Hydrology and Drainage Study

For

St John the Baptizer Ukrainian Catholic Church
APN 380-112-08-00
Address: Northwest corner of Carlton Oaks Dr. and Pike Rd intersection
Santee, CA 92071
Project No:
Drawing No:

Prepared by:
Jose Raul Gomez, P.E.
3071 Buena Vista Ave.
Lemon Grove, CA 91945
(619) 210-3371
Joseraulgomez1958@gmail.com

Prepared for:
Catherine George
Address: PO Box 3116
La Mesa, CA 91941
(818) 523-4499
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Rev01: April 17, 2023

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1. Declaration of Responsible Charge

DECLARATION OF RESPONSIBLE CHARGE

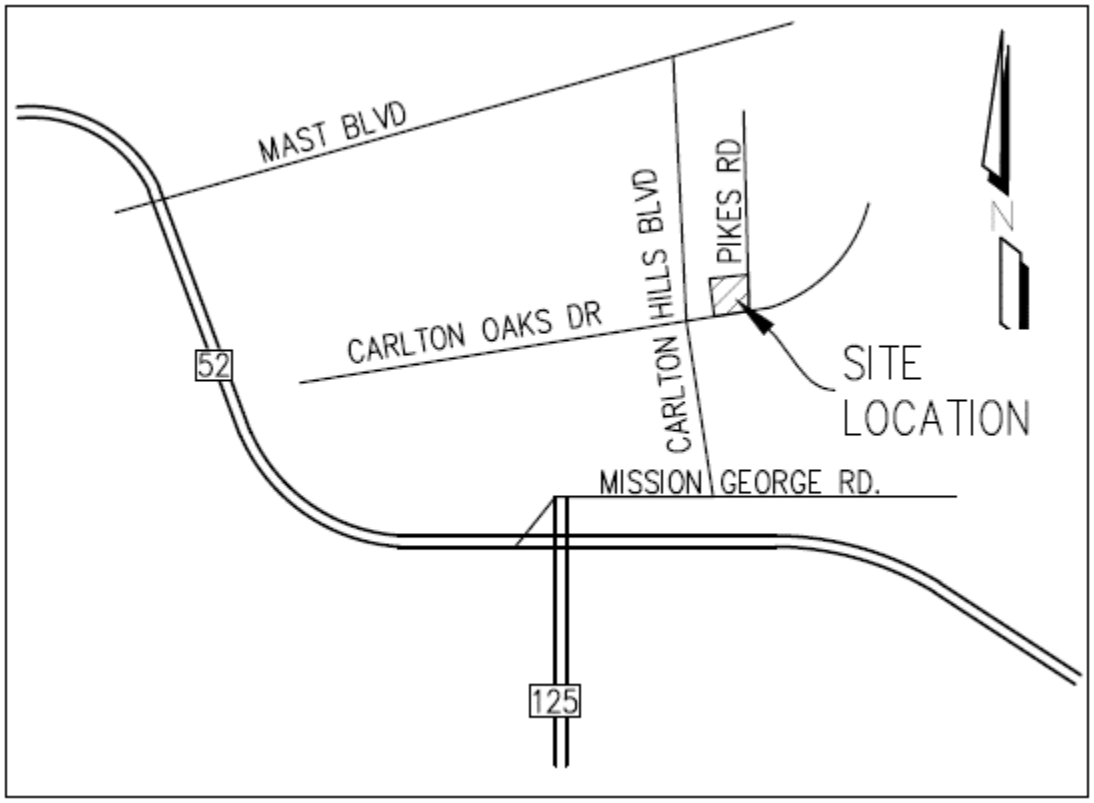
I, hereby declare that I am the civil engineer of work for this project, that I have exercised responsible charge over the design of the project as defined in section 6703 of the business and professions code, and that the design is consistent with current design.

I understand that the check of project drawings and specifications by the County of San Diego is confined to a review only and does not relieve me, as engineer of work, of my responsibilities for project design.

Jose Raul Gomez P.E.
R.C.E. 43306
Exp. 3/31/2022

09-15-20
Date

2. Vicinity Map



3. Introduction

The purpose of this report is to calculate the Peak Runoff Rates during the 100-year event that would be generated flow within the subject property towards the northerly portion of the property. The site is currently undeveloped with a natural slope and a seasonal creek at the west side that discharges into an existing 36" CMP storm drain. Refer to the Grading Plans and to the attached Hydrology Map.

The subject property is located in Santee. The onsite drainage basin is a Natural Terrain with low lying grass natural slope. The offsite basin runoff which is 49 cfs. per City of Santee Hydrology Master Plan, Plate 2, January 1990, concentration point F-20, flows through the existing seasonal creek at the west side of the site and discharges into the existing 36" CMP storm drain. This offside runoff does not impact the onsite drainage basin.
The onsite drainage area is 0.587 acres as shown in the attached Hydrology Map.

The peak runoff rates will be calculated using the Rational Method outlined in the San Diego County Hydrology Manual, June 2003 Edition and will be presented at the points of discharge shown on the respective hydrology maps.

