.03)	2.06 (1.63-2.63)	2.39 (1.86-3.12)	2.74 (2.07-3.66)	3.11 (2.29-4.28)	3.63 (2.55-5.20)	4.04 (2.75-5.99)
12-hr	0.997 (0.826-1.22)	1.38 (1.14-1.68)	1.90 (1.56-2.32)	2.32 (1.90-2.87)	2.92 (2.31-3.73)	3.39 (2.63-4.42)	3.88 (2.93-5.19)	4.39 (3.23-6.04)	5.09 (3.59-7.30)	5.65 (3.84-8.39)
24-hr	1.30 (1.15-1.49)	1.87 (1.66-2.16)	2.64 (2.33-3.05)	3.27 (2.86-3.81)	4.14 (3.51-4.99)	4.83 (4.01-5.94)	5.53 (4.48-6.97)	6.27 (4.94-8.12)	7.29 (5.51-9.84)	8.08 (5.90-11.3)
2-day	1.53 (1.35-1.76)	2.23 (1.97-2.57)	3.17 (2.80-3.67)	3.96 (3.47-4.61)	5.05 (4.28-6.08)	5.90 (4.90-7.26)	6.79 (5.50-8.56)	7.72 (6.08-10.0)	9.01 (6.81-12.2)	10.0 (7.32-14.0)
3-day	1.65 (1.46-1.90)	2.42 (2.14-2.79)	3.47 (3.06-4.01)	4.35 (3.81-5.06)	5.56 (4.72-6.70)	6.53 (5.42-8.03)	7.53 (6.10-9.49)	8.59 (6.77-11.1)	10.1 (7.61-13.6)	11.2 (8.21-15.7)
4-day	1.75 (1.55-2.02)	2.58 (2.29-2.98)	3.72 (3.29-4.30)	4.68 (4.10-5.45)	6.02 (5.10-7.25)	7.08 (5.88-8.71)	8.20 (6.64-10.3)	9.38 (7.39-12.1)	11.0 (8.34-14.9)	12.3 (9.02-17.2)
7-day	1.93 (1.71-2.22)	2.86 (2.53-3.30)	4.17 (3.68-4.82)	5.29 (4.63-6.16)	6.88 (5.83-8.29)	8.16 (6.77-10.0)	9.51 (7.70-12.0)	11.0 (8.63-14.2)	13.0 (9.83-17.6)	14.6 (10.7-20.5)
10-day	1.99 (1.76-2.29)	2.97 (2.63-3.42)	4.36 (3.85-5.04)	5.56 (4.87-6.48)	7.30 (6.19-8.79)	8.71 (7.23-10.7)	10.2 (8.27-12.9)	11.8 (9.32-15.3)	14.1 (10.7-19.1)	16.0 (11.7-22.4)
20-day	2.30 (2.04-2.65)	3.49 (3.09-4.02)	5.21 (4.60-6.03)	6.73 (5.90-7.85)	8.99 (7.61-10.8)	10.9 (9.01-13.3)	12.9 (10.4-16.2)	15.1 (11.9-19.5)	18.2 (13.8-24.6)	20.8 (15.2-29.1)
30-day	2.67 (2.37-3.07)	4.04 (3.58-4.66)	6.07 (5.36-7.02)	7.89 (6.90-9.19)	10.6 (8.98-12.8)	12.9 (10.7-15.8)	15.3 (12.4-19.3)	18.0 (14.2-23.3)	21.9 (16.6-29.6)	25.2 (18.4-35.2)
45-day	3.15 (2.79-3.63)	4.73 (4.19-5.46)	7.09 (6.26-8.20)	9.22 (8.07-10.7)	12.4 (10.5-15.0)	15.2 (12.6-18.7)	18.2 (14.7-22.9)	21.4 (16.9-27.7)	26.2 (19.8-35.4)	30.1 (22.0-42.1)
60-day	3.51 (3.11-4.04)	5.20 (4.60-5.99)	7.75 (6.84-8.96)	10.1 (8.82-11.7)	13.6 (11.5-16.4)	16.6 (13.8-20.4)	19.9 (16.1-25.1)	23.5 (18.5-30.4)	28.8 (21.7-38.8)	33.1 (24.2-46.3)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

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

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

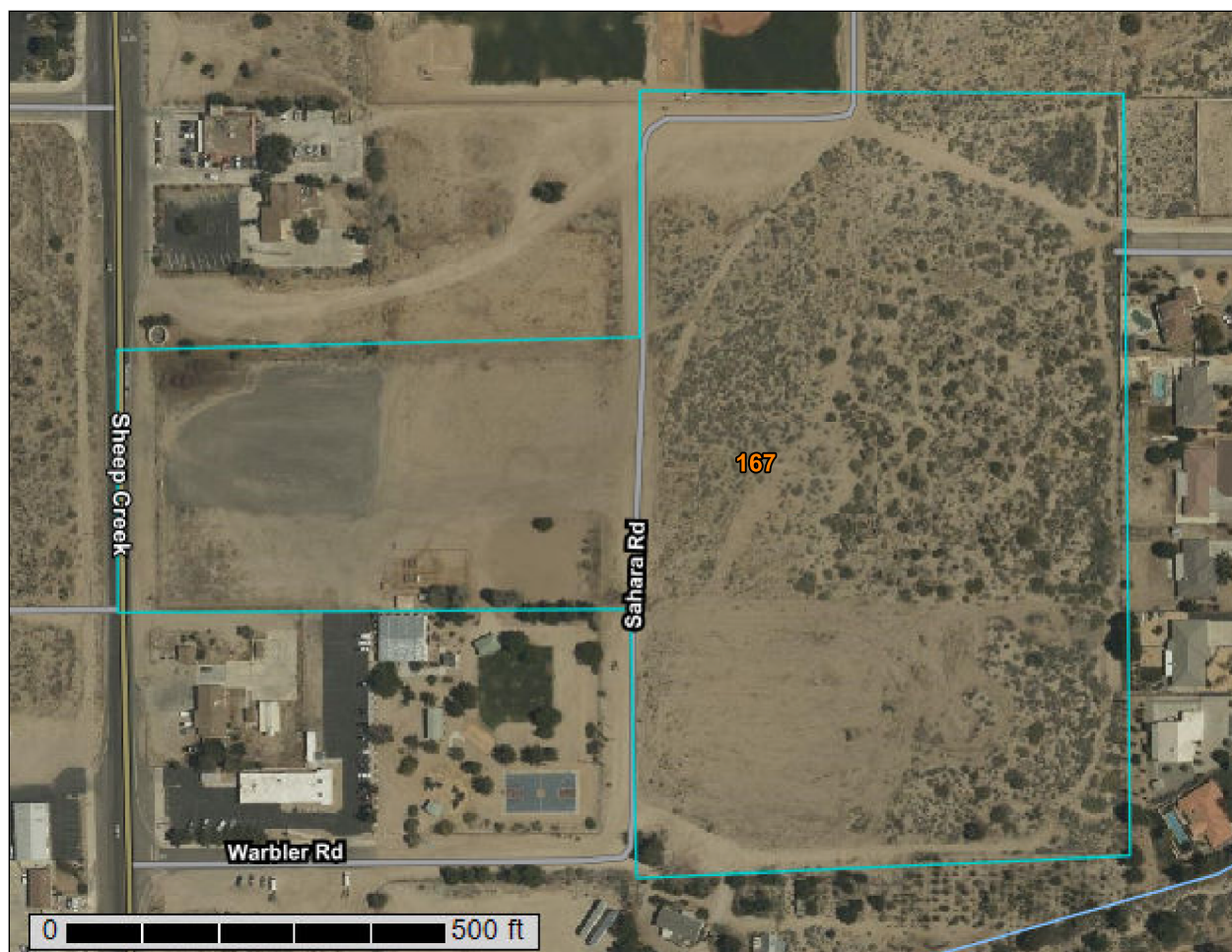
### PF graphical



# EXHIBIT D1 Custom Soil Resource Report for San Bernardino County, California, Mojave River Area

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
167	TUJUNGA SAND, COOL, 2 TO 9 PERCENT SLOPES	20.7	100.0%
Totals for Area of Interest		20.7	100.0%



## San Bernardino County, California, Mojave River Area

### 167—TUJUNGA SAND, COOL, 2 TO 9 PERCENT SLOPES

#### Map Unit Setting

*National map unit symbol:* hkt9  
*Elevation:* 2,700 to 4,300 feet  
*Mean annual precipitation:* 6 to 9 inches  
*Mean annual air temperature:* 57 to 61 degrees F  
*Frost-free period:* 150 to 250 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Tujunga and similar soils:* 85 percent  
*Minor components:* 15 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Tujunga

##### Setting

*Landform:* Fan aprons  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Tread  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium derived from granite sources

##### Typical profile

*H1 - 0 to 14 inches:* sand  
*H2 - 14 to 60 inches:* stratified gravelly sand to gravelly loamy sand

##### Properties and qualities

*Slope:* 2 to 9 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Somewhat excessively drained  
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* NoneOccasional  
*Frequency of ponding:* None  
*Available water capacity:* Low (about 3.7 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 7w  
*Hydrologic Soil Group:* A  
*Ecological site:* R030XE006CA - COARSE LOAMY  
*Hydric soil rating:* No

#### Minor Components

##### Soboba

*Percent of map unit:* 4 percent

##### Hanford

*Percent of map unit:* 4 percent

# EXHIBIT D2

## Curve (I) Numbers of Hydrologic Soil-Cover Complexes For Pervious Areas-AMC II

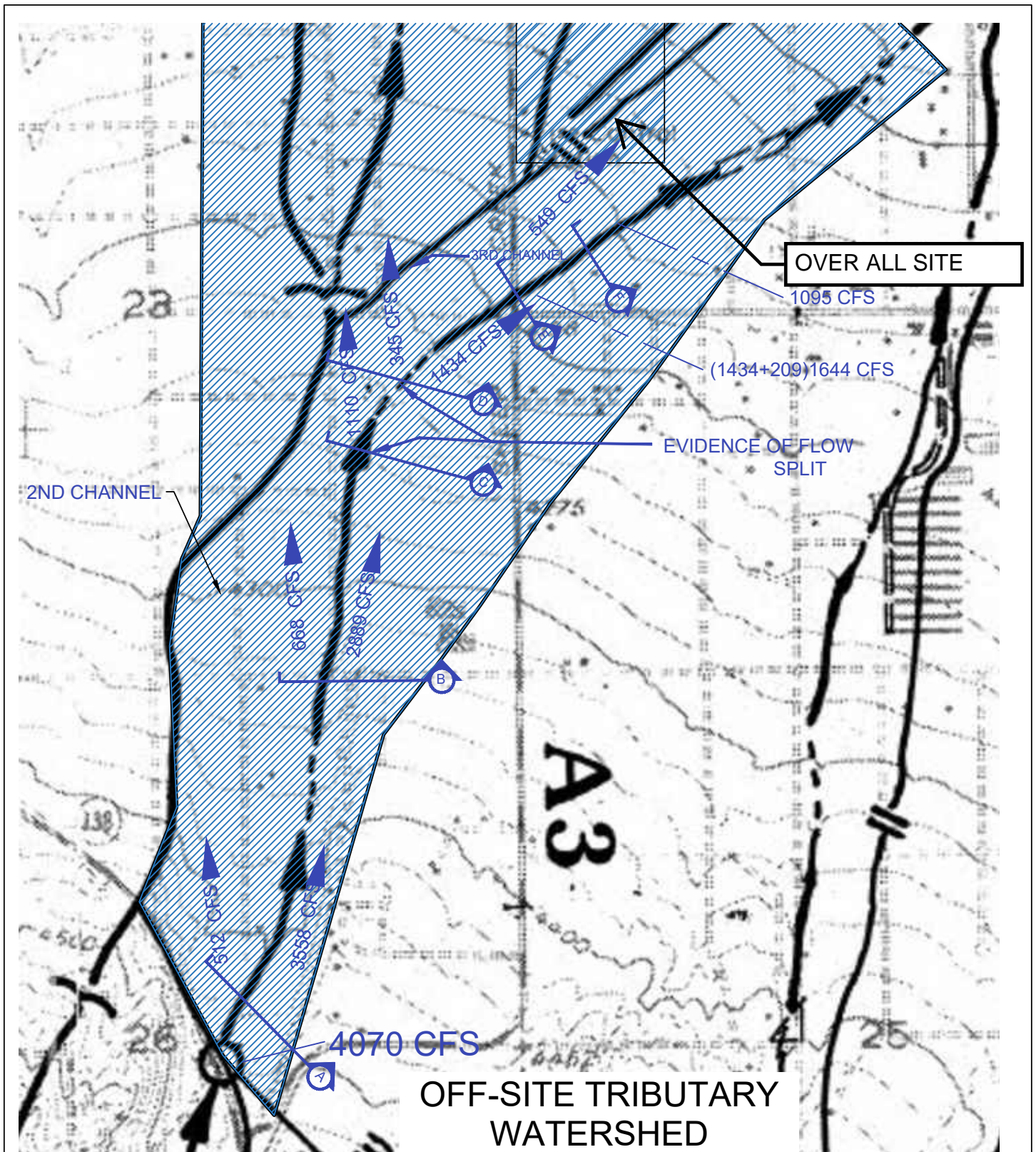
Cover Type (3)	Quality of Cover (2)	Soil Group			
		A	B	C	D
<b><u>NATURAL COVERS -</u></b>					
Barren (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Manzonita, ceanothus and scrub oak)	Poor	53	70	80	85
	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Chamise and redshank)	Poor	71	82	88	91
	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	67	78	86	89
	Fair	50	69	79	84
	Good	38	61	74	80
Meadows or Cienegas (Areas with seasonally high water table, principal vegetation is sod forming grass)	Poor	63	77	85	88
	Fair	51	70	80	84
	Good	30	58	71	78
Open Brush (Soft wood shrubs - buckwheat, sage, etc.)	Poor	62	76	84	88
	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (Coniferous or broadleaf trees predominate. Canopy density is at least 50 percent.)	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	25	55	70	77
Woodland, Grass (Coniferous or broadleaf trees with canopy density from 20 to 50 percent)	Poor	57	73	82	86
	Fair	44	65	77	82
	Good	33	58	72	79
<b><u>URBAN COVERS -</u></b>					
Residential or Commercial Landscaping (Lawn, shrubs, etc.)	Good	32	56	69	75
Turf (Irrigated and mowed grass)	Poor	58	74	83	87
	Fair	44	65	77	82
	Good	33	58	72	79



Impervious areas shall be assigned a CN of 98. It is noted that for ultimately developed conditions, the CN for urban landscaping (turf) is provided in Figure C-3.

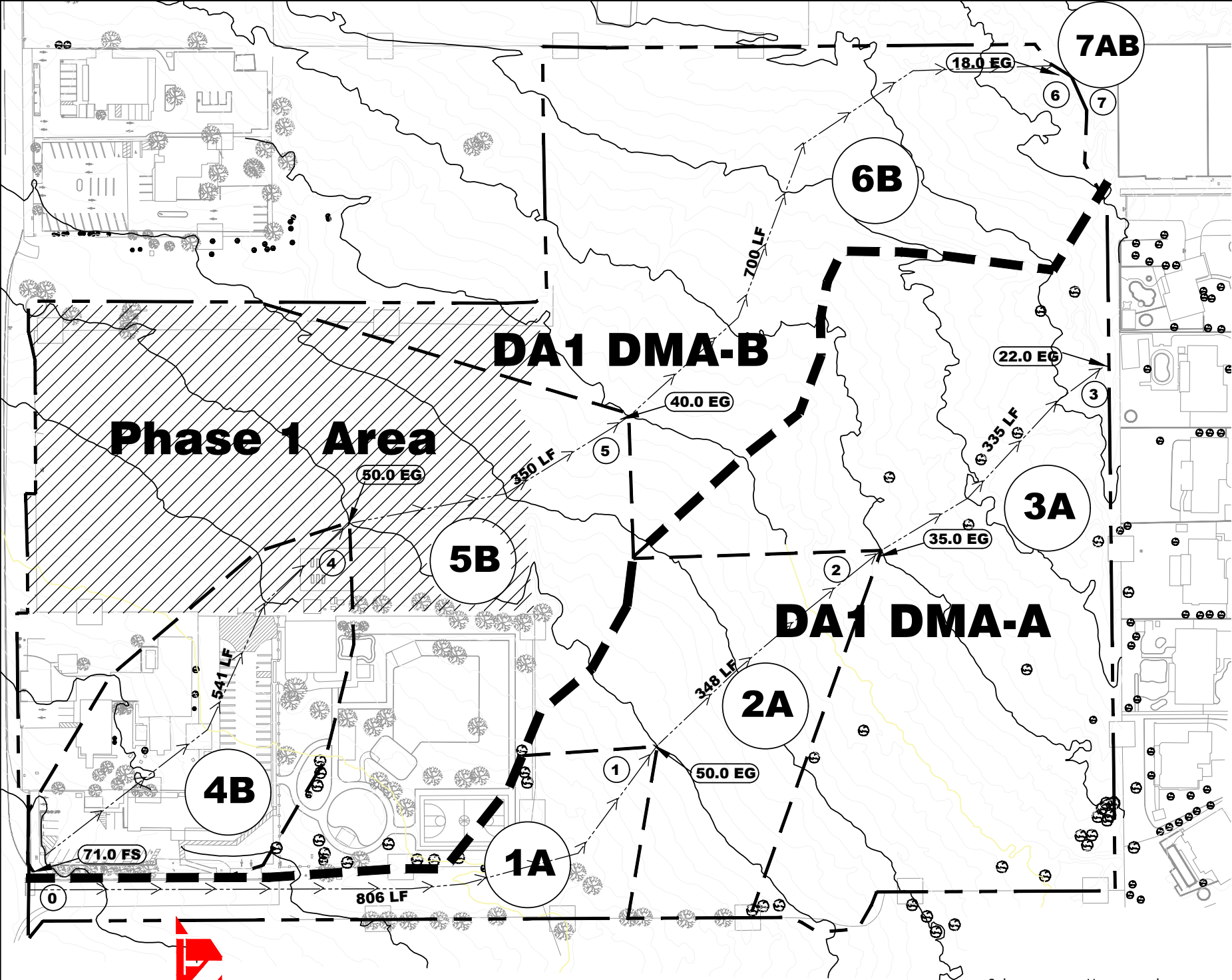
**SAN BERNARDINO COUNTY**  
**HYDROLOGY MANUAL**

**CURVE NUMBERS  
FOR  
PERVIOUS AREAS**





	JOB: 20039	EXHIBIT E		
	SCALE: 1" = 1000'	SAN BERNARDINO FLOOD CONTROL DISTRICT BSI ZONE 6-PHELAN AREA HYDROLOGY STUDY		
	FILE:	PROJECT PHELAN PINION HILLS PARK		
	DATE:	HYDROLOGY STUDY		



**LEGEND:**

SUB-AREA NUMBER

SUB-AREA

6B

SUB-AREA

##

NODE #

XX.XX

SPOT ELEVATION

---

OVERALL BOUNDARY

---

SUBAREA BOUNDARY

---

SUBAREA FLOWLINE

EG

EXISTING GRADE

FG

FINISH GRADE

FS

FINISH SURFACE

FF

FINISH FLOOR

IE

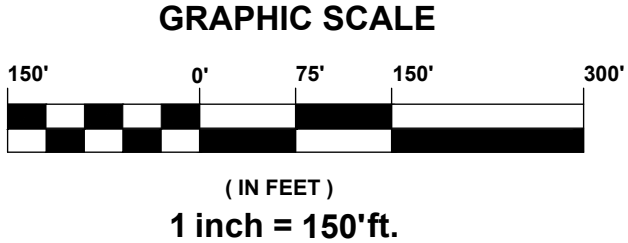
INVERT ELEVATION

LF

LINEAL FEET

**DA1**

Subarea Confluence	Upper node	lower node	C N Type	25-Year 1-Hour AMC II		Conveyance Type	Distance	Area sf	Acres ac	Q <sub>25</sub>
				Upper Elev	lower Elev					
1A	0	1	un-dev-p	71	50	Initial	806	64,024	1.470	2.34
2A	1	2	un-dev-p	50	35	n-Chan	348	100,498	2.307	4.82
3A	2	3	un-dev-p	35	22	n-Chan	335	282,573	6.487	11.18
Travel	3	6	Travel	22	18	n-Chan	346			11.18
AB21	3	7	Hold						10.260	11.18
4B	0	4	Com	71	50	Initial	541	100,868	2.316	8.31
5B	4	5	Com	50	40	n-Chan	350	312,114	7.165	23.23
6B	5	6	Com	40	18	n-Chan	700	246,480	5.658	26.28
AB22	5	6	Confluence	40	18				25.400	38.08



**HYDROLOGY STUDY**

**ON-SITE TRIBUTARY WATERSHED AREA**

**FOR: PPHCSD**

**IN PHELAND SAN BERNARDINO COUNTY, CA**

**APN: 3066-261-08,10 3066-251-14**

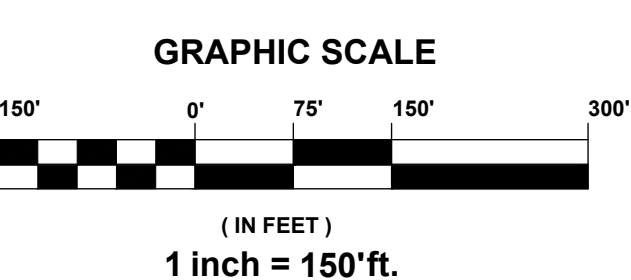
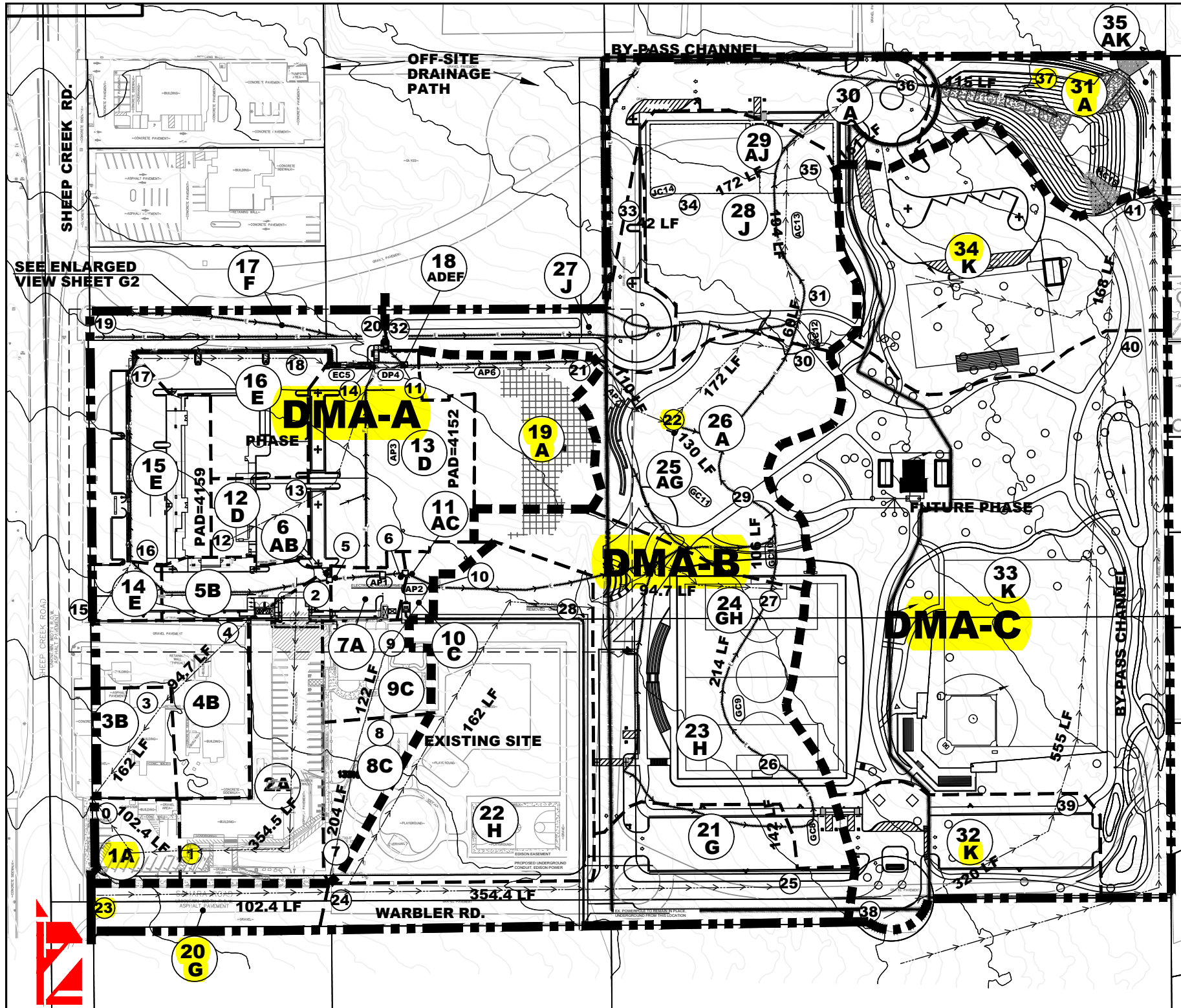
**PRE-DEVELOPED CONDITION**

**RED BRICK SOLUTION**

CONSULTING ENGINEERS & ARCHITECTS

**EXHIBIT F**





**DA1**

DMA-A = SUB-AREAS 1A-19A  
DMA-B = SUB-AREAS 20G-31A  
DMA-C = SUB-AREAS 32K-34K

**LEGEND:**

SUB-AREA SEQUENTIAL NUMBERING

SUB-AREAS

6B

DA1											
100-Year 1-Hour AMC III											
Subarea	Upper node	lower node	C N Type	Upper Elev	lower Elev	Conveyance	Distance	Area sf	Acres	Q <sub>100</sub>	
1A	0	1	Com	69.8	66	Initial	102.4	10,585	0.243	1.94	
2A	1	2	Com	66	55.5	Im-Chan	354.5	38,583	0.886	6.77	
AB21	1	2	HOLD						1.290	6.77	
3B	0	3	Com	69.8	65	Initial	162	14,484	0.333	2.26	
4B	3	4	Com	65	57.7	Im-Chan	94.7	27,932	0.641	6.27	
5B	4	2	Com	57.7	55.5	Im-Chan	107.2	10,975	0.252	7.36	
6AB22	4	2	Confluence						2.350	14.12	
Ap1	2	5	Travel	55.5	47.42	pipe	3			14.12	
7A	5	6	Com	47.42	44.7	pipe	90	5,490	0.126	14.12	
AC21	5	6	HOLD						2.480	14.12	
8C	7	8	Com	65.4	58	Initial	204	1,310	0.030	0.192	
9C	8	9	Com	58	54	Im-Chan	122	13,531	0.311	1.96	
10C	9	10	Com	54	51.4	Im-Chan	56	4,708	0.108	2.51	
11AC22	9	10	Confluence	45.76	44.7				2.930	16.58	
Ap2	10	6	Travel	51.4	44.7	pipe	3			16.58	
Ap3	6	11	Travel	44.7	42.3	pipe	246			16.58	
ADEF41	6	11	HOLD						2.930	16.58	
12D	12	13	Com	59.5	56.95	Initial	170	11,066	0.254	1.54	
13D	13	14	Com	56.95	50.3	Im-Chan	188	42,434	0.974	6.67	
Dp4	14	11	Travel	50.3	42.3	pipe				6.67	
ADEF42	14	11	HOLD						1.280	6.67	
14E	15	16	Com	61	58.08	Initial	75	5,740	0.132	1.16	
15E	16	17	Com	58.08	56.39	Im-Chan	250	27,203	0.624	4.41	
16E	17	18	Com	56.39	51.89	Im-Chan	232	21,540	0.494	6.29	
Ec5	18	11	Travel	51.89	50.7	ST-Flow	100			6.29	
ADEF43	18	11	HOLD						1.250	6.29	
17F	19	20	Com	51.74	49.33	Initial	344	16,817	0.386	1.72	
18ADEF44	19	20	Confluence	49.33	42.3		46		5.790	30.59	
Ap6	14	21	Travel	42.3	38.5	pipe	226			30.59	
19A	14	21	Add Area	42.3	38.5			28,791	0.661	31.71	
Ap7	21	22	Travel	38.5	34	pipe	110			31.71	
AG21m	21	22	HOLD						6.46	31.71	
20G	23	24	Com	71	65.4	Initial	102.4	13,830	0.317	2.67	
21G	24	25	Com	65.4	50	Im-Chan	354.5	53,182	1.221	10.41	
Gc8	25	26	Travel	50	41	Im-Chan	142			10.41	
Gc9	26	27	Travel	41	40	Im-Chan	214			10.41	
GH21	26	27	HOLD						1.540	10.41	
22H	24	28	Park	65.4	49	Initial	162	14,484	0.333	1.76	
23H	28	27	Park	49	40	n-Chan	94.7	27,932	0.641	4.73	
24GH22	28	27	Confluence						2.510	14.47	
Gc10	27	29	Travel	40	34	n-Chan	106			14.47	
Gc11	29	22	Travel	34	33	n-Chan	130			14.47	
25AG22m	29	22	Confluence						8.970	45.52	
26A	22	30	Park	33	32	Initial	172	60,907	1.398	45.52	
Ac12	30	31	Travel	32	27	n-Chan	60			45.52	
Ac13	31	35	Travel	27	26	n-Chan	194			45.52	
AJ21	31	35	HOLD						10.368	45.52	
27J	32	33	Com	40	34	Initial	422	24,592	0.565	2.63	
Jc14	33	34	Travel	34	28	n-Chan	42			2.63	
28J	34	35	Park	28	26	n-Chan	172	59,540	1.367	6.66	
29AJ22	34	35	Confluence						12.300	52.17	
30A	35	36	Park	26	22	n-Chan	161	36,723	0.843	52.17	
31A	36	37	Park	22	16	n-Chan	115	101,516	2.330	52.17	
AK21	36	37	HOLD	48	16				15.474	52.17	
32K	38	39	Park	50	36	Initial	320	40,815	0.937	3.49	
33K	39	40	Park	36	25	n-Chan	555	228,712	5.251	16.32	
34K	40	41	Park	25	20	n-Chan	168	91,844	2.108	20.69	
Kc14	41	37	Travel	20	16	n-Chan			8.296	20.69	
35AK22	41	37	Confluence						23.77	72.17	

## HYDROLOGY STUDY

### ON-SITE TRIBUTARY WATERSHED AREA

FOR:  
PPHCSD

IN  
PHELAND  
SAN BERNARDINO  
COUNTY, CA

APN:  
3066-261-08,10  
3066-251-14

POST-DEVELOPED  
CONDITION  
PHASE I

# RED BRICK SOLUTION

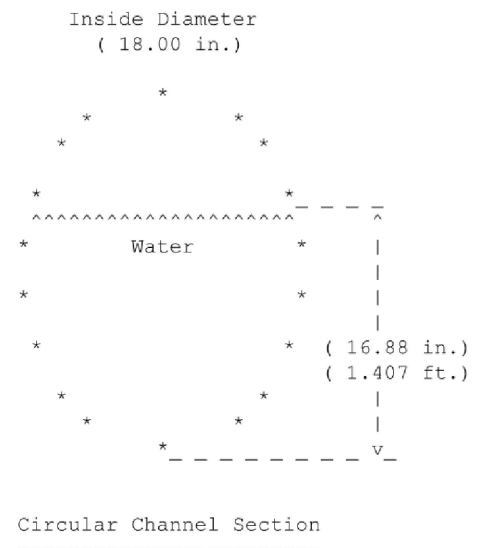
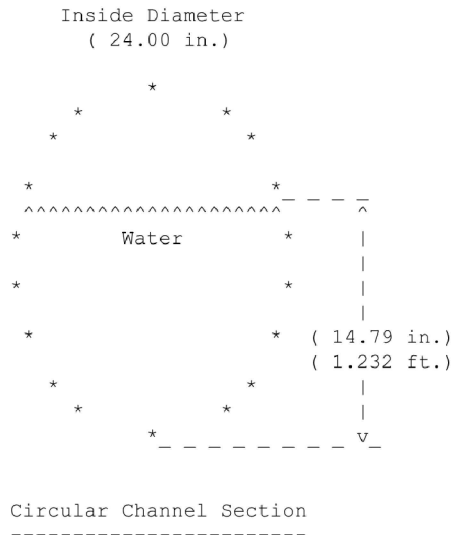
CONSULTING ENGINEERS  
& ARCHITECTS

## EXHIBIT G1





# GRAVITY STORM DRAIN CAPACITIES



Flowrate .....	32.000	CFS
Velocity .....	15.754	fps
Pipe Diameter .....	24.000	inches
Depth of Flow .....	14.787	inches
Depth of Flow .....	1.232	feet
Critical Depth .....	1.887	feet
Depth/Diameter (D/d) .....	0.616	
Slope of Pipe .....	4.090	%
X-Sectional Area .....	2.031	sq. ft.
Wetted Perimeter .....	3.610	feet
AR^(2/3) .....	1.384	
Mannings 'n' .....	0.013	
Min. Fric. Slope, 24 inch		
Pipe Flowing Full .....	2.001	%

Flowrate .....	7.990	CFS
Velocity .....	4.641	fps
Pipe Diameter .....	18.000	inches
Depth of Flow .....	16.884	inches
Depth of Flow .....	1.407	feet
Critical Depth .....	1.097	feet
Depth/Diameter (D/d) .....	0.938	
Slope of Pipe .....	0.500	%
X-Sectional Area .....	1.722	sq. ft.
Wetted Perimeter .....	3.957	feet
AR^(2/3) .....	0.989	
Mannings 'n' .....	0.013	
Min. Fric. Slope, 18 inch		
Pipe Flowing Full .....	0.579	%

DATE: 03/15/2022

DRAWN BY: DWL

CHECKED BY: DWL

SCALE: NTS

## EXHIBIT H

**PPHCSD-COMMUNITY CENTER  
PHELAN - SAN BERNARDINO, CA  
COUNTY, CA  
APN: 3066-261-08,10  
3066-251-14**



# OFF-SITE FLOW BY-PASS CHANNEL

SEE REACH BETWEEN NODE 39 AND 41 ON EXHIBIT G

```
|<----- ( 46.72' ) ----->|
***** - - - - -Channel Depth ( 3.17')- - - - - *****
***
***
***
*** |<----- ( 36.72' ) ----->| ***
***^ ^ ^ ^ ^ Water Depth ( 2.17') ^ ^ ^ ^ ^ ***
***
***
***
*** |<----- ( 15.00' ) ----->| ***
*****
*****
```

Trapezoidal Channel

Flowrate .....	549.000	CFS
Velocity .....	9.774	fps
Depth of Flow .....	2.172	feet
Critical Depth .....	2.596	feet
Freeboard .....	1.000	feet
Total Depth .....	3.172	feet
Width at Water Surface ....	36.720	feet
Top Width .....	46.720	feet
Slope of Channel .....	2.244	%
Left Side Slope .....	5.000	: 1
Right Side Slope .....	5.000	: 1
Base Width .....	15.000	feet
X-Sectional Area .....	56.167	sq. ft.
Wetted Perimeter .....	37.150	feet
AR^(2/3) .....	73.989	
Mannings 'n' .....	0.030	

DATE: 03/15/2022

DRAWN BY: DWL

CHECKED BY: DWL

SCALE: NTS

## EXHIBIT I

PPHCSD-COMMUNITY CENTER  
PHELAN - SAN BERNARDINO, CA  
COUNTY, CA  
APN: 3066-261-08,10  
3066-251-14



# PROPOSED SLOPE CHANNEL

\*\*\*\*\*

\*\*\*\*\*

SEE REACH GC8 AND GC10 ON EXHIBIT G  
Ac12 and Ac13

\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\* |<----- ( 29.96' ) ----->| \*\*\*

\*\*\*^^^ Water Depth ( 0.50' ) ^^^\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\*

\*\*\* |<----- ( 10.00' ) ----->| \*\*\*

\*\*\*\*\*

\*\*\*\*\*

Trapezoidal Channel

-----

Flowrate .....	53.000	CFS
Velocity .....	5.316	fps
Depth of Flow .....	0.499	feet
Critical Depth .....	0.644	feet
Freeboard .....	0.000	feet
Total Depth .....	0.499	feet
Width at Water Surface ....	29.960	feet
Top Width .....	29.960	feet
Slope of Channel .....	20.000	%
Left Side Slope .....	20.000	: 1
Right Side Slope .....	20.000	: 1
Base Width .....	10.000	feet
X-Sectional Area .....	9.970	sq. ft.
Wetted Perimeter .....	29.985	feet
AR^(2/3) .....	4.785	
Mannings 'n' .....	0.060	

DATE: 03/15/2022

DRAWN BY: DWL

CHECKED BY: DWL

SCALE: NTS

## EXHIBIT J1

PPHCSD-COMMUNITY CENTER  
PHELAN - SAN BERNARDINO, CA  
COUNTY, CA  
APN: 3066-261-08, 10  
3066-251-14



# PROPOSED SPILLWAY

```

*
*****
***
***
***
*** |<----- ( 21.97') ----->| ***
***^^^^^^^ Water Depth ( 0.70') ^^^^^^^
***
***
***
*** |<----- ( 15.00') ----->| ***
*****
*****

```

Trapezoidal Channel

Flowrate .....	92.000	CFS
Velocity .....	7.136	fps
Depth of Flow .....	0.697	feet
Critical Depth .....	0.941	feet
Freeboard .....	0.000	feet
Total Depth .....	0.697	feet
Width at Water Surface ....	21.974	feet
Top Width .....	21.974	feet
Slope of Channel .....	0.800	%
Left Side Slope .....	5.000	: 1
Right Side Slope .....	5.000	: 1
Base Width .....	15.000	feet
X-Sectional Area .....	12.893	sq. ft.
Wetted Perimeter .....	22.112	feet
AR^(2/3) .....	8.998	
Mannings 'n' .....	0.013	

DATE: 03/15/2022

DRAWN BY: DWL

CHECKED BY: DWL

SCALE: NTS

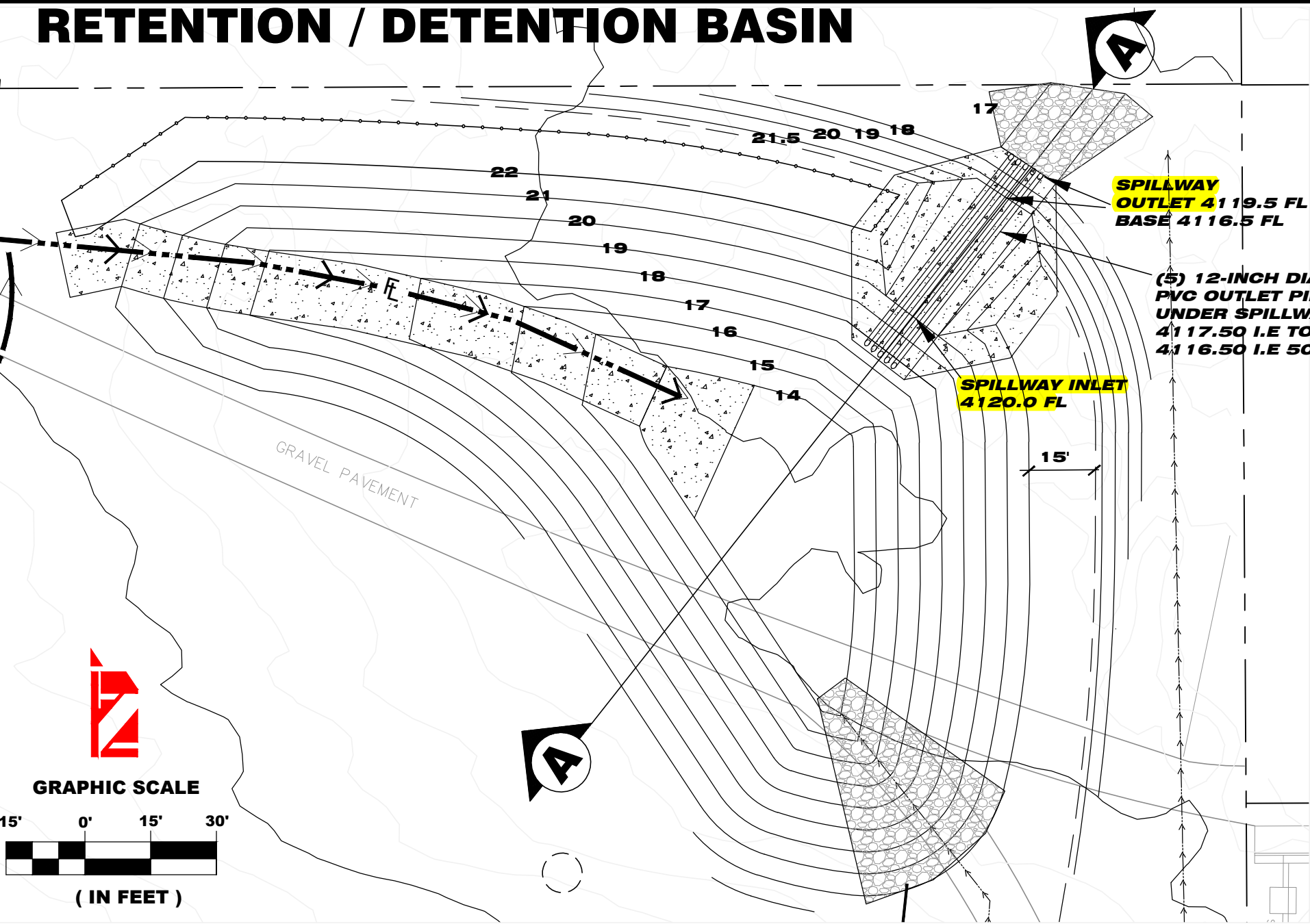
## EXHIBIT J2

PPHCSD-COMMUNITY CENTER  
 PHELAN - SAN BERNARDINO, CA  
 COUNTY, CA  
 APN: 3066-261-08,10  
 3066-251-14





# RETENTION / DETENTION BASIN



**BASIN DATA:**

**BOTTOM ELEV = 4114.0**  
**SPILLWAY ELEV = 4120.0**  
**RIM ELEV = 4122.0**

**100-YEAR STORM**  
**WSE = 4120.00**  
**DETENTION V=1.07 AC-FT**  
**BOTTOM AREA = 2,247.4 SF**  
**MID-VOLUME AREA = 5,684 SF**

**FROM FORM 4.3-3 3-HR**  
**BASIN INFILTR. = 23,323 CF**  
**CHANNEL INFILTR. = 8,109 CF**  
**REQ'D DCV = 31,431**  
**REQ'D DCV = 28,468 CF**

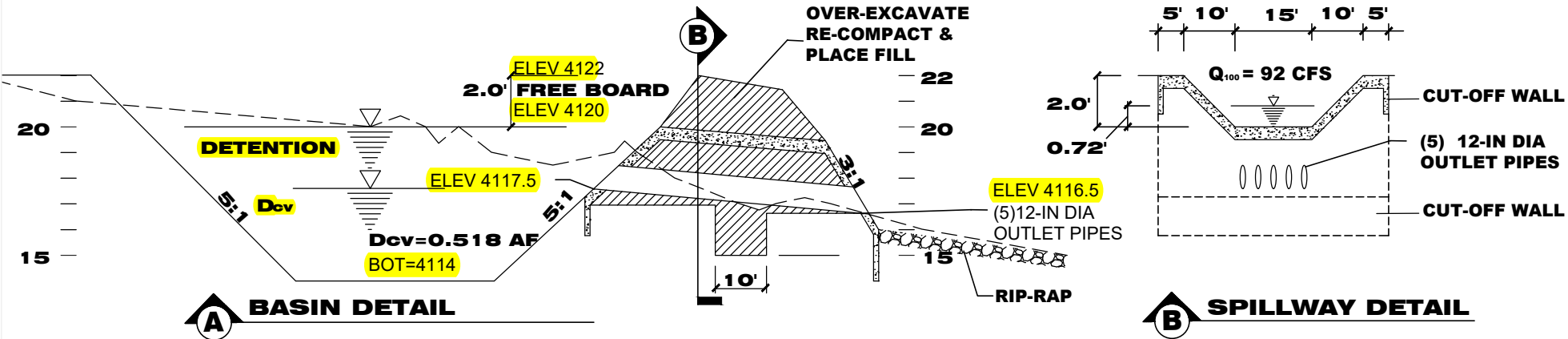
**DRAWDOWN TIME:**  
**REQ'D < 48 HRS**

**INFILTRATION RATE = 4.24 IN/HR**  
**FS = 2 = 2.12 IN/HR**

**DEPTH = 4117.5-4114.0=3.5 FT**  
**= 3.5\*12 = 42 IN**

**DRAWDOWN = 42/2.12 = 19.8 HR**  
**< 48 OK**

BASIN VOLUME/ FT ELEVATION					
FT/ELEV	Area	Area	Vol Ac/ft	Acc. Vol	
	SF	Ac.	per ft	Ac.-Ft	
21.5	7.5	19698.31	0.452211	0.216254	1.669949
21	7	17981.79	0.412805	0.378924	1.453695
20	6	15030.08	0.345043	0.313908	1.074771
19	5	12317.55	0.282772	0.253706	0.760863
18	4	9785.288	0.224639	0.195384	0.507157
17.5	3.5	8510.934	0.195384	0.090378	0.402151
17	3	7236.58	0.166129	0.143142	0.311773
16	2	5233.984	0.120156	0.101456	0.168631
15	1	3604.855	0.082756	0.067175	0.067175
14	0	2247.407	0.051593		



**HYDROLOGY STUDY**

**ON-SITE TRIBUTARY WATERSHED AREA**

**FOR: PPHCSD**

**IN PHELAN SAN BERNARDINO COUNTY, CA**

**APN: 3066-261-08,10 3066-251-14**

**RETENTION/ DETENTION BASIN**

**RED BRICK SOLUTION**

CONSULTING ENGINEERS & ARCHITECTS

**EXHIBIT K**

## **APPENDIX B – Hydrologic Calculations**

Pre-Developed 25-year Rational Method Analysis  
Post-Developed 100-year Rational Method Analysis  
Post-Developed 100-year Rational Method Analysis  
Post-developed 100-year Unit Hydrograph Method Analysis



San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2018 Version 9.0  
Rational Hydrology Study Date: 02/06/23

**PRE-DEVELOPED  
25-YEAR 1-HOUR  
AMC II  
2039p25**

Program License Serial Number 6434

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

Rational hydrology study storm event year is 25.0  
Computed rainfall intensity:  
Storm year = 25.00 1 hour rainfall = 0.927 (In.)  
Slope used for rainfall intensity curve b = 0.7000  
Soil antecedent moisture condition (AMC) = 2

+++++  
Process from Point/Station 0.000 to Point/Station 1.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

RESIDENTIAL(1 acre lot)  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Pervious ratio(Ap) = 0.8000 Max loss rate(Fm)= 0.782(In/Hr)  
Initial subarea data:  
Initial area flow distance = 806.000(Ft.)  
Top (of initial area) elevation = 71.000(Ft.)  
Bottom (of initial area) elevation = 50.000(Ft.)  
Difference in elevation = 21.000(Ft.)  
Slope = 0.02605 s(%)= 2.61  
 $TC = k(0.469)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 14.143 min.  
Rainfall intensity = 2.549(In/Hr) for a 25.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.624  
Subarea runoff = 2.338(CFS)  
Total initial stream area = 1.470(Ac.)  
Pervious area fraction = 0.800  
Initial area Fm value = 0.782(In/Hr)

+++++  
Process from Point/Station 1.000 to Point/Station 2.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

Upstream point elevation = 50.000(Ft.)  
Downstream point elevation = 35.000(Ft.)