The hydrologic soil type per County of San Diego Soil Hydrologic Groups Map, which is Type D soil. Refer to attached Soil Hydrologic Group Map.

The runoff coefficient will be obtained from Table 3-1. of the County of San Diego's Hydrology Manual, which for type D soil is 0.35 for Natural terrain and 0.71 for High density residential (65% impervious)

The ultimate proposed development will not alter the natural drainage path or divert any drainage from the current existing natural condition or drainage boundaries.

4. Hydrology Calculations

The precipitation rates for the 6-hour & 24-hour 100-year event were obtained from the isopluvial maps in Appendix B of the Hydrology Manual of San Diego County.

P_6 [in]	2.5
P_{24} [in]	4.7
P_6/P_{24}	0.53

To obtain Initial Time of Concentration, Figure 3-3 from San Diego County Hydrology Manual will be used, where:

$$T = \frac{1.8(1.1 - C)\sqrt{D}}{\sqrt[3]{S}}$$

Where C: Runoff coefficient
D: Watercourse Distance (ft.)
S: Slope (%)

The remaining Time of concentration Tc (or Travel time, T_T), Figure 3-4 from San Diego County Hydrology Manual will be used, where:

$$T = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

Where Tc: Time of concentration (hr.)
L: Watercourse Distance (miles)
ΔE: Change in elevation along effective slope line (ft.)

To obtain the intensity, the following formula is used in conjunction with the directions for application on Figure 3-1 of the County of San Diego's Hydrology Manual.

$I = 7.44\ P_6\ D^{-.645}$ [in/ hr] D = Time of concentration.

The Runoff Coefficient C is obtained from Table 3-1. of the County of San Diego's Hydrology Manual.

Onsite – Pre developed condition: Soil D, Natural Terrain → C =0.35
Onsite – Post developed condition: Soil D, 24.0 DU/A (High density Residential) → C =0.71

Runoff rate is calculated using the rational method as indicated in the County of San Diego Hydrology Manual and using the following formula:

Q = CIA*1.008 (cfs)
C = Runoff coefficient
I = Intensity (inches/hour)
A = Area basin (acres)

Junction analyses methodology per section 3.4.2 of San Diego County Hydrology Manual.

For Hydraulics capacity calculations the Manning's Equation from Figure 3-7 of San Diego County Hydrology Manual will be used.

$$Q = VA = \frac{1.49}{n} AR^{2/3} s^{1/2}$$

For Grated inlet capacity Equation 2-16 & 2-18 of San Diego County Drainage Design Manual will be used.

$$Q = C_w P_e d^{3/2} \quad \text{(operating as a weir)}$$

Where: Q: inlet capacity of the grated inlet (ft^3/s)
C_w: weir coefficient (C_w=3.0)
P_e: effective grate perimeter length (ft.)
d: flow depth approaching inlet (ft.)

$$Q = C_o A_e (2dg)^{1/2} \quad \text{(operating as an orifice)}$$

Where: Q: inlet capacity of the grated inlet (ft^3/s)
C_o: orifice coefficient (C_w=0.67)
g: gravitational acceleration (ft/s^2)
d: flow depth approaching inlet (ft.)
A_e: effective grate area (ft^2) = 0.50*A
A: actual opening area (ft^2)

For culvert capacity, Inlet control equations will be used per Appendix A of the *Hydraulic design of Highway culverts, U.S. Department of Transportation, Federal Highway Administration*

Unsubmerged Inlet control equations: Apply up to about $Q/AD^{0.5}$=3.5 (1.93 SI)

Form 1:

$$\frac{HW_i}{D} = \frac{H_C}{D} + K\left[\frac{K_U Q}{AD^{0.5}}\right]^M + K_S S$$

Form 2:

$$\frac{HW_i}{D} = K\left[\frac{K_U Q}{AD^{0.5}}\right]^M$$

Submerged Inlet control equations: Applies above about $Q/AD^{0.5}$=4.0 (2.21 SI)

$$\frac{HW_i}{D} = c\left[\frac{K_U Q}{AD^{0.5}}\right]^2 + Y + K_S S$$

where:

HWi	Headwater depth above inlet control section invert, ft. (m)
D	Interior jeight of culvert barrel, ft. (m)
H_c	Specific head at critical depth ($d_c + V_c^2/2g$), ft (m)
Q	Discharge, cfs (m^3/s)
A	Full cross sectional area of culvert barrel, ft^2 (m^2)
S	Culvert barrel slope, ft/ft (m/m)
K, M, c, Y	Constant from Tables A.1, A.2, A.3
K_u	Unit conversion 1.0 (1.811 SI)
K_s	Slope correction, -0.5 (mitered inlets +0.7)

4.1 Onsite Basin

Pre developed Plan view, Refer to Hydrology Map.