Channel length thru subarea = 348.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 3.619(CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 3.619(CFS)  
 Depth of flow = 0.122(Ft.), Average velocity = 1.852(Ft/s)  
 Channel flow top width = 22.154(Ft.)  
 Flow Velocity = 1.85(Ft/s)  
 Travel time = 3.13 min.  
 Time of concentration = 17.27 min.  
 Critical depth = 0.128(Ft.)  
 Adding area flow to channel  
 UNDEVELOPED (average cover) subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 50.00  
 Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.810(In/Hr)  
 Rainfall intensity = 2.216(In/Hr) for a 25.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.576  
 Subarea runoff = 2.480(CFS) for 2.307(Ac.)  
 Total runoff = 4.818(CFS)  
 Effective area this stream = 3.78(Ac.)  
 Total Study Area (Main Stream No. 1) = 3.78(Ac.)  
 Area averaged Fm value = 0.799(In/Hr)  
 Depth of flow = 0.141(Ft.), Average velocity = 2.009(Ft/s)  
 Critical depth = 0.150(Ft.)

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

---

Upstream point elevation = 35.000(Ft.)  
 Downstream point elevation = 22.000(Ft.)  
 Channel length thru subarea = 335.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 8.031(CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 8.031(CFS)  
 Depth of flow = 0.187(Ft.), Average velocity = 2.227(Ft/s)  
 Channel flow top width = 28.656(Ft.)  
 Flow Velocity = 2.23(Ft/s)  
 Travel time = 2.51 min.  
 Time of concentration = 19.78 min.  
 Critical depth = 0.197(Ft.)  
 Adding area flow to channel  
 UNDEVELOPED (average cover) subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 50.00  
 Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.810(In/Hr)  
 Rainfall intensity = 2.016(In/Hr) for a 25.0 year storm

Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.540  
Subarea runoff = 6.360(CFS) for 6.487(Ac.)  
Total runoff = 11.178(CFS)  
Effective area this stream = 10.26(Ac.)  
Total Study Area (Main Stream No. 1) = 10.26(Ac.)  
Area averaged Fm value = 0.806(In/Hr)  
Depth of flow = 0.219(Ft.), Average velocity = 2.435(Ft/s)  
Critical depth = 0.234(Ft.)

+++++  
Process from Point/Station 3.000 to Point/Station 6.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 22.000(Ft.)  
Downstream point elevation = 18.000(Ft.)  
Channel length thru subarea = 346.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 5.000  
Slope or 'Z' of right channel bank = 5.000  
Manning's 'N' = 0.033  
Maximum depth of channel = 3.000(Ft.)  
Flow(q) thru subarea = 11.178(CFS)  
Depth of flow = 0.397(Ft.), Average velocity = 2.351(Ft/s)  
Channel flow top width = 13.967(Ft.)  
Flow Velocity = 2.35(Ft/s)  
Travel time = 2.45 min.  
Time of concentration = 22.23 min.  
Critical depth = 0.320(Ft.)

+++++  
Process from Point/Station 3.000 to Point/Station 6.000  
\*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
Stream flow area = 10.264(Ac.)  
Runoff from this stream = 11.178(CFS)  
Time of concentration = 22.23 min.  
Rainfall intensity = 1.857(In/Hr)  
Area averaged loss rate (Fm) = 0.8056(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.9714

+++++  
Process from Point/Station 0.000 to Point/Station 4.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.098(In/Hr)  
Initial subarea data:  
Initial area flow distance = 541.000(Ft.)  
Top (of initial area) elevation = 71.000(Ft.)  
Bottom (of initial area) elevation = 50.000(Ft.)  
Difference in elevation = 21.000(Ft.)  
Slope = 0.03882 s(%)= 3.88  
TC = k(0.304)\*[(length^3)/(elevation change)]^0.2

Initial area time of concentration = 7.217 min.  
Rainfall intensity = 4.083(In/Hr) for a 25.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.878  
Subarea runoff = 8.306(CFS)  
Total initial stream area = 2.316(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.098(In/Hr)

+++++  
Process from Point/Station 4.000 to Point/Station 5.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 50.000(Ft.)  
Downstream point elevation = 40.000(Ft.)  
Channel length thru subarea = 350.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 40.000  
Slope or 'Z' of right channel bank = 40.000  
Estimated mean flow rate at midpoint of channel = 15.793(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 15.793(CFS)  
Depth of flow = 0.291(Ft.), Average velocity = 2.508(Ft/s)  
Channel flow top width = 33.279(Ft.)  
Flow Velocity = 2.51(Ft/s)  
Travel time = 2.33 min.  
Time of concentration = 9.54 min.  
Critical depth = 0.293(Ft.)  
Adding area flow to channel  
UNDEVELOPED (average cover) subarea  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 50.00  
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.810(In/Hr)  
Rainfall intensity = 3.358(In/Hr) for a 25.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.730  
Subarea runoff = 14.919(CFS) for 7.165(Ac.)  
Total runoff = 23.225(CFS)  
Effective area this stream = 9.48(Ac.)  
Total Study Area (Main Stream No. 1) = 19.74(Ac.)  
Area averaged Fm value = 0.636(In/Hr)  
Depth of flow = 0.349(Ft.), Average velocity = 2.778(Ft/s)  
Critical depth = 0.355(Ft.)

+++++  
Process from Point/Station 5.000 to Point/Station 6.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 40.000(Ft.)  
Downstream point elevation = 18.000(Ft.)  
Channel length thru subarea = 700.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 40.000  
Slope or 'Z' of right channel bank = 40.000  
Estimated mean flow rate at midpoint of channel = 24.781(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 24.781(CFS)

Depth of flow = 0.352(Ft.), Average velocity = 2.926(Ft/s)  
 Channel flow top width = 38.143(Ft.)  
 Flow Velocity = 2.93(Ft/s)  
 Travel time = 3.99 min.  
 Time of concentration = 13.53 min.  
 Critical depth = 0.367(Ft.)  
 Adding area flow to channel  
 UNDEVELOPED (average cover) subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 50.00  
 Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.810(In/Hr)  
 Rainfall intensity = 2.630(In/Hr) for a 25.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.660  
 Subarea runoff = 3.057(CFS) for 5.658(Ac.)  
 Total runoff = 26.283(CFS)  
 Effective area this stream = 15.14(Ac.)  
 Total Study Area (Main Stream No. 1) = 25.40(Ac.)  
 Area averaged Fm value = 0.701(In/Hr)  
 Depth of flow = 0.362(Ft.), Average velocity = 2.972(Ft/s)  
 Critical depth = 0.379(Ft.)

++++++  
 Process from Point/Station 5.000 to Point/Station 6.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 2

Stream flow area = 15.139(Ac.)  
 Runoff from this stream = 26.283(CFS)  
 Time of concentration = 13.53 min.  
 Rainfall intensity = 2.630(In/Hr)  
 Area averaged loss rate (Fm) = 0.7006(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.8623  
 Summary of stream data:

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

1	11.18	10.264	22.23	0.806	1.857
2	26.28	15.139	13.53	0.701	2.630

Qmax(1) =

1.000 *	1.000 *	11.178) +	
0.600 *	1.000 *	26.283) + =	26.937

Qmax(2) =

1.734 *	0.609 *	11.178) +	
1.000 *	1.000 *	26.283) + =	38.080

Total of 2 streams to confluence:

Flow rates before confluence point:

11.178	26.283
--------	--------

Maximum flow rates at confluence using above data:

26.937	38.080
--------	--------

Area of streams before confluence:

10.264	15.139
--------	--------

Effective area values after confluence:

25.403	21.385
--------	--------

Results of confluence:

Total flow rate = 38.080(CFS)

Time of concentration = 13.529 min.  
Effective stream area after confluence = 21.385 (Ac.)  
Study area average Pervious fraction( $A_p$ ) = 0.906  
Study area average soil loss rate( $F_m$ ) = 0.743 (In/Hr)  
Study area total (this main stream) = 25.40 (Ac.)  
End of computations, Total Study Area = 25.40 (Ac.)

The following figures may

be used for a unit hydrograph study of the same area.

Note: These figures do not consider reduced effective area effects caused by confluences in the rational equation.

Area averaged pervious area fraction( $A_p$ ) = 0.906

Area averaged SCS curve number = 47.3



San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2018 Version 9.0  
Rational Hydrology Study Date: 02/06/23

**PRE-DEVELOPED  
100-YEAR 1-HOUR  
AMC III**

2039p100

Program License Serial Number 6434

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

Rational hydrology study storm event year is 100.0  
Computed rainfall intensity:  
Storm year = 100.00 1 hour rainfall = 1.280 (In.)  
Slope used for rainfall intensity curve b = 0.7000  
Soil antecedent moisture condition (AMC) = 3

\*\*\*\*\*  
Process from Point/Station 0.000 to Point/Station 1.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

RESIDENTIAL(1 acre lot)  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.8000 Max loss rate(Fm)= 0.628(In/Hr)  
Initial subarea data:  
Initial area flow distance = 806.000(Ft.)  
Top (of initial area) elevation = 71.000(Ft.)  
Bottom (of initial area) elevation = 50.000(Ft.)  
Difference in elevation = 21.000(Ft.)  
Slope = 0.02605 s(%)= 2.61  
 $TC = k(0.469)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 14.143 min.  
Rainfall intensity = 3.520(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.739  
Subarea runoff = 3.826(CFS)  
Total initial stream area = 1.470(Ac.)  
Pervious area fraction = 0.800  
Initial area Fm value = 0.628(In/Hr)

\*\*\*\*\*  
Process from Point/Station 1.000 to Point/Station 2.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

Upstream point elevation = 50.000(Ft.)

Downstream point elevation = 35.000(Ft.)  
 Channel length thru subarea = 348.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 6.282(CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 6.282(CFS)  
 Depth of flow = 0.161(Ft.), Average velocity = 2.163(Ft/s)  
 Channel flow top width = 26.094(Ft.)  
 Flow Velocity = 2.16(Ft/s)  
 Travel time = 2.68 min.  
 Time of concentration = 16.82 min.  
 Critical depth = 0.173(Ft.)  
 Adding area flow to channel  
 UNDEVELOPED (average cover) subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 50.00  
 Adjusted SCS curve number for AMC 3 = 70.00  
 Pervious ratio(Ap) = 1.0000 Max loss rate(Fm)= 0.532(In/Hr)  
 Rainfall intensity = 3.117(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.736  
 Subarea runoff = 4.834(CFS) for 2.307(Ac.)  
 Total runoff = 8.660(CFS)  
 Effective area this stream = 3.78(Ac.)  
 Total Study Area (Main Stream No. 1) = 3.78(Ac.)  
 Area averaged Fm value = 0.570(In/Hr)  
 Depth of flow = 0.189(Ft.), Average velocity = 2.362(Ft/s)  
 Critical depth = 0.205(Ft.)

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

---

Upstream point elevation = 35.000(Ft.)  
 Downstream point elevation = 22.000(Ft.)  
 Channel length thru subarea = 335.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 15.094(CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 15.094(CFS)  
 Depth of flow = 0.253(Ft.), Average velocity = 2.638(Ft/s)  
 Channel flow top width = 35.275(Ft.)  
 Flow Velocity = 2.64(Ft/s)  
 Travel time = 2.12 min.  
 Time of concentration = 18.94 min.  
 Critical depth = 0.271(Ft.)  
 Adding area flow to channel  
 UNDEVELOPED (average cover) subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 50.00

Adjusted SCS curve number for AMC 3 = 70.00  
Pervious ratio(Ap) = 1.0000      Max loss rate(Fm)=      0.532(In/Hr)  
Rainfall intensity =      2.869(In/Hr) for a      100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.729  
Subarea runoff =      12.798(CFS) for      6.487(Ac.)  
Total runoff =      21.458(CFS)  
Effective area this stream =      10.26(Ac.)  
Total Study Area (Main Stream No. 1) =      10.26(Ac.)  
Area averaged Fm value =      0.546(In/Hr)  
Depth of flow =      0.298(Ft.), Average velocity =      2.894(Ft/s)  
Critical depth =      0.324(Ft.)

+++++  
Process from Point/Station      3.000 to Point/Station      6.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =      22.000(Ft.)  
Downstream point elevation =      18.000(Ft.)  
Channel length thru subarea =      346.000(Ft.)  
Channel base width =      10.000(Ft.)  
Slope or 'Z' of left channel bank =      5.000  
Slope or 'Z' of right channel bank =      5.000  
Manning's 'N'      = 0.033  
Maximum depth of channel      =      3.000(Ft.)  
Flow(q) thru subarea =      21.458(CFS)  
Depth of flow =      0.573(Ft.), Average velocity =      2.908(Ft/s)  
Channel flow top width =      15.734(Ft.)  
Flow Velocity =      2.91(Ft/s)  
Travel time      =      1.98 min.  
Time of concentration =      20.92 min.  
Critical depth =      0.480(Ft.)

+++++  
Process from Point/Station      3.000 to Point/Station      6.000  
\*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
Stream flow area =      10.264(Ac.)  
Runoff from this stream =      21.458(CFS)  
Time of concentration =      20.92 min.  
Rainfall intensity =      2.676(In/Hr)  
Area averaged loss rate (Fm) =      0.5462(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.9714

+++++  
Process from Point/Station      0.000 to Point/Station      4.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2)      = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)=      0.079(In/Hr)  
Initial subarea data:  
Initial area flow distance =      541.000(Ft.)  
Top (of initial area) elevation =      71.000(Ft.)



Bottom (of initial area) elevation = 50.000(Ft.)  
Difference in elevation = 21.000(Ft.)  
Slope = 0.03882 s(%) = 3.88  
 $TC = k(0.304)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 7.217 min.  
Rainfall intensity = 5.637(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.887  
Subarea runoff = 11.587(CFS)  
Total initial stream area = 2.316(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.079(In/Hr)

+++++  
Process from Point/Station 4.000 to Point/Station 5.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 50.000(Ft.)  
Downstream point elevation = 40.000(Ft.)  
Channel length thru subarea = 350.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 40.000  
Slope or 'Z' of right channel bank = 40.000  
Estimated mean flow rate at midpoint of channel = 24.168(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 24.168(CFS)  
Depth of flow = 0.355(Ft.), Average velocity = 2.807(Ft/s)  
Channel flow top width = 38.440(Ft.)  
Flow Velocity = 2.81(Ft/s)  
Travel time = 2.08 min.  
Time of concentration = 9.30 min.  
Critical depth = 0.363(Ft.)  
Adding area flow to channel  
UNDEVELOPED (average cover) subarea  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 50.00  
Adjusted SCS curve number for AMC 3 = 70.00  
Pervious ratio(Ap) = 1.0000 Max loss rate(Fm) = 0.532(In/Hr)  
Rainfall intensity = 4.722(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.820  
Subarea runoff = 25.109(CFS) for 7.165(Ac.)  
Total runoff = 36.696(CFS)  
Effective area this stream = 9.48(Ac.)  
Total Study Area (Main Stream No. 1) = 19.74(Ac.)  
Area averaged Fm value = 0.422(In/Hr)  
Depth of flow = 0.431(Ft.), Average velocity = 3.130(Ft/s)  
Critical depth = 0.445(Ft.)

+++++  
Process from Point/Station 5.000 to Point/Station 6.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 40.000(Ft.)  
Downstream point elevation = 18.000(Ft.)  
Channel length thru subarea = 700.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 40.000

Slope or 'Z' of right channel bank = 40.000  
 Estimated mean flow rate at midpoint of channel = 40.951 (CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000 (Ft.)  
 Flow(q) thru subarea = 40.951 (CFS)  
 Depth of flow = 0.443 (Ft.), Average velocity = 3.336 (Ft/s)  
 Channel flow top width = 45.433 (Ft.)  
 Flow Velocity = 3.34 (Ft/s)  
 Travel time = 3.50 min.  
 Time of concentration = 12.79 min.  
 Critical depth = 0.469 (Ft.)  
 Adding area flow to channel  
 UNDEVELOPED (average cover) subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil (AMC 2) = 50.00  
 Adjusted SCS curve number for AMC 3 = 70.00  
 Pervious ratio (Ap) = 1.0000 Max loss rate (Fm) = 0.532 (In/Hr)  
 Rainfall intensity = 3.776 (In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.790  
 Subarea runoff = 8.446 (CFS) for 5.658 (Ac.)  
 Total runoff = 45.142 (CFS)  
 Effective area this stream = 15.14 (Ac.)  
 Total Study Area (Main Stream No. 1) = 25.40 (Ac.)  
 Area averaged Fm value = 0.463 (In/Hr)  
 Depth of flow = 0.463 (Ft.), Average velocity = 3.421 (Ft/s)  
 Critical depth = 0.492 (Ft.)

++++++  
 Process from Point/Station 5.000 to Point/Station 6.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 2

Stream flow area = 15.139 (Ac.)  
 Runoff from this stream = 45.142 (CFS)  
 Time of concentration = 12.79 min.  
 Rainfall intensity = 3.776 (In/Hr)  
 Area averaged loss rate (Fm) = 0.4630 (In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.8623  
 Summary of stream data:

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

1	21.46	10.264	20.92	0.546	2.676
2	45.14	15.139	12.79	0.463	3.776

Qmax(1) =

1.000 \* 1.000 \* 21.458) +  
 0.668 \* 1.000 \* 45.142) + = 51.609

Qmax(2) =

1.517 \* 0.611 \* 21.458) +  
 1.000 \* 1.000 \* 45.142) + = 65.039

Total of 2 streams to confluence:

Flow rates before confluence point:

21.458 45.142

Maximum flow rates at confluence using above data:

51.609 65.039

Area of streams before confluence:

10.264          15.139

Effective area values after confluence:

25.403          21.414

Results of confluence:

Total flow rate = 65.039(CFS)

Time of concentration = 12.792 min.

Effective stream area after confluence = 21.414(Ac.)

Study area average Pervious fraction( $A_p$ ) = 0.906

Study area average soil loss rate( $F_m$ ) = 0.497(In/Hr)

Study area total (this main stream) = 25.40(Ac.)

End of computations, Total Study Area = 25.40 (Ac.)

The following figures may

be used for a unit hydrograph study of the same area.

Note: These figures do not consider reduced effective area effects caused by confluences in the rational equation.

Area averaged pervious area fraction( $A_p$ ) = 0.906

Area averaged SCS curve number = 47.3



San Bernardino County Rational Hydrology Program

(Hydrology Manual Date - August 1986)

CIVILCADD/CIVILDESIGN Engineering Software, (c) 1989-2018 Version 9.0  
Rational Hydrology Study Date: 03/26/22

**POST-DEVELOPED  
100-YEAR 1-HOUR  
AMC III  
2039OD**

Program License Serial Number 6434

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

Rational hydrology study storm event year is 100.0  
Computed rainfall intensity:  
Storm year = 100.00 1 hour rainfall = 1.280 (In.)  
Slope used for rainfall intensity curve b = 0.7000  
Soil antecedent moisture condition (AMC) = 3

\*\*\*\*\*  
Process from Point/Station 0.000 to Point/Station 1.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Initial subarea data:  
Initial area flow distance = 102.000(Ft.)  
Top (of initial area) elevation = 69.800(Ft.)  
Bottom (of initial area) elevation = 66.000(Ft.)  
Difference in elevation = 3.800(Ft.)  
Slope = 0.03725 s(%)= 3.73  
TC =  $k(0.304)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 3.733 min.  
Rainfall intensity = 8.943(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.892  
Subarea runoff = 1.939(CFS)  
Total initial stream area = 0.243(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.079(In/Hr)

\*\*\*\*\*  
Process from Point/Station 1.000 to Point/Station 2.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

Upstream point elevation = 66.000(Ft.)  
Downstream point elevation = 55.500(Ft.)

Channel length thru subarea = 355.000(Ft.)  
 Channel base width = 4.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 4.395(CFS)  
 Manning's 'N' = 0.015  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 4.395(CFS)  
 Depth of flow = 0.131(Ft.), Average velocity = 3.183(Ft/s)  
 Channel flow top width = 17.092(Ft.)  
 Flow Velocity = 3.18(Ft/s)  
 Travel time = 1.86 min.  
 Time of concentration = 5.59 min.  
 Critical depth = 0.182(Ft.)  
 Adding area flow to channel  
 COMMERCIAL subarea type  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
 Rainfall intensity = 6.740(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.890  
 Subarea runoff = 4.830(CFS) for 0.886(Ac.)  
 Total runoff = 6.768(CFS)  
 Effective area this stream = 1.13(Ac.)  
 Total Study Area (Main Stream No. 1) = 1.13(Ac.)  
 Area averaged Fm value = 0.079(In/Hr)  
 Depth of flow = 0.159(Ft.), Average velocity = 3.560(Ft/s)  
 Critical depth = 0.221(Ft.)

++++++  
 Process from Point/Station 1.000 to Point/Station 2.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
 Stream flow area = 1.129(Ac.)  
 Runoff from this stream = 6.768(CFS)  
 Time of concentration = 5.59 min.  
 Rainfall intensity = 6.740(In/Hr)  
 Area averaged loss rate (Fm) = 0.0785(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.1000

++++++  
 Process from Point/Station 0.000 to Point/Station 3.000  
 \*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
 Initial subarea data:  
 Initial area flow distance = 162.000(Ft.)  
 Top (of initial area) elevation = 69.800(Ft.)

Bottom (of initial area) elevation = 65.000(Ft.)  
Difference in elevation = 4.800(Ft.)  
Slope = 0.02963 s(%) = 2.96  
 $TC = k(0.304)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 4.703 min.  
Rainfall intensity = 7.608(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.891  
Subarea runoff = 2.257(CFS)  
Total initial stream area = 0.333(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.079(In/Hr)

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

---

Upstream point elevation = 65.000(Ft.)  
Downstream point elevation = 57.700(Ft.)  
Channel length thru subarea = 95.000(Ft.)  
Channel base width = 4.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel = 4.306(CFS)  
Manning's 'N' = 0.015  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 4.306(CFS)  
Depth of flow = 0.104(Ft.), Average velocity = 4.503(Ft/s)  
Channel flow top width = 14.395(Ft.)  
Flow Velocity = 4.50(Ft/s)  
Travel time = 0.35 min.  
Time of concentration = 5.05 min.  
Critical depth = 0.180(Ft.)  
Adding area flow to channel  
COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm) = 0.079(In/Hr)  
Rainfall intensity = 7.234(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.890  
Subarea runoff = 4.016(CFS) for 0.641(Ac.)  
Total runoff = 6.272(CFS)  
Effective area this stream = 0.97(Ac.)  
Total Study Area (Main Stream No. 1) = 2.10(Ac.)  
Area averaged Fm value = 0.079(In/Hr)  
Depth of flow = 0.124(Ft.), Average velocity = 4.971(Ft/s)  
Critical depth = 0.213(Ft.)

+++++  
Process from Point/Station 4.000 to Point/Station 2.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 57.700(Ft.)  
Downstream point elevation = 55.000(Ft.)  
Channel length thru subarea = 107.000(Ft.)  
Channel base width = 4.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000

Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 6.849 (CFS)  
 Manning's 'N' = 0.015  
 Maximum depth of channel = 1.000 (Ft.)  
 Flow (q) thru subarea = 6.849 (CFS)  
 Depth of flow = 0.166 (Ft.), Average velocity = 3.366 (Ft/s)  
 Channel flow top width = 20.566 (Ft.)  
 Flow Velocity = 3.37 (Ft/s)  
 Travel time = 0.53 min.  
 Time of concentration = 5.58 min.  
 Critical depth = 0.223 (Ft.)  
 Adding area flow to channel  
 COMMERCIAL subarea type  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil (AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio (Ap) = 0.1000 Max loss rate (Fm) = 0.079 (In/Hr)  
 Rainfall intensity = 6.746 (In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.890  
 Subarea runoff = 1.085 (CFS) for 0.252 (Ac.)  
 Total runoff = 7.357 (CFS)  
 Effective area this stream = 1.23 (Ac.)  
 Total Study Area (Main Stream No. 1) = 2.35 (Ac.)  
 Area averaged Fm value = 0.079 (In/Hr)  
 Depth of flow = 0.171 (Ft.), Average velocity = 3.428 (Ft/s)  
 Critical depth = 0.230 (Ft.)

++++++  
 Process from Point/Station 4.000 to Point/Station 2.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 2

Stream flow area = 1.226 (Ac.)  
 Runoff from this stream = 7.357 (CFS)  
 Time of concentration = 5.58 min.  
 Rainfall intensity = 6.746 (In/Hr)  
 Area averaged loss rate (Fm) = 0.0785 (In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.1000  
 Summary of stream data:

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

1	6.77	1.129	5.59	0.079	6.740
2	7.36	1.226	5.58	0.079	6.746

Qmax(1) =  
     1.000 \* 1.000 \* 6.768) +  
     0.999 \* 1.000 \* 7.357) + = 14.118  
 Qmax(2) =  
     1.001 \* 0.999 \* 6.768) +  
     1.000 \* 1.000 \* 7.357) + = 14.123

Total of 2 streams to confluence:

Flow rates before confluence point:

6.768      7.357

Maximum flow rates at confluence using above data:

14.118      14.123

Area of streams before confluence:  
1.129 1.226  
Effective area values after confluence:  
2.355 2.353  
Results of confluence:  
Total flow rate = 14.123(CFS)  
Time of concentration = 5.584 min.  
Effective stream area after confluence = 2.353(Ac.)  
Study area average Pervious fraction(Ap) = 0.100  
Study area average soil loss rate(Fm) = 0.079(In/Hr)  
Study area total (this main stream) = 2.36(Ac.)

+++++  
Process from Point/Station 2.000 to Point/Station 5.000  
\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation = 55.000(Ft.)  
Downstream point/station elevation = 47.200(Ft.)  
Pipe length = 3.00(Ft.) Manning's N = 0.013  
No. of pipes = 1 Required pipe flow = 14.123(CFS)  
Nearest computed pipe diameter = 9.00(In.)  
Calculated individual pipe flow = 14.123(CFS)  
Normal flow depth in pipe = 4.66(In.)  
Flow top width inside pipe = 8.99(In.)  
Critical depth could not be calculated.  
Pipe flow velocity = 61.24(Ft/s)  
Travel time through pipe = 0.00 min.  
Time of concentration (TC) = 5.58 min.

+++++  
Process from Point/Station 5.000 to Point/Station 6.000  
\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation = 47.200(Ft.)  
Downstream point/station elevation = 44.700(Ft.)  
Pipe length = 90.00(Ft.) Manning's N = 0.013  
No. of pipes = 1 Required pipe flow = 14.123(CFS)  
Nearest computed pipe diameter = 18.00(In.)  
Calculated individual pipe flow = 14.123(CFS)  
Normal flow depth in pipe = 12.26(In.)  
Flow top width inside pipe = 16.78(In.)  
Critical Depth = 16.61(In.)  
Pipe flow velocity = 11.02(Ft/s)  
Travel time through pipe = 0.14 min.  
Time of concentration (TC) = 5.72 min.

+++++  
Process from Point/Station 5.000 to Point/Station 6.000  
\*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
Stream flow area = 2.353(Ac.)  
Runoff from this stream = 14.123(CFS)  
Time of concentration = 5.72 min.  
Rainfall intensity = 6.633(In/Hr)  
Area averaged loss rate (Fm) = 0.0785(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.1000

+++++



Process from Point/Station 7.000 to Point/Station 8.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type

Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Initial subarea data:  
Initial area flow distance = 204.000(Ft.)  
Top (of initial area) elevation = 65.400(Ft.)  
Bottom (of initial area) elevation = 59.000(Ft.)  
Difference in elevation = 6.400(Ft.)  
Slope = 0.03137 s(%)= 3.14  
TC =  $k(0.304)*[(\text{length}^3)/(\text{elevation change})]^{0.2}$   
Initial area time of concentration = 5.098 min.  
Rainfall intensity = 7.190(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.890  
Subarea runoff = 0.192(CFS)  
Total initial stream area = 0.030(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.079(In/Hr)

+++++  
Process from Point/Station 8.000 to Point/Station 9.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 59.000(Ft.)  
Downstream point elevation = 54.000(Ft.)  
Channel length thru subarea = 122.000(Ft.)  
Channel base width = 4.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel = 1.106(CFS)  
Manning's 'N' = 0.015  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 1.106(CFS)  
Depth of flow = 0.063(Ft.), Average velocity = 2.480(Ft/s)  
Channel flow top width = 10.257(Ft.)  
Flow Velocity = 2.48(Ft/s)  
Travel time = 0.82 min.  
Time of concentration = 5.92 min.  
Critical depth = 0.092(Ft.)

Adding area flow to channel

COMMERCIAL subarea type

Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Rainfall intensity = 6.477(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.889  
Subarea runoff = 1.772(CFS) for 0.311(Ac.)  
Total runoff = 1.964(CFS)  
Effective area this stream = 0.34(Ac.)  
Total Study Area (Main Stream No. 1) = 2.70(Ac.)

Area averaged Fm value = 0.079(In/Hr)  
Depth of flow = 0.083(Ft.), Average velocity = 2.901(Ft/s)  
Critical depth = 0.123(Ft.)

+++++  
Process from Point/Station 9.000 to Point/Station 10.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 54.000(Ft.)  
Downstream point elevation = 51.400(Ft.)  
Channel length thru subarea = 56.000(Ft.)  
Channel base width = 4.000(Ft.)  
Slope or 'Z' of left channel bank = 20.000  
Slope or 'Z' of right channel bank = 20.000  
Estimated mean flow rate at midpoint of channel = 2.275(CFS)  
Manning's 'N' = 0.015  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 2.275(CFS)  
Depth of flow = 0.100(Ft.), Average velocity = 3.794(Ft/s)  
Channel flow top width = 7.998(Ft.)  
Flow Velocity = 3.79(Ft/s)  
Travel time = 0.25 min.  
Time of concentration = 6.16 min.  
Critical depth = 0.164(Ft.)  
Adding area flow to channel  
COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Rainfall intensity = 6.295(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.889  
Subarea runoff = 0.548(CFS) for 0.108(Ac.)  
Total runoff = 2.512(CFS)  
Effective area this stream = 0.45(Ac.)  
Total Study Area (Main Stream No. 1) = 2.80(Ac.)  
Area averaged Fm value = 0.079(In/Hr)  
Depth of flow = 0.105(Ft.), Average velocity = 3.906(Ft/s)  
Critical depth = 0.173(Ft.)

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

---

Along Main Stream number: 1 in normal stream number 2  
Stream flow area = 0.449(Ac.)  
Runoff from this stream = 2.512(CFS)  
Time of concentration = 6.16 min.  
Rainfall intensity = 6.295(In/Hr)  
Area averaged loss rate (Fm) = 0.0785(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.1000  
Summary of stream data:

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

1	14.12	2.353	5.72	0.079	6.633
2	2.51	0.449	6.16	0.079	6.295

Qmax(1) =

1.000 *	1.000 *	14.123) +	
1.054 *	0.928 *	2.512) + =	16.581

Qmax(2) =

0.948 *	1.000 *	14.123) +	
1.000 *	1.000 *	2.512) + =	15.907

Total of 2 streams to confluence:  
Flow rates before confluence point:  
14.123      2.512  
Maximum flow rates at confluence using above data:  
16.581      15.907  
Area of streams before confluence:  
2.353      0.449  
Effective area values after confluence:  
2.770      2.802  
Results of confluence:  
Total flow rate = 16.581(CFS)  
Time of concentration = 5.721 min.  
Effective stream area after confluence = 2.770(Ac.)  
Study area average Pervious fraction(Ap) = 0.100  
Study area average soil loss rate(Fm) = 0.079(In/Hr)  
Study area total (this main stream) = 2.80(Ac.)

\*\*\*\*\*  
Process from Point/Station 10.000 to Point/Station 6.000  
\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation = 51.400(Ft.)  
Downstream point/station elevation = 44.700(Ft.)  
Pipe length = 3.00(Ft.) Manning's N = 0.013  
No. of pipes = 1 Required pipe flow = 16.581(CFS)  
Nearest computed pipe diameter = 9.00(In.)  
Calculated individual pipe flow = 16.581(CFS)  
Normal flow depth in pipe = 5.39(In.)  
Flow top width inside pipe = 8.82(In.)  
Critical depth could not be calculated.  
Pipe flow velocity = 59.98(Ft/s)  
Travel time through pipe = 0.00 min.  
Time of concentration (TC) = 5.72 min.

\*\*\*\*\*  
Process from Point/Station 6.000 to Point/Station 11.000  
\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation = 44.700(Ft.)  
Downstream point/station elevation = 42.300(Ft.)  
Pipe length = 246.00(Ft.) Manning's N = 0.013  
No. of pipes = 1 Required pipe flow = 16.581(CFS)  
Nearest computed pipe diameter = 24.00(In.)  
Calculated individual pipe flow = 16.581(CFS)  
Normal flow depth in pipe = 15.40(In.)  
Flow top width inside pipe = 23.02(In.)  
Critical Depth = 17.61(In.)  
Pipe flow velocity = 7.79(Ft/s)  
Travel time through pipe = 0.53 min.  
Time of concentration (TC) = 6.25 min.

+++++  
Process from Point/Station        6.000 to Point/Station        11.000  
\*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
Stream flow area =        2.770(Ac.)  
Runoff from this stream =        16.581(CFS)  
Time of concentration =        6.25 min.  
Rainfall intensity =        6.236(In/Hr)  
Area averaged loss rate (Fm) =        0.0785(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.1000

+++++  
Process from Point/Station        12.000 to Point/Station        13.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000        Max loss rate(Fm)=        0.079(In/Hr)  
Initial subarea data:  
Initial area flow distance =    170.000(Ft.)  
Top (of initial area) elevation =    59.500(Ft.)  
Bottom (of initial area) elevation =    56.950(Ft.)  
Difference in elevation =        2.550(Ft.)  
Slope =        0.01500    s(%)=        1.50  
TC =  $k(0.304)*[(\text{length}^3)/(\text{elevation change})]^{0.2}$   
Initial area time of concentration =    5.493 min.  
Rainfall intensity =        6.824(In/Hr) for a    100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.890  
Subarea runoff =        1.542(CFS)  
Total initial stream area =        0.254(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value =        0.079(In/Hr)

+++++  
Process from Point/Station        13.000 to Point/Station        14.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =    56.950(Ft.)  
Downstream point elevation =    50.300(Ft.)  
Channel length thru subarea =    188.000(Ft.)  
Channel base width =        4.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel =        4.131(CFS)  
Manning's 'N' = 0.015  
Maximum depth of channel =        1.000(Ft.)  
Flow(q) thru subarea =        4.131(CFS)  
Depth of flow =        0.122(Ft.), Average velocity =    3.347(Ft/s)  
Channel flow top width =    16.214(Ft.)  
Flow Velocity =        3.35(Ft/s)  
Travel time =        0.94 min.  
Time of concentration =        6.43 min.  
Critical depth =        0.176(Ft.)  
Adding area flow to channel  
COMMERCIAL subarea type

Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)=      0.079(In/Hr)  
Rainfall intensity =      6.112(In/Hr) for a      100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.888  
Subarea runoff =      5.126(CFS) for      0.974(Ac.)  
Total runoff =      6.668(CFS)  
Effective area this stream =      1.23(Ac.)  
Total Study Area (Main Stream No. 1) =      4.03(Ac.)  
Area averaged Fm value =      0.079(In/Hr)  
Depth of flow =      0.152(Ft.), Average velocity =      3.789(Ft/s)  
Critical depth =      0.221(Ft.)

+++++  
Process from Point/Station      14.000 to Point/Station      11.000  
\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation =      50.300(Ft.)  
Downstream point/station elevation =      42.300(Ft.)  
Pipe length =      35.00(Ft.)      Manning's N = 0.013  
No. of pipes = 1      Required pipe flow =      6.668(CFS)  
Nearest computed pipe diameter =      9.00(In.)  
Calculated individual pipe flow =      6.668(CFS)  
Normal flow depth in pipe =      6.33(In.)  
Flow top width inside pipe =      8.22(In.)  
Critical depth could not be calculated.  
Pipe flow velocity =      20.07(Ft/s)  
Travel time through pipe =      0.03 min.  
Time of concentration (TC) =      6.46 min.

+++++  
Process from Point/Station      14.000 to Point/Station      11.000  
\*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 2  
Stream flow area =      1.228(Ac.)  
Runoff from this stream =      6.668(CFS)  
Time of concentration =      6.46 min.  
Rainfall intensity =      6.093(In/Hr)  
Area averaged loss rate (Fm) =      0.0785(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.1000

+++++  
Process from Point/Station      15.000 to Point/Station      16.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)=      0.079(In/Hr)  
Initial subarea data:

Initial area flow distance = 75.000(Ft.)  
Top (of initial area) elevation = 61.000(Ft.)  
Bottom (of initial area) elevation = 58.100(Ft.)  
Difference in elevation = 2.900(Ft.)  
Slope = 0.03867 s(%)= 3.87  
TC =  $k(0.304)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 3.277 min.  
Rainfall intensity = 9.797(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.893  
Subarea runoff = 1.155(CFS)  
Total initial stream area = 0.132(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.079(In/Hr)

+++++  
Process from Point/Station 16.000 to Point/Station 17.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 58.100(Ft.)  
Downstream point elevation = 56.400(Ft.)  
Channel length thru subarea = 250.000(Ft.)  
Channel base width = 4.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel = 2.827(CFS)  
Manning's 'N' = 0.015  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 2.827(CFS)  
Depth of flow = 0.150(Ft.), Average velocity = 1.647(Ft/s)  
Channel flow top width = 18.954(Ft.)  
Flow Velocity = 1.65(Ft/s)  
Travel time = 2.53 min.  
Time of concentration = 5.81 min.  
Critical depth = 0.146(Ft.)  
Adding area flow to channel  
COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Rainfall intensity = 6.564(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.889  
Subarea runoff = 3.258(CFS) for 0.624(Ac.)  
Total runoff = 4.413(CFS)  
Effective area this stream = 0.76(Ac.)  
Total Study Area (Main Stream No. 1) = 4.79(Ac.)  
Area averaged Fm value = 0.079(In/Hr)  
Depth of flow = 0.182(Ft.), Average velocity = 1.847(Ft/s)  
Critical depth = 0.182(Ft.)

+++++  
Process from Point/Station 17.000 to Point/Station 18.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 56.400(Ft.)  
Downstream point elevation = 51.900(Ft.)  
Channel length thru subarea = 232.000(Ft.)

Channel base width = 4.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 5.386(CFS)  
 Manning's 'N' = 0.015  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 5.386(CFS)  
 Depth of flow = 0.158(Ft.), Average velocity = 2.870(Ft/s)  
 Channel flow top width = 19.783(Ft.)  
 Flow Velocity = 2.87(Ft/s)  
 Travel time = 1.35 min.  
 Time of concentration = 7.15 min.  
 Critical depth = 0.199(Ft.)  
 Adding area flow to channel  
 COMMERCIAL subarea type  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
 Rainfall intensity = 5.672(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.888  
 Subarea runoff = 1.880(CFS) for 0.494(Ac.)  
 Total runoff = 6.293(CFS)  
 Effective area this stream = 1.25(Ac.)  
 Total Study Area (Main Stream No. 1) = 5.28(Ac.)  
 Area averaged Fm value = 0.079(In/Hr)  
 Depth of flow = 0.169(Ft.), Average velocity = 2.987(Ft/s)  
 Critical depth = 0.215(Ft.)

++++++  
 Process from Point/Station 18.000 to Point/Station 11.000  
 \*\*\*\* STREET FLOW TRAVEL TIME + SUBAREA FLOW ADDITION \*\*\*\*

---

Top of street segment elevation = 51.900(Ft.)  
 End of street segment elevation = 50.700(Ft.)  
 Length of street segment = 134.000(Ft.)  
 Height of curb above gutter flowline = 6.0(In.)  
 Width of half street (curb to crown) = 20.000(Ft.)  
 Distance from crown to crossfall grade break = 18.000(Ft.)  
 Slope from gutter to grade break (v/hz) = 0.020  
 Slope from grade break to crown (v/hz) = 0.020  
 Street flow is on [2] side(s) of the street  
 Distance from curb to property line = 10.000(Ft.)  
 Slope from curb to property line (v/hz) = 0.020  
 Gutter width = 2.000(Ft.)  
 Gutter hike from flowline = 2.000(In.)  
 Manning's N in gutter = 0.0150  
 Manning's N from gutter to grade break = 0.0150  
 Manning's N from grade break to crown = 0.0150  
 Estimated mean flow rate at midpoint of street = 6.356(CFS)  
 Depth of flow = 0.352(Ft.), Average velocity = 2.280(Ft/s)  
 Streetflow hydraulics at midpoint of street travel:  
 Halfstreet flow width = 11.256(Ft.)  
 Flow velocity = 2.28(Ft/s)  
 Travel time = 0.98 min. TC = 8.13 min.  
 Adding area flow to street  
 COMMERCIAL subarea type  
 Decimal fraction soil group A = 1.000

Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)=      0.079(In/Hr)  
 The area added to the existing stream causes a  
 a lower flow rate of Q =      6.204(CFS)  
 therefore the upstream flow rate of Q =      6.293(CFS) is being used  
 Rainfall intensity =      5.185(In/Hr) for a      100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.886  
 Subarea runoff =      0.000(CFS) for      0.100 (Ac.)  
 Total runoff =      6.293(CFS)  
 Effective area this stream =      1.35 (Ac.)  
 Total Study Area (Main Stream No. 1) =      5.38 (Ac.)  
 Area averaged Fm value =      0.079(In/Hr)  
 Street flow at end of street =      6.293(CFS)  
 Half street flow at end of street =      3.146(CFS)  
 Depth of flow =      0.351(Ft.), Average velocity =      2.275 (Ft/s)  
 Flow width (from curb towards crown)=      11.208(Ft.)

\*\*\*\*\*  
 Process from Point/Station      18.000 to Point/Station      11.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 3  
 Stream flow area =      1.350 (Ac.)  
 Runoff from this stream =      6.293(CFS)  
 Time of concentration =      8.13 min.  
 Rainfall intensity =      5.185(In/Hr)  
 Area averaged loss rate (Fm) =      0.0785(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.1000

\*\*\*\*\*  
 Process from Point/Station      19.000 to Point/Station      20.000  
 \*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)=      0.079(In/Hr)  
 Initial subarea data:  
 Initial area flow distance =      344.000(Ft.)  
 Top (of initial area) elevation =      51.800(Ft.)  
 Bottom (of initial area) elevation =      49.400(Ft.)  
 Difference in elevation =      2.400(Ft.)  
 Slope =      0.00698      s(%)=      0.70  
 $TC = k(0.304) * [(length^3) / (elevation\ change)]^{0.2}$   
 Initial area time of concentration =      8.487 min.  
 Rainfall intensity =      5.032(In/Hr) for a      100.0 year storm  
 Effective runoff coefficient used for area (Q=KCIA) is C = 0.886  
 Subarea runoff =      1.721(CFS)  
 Total initial stream area =      0.386(Ac.)  
 Pervious area fraction = 0.100  
 Initial area Fm value =      0.079(In/Hr)



+++++  
 Process from Point/Station 19.000 to Point/Station 20.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

Along Main Stream number: 1 in normal stream number 4  
 Stream flow area = 0.386(Ac.)  
 Runoff from this stream = 1.721(CFS)  
 Time of concentration = 8.49 min.  
 Rainfall intensity = 5.032(In/Hr)  
 Area averaged loss rate (Fm) = 0.0785(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.1000  
 Summary of stream data:

Stream No.	Flow rate (CFS)	Area (Ac.)	TC (min)	Fm (In/Hr)	Rainfall Intensity (In/Hr)
1	16.58	2.770	6.25	0.079	6.236
2	6.67	1.228	6.46	0.079	6.093
3	6.29	1.350	8.13	0.079	5.185
4	1.72	0.386	8.49	0.079	5.032

Qmax(1) =  
 1.000 \* 1.000 \* 16.581) +  
 1.024 \* 0.967 \* 6.668) +  
 1.206 \* 0.768 \* 6.293) +  
 1.243 \* 0.736 \* 1.721) + = 30.589

Qmax(2) =  
 0.977 \* 1.000 \* 16.581) +  
 1.000 \* 1.000 \* 6.668) +  
 1.178 \* 0.794 \* 6.293) +  
 1.214 \* 0.761 \* 1.721) + = 30.339

Qmax(3) =  
 0.829 \* 1.000 \* 16.581) +  
 0.849 \* 1.000 \* 6.668) +  
 1.000 \* 1.000 \* 6.293) +  
 1.031 \* 0.958 \* 1.721) + = 27.404

Qmax(4) =  
 0.805 \* 1.000 \* 16.581) +  
 0.824 \* 1.000 \* 6.668) +  
 0.970 \* 1.000 \* 6.293) +  
 1.000 \* 1.000 \* 1.721) + = 26.659

Total of 4 streams to confluence:  
 Flow rates before confluence point:  
 16.581 6.668 6.293 1.721  
 Maximum flow rates at confluence using above data:  
 30.589 30.339 27.404 26.659  
 Area of streams before confluence:  
 2.770 1.228 1.350 0.386  
 Effective area values after confluence:  
 5.279 5.364 5.718 5.734  
 Results of confluence:  
 Total flow rate = 30.589(CFS)  
 Time of concentration = 6.248 min.  
 Effective stream area after confluence = 5.279(Ac.)  
 Study area average Pervious fraction(Ap) = 0.100  
 Study area average soil loss rate(Fm) = 0.079(In/Hr)  
 Study area total (this main stream) = 5.73(Ac.)

+++++  
 Process from Point/Station 14.000 to Point/Station 21.000

\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation = 42.300(Ft.)  
Downstream point/station elevation = 38.500(Ft.)  
Pipe length = 226.00(Ft.) Manning's N = 0.013  
No. of pipes = 1 Required pipe flow = 30.589(CFS)  
Nearest computed pipe diameter = 27.00(In.)  
Calculated individual pipe flow = 30.589(CFS)  
Normal flow depth in pipe = 17.63(In.)  
Flow top width inside pipe = 25.71(In.)  
Critical Depth = 22.95(In.)  
Pipe flow velocity = 11.12(Ft/s)  
Travel time through pipe = 0.34 min.  
Time of concentration (TC) = 6.59 min.

+++++  
Process from Point/Station 14.000 to Point/Station 21.000  
\*\*\*\* SUBAREA FLOW ADDITION \*\*\*\*

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Time of concentration = 6.59 min.  
Rainfall intensity = 6.010(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area,(total area with modified  
rational method) (Q=KCIA) is C = 0.888  
Subarea runoff = 1.120(CFS) for 0.661(Ac.)  
Total runoff = 31.709(CFS)  
Effective area this stream = 5.94(Ac.)  
Total Study Area (Main Stream No. 1) = 6.43(Ac.)  
Area averaged Fm value = 0.079(In/Hr)

+++++  
Process from Point/Station 21.000 to Point/Station 22.000  
\*\*\*\* PIPEFLOW TRAVEL TIME (Program estimated size) \*\*\*\*

---

Upstream point/station elevation = 38.500(Ft.)  
Downstream point/station elevation = 34.000(Ft.)  
Pipe length = 110.00(Ft.) Manning's N = 0.013  
No. of pipes = 1 Required pipe flow = 31.709(CFS)  
Nearest computed pipe diameter = 21.00(In.)  
Calculated individual pipe flow = 31.709(CFS)  
Normal flow depth in pipe = 17.02(In.)  
Flow top width inside pipe = 16.47(In.)  
Critical depth could not be calculated.  
Pipe flow velocity = 15.19(Ft/s)  
Travel time through pipe = 0.12 min.  
Time of concentration (TC) = 6.71 min.