BASIN	A
Area (sf)	25,557
Area (Ac)	0.587

4.1.1 Pre developed condition

Initial time of concentration from equation described in Section 3:

ONSITE	
BASIN	A
D [ft]	22
S %	36
C	0.35
Ti [min]	1.92

Travel time T_T from equation described in Section 3:

ONSITE	
BASIN	A
L [ft]	186
L [miles]	0.035
ΔE [ft]	13.5
T_T [min]	1.19

Time of concentration: $Tc = T_i + T_T$
Intensity is obtained from equation described in Section 3:

ONSITE	
BASIN	A
Ti [min]	1.92
T_T [min]	1.19
T_c [min]	3.11
I [in/hr]	8.95

Total runoff is obtained from equation described in Section 3:

ONSITE	
BASIN	A
Area (Ac)	0.587
C	0.35
I [in/hr]	8.95
Q_{PRE} [cfs]	1.85

Runoff from Basin A will discharge into the existing season creek and headwall at the southwestern corner of the site.

4.1.2 Post developed condition

The storm water for the proposed grade will drain by an earthen swale, get into a proposed grate inlet and discharge into an existing rock lined ditch. Refer to Hydrology Map.

Initial Area and Initial time of concentration from equation described in Section 3:

BASIN	A1	A2
Ai [Ac]	0.031	0.037
D [ft]	22	95
S %	36	3.88
C	0.35	0.71
Ti [min]	1.92	4.35

Intensity for Initial Area from equation in Section 3:

BASIN	A1	A2
Ti [min]	1.92	4.35
I [in/hr]	12.21	7.21

Runoff rate for Initial Area from equation in Section 3:

BASIN	A1	A2
Ai [Ac]	0.031	0.037
C	0.35	0.71
I [in/hr]	12.21	7.21
Qi [cfs]	0.13	0.19

Runoff rate for initial area A1 will flow through an earthen ditch and discharge into the existing seasonal creek

Runoff rate for initial area A2 will flow through a proposed gutter and discharge into a BMP facility for treatment and detention

Earthen Ditch @ 3.88% Capacity

Hydraulic capacity and velocity are obtained using Manning's equations described at Section 3.

n: 0.023 (Manning Roughness coefficient for concrete gutter, Table A-3 San Diego County Drainage Design manual)

Channel type	Triangle	
Q [cfs]	0.13	
n	0.023	
s [ft/ft]	0.0388	
Left Slope Z1	1	to 1 (H:V)
Right Slope Z2	1	to 1 (H:V)

CALCULATIONS	
Flow depth, D [ft]	0.23
Flow area, A [sf]	0.05
Wetted perimeter, P [ft]	0.66
Hydraulic Radius, R [ft]	0.08
AR^2/3	0.01
Top width [ft]	0.46
Flow Velocity [fps]	2.41

Gutter @ 2.9% Capacity

Hydraulic capacity and velocity are obtained using Manning's equations described at Section 3.

n: 0.015 (Manning Roughness coefficient for concrete gutter, Table A-3 San Diego County Drainage Design manual)

Channel type	Triangle	
Q [cfs]	0.19	
n	0.015	
s [ft/ft]	0.029	
Left Slope Z1	0.33	to 1 (H:V)
Right Slope Z2	10.67	to 1 (H:V)

CALCULATIONS	
Flow depth, D [ft]	0.12
Flow area, A [sf]	0.08
Wetted perimeter, P [ft]	1.39
Hydraulic Radius, R [ft]	0.06
AR^2/3	0.01
Top width [ft]	1.30
Flow Velocity [fps]	2.46

Travel time is obtained as follow:

$$T = \frac{L}{V * 60}[min]$$

where: L: Channel Length [ft.]
V: Flow velocity [fps.]

BASIN	A1	A2
V [fps]	2.41	2.46
Length [ft]	102	166
T_T [min]	0.71	1.12

Time of concentration: $Tc = T_i + T_T$
A new Intensity is obtained from equation described in Section 3:

BASIN	A1	A2
Ti [min]	1.92	4.35
T_T [min]	0.71	1.12
Tc [min]	2.63	5.47
I [in/hr]	9.97	6.22

The entire area is added and Total runoff rate is obtained from equation described in Section 3

BASIN	A1	A2
C	0.35	0.71
I [in/hr]	9.97	6.22
A_T [ac]	0.143	0.444
$Q_{POST\ [cfs]}$	0.50	1.98

Runoff from Basin A1 will discharge into the existing headwall at the southwestern corner of the site.
Runoff from Basin A2 will discharge into proposed BMP facility (POC-A) for treatment and detention. The overflow facility will discharge into the existing headwall at the southwestern corner of the site.

Junction Analysis

The junction of basins will be calculated using the procedure for combining independent drainage system per Section 3.4.2 of San Diego County Hydrology Manual.