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

---

The following data inside Main Stream is listed:  
In Main Stream number: 1

Stream flow area = 5.940(Ac.)  
Runoff from this stream = 31.709(CFS)  
Time of concentration = 6.71 min.  
Rainfall intensity = 5.934(In/Hr)  
Area averaged loss rate (Fm) = 0.0785(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.1000  
Program is now starting with Main Stream No. 2

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

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.1000 Max loss rate(Fm)= 0.079(In/Hr)  
Initial subarea data:  
Initial area flow distance = 102.400(Ft.)  
Top (of initial area) elevation = 71.000(Ft.)  
Bottom (of initial area) elevation = 65.400(Ft.)  
Difference in elevation = 5.600(Ft.)  
Slope = 0.05469 s(%)= 5.47  
TC =  $k(0.304)*[(length^3)/(elevation\ change)]^{0.2}$   
Initial area time of concentration = 3.463 min.  
Rainfall intensity = 9.426(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.893  
Subarea runoff = 2.667(CFS)  
Total initial stream area = 0.317(Ac.)  
Pervious area fraction = 0.100  
Initial area Fm value = 0.079(In/Hr)

\*\*\*\*\*  
Process from Point/Station 24.000 to Point/Station 25.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 65.400(Ft.)  
Downstream point elevation = 50.000(Ft.)  
Channel length thru subarea = 354.500(Ft.)  
Channel base width = 4.000(Ft.)  
Slope or 'Z' of left channel bank = 1.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel = 6.585(CFS)  
Manning's 'N' = 0.015  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 6.585(CFS)  
Depth of flow = 0.168(Ft.), Average velocity = 4.740(Ft/s)  
Channel flow top width = 12.558(Ft.)  
Flow Velocity = 4.74(Ft/s)  
Travel time = 1.25 min.  
Time of concentration = 4.71 min.  
Critical depth = 0.266(Ft.)  
Adding area flow to channel  
COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000

SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)= 0.079(In/Hr)  
 Rainfall intensity = 7.601(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area,(total area with modified  
 rational method) (Q=KCIA) is C = 0.891  
 Subarea runoff = 7.746(CFS) for 1.221(Ac.)  
 Total runoff = 10.412(CFS)  
 Effective area this stream = 1.54(Ac.)  
 Total Study Area (Main Stream No. 2) = 7.97(Ac.)  
 Area averaged Fm value = 0.079(In/Hr)  
 Depth of flow = 0.209(Ft.), Average velocity = 5.354(Ft/s)  
 Critical depth = 0.332(Ft.)

++++++  
 Process from Point/Station 25.000 to Point/Station 26.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 50.000(Ft.)  
 Downstream point elevation = 41.000(Ft.)  
 Channel length thru subarea = 143.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 10.000  
 Slope or 'Z' of right channel bank = 10.000  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 10.412(CFS)  
 Depth of flow = 0.227(Ft.), Average velocity = 3.746(Ft/s)  
 Channel flow top width = 14.532(Ft.)  
 Flow Velocity = 3.75(Ft/s)  
 Travel time = 0.64 min.  
 Time of concentration = 5.35 min.  
 Critical depth = 0.293(Ft.)

++++++  
 Process from Point/Station 26.000 to Point/Station 27.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 41.000(Ft.)  
 Downstream point elevation = 40.000(Ft.)  
 Channel length thru subarea = 214.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 5.000  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 10.412(CFS)  
 Depth of flow = 0.397(Ft.), Average velocity = 1.255(Ft/s)  
 Channel flow top width = 31.821(Ft.)  
 Flow Velocity = 1.26(Ft/s)  
 Travel time = 2.84 min.  
 Time of concentration = 8.19 min.  
 Critical depth = 0.254(Ft.)

++++++  
 Process from Point/Station 26.000 to Point/Station 27.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 2 in normal stream number 1  
 Stream flow area = 1.538(Ac.)

Runoff from this stream = 10.412(CFS)  
Time of concentration = 8.19 min.  
Rainfall intensity = 5.161(In/Hr)  
Area averaged loss rate (Fm) = 0.0785(In/Hr)  
Area averaged Pervious ratio (Ap) = 0.1000

+++++  
Process from Point/Station 24.000 to Point/Station 28.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

PARK subarea  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.8500 Max loss rate(Fm)= 0.667(In/Hr)  
Initial subarea data:  
Initial area flow distance = 162.000(Ft.)  
Top (of initial area) elevation = 65.400(Ft.)  
Bottom (of initial area) elevation = 49.000(Ft.)  
Difference in elevation = 16.400(Ft.)  
Slope = 0.10123 s(%)= 10.12  
TC =  $k(0.483)*[(\text{length}^3)/(\text{elevation change})]^{0.2}$   
Initial area time of concentration = 5.844 min.  
Rainfall intensity = 6.535(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area (Q=KCIA) is C = 0.808  
Subarea runoff = 1.758(CFS)  
Total initial stream area = 0.333(Ac.)  
Pervious area fraction = 0.850  
Initial area Fm value = 0.667(In/Hr)

+++++  
Process from Point/Station 28.000 to Point/Station 27.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 49.000(Ft.)  
Downstream point elevation = 40.000(Ft.)  
Channel length thru subarea = 95.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel = 3.269(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 3.269(CFS)  
Depth of flow = 0.094(Ft.), Average velocity = 2.377(Ft/s)  
Channel flow top width = 19.368(Ft.)  
Flow Velocity = 2.38(Ft/s)  
Travel time = 0.67 min.  
Time of concentration = 6.51 min.  
Critical depth = 0.121(Ft.)  
Adding area flow to channel  
PARK subarea  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00

Pervious ratio(Ap) = 0.8500      Max loss rate(Fm)=      0.667(In/Hr)  
 Rainfall intensity =      6.059(In/Hr) for a      100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.801  
 Subarea runoff =      2.968(CFS) for      0.641(Ac.)  
 Total runoff =      4.726(CFS)  
 Effective area this stream =      0.97(Ac.)  
 Total Study Area (Main Stream No. 2) =      8.94(Ac.)  
 Area averaged Fm value =      0.667(In/Hr)  
 Depth of flow =      0.114(Ft.), Average velocity =      2.648(Ft/s)  
 Critical depth =      0.148(Ft.)

++++++  
 Process from Point/Station      28.000 to Point/Station      27.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 2 in normal stream number 2

Stream flow area =      0.974(Ac.)  
 Runoff from this stream =      4.726(CFS)  
 Time of concentration =      6.51 min.  
 Rainfall intensity =      6.059(In/Hr)  
 Area averaged loss rate (Fm) =      0.6674(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.8500  
 Summary of stream data:

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

1	10.41	1.538	8.19	0.079	5.161
2	4.73	0.974	6.51	0.667	6.059

Qmax(1) =  
     1.000 \*      1.000 \*      10.412) +  
     0.833 \*      1.000 \*      4.726) + =      14.351  
 Qmax(2) =  
     1.177 \*      0.795 \*      10.412) +  
     1.000 \*      1.000 \*      4.726) + =      14.469

Total of 2 streams to confluence:  
 Flow rates before confluence point:  
     10.412      4.726  
 Maximum flow rates at confluence using above data:  
     14.351      14.469  
 Area of streams before confluence:  
     1.538      0.974  
 Effective area values after confluence:  
     2.512      2.197  
 Results of confluence:  
 Total flow rate =      14.469(CFS)  
 Time of concentration =      6.510 min.  
 Effective stream area after confluence =      2.197(Ac.)  
 Study area average Pervious fraction(Ap) =      0.391  
 Study area average soil loss rate(Fm) =      0.307(In/Hr)  
 Study area total (this main stream) =      2.51(Ac.)

++++++  
 Process from Point/Station      27.000 to Point/Station      29.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =      40.000(Ft.)  
 Downstream point elevation =      34.000(Ft.)

Channel length thru subarea = 106.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 10.000  
 Slope or 'Z' of right channel bank = 10.000  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 14.469(CFS)  
 Depth of flow = 0.281(Ft.), Average velocity = 4.021(Ft/s)  
 Channel flow top width = 15.618(Ft.)  
 Flow Velocity = 4.02(Ft/s)  
 Travel time = 0.44 min.  
 Time of concentration = 6.95 min.  
 Critical depth = 0.355(Ft.)

++++++  
 Process from Point/Station 29.000 to Point/Station 22.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 34.000(Ft.)  
 Downstream point elevation = 33.000(Ft.)  
 Channel length thru subarea = 130.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 10.000  
 Slope or 'Z' of right channel bank = 10.000  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 14.469(CFS)  
 Depth of flow = 0.484(Ft.), Average velocity = 2.014(Ft/s)  
 Channel flow top width = 19.682(Ft.)  
 Flow Velocity = 2.01(Ft/s)  
 Travel time = 1.08 min.  
 Time of concentration = 8.03 min.  
 Critical depth = 0.355(Ft.)

++++++  
 Process from Point/Station 29.000 to Point/Station 22.000  
 \*\*\*\* CONFLUENCE OF MAIN STREAMS \*\*\*\*

---

The following data inside Main Stream is listed:

In Main Stream number: 2  
 Stream flow area = 2.197(Ac.)  
 Runoff from this stream = 14.469(CFS)  
 Time of concentration = 8.03 min.  
 Rainfall intensity = 5.234(In/Hr)  
 Area averaged loss rate (Fm) = 0.3068(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.3908  
 Summary of stream data:

Stream No.	Flow rate (CFS)	Area (Ac.)	TC (min)	Fm (In/Hr)	Rainfall Intensity (In/Hr)
1	31.71	5.940	6.71	0.079	5.934
2	14.47	2.197	8.03	0.307	5.234
Qmax(1) =					
	1.000 *	1.000 *	31.709)	+	
	1.142 *	0.836 *	14.469)	+	45.521
Qmax(2) =					
	0.880 *	1.000 *	31.709)	+	
	1.000 *	1.000 *	14.469)	+	42.387

Total of 2 main streams to confluence:  
 Flow rates before confluence point:  
     32.709          15.469  
 Maximum flow rates at confluence using above data:  
     45.521          42.387  
 Area of streams before confluence:  
     5.940          2.197  
 Effective area values after confluence:  
     7.777          8.137

Results of confluence:  
 Total flow rate = 45.521(CFS)  
 Time of concentration = 6.708 min.  
 Effective stream area after confluence = 7.777(Ac.)  
 Study area average Pervious fraction(Ap) = 0.179  
 Study area average soil loss rate(Fm) = 0.140(In/Hr)  
 Study area total = 8.14(Ac.)

+++++  
 Process from Point/Station 22.000 to Point/Station 30.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 33.000(Ft.)  
 Downstream point elevation = 32.000(Ft.)  
 Channel length thru subarea = 172.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 50.000  
 Slope or 'Z' of right channel bank = 50.000  
 Estimated mean flow rate at midpoint of channel = 45.553(CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 45.553(CFS)  
 Depth of flow = 0.632(Ft.), Average velocity = 1.734(Ft/s)  
 Channel flow top width = 73.168(Ft.)  
 Flow Velocity = 1.73(Ft/s)  
 Travel time = 1.65 min.  
 Time of concentration = 8.36 min.  
 Critical depth = 0.465(Ft.)  
 Adding area flow to channel  
 PARK subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.8500      Max loss rate(Fm)= 0.667(In/Hr)  
 The area added to the existing stream causes a  
 a lower flow rate of Q = 40.172(CFS)  
 therefore the upstream flow rate of Q = 45.521(CFS) is being used  
 Rainfall intensity = 5.086(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.861  
 Subarea runoff = 0.000(CFS) for 1.398(Ac.)  
 Total runoff = 45.521(CFS)  
 Effective area this stream = 9.17(Ac.)  
 Total Study Area (Main Stream No. 1) = 10.34(Ac.)  
 Area averaged Fm value = 0.220(In/Hr)  
 Depth of flow = 0.631(Ft.), Average velocity = 1.734(Ft/s)  
 Critical depth = 0.465(Ft.)



+++++  
Process from Point/Station        30.000 to Point/Station        31.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =    32.000 (Ft.)  
Downstream point elevation =    27.000 (Ft.)  
Channel length thru subarea =    60.000 (Ft.)  
Channel base width =    10.000 (Ft.)  
Slope or 'Z' of left channel bank =    10.000  
Slope or 'Z' of right channel bank =    10.000  
Manning's 'N'        = 0.033  
Maximum depth of channel    =    1.000 (Ft.)  
Flow(q) thru subarea =        45.521 (CFS)  
Depth of flow =    0.473 (Ft.), Average velocity =    6.541 (Ft/s)  
Channel flow top width =    19.452 (Ft.)  
Flow Velocity =    6.54 (Ft/s)  
Travel time        =    0.15 min.  
Time of concentration =    8.51 min.  
Critical depth =        0.684 (Ft.)

+++++  
Process from Point/Station        31.000 to Point/Station        35.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =    27.000 (Ft.)  
Downstream point elevation =    26.000 (Ft.)  
Channel length thru subarea =    194.000 (Ft.)  
Channel base width =    10.000 (Ft.)  
Slope or 'Z' of left channel bank =    50.000  
Slope or 'Z' of right channel bank =    50.000  
Manning's 'N'        = 0.033  
Maximum depth of channel    =    1.000 (Ft.)  
Flow(q) thru subarea =        45.521 (CFS)  
Depth of flow =    0.648 (Ft.), Average velocity =    1.658 (Ft/s)  
Channel flow top width =    74.780 (Ft.)  
Flow Velocity =    1.66 (Ft/s)  
Travel time        =    1.95 min.  
Time of concentration =    10.46 min.  
Critical depth =        0.465 (Ft.)

+++++  
Process from Point/Station        31.000 to Point/Station        35.000  
\*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
Stream flow area =    9.175 (Ac.)  
Runoff from this stream =    45.521 (CFS)  
Time of concentration =    10.46 min.  
Rainfall intensity =    4.346 (In/Hr)  
Area averaged loss rate (Fm) =    0.2205 (In/Hr)  
Area averaged Pervious ratio (Ap) = 0.2808

+++++  
Process from Point/Station        32.000 to Point/Station        33.000  
\*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

COMMERCIAL subarea type  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000

Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.1000      Max loss rate(Fm)=      0.079(In/Hr)  
 Initial subarea data:  
 Initial area flow distance =    422.000(Ft.)  
 Top (of initial area) elevation =    40.000(Ft.)  
 Bottom (of initial area) elevation =    34.000(Ft.)  
 Difference in elevation =      6.000(Ft.)  
 Slope =      0.01422    s(%)=      1.42  
 $TC = k(0.304)*[(length^3)/(elevation\ change)]^{0.2}$   
 Initial area time of concentration =    7.988 min.  
 Rainfall intensity =      5.251(In/Hr) for a    100.0 year storm  
 Effective runoff coefficient used for area (Q=KCIA) is C = 0.887  
 Subarea runoff =      2.630(CFS)  
 Total initial stream area =      0.565(Ac.)  
 Pervious area fraction = 0.100  
 Initial area Fm value =      0.079(In/Hr)

++++++  
 Process from Point/Station      33.000 to Point/Station      34.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =    34.000(Ft.)  
 Downstream point elevation =    28.000(Ft.)  
 Channel length thru subarea =    42.000(Ft.)  
 Channel base width =    10.000(Ft.)  
 Slope or 'Z' of left channel bank =    10.000  
 Slope or 'Z' of right channel bank =    10.000  
 Manning's 'N' = 0.033  
 Maximum depth of channel =    1.000(Ft.)  
 Flow(q) thru subarea =      2.630(CFS)  
 Depth of flow =    0.081(Ft.), Average velocity =    3.023(Ft/s)  
 Channel flow top width =    11.610(Ft.)  
 Flow Velocity =    3.02(Ft/s)  
 Travel time =    0.23 min.  
 Time of concentration =    8.22 min.  
 Critical depth =    0.123(Ft.)

++++++  
 Process from Point/Station      34.000 to Point/Station      35.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation =    28.000(Ft.)  
 Downstream point elevation =    26.000(Ft.)  
 Channel length thru subarea =    172.000(Ft.)  
 Channel base width =    10.000(Ft.)  
 Slope or 'Z' of left channel bank =    50.000  
 Slope or 'Z' of right channel bank =    50.000  
 Estimated mean flow rate at midpoint of channel =      4.688(CFS)  
 Manning's 'N' = 0.033  
 Maximum depth of channel =    1.000(Ft.)  
 Flow(q) thru subarea =      4.688(CFS)  
 Depth of flow =    0.193(Ft.), Average velocity =    1.241(Ft/s)  
 Channel flow top width =    29.252(Ft.)  
 Flow Velocity =    1.24(Ft/s)  
 Travel time =    2.31 min.  
 Time of concentration =    10.53 min.  
 Critical depth =    0.148(Ft.)  
 Adding area flow to channel

PARK subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.8500      Max loss rate(Fm)=      0.667(In/Hr)  
 Rainfall intensity =      4.327(In/Hr) for a      100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.797  
 Subarea runoff =      4.033(CFS) for      1.367(Ac.)  
 Total runoff =      6.663(CFS)  
 Effective area this stream =      1.93(Ac.)  
 Total Study Area (Main Stream No. 1) =      12.27(Ac.)  
 Area averaged Fm value =      0.495(In/Hr)  
 Depth of flow =      0.228(Ft.), Average velocity =      1.364(Ft/s)  
 Critical depth =      0.178(Ft.)

+++++  
 Process from Point/Station      34.000 to Point/Station      35.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 2  
 Stream flow area =      1.932(Ac.)  
 Runoff from this stream =      6.663(CFS)  
 Time of concentration =      10.53 min.  
 Rainfall intensity =      4.327(In/Hr)  
 Area averaged loss rate (Fm) =      0.4952(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.6307  
 Summary of stream data:

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

1	45.52	9.175	10.46	0.220	4.346
2	6.66	1.932	10.53	0.495	4.327

Qmax(1) =  
           1.000 \*      1.000 \*      45.521) +  
           1.005 \*      0.994 \*      6.663) + =      52.175  
 Qmax(2) =  
           0.995 \*      1.000 \*      45.521) +  
           1.000 \*      1.000 \*      6.663) + =      51.974

Total of 2 streams to confluence:  
 Flow rates before confluence point:  
           45.521      6.663  
 Maximum flow rates at confluence using above data:  
           52.175      51.974  
 Area of streams before confluence:  
           9.175      1.932  
 Effective area values after confluence:  
           11.094      11.107  
 Results of confluence:  
 Total flow rate =      52.175(CFS)  
 Time of concentration =      10.464 min.  
 Effective stream area after confluence =      11.094(Ac.)  
 Study area average Pervious fraction(Ap) =      0.342  
 Study area average soil loss rate(Fm) =      0.268(In/Hr)  
 Study area total (this main stream) =      11.11(Ac.)

+++++  
Process from Point/Station 35.000 to Point/Station 36.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 26.000(Ft.)  
Downstream point elevation = 22.000(Ft.)  
Channel length thru subarea = 161.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 50.000  
Estimated mean flow rate at midpoint of channel = 52.206(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 52.206(CFS)  
Depth of flow = 0.490(Ft.), Average velocity = 3.085(Ft/s)  
Channel flow top width = 59.026(Ft.)  
Flow Velocity = 3.09(Ft/s)  
Travel time = 0.87 min.  
Time of concentration = 11.33 min.  
Critical depth = 0.492(Ft.)  
Adding area flow to channel  
PARK subarea  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.8500 Max loss rate(Fm)= 0.667(In/Hr)  
The area added to the existing stream causes a  
a lower flow rate of Q = 40.973(CFS)  
therefore the upstream flow rate of Q = 52.175(CFS) is being used  
Rainfall intensity = 4.110(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.835  
Subarea runoff = 0.000(CFS) for 0.843(Ac.)  
Total runoff = 52.175(CFS)  
Effective area this stream = 11.94(Ac.)  
Total Study Area (Main Stream No. 1) = 13.11(Ac.)  
Area averaged Fm value = 0.296(In/Hr)  
Depth of flow = 0.490(Ft.), Average velocity = 3.085(Ft/s)  
Critical depth = 0.492(Ft.)

+++++  
Process from Point/Station 36.000 to Point/Station 37.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 22.000(Ft.)  
Downstream point elevation = 16.000(Ft.)  
Channel length thru subarea = 115.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 10.000  
Slope or 'Z' of right channel bank = 10.000  
Estimated mean flow rate at midpoint of channel = 52.215(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 52.215(CFS)  
Depth of flow = 0.575(Ft.), Average velocity = 5.768(Ft/s)  
Channel flow top width = 21.496(Ft.)  
Flow Velocity = 5.77(Ft/s)  
Travel time = 0.33 min.

Time of concentration = 11.67 min.  
 Critical depth = 0.734(Ft.)  
 Adding area flow to channel  
 PARK subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.8500      Max loss rate(Fm)= 0.667(In/Hr)  
 The area added to the existing stream causes a  
 a lower flow rate of Q = 47.136(CFS)  
 therefore the upstream flow rate of Q = 52.175(CFS) is being used  
 Rainfall intensity = 4.028(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.820  
 Subarea runoff = 0.000(CFS) for 2.330(Ac.)  
 Total runoff = 52.175(CFS)  
 Effective area this stream = 14.27(Ac.)  
 Total Study Area (Main Stream No. 1) = 15.44(Ac.)  
 Area averaged Fm value = 0.357(In/Hr)  
 Depth of flow = 0.575(Ft.), Average velocity = 5.767(Ft/s)  
 Critical depth = 0.734(Ft.)

++++++  
 Process from Point/Station 36.000 to Point/Station 37.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 1  
 Stream flow area = 14.267(Ac.)  
 Runoff from this stream = 52.175(CFS)  
 Time of concentration = 11.67 min.  
 Rainfall intensity = 4.028(In/Hr)  
 Area averaged loss rate (Fm) = 0.3570(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.4547

++++++  
 Process from Point/Station 38.000 to Point/Station 39.000  
 \*\*\*\* INITIAL AREA EVALUATION \*\*\*\*

---

PARK subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.8500      Max loss rate(Fm)= 0.667(In/Hr)  
 Initial subarea data:  
 Initial area flow distance = 320.000(Ft.)  
 Top (of initial area) elevation = 50.000(Ft.)  
 Bottom (of initial area) elevation = 36.000(Ft.)  
 Difference in elevation = 14.000(Ft.)  
 Slope = 0.04375 s(%)= 4.38  
 $TC = k(0.483) * [(length^3) / (elevation\ change)]^{0.2}$   
 Initial area time of concentration = 9.074 min.  
 Rainfall intensity = 4.802(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area (Q=KCIA) is C = 0.775  
 Subarea runoff = 3.487(CFS)  
 Total initial stream area = 0.937(Ac.)

Pervious area fraction = 0.850  
Initial area Fm value = 0.667(In/Hr)

+++++  
Process from Point/Station 39.000 to Point/Station 40.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 36.000(Ft.)  
Downstream point elevation = 25.000(Ft.)  
Channel length thru subarea = 555.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 50.000  
Slope or 'Z' of right channel bank = 20.000  
Estimated mean flow rate at midpoint of channel = 9.938(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 9.938(CFS)  
Depth of flow = 0.261(Ft.), Average velocity = 1.994(Ft/s)  
Channel flow top width = 28.245(Ft.)  
Flow Velocity = 1.99(Ft/s)  
Travel time = 4.64 min.  
Time of concentration = 13.71 min.  
Critical depth = 0.238(Ft.)  
Adding area flow to channel  
PARK subarea  
Decimal fraction soil group A = 1.000  
Decimal fraction soil group B = 0.000  
Decimal fraction soil group C = 0.000  
Decimal fraction soil group D = 0.000  
SCS curve number for soil(AMC 2) = 32.00  
Adjusted SCS curve number for AMC 3 = 52.00  
Pervious ratio(Ap) = 0.8500 Max loss rate(Fm)= 0.667(In/Hr)  
Rainfall intensity = 3.597(In/Hr) for a 100.0 year storm  
Effective runoff coefficient used for area, (total area with modified  
rational method) (Q=KCIA) is C = 0.733  
Subarea runoff = 12.828(CFS) for 5.251(Ac.)  
Total runoff = 16.315(CFS)  
Effective area this stream = 6.19(Ac.)  
Total Study Area (Main Stream No. 1) = 21.63(Ac.)  
Area averaged Fm value = 0.667(In/Hr)  
Depth of flow = 0.331(Ft.), Average velocity = 2.279(Ft/s)  
Critical depth = 0.309(Ft.)

+++++  
Process from Point/Station 40.000 to Point/Station 41.000  
\*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 25.000(Ft.)  
Downstream point elevation = 20.000(Ft.)  
Channel length thru subarea = 168.000(Ft.)  
Channel base width = 10.000(Ft.)  
Slope or 'Z' of left channel bank = 20.000  
Slope or 'Z' of right channel bank = 20.000  
Estimated mean flow rate at midpoint of channel = 18.541(CFS)  
Manning's 'N' = 0.033  
Maximum depth of channel = 1.000(Ft.)  
Flow(q) thru subarea = 18.541(CFS)  
Depth of flow = 0.353(Ft.), Average velocity = 3.079(Ft/s)  
Channel flow top width = 24.120(Ft.)  
Flow Velocity = 3.08(Ft/s)  
Travel time = 0.91 min.

Time of concentration = 14.62 min.  
 Critical depth = 0.371(Ft.)  
 Adding area flow to channel  
 PARK subarea  
 Decimal fraction soil group A = 1.000  
 Decimal fraction soil group B = 0.000  
 Decimal fraction soil group C = 0.000  
 Decimal fraction soil group D = 0.000  
 SCS curve number for soil(AMC 2) = 32.00  
 Adjusted SCS curve number for AMC 3 = 52.00  
 Pervious ratio(Ap) = 0.8500 Max loss rate(Fm)= 0.667(In/Hr)  
 Rainfall intensity = 3.439(In/Hr) for a 100.0 year storm  
 Effective runoff coefficient used for area, (total area with modified  
 rational method) (Q=KCIA) is C = 0.725  
 Subarea runoff = 4.377(CFS) for 2.108(Ac.)  
 Total runoff = 20.692(CFS)  
 Effective area this stream = 8.30(Ac.)  
 Total Study Area (Main Stream No. 1) = 23.74(Ac.)  
 Area averaged Fm value = 0.667(In/Hr)  
 Depth of flow = 0.373(Ft.), Average velocity = 3.175(Ft/s)  
 Critical depth = 0.391(Ft.)

++++++  
 Process from Point/Station 41.000 to Point/Station 37.000  
 \*\*\*\* IMPROVED CHANNEL TRAVEL TIME \*\*\*\*

---

Upstream point elevation = 20.000(Ft.)  
 Downstream point elevation = 16.000(Ft.)  
 Channel length thru subarea = 40.000(Ft.)  
 Channel base width = 10.000(Ft.)  
 Slope or 'Z' of left channel bank = 10.000  
 Slope or 'Z' of right channel bank = 10.000  
 Manning's 'N' = 0.033  
 Maximum depth of channel = 1.000(Ft.)  
 Flow(q) thru subarea = 20.692(CFS)  
 Depth of flow = 0.293(Ft.), Average velocity = 5.471(Ft/s)  
 Channel flow top width = 15.852(Ft.)  
 Flow Velocity = 5.47(Ft/s)  
 Travel time = 0.12 min.  
 Time of concentration = 14.74 min.  
 Critical depth = 0.438(Ft.)

++++++  
 Process from Point/Station 41.000 to Point/Station 37.000  
 \*\*\*\* CONFLUENCE OF MINOR STREAMS \*\*\*\*

---

Along Main Stream number: 1 in normal stream number 2  
 Stream flow area = 8.296(Ac.)  
 Runoff from this stream = 20.692(CFS)  
 Time of concentration = 14.74 min.  
 Rainfall intensity = 3.419(In/Hr)  
 Area averaged loss rate (Fm) = 0.6674(In/Hr)  
 Area averaged Pervious ratio (Ap) = 0.8500  
 Summary of stream data:

Stream No.	Flow rate (CFS)	Area (Ac.)	TC (min)	Fm (In/Hr)	Rainfall Intensity (In/Hr)
1	52.18	14.267	11.67	0.357	4.028
2	20.69	8.296	14.74	0.667	3.419

$Q_{max}(1) =$   
 $1.000 * 1.000 * 52.175) +$   
 $1.221 * 0.791 * 20.692) + = 72.171$   
 $Q_{max}(2) =$   
 $0.834 * 1.000 * 52.175) +$   
 $1.000 * 1.000 * 20.692) + = 64.211$

Total of 2 streams to confluence:

Flow rates before confluence point:

52.175      20.692

Maximum flow rates at confluence using above data:

72.171      64.211

Area of streams before confluence:

14.267      8.296

Effective area values after confluence:

20.831      22.563

Results of confluence:

Total flow rate = 72.171(CFS) = 62.8

Time of concentration = 11.666 min.

Effective stream area after confluence = 20.831(Ac.)

Study area average Pervious fraction( $A_p$ ) = 0.600

Study area average soil loss rate( $F_m$ ) = 0.471(In/Hr)

Study area total (this main stream) = 22.56(Ac.)

End of computations, Total Study Area = 23.74 (Ac.)

The following figures may

be used for a unit hydrograph study of the same area.

Note: These figures do not consider reduced effective area effects caused by confluences in the rational equation.

Area averaged pervious area fraction( $A_p$ ) = 0.580

Area averaged SCS curve number = 32.0

100-yr, 1-hr

100-yr, 24-hr = 68.04 cfs





Unit Hydrograph Analysis

Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2018, Version 9.0

Study date 08/25/22

+++++

San Bernardino County Synthetic Unit Hydrology Method  
Manual date - August 1986

Program License Serial Number 6434

UNIT HYDROGRAPH

100-year 24-hour

AMC III

POST-DEV

2039UD

Storm Event Year = 100

Antecedent Moisture Condition = 3

English (in-lb) Input Units Used

English Rainfall Data (Inches) Input Values Used

English Units used in output format

Area averaged rainfall intensity isohyetal data:

Sub-Area (Ac.)	Duration (hours)	Isohyetal (In)
-------------------	---------------------	-------------------

Rainfall data for year 100

25.40	1	1.28
-------	---	------

Rainfall data for year 100

25.40	6	2.74
-------	---	------

Rainfall data for year 100

25.40	24	5.53
-------	----	------

+++++

\*\*\*\*\* Area-averaged max loss rate, Fm \*\*\*\*\*

SCS curve No. (AMCII)	SCS curve NO. (AMC 3)	Area (Ac.)	Area Fraction	Fp (Fig C6) (In/Hr)	Ap (dec.)	Fm (In/Hr)
32.0	52.0	25.40	1.000	0.785	0.590	0.463

Area-averaged adjusted loss rate Fm (In/Hr) = 0.463

\*\*\*\*\* Area-Averaged low loss rate fraction, Yb \*\*\*\*\*

Area (Ac.)	Area Fract	SCS CN (AMC2)	SCS CN (AMC3)	S	Pervious Yield Fr
14.99	0.590	32.0	52.0	9.23	0.190
10.41	0.410	98.0	98.0	0.20	0.957

Area-averaged catchment yield fraction, Y = 0.504  
 Area-averaged low loss fraction, Yb = 0.496  
 User entry of time of concentration = 0.190 (hours)  
 ++++++  
 Watershed area = 25.40 (Ac.)  
 Catchment Lag time = 0.152 hours  
 Unit interval = 5.000 minutes  
 Unit interval percentage of lag time = 54.7718  
 Hydrograph baseflow = 0.00 (CFS)  
 Average maximum watershed loss rate (Fm) = 0.463 (In/Hr)  
 Average low loss rate fraction (Yb) = 0.496 (decimal)  
 DESERT S-Graph Selected  
 Computed peak 5-minute rainfall = 0.607 (In)  
 Computed peak 30-minute rainfall = 1.040 (In)  
 Specified peak 1-hour rainfall = 1.280 (In)  
 Computed peak 3-hour rainfall = 2.041 (In)  
 Specified peak 6-hour rainfall = 2.740 (In)  
 Specified peak 24-hour rainfall = 5.530 (In)

Rainfall depth area reduction factors:  
 Using a total area of 25.40 (Ac.) (Ref: fig. E-4)

5-minute factor = 0.999	Adjusted rainfall = 0.607 (In)
30-minute factor = 0.999	Adjusted rainfall = 1.038 (In)
1-hour factor = 0.999	Adjusted rainfall = 1.278 (In)
3-hour factor = 1.000	Adjusted rainfall = 2.041 (In)
6-hour factor = 1.000	Adjusted rainfall = 2.740 (In)
24-hour factor = 1.000	Adjusted rainfall = 5.530 (In)

U n i t   H y d r o g r a p h

Interval Number	'S' Graph Mean values	Unit Hydrograph (CFS)
-----		
	(K = 307.18 (CFS))	
1	4.665	14.330
2	35.951	96.104
3	64.493	87.676
4	76.722	37.565
5	83.849	21.894
6	88.649	14.745
7	91.853	9.841
8	94.242	7.338
9	95.994	5.384
10	97.262	3.895
11	98.051	2.422
12	98.659	1.867
13	99.308	1.996
14	99.746	1.346
15	100.000	0.779

Total soil rain loss = 2.44 (In)

Total effective rainfall = 3.09(In)  
Peak flow rate in flood hydrograph = 68.04(CFS)

+++++

24 - H O U R S T O R M  
R u n o f f H y d r o g r a p h

Hydrograph in 5 Minute intervals ((CFS))

Time(h+m)	Volume	Ac.Ft	Q(CFS)	0	17.5	35.0	52.5	70.0
0+ 5	0.0005		0.07 Q					
0+10	0.0042		0.54 Q					
0+15	0.0109		0.97 Q					
0+20	0.0189		1.16 Q					
0+25	0.0277		1.27 Q					
0+30	0.0370		1.35 Q					
0+35	0.0466		1.40 Q					
0+40	0.0565		1.44 Q					
0+45	0.0666		1.47 Q					
0+50	0.0769		1.49 Q					
0+55	0.0873		1.51 Q					
1+ 0	0.0978		1.52 Q					
1+ 5	0.1083		1.54 Q					
1+10	0.1190		1.55 Q					
1+15	0.1297		1.55 Q					
1+20	0.1404		1.56 Q					
1+25	0.1512		1.56 Q					
1+30	0.1620		1.57 Q					
1+35	0.1728		1.57 QV					
1+40	0.1836		1.58 QV					
1+45	0.1945		1.58 QV					
1+50	0.2054		1.58 QV					
1+55	0.2164		1.59 QV					
2+ 0	0.2274		1.59 QV					
2+ 5	0.2384		1.60 QV					
2+10	0.2494		1.60 QV					
2+15	0.2605		1.61 QV					
2+20	0.2716		1.61 QV					
2+25	0.2827		1.62 QV					
2+30	0.2939		1.62 QV					
2+35	0.3051		1.63 QV					
2+40	0.3163		1.63 QV					
2+45	0.3276		1.64 Q V					
2+50	0.3389		1.64 Q V					
2+55	0.3503		1.65 Q V					
3+ 0	0.3616		1.65 Q V					
3+ 5	0.3730		1.66 Q V					
3+10	0.3845		1.66 Q V					
3+15	0.3960		1.67 Q V					
3+20	0.4075		1.67 Q V					
3+25	0.4190		1.68 Q V					
3+30	0.4306		1.68 Q V					
3+35	0.4423		1.69 Q V					
3+40	0.4539		1.69 Q V					
3+45	0.4656		1.70 Q V					
3+50	0.4774		1.71 Q V					
3+55	0.4892		1.71 Q V					
4+ 0	0.5010		1.72 Q V					
4+ 5	0.5129		1.72 Q V					
4+10	0.5248		1.73 Q V					
4+15	0.5367		1.73 Q V					

4+20	0.5487	1.74	Q	V				
4+25	0.5607	1.75	Q	V				
4+30	0.5728	1.75	IQ	V				
4+35	0.5849	1.76	IQ	V				
4+40	0.5970	1.76	IQ	V				
4+45	0.6092	1.77	IQ	V				
4+50	0.6215	1.78	IQ	V				
4+55	0.6338	1.78	IQ	V				
5+ 0	0.6461	1.79	IQ	V				
5+ 5	0.6585	1.80	IQ	V				
5+10	0.6709	1.80	IQ	V				
5+15	0.6834	1.81	IQ	V				
5+20	0.6959	1.82	IQ	V				
5+25	0.7084	1.82	IQ	V				
5+30	0.7210	1.83	IQ	V				
5+35	0.7337	1.84	IQ	V				
5+40	0.7464	1.84	IQ	V				
5+45	0.7592	1.85	IQ	V				
5+50	0.7720	1.86	IQ	V				
5+55	0.7848	1.87	IQ	V				
6+ 0	0.7977	1.87	IQ	V				
6+ 5	0.8107	1.88	IQ	V				
6+10	0.8237	1.89	IQ	V				
6+15	0.8368	1.90	IQ	V				
6+20	0.8499	1.90	IQ	V				
6+25	0.8630	1.91	IQ	V				
6+30	0.8763	1.92	IQ	V				
6+35	0.8896	1.93	IQ	V				
6+40	0.9029	1.94	IQ	V				
6+45	0.9163	1.95	IQ	V				
6+50	0.9297	1.95	IQ	V				
6+55	0.9433	1.96	IQ	V				
7+ 0	0.9568	1.97	IQ	V				
7+ 5	0.9705	1.98	IQ	V				
7+10	0.9842	1.99	IQ	V				
7+15	0.9979	2.00	IQ	V				
7+20	1.0117	2.01	IQ	V				
7+25	1.0256	2.02	IQ	V				
7+30	1.0396	2.03	IQ	V				
7+35	1.0536	2.03	IQ	V				
7+40	1.0677	2.04	IQ	V				
7+45	1.0818	2.05	IQ	V				
7+50	1.0960	2.06	IQ	V				
7+55	1.1103	2.07	IQ	V				
8+ 0	1.1247	2.09	IQ	V				
8+ 5	1.1391	2.10	IQ	V				
8+10	1.1536	2.11	IQ	V				
8+15	1.1682	2.12	IQ	V				
8+20	1.1829	2.13	IQ	V				
8+25	1.1976	2.14	IQ	V				
8+30	1.2124	2.15	IQ	V				
8+35	1.2273	2.16	IQ	V				
8+40	1.2422	2.17	IQ	V				
8+45	1.2573	2.18	IQ	V				
8+50	1.2724	2.20	IQ	V				
8+55	1.2876	2.21	IQ	V				
9+ 0	1.3029	2.22	IQ	V				
9+ 5	1.3183	2.23	IQ	V				
9+10	1.3338	2.25	IQ	V				
9+15	1.3494	2.26	IQ	V				
9+20	1.3650	2.27	IQ	V				
9+25	1.3808	2.29	IQ	V				
9+30	1.3966	2.30	IQ	V				

9+35	1.4126	2.31	Q	V				
9+40	1.4286	2.33	Q	V				
9+45	1.4447	2.34	Q	V				
9+50	1.4610	2.36	Q	V				
9+55	1.4773	2.37	Q	V				
10+ 0	1.4938	2.39	Q	V				
10+ 5	1.5104	2.40	Q	V				
10+10	1.5270	2.42	Q	V				
10+15	1.5438	2.44	Q	V				
10+20	1.5607	2.45	Q	V				
10+25	1.5777	2.47	Q	V				
10+30	1.5949	2.49	Q	V				
10+35	1.6122	2.51	Q	V				
10+40	1.6295	2.53	Q	V				
10+45	1.6471	2.54	Q	V				
10+50	1.6647	2.56	Q	V				
10+55	1.6825	2.58	Q	V				
11+ 0	1.7004	2.60	Q	V				
11+ 5	1.7185	2.62	Q	V				
11+10	1.7367	2.64	Q	V				
11+15	1.7551	2.67	Q	V				
11+20	1.7736	2.69	Q	V				
11+25	1.7922	2.71	Q	V				
11+30	1.8111	2.73	Q	V				
11+35	1.8301	2.76	Q	V				
11+40	1.8492	2.78	Q	V				
11+45	1.8685	2.81	Q	V				
11+50	1.8881	2.83	Q	V				
11+55	1.9077	2.86	Q	V				
12+ 0	1.9276	2.89	Q	V				
12+ 5	1.9475	2.89	Q	V				
12+10	1.9666	2.77	Q	V				
12+15	1.9850	2.66	Q	V				
12+20	2.0031	2.63	Q	V				
12+25	2.0212	2.63	Q	V				
12+30	2.0394	2.64	Q	V				
12+35	2.0577	2.66	Q	V				
12+40	2.0762	2.68	Q	V				
12+45	2.0948	2.71	Q	V				
12+50	2.1137	2.74	Q	V				
12+55	2.1328	2.77	Q	V				
13+ 0	2.1522	2.81	Q	V				
13+ 5	2.1718	2.85	Q	V				
13+10	2.1917	2.89	Q	V				
13+15	2.2119	2.94	Q	V				
13+20	2.2325	2.98	Q	V				
13+25	2.2534	3.03	Q	V				
13+30	2.2746	3.09	Q	V				
13+35	2.2963	3.14	Q	V				
13+40	2.3183	3.20	Q	V				
13+45	2.3407	3.26	Q	V				
13+50	2.3636	3.32	Q	V				
13+55	2.3869	3.39	Q	V				
14+ 0	2.4108	3.46	Q	V				
14+ 5	2.4351	3.53	Q	V				
14+10	2.4600	3.62	Q	V				
14+15	2.4855	3.70	Q	V				
14+20	2.5117	3.80	Q	V				
14+25	2.5385	3.89	Q	V				
14+30	2.5660	4.00	Q	V				
14+35	2.5943	4.11	Q	V				
14+40	2.6235	4.24	Q	V				
14+45	2.6536	4.36	Q	V				

14+50	2.6846	4.51	Q		V			
14+55	2.7168	4.67	Q		V			
15+ 0	2.7502	4.85	Q		V			
15+ 5	2.7848	5.04	Q		V			
15+10	2.8211	5.26	Q		V			
15+15	2.8589	5.50	Q		V			
15+20	2.8988	5.79	Q		V			
15+25	2.9402	6.01	Q		V			
15+30	2.9798	5.75	Q		V			
15+35	3.0182	5.57	Q		V			
15+40	3.0585	5.85	Q		V			
15+45	3.1021	6.34	Q		V			
15+50	3.1516	7.18	Q		V			
15+55	3.2106	8.57	Q		V			
16+ 0	3.2955	12.33		Q	V			
16+ 5	3.4732	25.80			Q	V		
16+10	3.9418	68.04				V		Q
16+15	4.3563	60.19				V		Q
16+20	4.5720	31.32			Q	V		
16+25	4.7160	20.90		Q		V		
16+30	4.8270	16.12		Q		V		
16+35	4.9158	12.90		Q		V		
16+40	4.9905	10.84		Q		V		
16+45	5.0535	9.15		Q		V		
16+50	5.1071	7.79		Q		V		
16+55	5.1524	6.58		Q		V		
17+ 0	5.1932	5.92		Q		V		
17+ 5	5.2320	5.64		Q		V		
17+10	5.2663	4.97		Q		V		
17+15	5.2964	4.38		Q		V		
17+20	5.3223	3.75		Q		V		
17+25	5.3469	3.57		Q		V		
17+30	5.3704	3.42		Q		V		
17+35	5.3930	3.28		Q		V		
17+40	5.4148	3.16		Q		V		
17+45	5.4357	3.05		Q		V		
17+50	5.4560	2.94		Q		V		
17+55	5.4757	2.85		Q		V		
18+ 0	5.4947	2.77		Q		V		
18+ 5	5.5134	2.71		Q		V		
18+10	5.5327	2.79		Q		V		
18+15	5.5524	2.86		Q		V		
18+20	5.5721	2.86		Q		V		
18+25	5.5916	2.83		Q		V		
18+30	5.6109	2.80		Q		V		
18+35	5.6300	2.77		Q		V		
18+40	5.6487	2.73		Q		V		
18+45	5.6673	2.69		Q		V		
18+50	5.6855	2.65		Q		V		
18+55	5.7035	2.61		Q		V		
19+ 0	5.7212	2.57		Q		V		
19+ 5	5.7387	2.54		Q		V		
19+10	5.7559	2.50		Q		V		
19+15	5.7729	2.47		Q		V		
19+20	5.7897	2.43		Q		V		
19+25	5.8062	2.40		Q		V		
19+30	5.8226	2.37		Q		V		
19+35	5.8387	2.34		Q		V		
19+40	5.8546	2.31		Q		V		
19+45	5.8703	2.28		Q		V		
19+50	5.8859	2.26		Q		V		
19+55	5.9013	2.23		Q		V		
20+ 0	5.9165	2.21		Q		V		

20+ 5	5.9315	2.18	Q				V	
20+10	5.9464	2.16	Q				V	
20+15	5.9611	2.14	Q				V	
20+20	5.9756	2.11	Q				V	
20+25	5.9900	2.09	Q				V	
20+30	6.0043	2.07	Q				V	
20+35	6.0184	2.05	Q				V	
20+40	6.0324	2.03	Q				V	
20+45	6.0463	2.01	Q				V	
20+50	6.0601	2.00	Q				V	
20+55	6.0737	1.98	Q				V	
21+ 0	6.0872	1.96	Q				V	
21+ 5	6.1006	1.94	Q				V	
21+10	6.1138	1.93	Q				V	
21+15	6.1270	1.91	Q				V	
21+20	6.1400	1.89	Q				V	
21+25	6.1530	1.88	Q				V	
21+30	6.1658	1.86	Q				V	
21+35	6.1786	1.85	Q				V	
21+40	6.1912	1.84	Q				V	
21+45	6.2037	1.82	Q				V	
21+50	6.2162	1.81	Q				V	
21+55	6.2286	1.79	Q				V	
22+ 0	6.2408	1.78	Q				V	
22+ 5	6.2530	1.77	Q				V	
22+10	6.2651	1.76	Q				V	
22+15	6.2771	1.74	Q				V	
22+20	6.2891	1.73	Q				V	
22+25	6.3009	1.72	Q				V	
22+30	6.3127	1.71	Q				V	
22+35	6.3244	1.70	Q				V	
22+40	6.3360	1.69	Q				V	
22+45	6.3475	1.68	Q				V	
22+50	6.3590	1.67	Q				V	
22+55	6.3704	1.66	Q				V	
23+ 0	6.3818	1.65	Q				V	
23+ 5	6.3930	1.64	Q				V	
23+10	6.4042	1.63	Q				V	
23+15	6.4153	1.62	Q				V	
23+20	6.4264	1.61	Q				V	
23+25	6.4374	1.60	Q				V	
23+30	6.4483	1.59	Q				V	
23+35	6.4592	1.58	Q				V	
23+40	6.4700	1.57	Q				V	
23+45	6.4808	1.56	Q				V	
23+50	6.4915	1.55	Q				V	
23+55	6.5021	1.54	Q				V	
24+ 0	6.5127	1.54	Q				V	
24+ 5	6.5227	1.46	Q				V	
24+10	6.5295	0.98	Q				V	
24+15	6.5332	0.54	Q				V	
24+20	6.5357	0.36	Q				V	
24+25	6.5374	0.25	Q				V	
24+30	6.5386	0.17	Q				V	
24+35	6.5394	0.12	Q				V	
24+40	6.5400	0.09	Q				V	
24+45	6.5404	0.06	Q				V	
24+50	6.5407	0.04	Q				V	
24+55	6.5409	0.03	Q				V	
25+ 0	6.5411	0.02	Q				V	
25+ 5	6.5411	0.01	Q				V	
25+10	6.5412	0.00	Q				V	

## **APPENDIX C – Retarding Basin Calculations**





FLOOD HYDROGRAPH ROUTING PROGRAM  
Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2018  
Study date: 01/28/23

2039RTE

**DEVELOPED**  
**100-YEAR 24-HOUR REDUCED TO 90 PRE-DEVELOPED**  
**(5)-12-in DIA OUTLETS**

Program License Serial Number 6434

\*\*\*\*\* HYDROGRAPH INFORMATION \*\*\*\*\*

From study/file name: 2039ud.rte

\*\*\*\*\*HYDROGRAPH DATA\*\*\*\*\*

Number of intervals = 302  
Time interval = 5.0 (Min.)  
Maximum/Peak flow rate = 68.042 (CFS)  
Total volume = 6.541 (Ac.Ft)  
Status of hydrographs being held in storage  
Stream 1 Stream 2 Stream 3 Stream 4 Stream 5  
Peak (CFS) 0.000 0.000 0.000 0.000 0.000  
Vol (Ac.Ft) 0.000 0.000 0.000 0.000 0.000  
\*\*\*\*\*

+++++  
Process from Point/Station 37.000 to Point/Station 42.000  
\*\*\*\* RETARDING BASIN ROUTING \*\*\*\*

Program computation of outflow v. depth

CALCULATED OUTFLOW DATA AT DEPTH = 1.00 (Ft.))  
Total outflow at this depth = 0.00 (CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 2.00 (Ft.))  
Total outflow at this depth = 0.00 (CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 3.00 (Ft.))  
Total outflow at this depth = 0.00 (CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 3.50 (Ft.))  
Total outflow at this depth = 0.00 (CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 4.00(Ft.))  
Pipe length = 50.00(Ft.) Elevation difference = 1.00(Ft.)  
Manning's N = 0.013 No. of pipes = 5  
Given pipe size = 12.00(In.)  
Calculated individual pipe flow = 1.398(CFS)  
Normal flow depth in pipe = 4.32(In.)  
Flow top width inside pipe = 11.52(In.)  
Critical Depth = 0.50(Ft.)  
Calculated flow rate through pipe(s) = 6.988(CFS)  
  
Total outflow at this depth = 6.99(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 5.00(Ft.))  
Pipe length = 50.00(Ft.) Elevation difference = 1.00(Ft.)  
Manning's N = 0.013 No. of pipes = 5  
Given pipe size = 12.00(In.)  
NOTE: Assuming free outlet flow.  
NOTE: Normal flow is pressure flow.  
The total friction loss through the pipe is 2.500(Ft.)  
Pipe friction loss = 1.277(Ft.)  
Minor friction loss = 1.224(Ft.) K-factor = 1.50  
Calculated flow rate through pipe(s) = 28.467(CFS)  
  
Total outflow at this depth = 28.47(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 6.00(Ft.))  
Pipe length = 50.00(Ft.) Elevation difference = 1.00(Ft.)  
Manning's N = 0.013 No. of pipes = 5  
Given pipe size = 12.00(In.)  
NOTE: Assuming free outlet flow.  
NOTE: Normal flow is pressure flow.  
The total friction loss through the pipe is 3.500(Ft.)  
Pipe friction loss = 1.788(Ft.)  
Minor friction loss = 1.714(Ft.) K-factor = 1.50  
Calculated flow rate through pipe(s) = 33.683(CFS)  
  
Total outflow at this depth = 33.68(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 7.00(Ft.))  
Pipe length = 50.00(Ft.) Elevation difference = 1.00(Ft.)  
Manning's N = 0.013 No. of pipes = 5  
Given pipe size = 12.00(In.)  
NOTE: Assuming free outlet flow.  
NOTE: Normal flow is pressure flow.  
The total friction loss through the pipe is 4.500(Ft.)  
Pipe friction loss = 2.298(Ft.)  
Minor friction loss = 2.203(Ft.) K-factor = 1.50  
Calculated flow rate through pipe(s) = 38.193(CFS)  
  
Total outflow at this depth = 38.19(CFS)

CALCULATED OUTFLOW DATA AT DEPTH = 7.50(Ft.))  
Pipe length = 50.00(Ft.) Elevation difference = 1.00(Ft.)  
Manning's N = 0.013 No. of pipes = 5  
Given pipe size = 12.00(In.)  
NOTE: Assuming free outlet flow.  
NOTE: Normal flow is pressure flow.  
The total friction loss through the pipe is 5.000(Ft.)