Junction Equation: $T_1 < T_2 < T_3$: A1 is associated to the shortest Tc

$$Q_{T1} = Q_1 + \frac{T_1}{T_2}Q_2 + \frac{T_1}{T_3}Q_3$$

$$Q_{T2} = Q_2 + \frac{I_2}{I_1}Q_1 + \frac{T_2}{T_3}Q_3$$

$$Q_{T3} = Q_3 + \frac{I_3}{I_1}Q_1 + \frac{I_3}{I_2}Q_2$$

Unmitigated		
Tc [min]	2.63	5.47
I [in/hr]	9.97	6.22
Q_{POST} [cfs]	0.50	1.98
Q_{T1} [cfs]	1.45	
Q_{T2} [cfs]	2.29	

The Unmitigated 100-year Runoff rate for post developed condition is equal to Q_{POST} = 2.29 cfs.

4.1.3 Pre and Post Runoff Calculation Comparison

Point of Confluence	Q Pre [cfs]	Q Post [cfs]	ΔQ [cfs]	
POC-A	1.85	2.29	0.44	MITIGATE

The results for pre and post developed shows the runoff rate increases of 0.44 cfs. This increase is due to the change of impervious surface and runoff coefficient. This increase will be mitigated using a detention facility at the proposed BMP for Basin A2 only. Therefore, the proposed grading will not impact the adjacent properties located downstream of the project.

4.1.4 Detention calculations

Inflow hydrograph

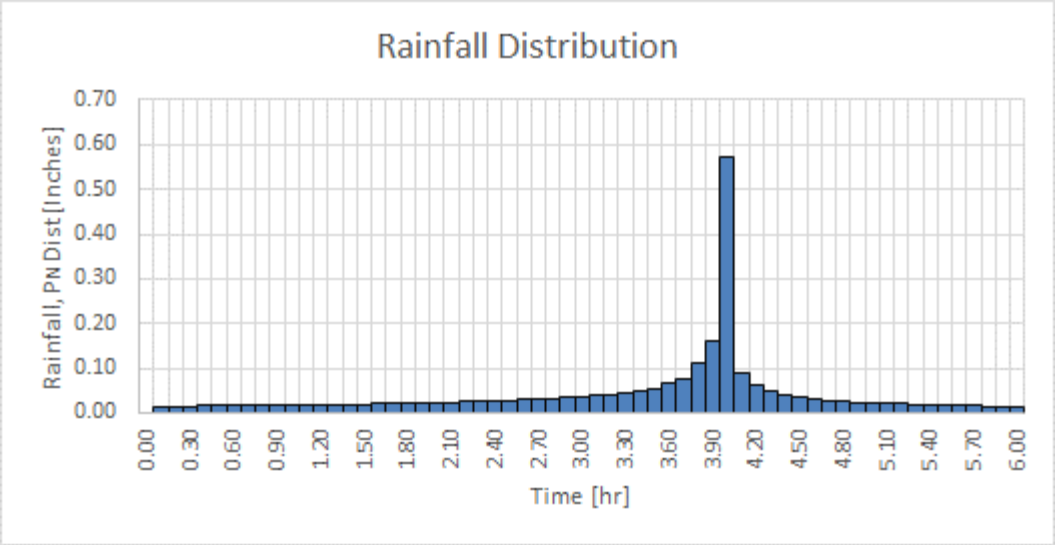
To obtain the Inflow hydrograph the 6-hour, rainfall distribution described at section 6.2.1 of San Diego County Hydrology Manual will be used, where the number of blocks in the distribution is determined by dividing 360 min by the nearest whole number of Tc.

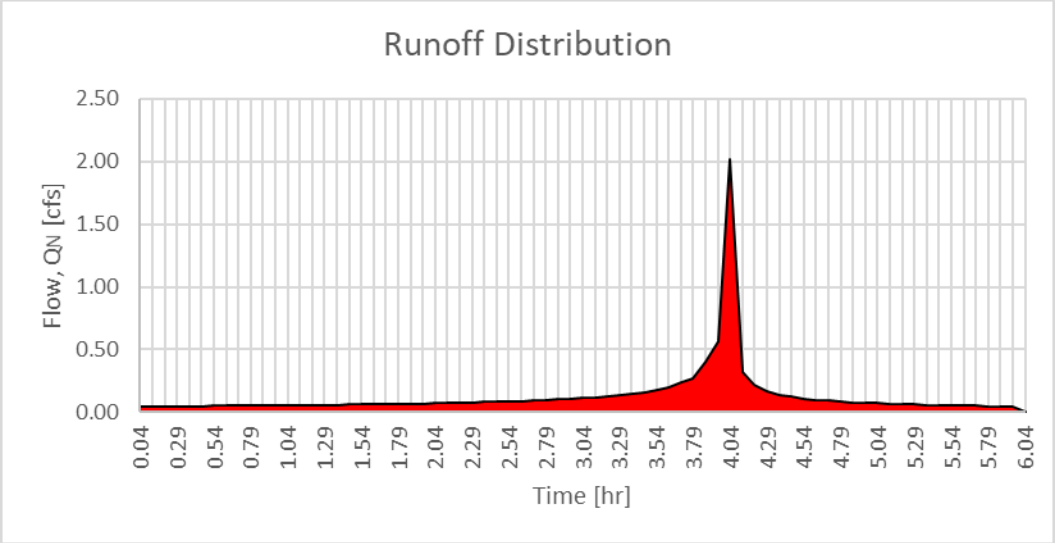
P6 [in]	2.5
P24 [in]	4.7
Area [ac]	0.444
Tc [min]	5.47
Tp [min]	3.66
C	0.71
Blocks	72