Pipe friction loss = 2.554(Ft.)  
 Minor friction loss = 2.448(Ft.) K-factor = 1.50  
 Calculated flow rate through pipe(s) = 40.259(CFS)

Total outflow at this depth = 40.26(CFS)

-----  
 Total number of inflow hydrograph intervals = 302  
 Hydrograph time unit = 5.000 (Min.)  
 Initial depth in storage basin = 0.00(Ft.)  
 -----

-----  
 Initial basin depth = 0.00 (Ft.)  
 Initial basin storage = 0.00 (Ac.Ft)  
 Initial basin outflow = 0.00 (CFS)  
 -----

-----  
 Depth vs. Storage and Depth vs. Discharge data:  
 Basin Depth Storage Outflow (S-O\*dt/2) (S+O\*dt/2)  
 (Ft.) (Ac.Ft) (CFS) (Ac.Ft) (Ac.Ft)  
 -----

0.000	0.000	0.000	0.000	0.000
1.000	0.067	0.000	0.067	0.067
2.000	0.169	0.000	0.169	0.169
3.000	0.312	0.000	0.312	0.312
3.500	0.402	0.000	0.402	0.402
4.000	0.507	6.988	0.483	0.531
5.000	0.761	28.467	0.663	0.859
6.000	1.075	33.683	0.959	1.191
7.000	1.454	38.193	1.322	1.586
7.500	1.670	40.259	1.531	1.809

-----  
 Hydrograph Detention Basin Routing  
 -----

Graph values: 'I'= unit inflow; 'O'=outflow at time shown  
 -----

Time (Hours)	Inflow (CFS)	Outflow (CFS)	Storage (Ac.Ft)	.0	17.0	34.02	51.03	68.04	Depth (Ft.)
0.083	0.07	0.00	0.000	O					0.00
0.167	0.54	0.00	0.002	O					0.04
0.250	0.97	0.00	0.008	O					0.11
0.333	1.16	0.00	0.015	O					0.22
0.417	1.27	0.00	0.023	O					0.35
0.500	1.35	0.00	0.032	O					0.48
0.583	1.40	0.00	0.042	O					0.62
0.667	1.44	0.00	0.052	O					0.77
0.750	1.47	0.00	0.062	O					0.92
0.833	1.49	0.00	0.072	O					1.05
0.917	1.51	0.00	0.082	O					1.15
1.000	1.52	0.00	0.093	O					1.25
1.083	1.54	0.00	0.103	O					1.35
1.167	1.55	0.00	0.114	O					1.46
1.250	1.55	0.00	0.124	O					1.56
1.333	1.56	0.00	0.135	O					1.67
1.417	1.56	0.00	0.146	O					1.77
1.500	1.57	0.00	0.157	O					1.88
1.583	1.57	0.00	0.167	O					1.98
1.667	1.58	0.00	0.178	O					2.06
1.750	1.58	0.00	0.189	O					2.14
1.833	1.58	0.00	0.200	O					2.22
1.917	1.59	0.00	0.211	O					2.29
2.000	1.59	0.00	0.222	O					2.37

2.083	1.60	0.00	0.233	O					2.45
2.167	1.60	0.00	0.244	O					2.52
2.250	1.61	0.00	0.255	O					2.60
2.333	1.61	0.00	0.266	O					2.68
2.417	1.62	0.00	0.277	O					2.76
2.500	1.62	0.00	0.288	O					2.83
2.583	1.63	0.00	0.299	O					2.91
2.667	1.63	0.00	0.311	O					2.99
2.750	1.64	0.00	0.322	O					3.06
2.833	1.64	0.00	0.333	O					3.12
2.917	1.65	0.00	0.345	O					3.18
3.000	1.65	0.00	0.356	O					3.24
3.083	1.66	0.00	0.367	O					3.31
3.167	1.66	0.00	0.379	O					3.37
3.250	1.67	0.00	0.390	O					3.43
3.333	1.67	0.00	0.402	O					3.50
3.417	1.68	0.61	0.411	O					3.54
3.500	1.68	1.01	0.417	O					3.57
3.583	1.69	1.26	0.421	O					3.59
3.667	1.69	1.42	0.423	O					3.60
3.750	1.70	1.52	0.425	O					3.61
3.833	1.71	1.59	0.426	O					3.61
3.917	1.71	1.63	0.427	O					3.62
4.000	1.72	1.66	0.427	O					3.62
4.083	1.72	1.68	0.427	O					3.62
4.167	1.73	1.70	0.428	O					3.62
4.250	1.73	1.71	0.428	O					3.62
4.333	1.74	1.72	0.428	O					3.62
4.417	1.75	1.73	0.428	O					3.62
4.500	1.75	1.74	0.428	O					3.62
4.583	1.76	1.74	0.428	O					3.62
4.667	1.76	1.75	0.428	O					3.63
4.750	1.77	1.76	0.428	O					3.63
4.833	1.78	1.76	0.428	O					3.63
4.917	1.78	1.77	0.429	O					3.63
5.000	1.79	1.78	0.429	O					3.63
5.083	1.80	1.78	0.429	O					3.63
5.167	1.80	1.79	0.429	O					3.63
5.250	1.81	1.80	0.429	O					3.63
5.333	1.82	1.80	0.429	O					3.63
5.417	1.82	1.81	0.429	O					3.63
5.500	1.83	1.82	0.429	O					3.63
5.583	1.84	1.82	0.429	O					3.63
5.667	1.84	1.83	0.429	O					3.63
5.750	1.85	1.84	0.430	O					3.63
5.833	1.86	1.84	0.430	O					3.63
5.917	1.87	1.85	0.430	O					3.63
6.000	1.87	1.86	0.430	O					3.63
6.083	1.88	1.87	0.430	O					3.63
6.167	1.89	1.87	0.430	O					3.63
6.250	1.90	1.88	0.430	O					3.63
6.333	1.90	1.89	0.430	O					3.64
6.417	1.91	1.90	0.430	O					3.64
6.500	1.92	1.90	0.431	O					3.64
6.583	1.93	1.91	0.431	O					3.64
6.667	1.94	1.92	0.431	O					3.64
6.750	1.95	1.93	0.431	O					3.64
6.833	1.95	1.94	0.431	O					3.64
6.917	1.96	1.94	0.431	O					3.64
7.000	1.97	1.95	0.431	O					3.64
7.083	1.98	1.96	0.431	O					3.64
7.167	1.99	1.97	0.432	O					3.64
7.250	2.00	1.98	0.432	O					3.64

7.333	2.01	1.99	0.432	O					3.64
7.417	2.02	2.00	0.432	O					3.64
7.500	2.03	2.01	0.432	O					3.64
7.583	2.03	2.01	0.432	O					3.64
7.667	2.04	2.02	0.432	O					3.64
7.750	2.05	2.03	0.433	O					3.65
7.833	2.06	2.04	0.433	O					3.65
7.917	2.07	2.05	0.433	O					3.65
8.000	2.09	2.06	0.433	O					3.65
8.083	2.10	2.07	0.433	O					3.65
8.167	2.11	2.08	0.433	O					3.65
8.250	2.12	2.09	0.433	O					3.65
8.333	2.13	2.10	0.434	OI					3.65
8.417	2.14	2.12	0.434	OI					3.65
8.500	2.15	2.13	0.434	OI					3.65
8.583	2.16	2.14	0.434	IO					3.65
8.667	2.17	2.15	0.434	IO					3.65
8.750	2.18	2.16	0.434	IO					3.65
8.833	2.20	2.17	0.435	IO					3.66
8.917	2.21	2.18	0.435	IO					3.66
9.000	2.22	2.20	0.435	IO					3.66
9.083	2.23	2.21	0.435	IO					3.66
9.167	2.25	2.22	0.435	IO					3.66
9.250	2.26	2.23	0.436	IO					3.66
9.333	2.27	2.25	0.436	IO					3.66
9.417	2.29	2.26	0.436	IO					3.66
9.500	2.30	2.27	0.436	IO					3.66
9.583	2.31	2.29	0.436	IO					3.66
9.667	2.33	2.30	0.437	IO					3.66
9.750	2.34	2.31	0.437	IO					3.67
9.833	2.36	2.33	0.437	IO					3.67
9.917	2.37	2.34	0.437	IO					3.67
10.000	2.39	2.36	0.437	IO					3.67
10.083	2.40	2.37	0.438	IO					3.67
10.167	2.42	2.39	0.438	IO					3.67
10.250	2.44	2.40	0.438	IO					3.67
10.333	2.45	2.42	0.438	IO					3.67
10.417	2.47	2.44	0.439	IO					3.67
10.500	2.49	2.45	0.439	IO					3.68
10.583	2.51	2.47	0.439	IO					3.68
10.667	2.53	2.49	0.439	IO					3.68
10.750	2.54	2.50	0.440	IO					3.68
10.833	2.56	2.52	0.440	IO					3.68
10.917	2.58	2.54	0.440	IO					3.68
11.000	2.60	2.56	0.440	IO					3.68
11.083	2.62	2.58	0.441	IO					3.68
11.167	2.64	2.60	0.441	IO					3.69
11.250	2.67	2.62	0.441	IO					3.69
11.333	2.69	2.64	0.442	IO					3.69
11.417	2.71	2.66	0.442	IO					3.69
11.500	2.73	2.68	0.442	IO					3.69
11.583	2.76	2.71	0.443	IO					3.69
11.667	2.78	2.73	0.443	IO					3.70
11.750	2.81	2.75	0.443	IO					3.70
11.833	2.83	2.78	0.444	IO					3.70
11.917	2.86	2.80	0.444	IO					3.70
12.000	2.89	2.83	0.445	IO					3.70
12.083	2.89	2.85	0.445	IO					3.70
12.167	2.77	2.84	0.445	IO					3.70
12.250	2.66	2.80	0.444	IO					3.70
12.333	2.63	2.74	0.443	IO					3.70
12.417	2.63	2.70	0.443	IO					3.69
12.500	2.64	2.68	0.442	IO					3.69

12.583	2.66	2.67	0.442	O					3.69
12.667	2.68	2.67	0.442	O					3.69
12.750	2.71	2.68	0.442	O					3.69
12.833	2.74	2.69	0.442	O					3.69
12.917	2.77	2.72	0.443	O					3.69
13.000	2.81	2.75	0.443	O					3.70
13.083	2.85	2.78	0.444	O					3.70
13.167	2.89	2.81	0.444	O					3.70
13.250	2.94	2.85	0.445	O					3.70
13.333	2.98	2.89	0.445	O					3.71
13.417	3.03	2.94	0.446	O					3.71
13.500	3.09	2.98	0.447	O					3.71
13.583	3.14	3.03	0.448	O					3.72
13.667	3.20	3.08	0.448	O					3.72
13.750	3.26	3.14	0.449	O					3.72
13.833	3.32	3.19	0.450	O					3.73
13.917	3.39	3.25	0.451	O					3.73
14.000	3.46	3.32	0.452	O					3.74
14.083	3.53	3.38	0.453	O					3.74
14.167	3.62	3.46	0.454	O					3.75
14.250	3.70	3.53	0.455	O					3.75
14.333	3.80	3.61	0.456	O					3.76
14.417	3.89	3.70	0.458	O					3.76
14.500	4.00	3.79	0.459	O					3.77
14.583	4.11	3.89	0.460	O					3.78
14.667	4.24	4.00	0.462	O					3.79
14.750	4.36	4.11	0.464	OI					3.79
14.833	4.51	4.23	0.466	OI					3.80
14.917	4.67	4.37	0.468	O					3.81
15.000	4.85	4.51	0.470	O					3.82
15.083	5.04	4.67	0.472	O					3.83
15.167	5.26	4.85	0.475	O					3.85
15.250	5.50	5.05	0.478	O					3.86
15.333	5.79	5.27	0.481	O					3.88
15.417	6.01	5.50	0.485	O					3.89
15.500	5.75	5.64	0.487	O					3.90
15.583	5.57	5.65	0.487	O					3.90
15.667	5.85	5.67	0.487	O					3.91
15.750	6.34	5.83	0.490	O					3.92
15.833	7.18	6.18	0.495	OI					3.94
15.917	8.57	6.81	0.504	OI					3.99
16.000	12.33	8.41	0.524	O I					4.07
16.083	25.80	13.22	0.581	O I					4.29
16.167	68.04	28.42	0.760	O				I	5.00
16.250	60.19	32.32	0.993	O		I			5.74
16.333	31.32	33.61	1.080	IO					6.00
16.417	20.90	32.95	1.031	I O					5.86
16.500	16.12	31.38	0.937	I O					5.56
16.583	12.90	29.56	0.827	I O					5.21
16.667	10.84	25.03	0.720	I O					4.84
16.750	9.15	18.25	0.640	I O					4.52
16.833	7.79	13.84	0.588	I O					4.32
16.917	6.58	10.84	0.553	I O					4.18
17.000	5.92	8.77	0.528	I O					4.08
17.083	5.64	7.42	0.512	IO					4.02
17.167	4.97	6.56	0.501	IO					3.97
17.250	4.38	5.86	0.490	O					3.92
17.333	3.75	5.19	0.480	IO					3.87
17.417	3.57	4.62	0.471	IO					3.83
17.500	3.42	4.20	0.465	O					3.80
17.583	3.28	3.88	0.460	O					3.78
17.667	3.16	3.64	0.457	O					3.76
17.750	3.05	3.44	0.454	O					3.75

17.833	2.94	3.27	0.451	IO					3.73
17.917	2.85	3.13	0.449	IO					3.72
18.000	2.77	3.01	0.447	IO					3.72
18.083	2.71	2.91	0.446	IO					3.71
18.167	2.79	2.85	0.445	IO					3.70
18.250	2.86	2.84	0.445	IO					3.70
18.333	2.86	2.85	0.445	IO					3.70
18.417	2.83	2.85	0.445	IO					3.70
18.500	2.80	2.84	0.445	IO					3.70
18.583	2.77	2.82	0.444	IO					3.70
18.667	2.73	2.79	0.444	IO					3.70
18.750	2.69	2.76	0.443	IO					3.70
18.833	2.65	2.73	0.443	IO					3.70
18.917	2.61	2.69	0.442	IO					3.69
19.000	2.57	2.65	0.442	IO					3.69
19.083	2.54	2.62	0.441	IO					3.69
19.167	2.50	2.58	0.441	IO					3.68
19.250	2.47	2.55	0.440	IO					3.68
19.333	2.43	2.51	0.440	IO					3.68
19.417	2.40	2.48	0.439	IO					3.68
19.500	2.37	2.44	0.439	IO					3.67
19.583	2.34	2.41	0.438	IO					3.67
19.667	2.31	2.38	0.438	IO					3.67
19.750	2.28	2.35	0.437	IO					3.67
19.833	2.26	2.32	0.437	IO					3.67
19.917	2.23	2.29	0.436	IO					3.66
20.000	2.21	2.26	0.436	IO					3.66
20.083	2.18	2.24	0.436	IO					3.66
20.167	2.16	2.21	0.435	IO					3.66
20.250	2.14	2.19	0.435	IO					3.66
20.333	2.11	2.16	0.435	IO					3.65
20.417	2.09	2.14	0.434	IO					3.65
20.500	2.07	2.12	0.434	O					3.65
20.583	2.05	2.10	0.434	O					3.65
20.667	2.03	2.08	0.433	O					3.65
20.750	2.01	2.06	0.433	O					3.65
20.833	2.00	2.04	0.433	O					3.65
20.917	1.98	2.02	0.432	O					3.64
21.000	1.96	2.00	0.432	O					3.64
21.083	1.94	1.98	0.432	O					3.64
21.167	1.93	1.96	0.432	O					3.64
21.250	1.91	1.95	0.431	O					3.64
21.333	1.89	1.93	0.431	O					3.64
21.417	1.88	1.91	0.431	O					3.64
21.500	1.86	1.90	0.431	O					3.64
21.583	1.85	1.88	0.430	O					3.63
21.667	1.84	1.87	0.430	O					3.63
21.750	1.82	1.85	0.430	O					3.63
21.833	1.81	1.84	0.430	O					3.63
21.917	1.79	1.83	0.429	O					3.63
22.000	1.78	1.81	0.429	O					3.63
22.083	1.77	1.80	0.429	O					3.63
22.167	1.76	1.78	0.429	O					3.63
22.250	1.74	1.77	0.429	O					3.63
22.333	1.73	1.76	0.428	O					3.63
22.417	1.72	1.75	0.428	O					3.63
22.500	1.71	1.74	0.428	O					3.62
22.583	1.70	1.72	0.428	O					3.62
22.667	1.69	1.71	0.428	O					3.62
22.750	1.68	1.70	0.428	O					3.62
22.833	1.67	1.69	0.427	O					3.62
22.917	1.66	1.68	0.427	O					3.62
23.000	1.65	1.67	0.427	O					3.62

23.083	1.64	1.66	0.427	O					3.62
23.167	1.63	1.65	0.427	O					3.62
23.250	1.62	1.64	0.427	O					3.62
23.333	1.61	1.63	0.426	O					3.62
23.417	1.60	1.62	0.426	O					3.62
23.500	1.59	1.61	0.426	O					3.62
23.583	1.58	1.60	0.426	O					3.61
23.667	1.57	1.59	0.426	O					3.61
23.750	1.56	1.58	0.426	O					3.61
23.833	1.55	1.57	0.426	O					3.61
23.917	1.54	1.56	0.425	O					3.61
24.000	1.54	1.55	0.425	O					3.61
24.083	1.46	1.53	0.425	O					3.61
24.167	0.98	1.42	0.423	O					3.60
24.250	0.54	1.17	0.420	O					3.58
24.333	0.36	0.90	0.416	O					3.56
24.417	0.25	0.68	0.412	O					3.55
24.500	0.17	0.50	0.410	O					3.54
24.583	0.12	0.37	0.408	O					3.53
24.667	0.09	0.27	0.406	O					3.52
24.750	0.06	0.20	0.405	O					3.51
24.833	0.04	0.14	0.404	O					3.51
24.917	0.03	0.10	0.404	O					3.51
25.000	0.02	0.07	0.403	O					3.51
25.083	0.01	0.05	0.403	O					3.50
25.167	0.00	0.04	0.403	O					3.50
25.250	0.00	0.02	0.402	O					3.50
25.333	0.00	0.01	0.402	O					3.50
25.417	0.00	0.01	0.402	O					3.50
25.500	0.00	0.01	0.402	O					3.50
25.583	0.00	0.00	0.402	O					3.50
25.667	0.00	0.00	0.402	O					3.50
25.750	0.00	0.00	0.402	O					3.50
25.833	0.00	0.00	0.402	O					3.50

Remaining water in basin = 0.40 (Ac.Ft)

\*\*\*\*\*HYDROGRAPH DATA\*\*\*\*\*

Number of intervals = 310

Time interval = 5.0 (Min.)