Blocks: 72
Ni: Block number
T_N: Time at each block increment = Ni*360/Blocks [minutes]
$P_{T(N)}$: Total amount of rainfall for any given block = $0.124*P6*(N*Tc)^{0.355}$
P_N: Rainfall at block Ni = $P_{T(N)} - P_{T(N-1)}$
$P_{N\ Dist}$: Distributed Rainfall blocks using a 2/3, 1/3 distribution and placing the peak rainfall at the 4-hour time.
I_N: Distributed Intensity for a duration Tc, $I_N = 60*P_N/Tc$ [in/hr],
Q_N [cfs]: Distributed Runoff for a duration Tc, $Q_N = 60*C*A*P_N/Tc$ [cfs] *1.008 (Conversion Factor). The peak Q is placed at the 4-hour + 0.5 Tc time.

Ni	TN [min]	TN [hr]	PT(N)	PN	PN Dist	IN [in/hr	QN [cfs]
0	0.00	0.00	0.00	0.00	0.01	0.14	0.04
1	5.00	0.08	0.57	0.57	0.01	0.14	0.05
2	10.00	0.17	0.72	0.16	0.01	0.14	0.05
3	15.00	0.25	0.84	0.11	0.01	0.15	0.05
4	20.00	0.33	0.93	0.09	0.01	0.15	0.05
5	25.00	0.42	1.00	0.08	0.01	0.15	0.05
6	30.00	0.50	1.07	0.07	0.01	0.15	0.05
7	35.00	0.58	1.13	0.06	0.01	0.15	0.05
8	40.00	0.67	1.19	0.05	0.01	0.16	0.05
9	45.00	0.75	1.24	0.05	0.01	0.16	0.05
10	50.00	0.83	1.28	0.05	0.01	0.16	0.05
11	55.00	0.92	1.33	0.04	0.02	0.17	0.05
12	60.00	1.00	1.37	0.04	0.02	0.17	0.05
13	65.00	1.08	1.41	0.04	0.02	0.17	0.05
14	70.00	1.17	1.45	0.04	0.02	0.18	0.06
15	75.00	1.25	1.48	0.04	0.02	0.18	0.06
16	80.00	1.33	1.52	0.03	0.02	0.18	0.06
17	85.00	1.42	1.55	0.03	0.02	0.19	0.06
18	90.00	1.50	1.58	0.03	0.02	0.19	0.06
19	95.00	1.58	1.61	0.03	0.02	0.19	0.06
20	100.00	1.67	1.64	0.03	0.02	0.20	0.06
21	105.00	1.75	1.67	0.03	0.02	0.20	0.06
22	110.00	1.83	1.70	0.03	0.02	0.21	0.07
23	115.00	1.92	1.72	0.03	0.02	0.21	0.07
24	120.00	2.00	1.75	0.03	0.02	0.22	0.07
25	125.00	2.08	1.78	0.03	0.02	0.22	0.07
26	130.00	2.17	1.80	0.02	0.02	0.23	0.07
27	135.00	2.25	1.83	0.02	0.02	0.24	0.08
28	140.00	2.33	1.85	0.02	0.02	0.25	0.08
29	145.00	2.42	1.87	0.02	0.02	0.25	0.08
30	150.00	2.50	1.90	0.02	0.02	0.27	0.08
31	155.00	2.58	1.92	0.02	0.02	0.27	0.09
32	160.00	2.67	1.94	0.02	0.03	0.29	0.09
33	165.00	2.75	1.96	0.02	0.03	0.30	0.09
34	170.00	2.83	1.98	0.02	0.03	0.31	0.10
35	175.00	2.92	2.00	0.02	0.03	0.32	0.10
36	180.00	3.00	2.02	0.02	0.03	0.35	0.11

Ni	TN [min]	TN [hr]	PT(N)	PN	PN Dist	IN [in/hr	QN [cfs]
37	185.00	3.08	2.04	0.02	0.03	0.36	0.11
38	190.00	3.17	2.06	0.02	0.04	0.39	0.12
39	195.00	3.25	2.08	0.02	0.04	0.41	0.13
40	200.00	3.33	2.10	0.02	0.04	0.46	0.15
41	205.00	3.42	2.12	0.02	0.04	0.48	0.15
42	210.00	3.50	2.14	0.02	0.05	0.56	0.18
43	215.00	3.58	2.15	0.02	0.05	0.60	0.19
44	220.00	3.67	2.17	0.02	0.07	0.74	0.23
45	225.00	3.75	2.19	0.02	0.08	0.84	0.27
46	230.00	3.83	2.21	0.02	0.11	1.23	0.39
47	235.00	3.92	2.22	0.02	0.16	1.73	0.55
48	240.00	4.00	2.24	0.02	0.57	6.22	1.98
49	245.00	4.08	2.26	0.02	0.09	0.99	0.31
50	250.00	4.17	2.27	0.02	0.06	0.66	0.21
51	255.00	4.25	2.29	0.02	0.05	0.52	0.16
52	260.00	4.33	2.30	0.02	0.04	0.43	0.14
53	265.00	4.42	2.32	0.02	0.03	0.38	0.12
54	270.00	4.50	2.34	0.02	0.03	0.34	0.11
55	275.00	4.58	2.35	0.02	0.03	0.31	0.10
56	280.00	4.67	2.37	0.02	0.03	0.28	0.09
57	285.00	4.75	2.38	0.01	0.02	0.26	0.08
58	290.00	4.83	2.40	0.01	0.02	0.24	0.08
59	295.00	4.92	2.41	0.01	0.02	0.23	0.07
60	300.00	5.00	2.42	0.01	0.02	0.22	0.07
61	305.00	5.08	2.44	0.01	0.02	0.21	0.07
62	310.00	5.17	2.45	0.01	0.02	0.20	0.06
63	315.00	5.25	2.47	0.01	0.02	0.19	0.06
64	320.00	5.33	2.48	0.01	0.02	0.18	0.06
65	325.00	5.42	2.49	0.01	0.02	0.17	0.06
66	330.00	5.50	2.51	0.01	0.02	0.17	0.05
67	335.00	5.58	2.52	0.01	0.01	0.16	0.05
68	340.00	5.67	2.53	0.01	0.01	0.16	0.05
69	345.00	5.75	2.55	0.01	0.01	0.15	0.05
70	350.00	5.83	2.56	0.01	0.01	0.15	0.05
71	355.00	5.92	2.57	0.01	0.01	0.14	0.05
72	360.00	6.00	2.59	0.01	0.00	0.00	0.00





The footprint area of the detention basin is equal to 488 sf. at the elevation 335.22 with 0.5 ft. ponding depth (3:1 side slopes, 2 sides). An overflow structure with a 2 feet length weir will be located at elevation 335.89 (0.67 feet above finish grade) where the surface area is equal to 549 sf.

The discharge capacity at the weir is calculated using the broad crested weir equation,

$$Q = C_{bcw} * L * H^{1.5}, \text{ where:}$$

L: Weir Length [ft.]
H: Measured Head (2" increment (0.17 ft.)).
C_{bcw}: Broad Crested Weir Coefficient is obtained and interpolated (0.17 ft. H increment) from table 6-1 San Diego County Hydraulic Design Manual, 2014.

Measured Head (H) (1)	Weir Crest Breadth, b (ft)										
	0.5	0.75	1	1.5	2	2.5	3	4	5	10	15
0.17	2.80	2.75	2.69	2.62	2.54	2.48	2.44	2.38	2.34	2.49	2.68
0.33	2.88	2.78	2.71	2.63	2.59	2.56	2.53	2.49	2.45	2.54	2.69
0.50	3.00	2.85	2.74	2.64	2.61	2.60	2.63	2.62	2.60	2.63	2.70
0.67	3.15	2.94	2.78	2.65	2.61	2.60	2.68	2.69	2.69	2.70	2.68
0.83	3.30	3.06	2.87	2.69	2.61	2.61	2.67	2.68	2.68	2.69	2.64
1.00	3.32	3.14	2.98	2.75	2.66	2.64	2.65	2.67	2.68	2.68	2.63

Weir Crest Breadth b = 0.5 ft.

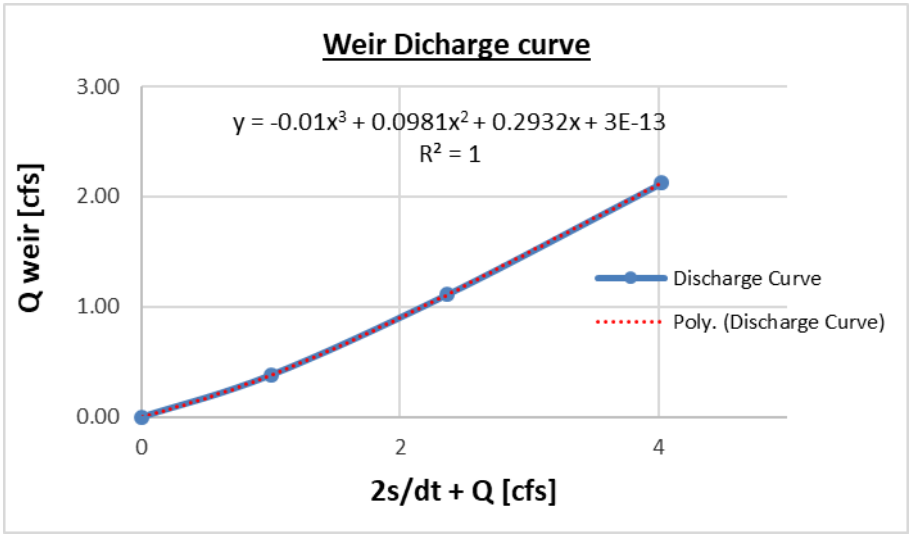
Weir discharge table

WEIR DISCHARGE CURVE				
Elev [ft]	A [sf]	Qweir [cfs]	S [cf]	2S/dt + Q
335.89	549	0.00	0.00	0.00
336.05	564	0.38	92.75	1.00
336.22	579	1.11	188.00	2.36
336.39	595	2.12	285.83	4.03