Maximum/Peak flow rate = 33.748 (CFS)

Total volume = 6.139 (Ac.Ft)

Status of hydrographs being held in storage

Stream 1 Stream 2 Stream 3 Stream 4 Stream 5

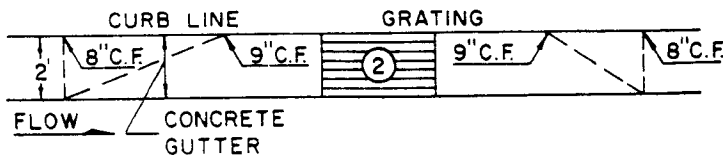
Peak (CFS) 0.000 0.000 0.000 0.000 0.000

Vol (Ac.Ft) 0.000 0.000 0.000 0.000 0.000

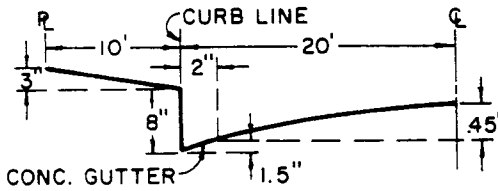
\*\*\*\*\*

-----

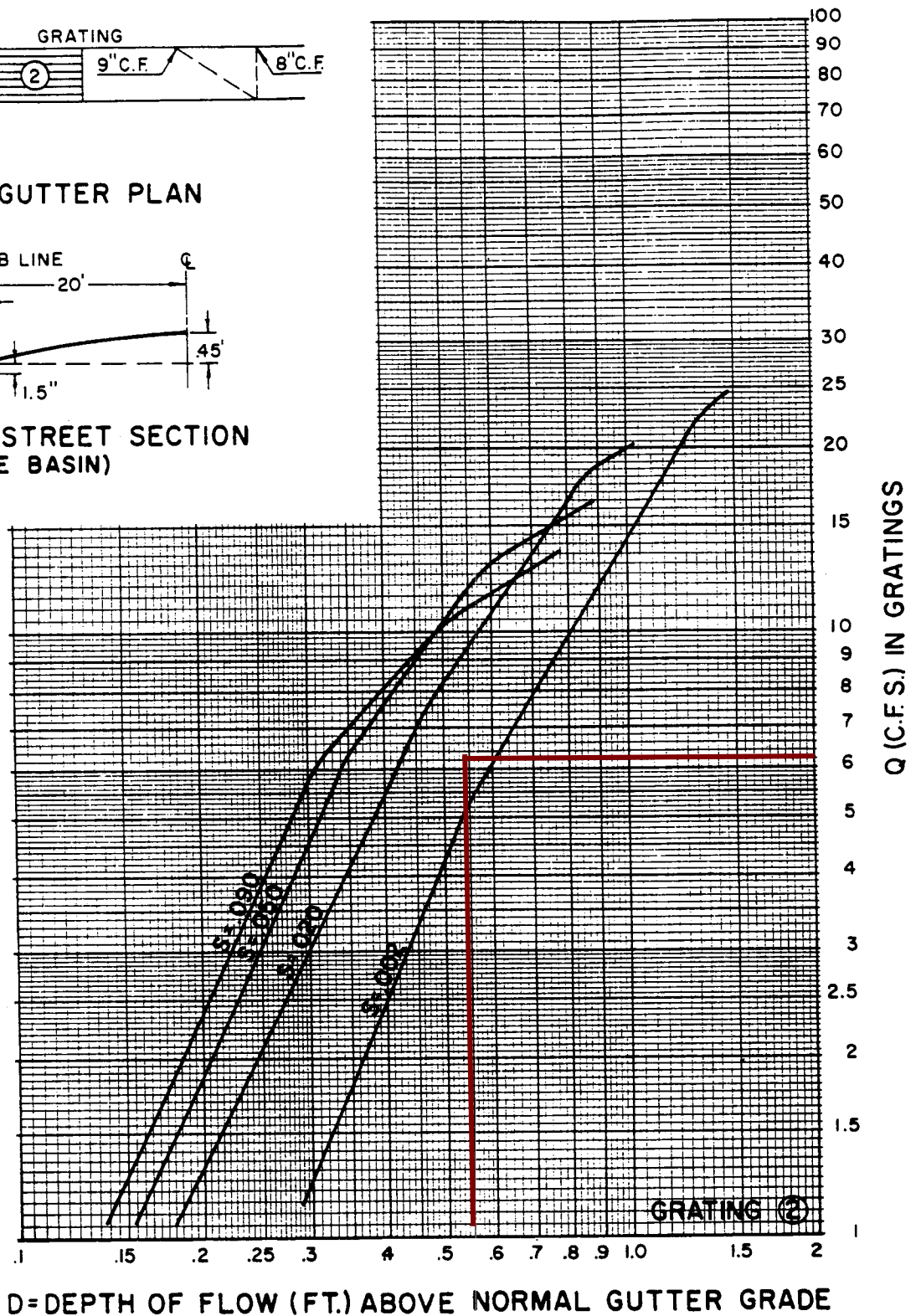




GRATING & GUTTER PLAN

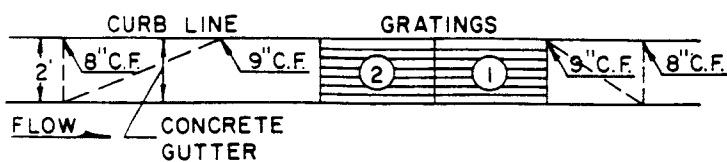


TYPICAL HALF STREET SECTION  
(ABOVE BASIN)

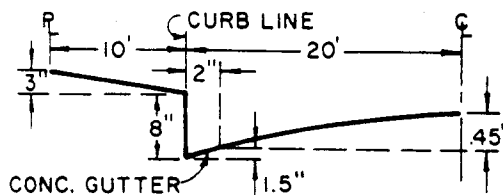


Los Angeles County Flood Control District

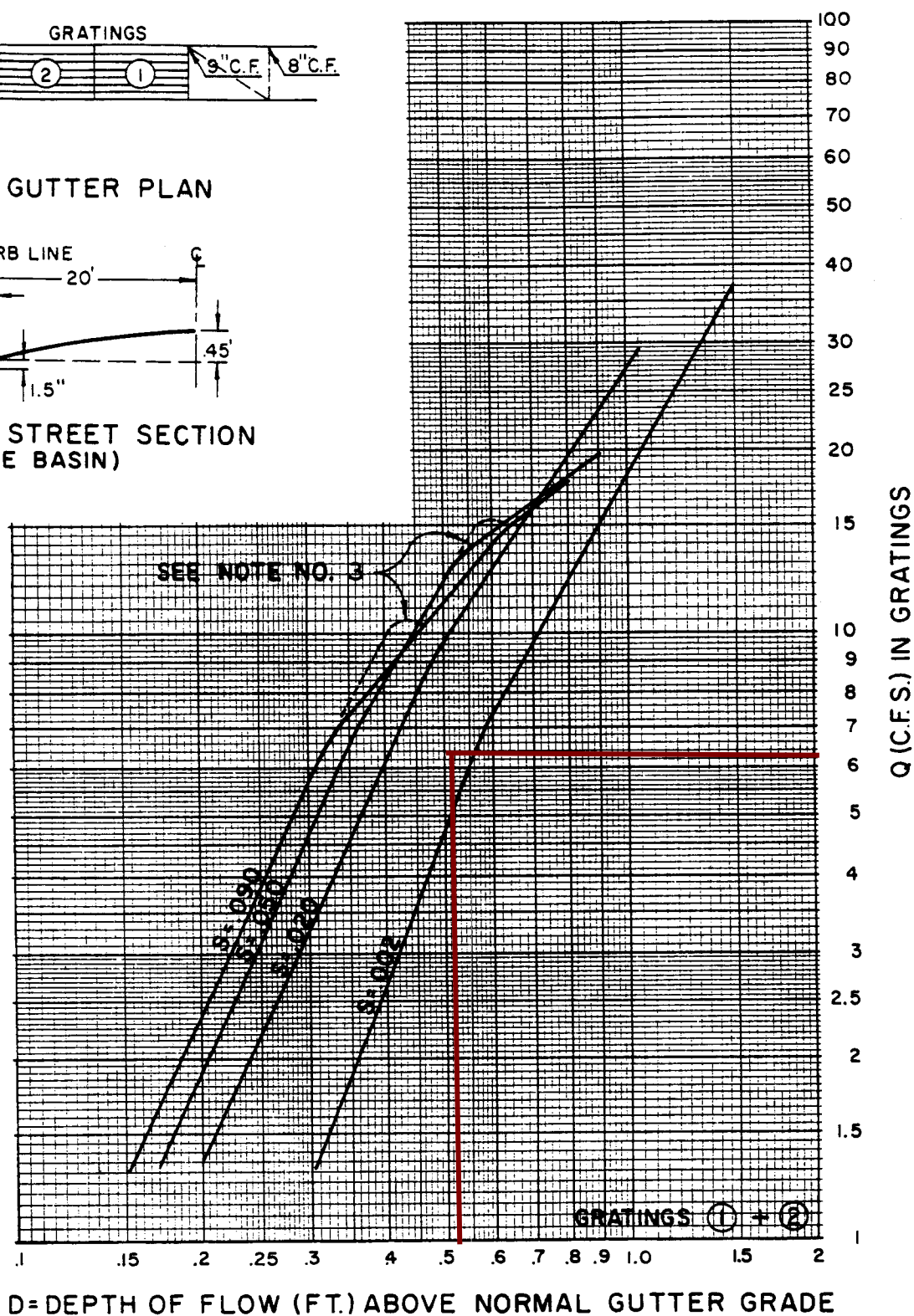
**GRATING CAPACITIES**  
To Be Used For C.B. Nos. 4, 5 & 7



GRATING & GUTTER PLAN

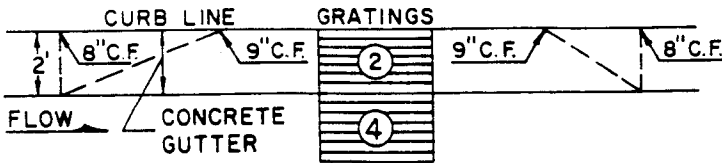


TYPICAL HALF STREET SECTION  
(ABOVE BASIN)

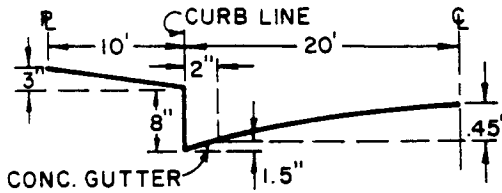


Los Angeles County Flood Control District

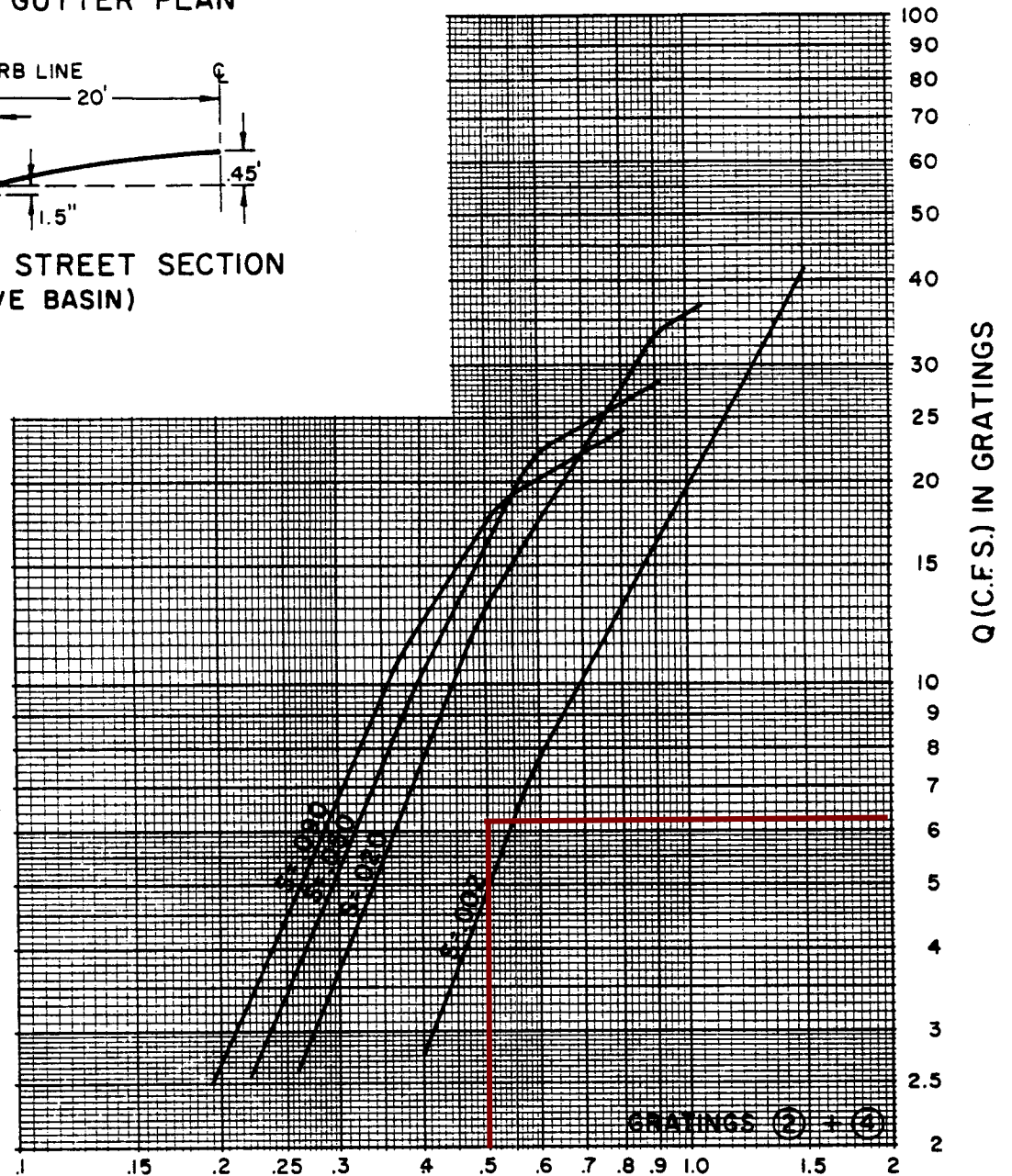
**GRATING CAPACITIES**  
To Be Used For C.B. Nos. 4, 5 & 7



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION  
(ABOVE BASIN)



D=DEPTH OF FLOW (FT.) ABOVE NORMAL GUTTER GRADE

Los Angeles County Flood Control District

**GRATING CAPACITIES**  
To Be Used For C.B. Nos. 4, 5 & 7

30FT HALF STREET FLOW CALCULATIONS

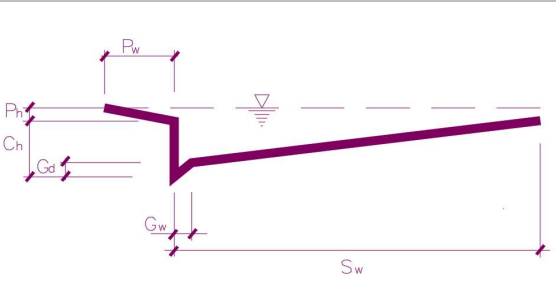
Given:

Half Street CL to Curb Sw = 20 Ft  
Street X-Slope Cs = 0.02 Ft/Ft  
Gutter Width Gw = 2 Ft  
Gutter Depth Gd = 0.17 Ft  
Parkway width Pw = 10 Ft  
Curb Height Ch = 0.5 Ft

Slope of Street s = 0.005 Ft/Ft  
Manning's Coeficient n= 0.015

Then: Ph = 0.2  
Ch-Gd = 0.33  
Ch-Gd+Ph = 0.53

Sw1 = 16.5  
Sw2 = 26.5



ROW Street Capacity

AREA A = 7.53 SF  
WETTED PERIMETER Wp = 32.51 FT  
R= A/P R = 0.231607  
Q = 19.85 CFS

CF Street Capacity

AREA A = 4.13 SF  
WETTED PERIMETER Wp = 22.51 FT  
R= A/P R = 0.183475  
Q = 9.31 CFS



CONSULTING ENGINEERS  
& ARCHITECTS

Manufacture	Size	Product	Style	Model
EJ	24x24	45624032	bar/flat	V5624

## RECTANGULAR DRAINAGE GRATE FLOW CALCULATOR

Depth d (in)	Q cfs
-----------------	----------

Depth of Flow     d=            6 in

1	0.69
---	------

1.5	1.26
-----	------

Up to 4-inches Weir Calculator      $Q=3.33Lp(d)^{1.5}$

2	1.94
---	------

2.5	2.72
-----	------

Grate Width     Gw=        25.75 in

3	3.57
---	------

Grate Length     Gl=        25.75 in

3.5	4.50
-----	------

Perimeter     Lp=        8.58 ft<sup>2</sup>

4	6.36
---	------

4.5	6.75
-----	------

Flow Rate     Q=            0.00 cfs

5	7.11
---	------

5.5	7.46
-----	------

Over 4-inches Orifice Calculator      $Q=CA(2gd)^{.5}$

6	7.79
---	------

6.5	8.11
-----	------

Coefficient     C=            0.67

7	8.41
---	------

Opening Area     Ao=        295 in <sup>2</sup>        (see Manufacture)

7.5	8.71
-----	------

Gravity Acc     g=            32.2 ft/sec<sup>2</sup>

8	8.99
---	------

8.5	9.27
-----	------

Flow Rate     Q=            7.79

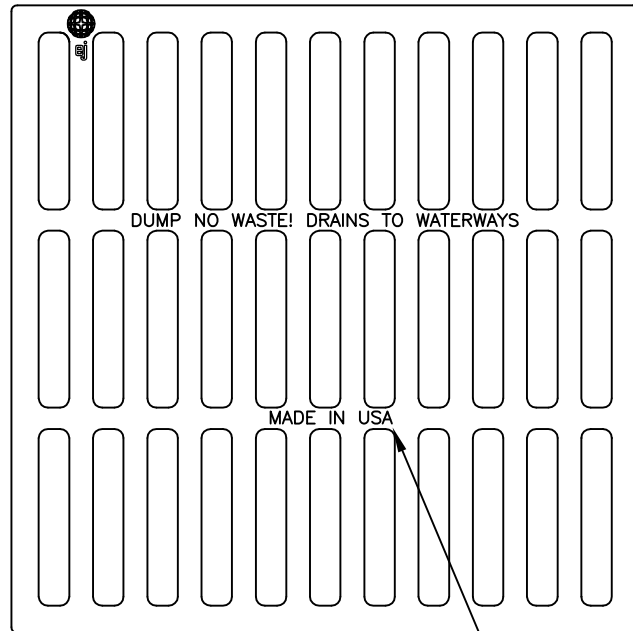
9	9.54
---	------

9.2	9.64
-----	------

10	10.06
----	-------

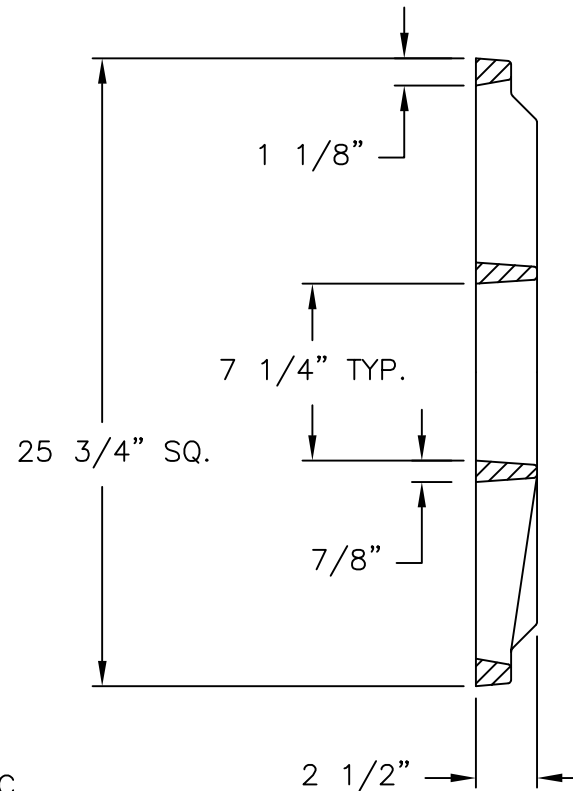
**Q=    7.79**

# V5624 Grate

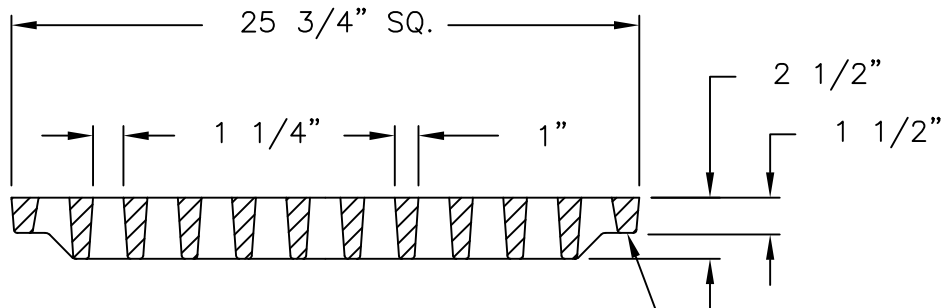


PLAN VIEW

1/2" TYP.  
SHARP FACE GOTHIC



GRATE SECTION



GRATE SECTION

PROD NO.  
V5624  
MO/DY/YR X  
ASTM A536 DI

## Product Number

45624032

## Design Features

- Materials  
Ductile Iron (70-50-05)
- Design Load  
Extra Heavy Duty
- Open Area  
295 sq in
- Coating  
Undipped
- ✓ Designates Machined Surface

## Certification

- ASTM A536
- 
- 
- Country of Origin: USA

## Drawing Revision

03/27/2003 Designer: SBB  
8/21/2018 Revised By: MAH

## Disclaimer

Weights (lbs./kg) dimensions (inches/mm) and drawings provided for your guidance. We reserve the right to modify specifications without prior notice.

CONFIDENTIAL: This drawing is the property of EJ GROUP, Inc., and embodies confidential information, registered marks, patents, trade secret information, and/or know how that is the property of EJ GROUP, Inc. Copyright © 2012 EJ GROUP, Inc. All rights reserved.

## Contact

800 626 4653  
ejco.com

```

*****
***
***
***
*** |<----- ( 25.64' )----->| ***
***^^^^^W.S. ( 0.26' )^^^^^***
***
***
***
***
***
***
*****
**

```

## Channel Jc14, Ec5

Triangular Channel

Flowrate .....	6.750	CFS
Velocity .....	2.055	fps
Depth of Flow .....	0.256	feet
Critical Depth .....	0.257	feet
Freeboard .....	0.000	feet
Total Depth .....	0.256	feet
Width at Water Surface ....	25.640	feet
Top Width .....	25.640	feet
Slope of Channel .....	0.500	%
Left Side Slope .....	50.000	: 1
Right Side Slope .....	50.000	: 1
X-Sectional Area .....	3.287	sq. ft.
Wetted Perimeter .....	25.645	feet
AR^(2/3) .....	0.836	
Mannings 'n' .....	0.013	

```

*****
***
***
***
*** |<----- ( 22.51' )----->| ***
***^^^^^W.S. ( 0.23' )^^^^^***
***
***
***
***
***
***
*****
**

```

## Channel Jc14, Ec5

Triangular Channel

-----

Flowrate .....	6.750	CFS
Velocity .....	2.665	fps
Depth of Flow .....	0.225	feet
Critical Depth .....	0.257	feet
Freeboard .....	0.000	feet
Total Depth .....	0.225	feet
Width at Water Surface ....	22.511	feet
Top Width .....	22.511	feet
Slope of Channel .....	1.000	%
Left Side Slope .....	50.000	: 1
Right Side Slope .....	50.000	: 1
X-Sectional Area .....	2.534	sq. ft.
Wetted Perimeter .....	22.515	feet
AR^(2/3) .....	0.591	
Mannings 'n' .....	0.013	



## INFILTRATION RATE CALCULATIONS

The observed infiltration rate ( $I_t$ ) was converted from the data collected at the final percolation test interval using the Porchet Method equation presented below:

$$I_t = \frac{\Delta H \pi r^2 60}{\Delta t (\pi r^2 + 2 \pi r H_{avg})} = \frac{\Delta H 60 r}{\Delta t (r + 2 H_{avg})}$$

Where:

- $I_t$  = observed infiltration rate, inches per hour
- $\Delta H$  = change in head over the time interval, inches
- $\Delta t$  = time interval, minutes
- $r$  = effective radius of the test hole  $H_{avg}$

**P-1** - The observed infiltration rate for Boring P-3 was calculated as follows:

- Time interval,  $\Delta t$  = 10 minutes
- Final depth to water,  $D_f$  = 101.7 inches
- Test hole radius,  $r$  = 4 inches
- Initial depth to water,  $D_0$  = 93.0 inches
- The total depth of the test hole,  $D_t$  = 120 inches

The conversion equation is used:

$$I_t = \frac{\Delta H 60 r}{\Delta t (r + 2 H_{avg})}$$

$$H_0 = D_t - D_0 = 120 \text{ inches} - 93.0 \text{ inches} = 27.0 \text{ inches}$$

$$H_f = D_t - D_f = 120 \text{ inches} - 101.7 \text{ inches} = 18.3 \text{ inches}$$

$$\Delta H = \Delta D = H_0 - H_f = 27.0 \text{ inches} - 18.3 \text{ inches} = 8.7 \text{ inches}$$

$$H_{avg} = (H_0 + H_f) / 2 = (27.0 + 18.3) / 2 = 22.65 \text{ inches}$$

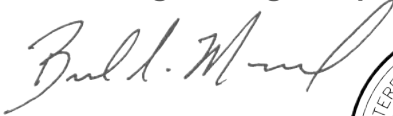
$$\text{P-3 } I_t = \frac{\Delta H 60 r}{\Delta t (r + 2 H_{avg})} = \frac{(8.7 \text{ in})(60 \text{ min/hr})(4 \text{ in})}{10 \text{ min } ((4 \text{ in} + 2 (22.65 \text{ in})))} = 4.24 \text{ in/hr}$$

Summary of Results				
Test Boring	Boring Depth (inches)	Soil Type	Measured Percolation Rate (min/in)	Observed Infiltration Rate (in/hr)
P-3	120	Silty Sand (SM)	1.15	4.24

We appreciate this opportunity to be of service. Should you have questions, please contact our office.

Sincerely,

**Merrell Engineering Company, Inc.**



**Brad S. Merrell, P.E.**

President

R.C.E. 49423



Enclosure 1 – Site Vicinity Map and Google Earth Image

Enclosure 2 – Site Plan Indicating Test Boring Locations

Enclosure 3 – Percolation Test Data Sheet

April 27, 2022

Observed Infiltration Rates Derived Using the Porchet Method

Proposed Park, Warbler Road, East of Sheepcreek Road, Phelan, CA

MJ Project No. 3103.006.500

Page 6