Where:

Elev: Elevation at BMP facility [ft]
A: BMP surface area at elevation i [sf]
Q_{weir}: Weir Discharge at elevation i [cfs]
S: Storage volume at elevation i. [cf]
2S/dt + Q: Storage-Outflow at elevation i

The above values from columns 3 and 5 were plotted to generate a curve with corresponding formula. The formula was generated using the polynomial regression analysis.

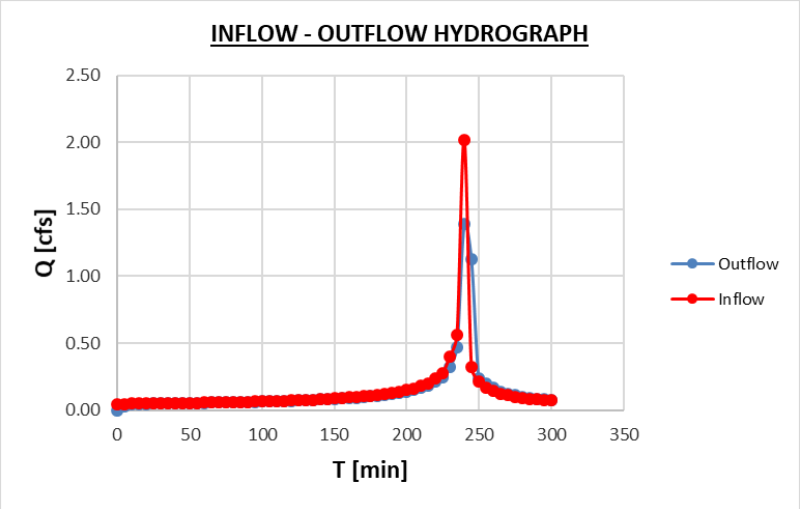


To build the inflow & outflow hydrograph, we used the methodology described in section 6.3 Design Procedure – Detention Routing Analysis, of the San Diego County Hydraulic Design Manual, September 2014. Where:

T: Time increment [min]
Ij: Inflow rate at Time j [cfs]
I_j+I_{j+1}: Inflow rate at time j + Inflow rate at time j+1 [cfs]
$2S_j/dt - Q_j$: Storage-Outflow at time j [cfs]
$2S_{j+1}/dt + Q_{j+1}$: Storage-Outflow at time j+1 [cfs]
Q_{out}: Outflow rate [cfs]

INFLOW - OUTFLOW HYDROGRAPH						
Line #	T [min]	Ij [cfs]	Ij + Ij+1 [cfs]	2Sj/dt - Qj [cfs]	2Sj+1/dt + Qj+1 [cfs]	Qout [cfs]
0	0.00	0.04	0	0	0	0.00
1	5.00	0.05	0.09	0.04	0.09	0.03
2	10.00	0.05	0.09	0.05	0.13	0.04
3	15.00	0.05	0.09	0.05	0.14	0.04
4	20.00	0.05	0.09	0.06	0.15	0.05
5	25.00	0.05	0.09	0.06	0.15	0.05
6	30.00	0.05	0.10	0.06	0.15	0.05
7	35.00	0.05	0.10	0.06	0.16	0.05
8	40.00	0.05	0.10	0.06	0.16	0.05
9	45.00	0.05	0.10	0.06	0.16	0.05
10	50.00	0.05	0.10	0.06	0.16	0.05
11	55.00	0.05	0.10	0.06	0.17	0.05
12	60.00	0.05	0.11	0.06	0.17	0.05
13	65.00	0.05	0.11	0.07	0.17	0.05
14	70.00	0.06	0.11	0.07	0.18	0.05
15	75.00	0.06	0.11	0.07	0.18	0.06
16	80.00	0.06	0.11	0.07	0.18	0.06
17	85.00	0.06	0.12	0.07	0.19	0.06
18	90.00	0.06	0.12	0.07	0.19	0.06
19	95.00	0.06	0.12	0.07	0.19	0.06
20	100.00	0.06	0.12	0.07	0.20	0.06
21	105.00	0.06	0.13	0.08	0.20	0.06
22	110.00	0.07	0.13	0.08	0.21	0.06
23	115.00	0.07	0.13	0.08	0.21	0.07
24	120.00	0.07	0.14	0.08	0.22	0.07
25	125.00	0.07	0.14	0.08	0.22	0.07
26	130.00	0.07	0.15	0.08	0.23	0.07
27	135.00	0.08	0.15	0.09	0.23	0.07
28	140.00	0.08	0.15	0.09	0.24	0.08
29	145.00	0.08	0.16	0.09	0.25	0.08
30	150.00	0.08	0.17	0.09	0.26	0.08
31	155.00	0.09	0.17	0.10	0.27	0.08
32	160.00	0.09	0.18	0.10	0.27	0.09
33	165.00	0.09	0.19	0.10	0.28	0.09
34	170.00	0.10	0.19	0.11	0.30	0.10
35	175.00	0.10	0.20	0.11	0.31	0.10
36	180.00	0.11	0.21	0.11	0.32	0.10
37	185.00	0.11	0.23	0.12	0.34	0.11
38	190.00	0.12	0.24	0.12	0.36	0.12
39	195.00	0.13	0.26	0.13	0.38	0.12

INFLOW - OUTFLOW HYDROGRAPH						
Line #	T [min]	Ij [cfs]	Ij + Ij+1 [cfs]	2Sj/dt - Qj [cfs]	2Sj+1/dt + Qj+1 [cfs]	Qout [cfs]
40	200.00	0.15	0.28	0.14	0.41	0.13
41	205.00	0.15	0.30	0.14	0.44	0.15
42	210.00	0.18	0.33	0.15	0.48	0.16
43	215.00	0.19	0.37	0.17	0.52	0.18
44	220.00	0.23	0.43	0.18	0.59	0.21
45	225.00	0.27	0.50	0.20	0.68	0.24
46	230.00	0.39	0.66	0.22	0.85	0.32
47	235.00	0.55	0.94	0.25	1.16	0.46
48	240.00	1.98	2.53	0.06	2.77	1.35
49	245.00	0.31	2.29	0.15	2.35	1.10
50	250.00	0.21	0.52	0.20	0.67	0.24
51	255.00	0.16	0.37	0.18	0.57	0.20
52	260.00	0.14	0.30	0.15	0.48	0.16
53	265.00	0.12	0.26	0.14	0.41	0.14
54	270.00	0.11	0.23	0.13	0.37	0.12
55	275.00	0.10	0.20	0.12	0.33	0.11
56	280.00	0.09	0.19	0.11	0.30	0.10
57	285.00	0.08	0.17	0.10	0.28	0.09
58	290.00	0.08	0.16	0.09	0.26	0.08
59	295.00	0.07	0.15	0.09	0.25	0.08
60	300.00	0.07	0.14	0.09	0.23	0.07
61	305.00	0.07	0.13	0.08	0.22	0.07
62	310.00	0.06	0.13	0.08	0.21	0.07
63	315.00	0.06	0.12	0.08	0.20	0.06
64	320.00	0.06	0.12	0.07	0.19	0.06
65	325.00	0.06	0.11	0.07	0.18	0.06
66	330.00	0.05	0.11	0.07	0.18	0.06
67	335.00	0.05	0.10	0.07	0.17	0.05
68	340.00	0.05	0.10	0.06	0.17	0.05
69	345.00	0.05	0.10	0.06	0.16	0.05
70	350.00	0.05	0.09	0.06	0.16	0.05
71	355.00	0.05	0.09	0.06	0.15	0.05
72	360.00	0.00	0.05	0.04	0.10	0.03



The maximum outflow runoff from basin A2 is equal to 1.39 cfs. The maximum water surface elevation is 336.26.

Junction Analysis for mitigated condition

The junction of basins will be calculated using the procedure for combining independent drainage system per Section 3.4.2 of San Diego County Hydrology Manual.

Junction Equation: $T_1 < T_2 < T_3$: A1 is associated to the shortest Tc

$$Q_{T1} = Q_1 + \frac{T_1}{T_2}Q_2 + \frac{T_1}{T_3}Q_3$$

$$Q_{T2} = Q_2 + \frac{I_2}{I_1}Q_1 + \frac{T_2}{T_3}Q_3$$

$$Q_{T3} = Q_3 + \frac{I_3}{I_1}Q_1 + \frac{I_3}{I_2}Q_2$$

Mitigated		
Tc [min]	2.63	5.47
I [in/hr]	9.97	6.22
Q_{POST} [cfs]	0.50	1.35
Q_{T1} [cfs]	1.15	
Q_{T2} [cfs]	1.67	

The Mitigated 100-year Runoff rate for post developed condition is equal to Q_{POST} = 1.67 cfs. which is less than runoff for pre developed condition.

Outlet Pipe Capacity Calculation (Per Section 3, this Report)

Runoff from Biofiltration Basin BF-A will flow through a 12" HDPE/PVC pipe @ 1% and discharges into the existing seasonal creek / headwall. **For Hydraulic Analyses and capacity calculations, Unmitigated runoff rates will be used.**

n: 0.013 (Manning Roughness coefficient for HDPE/PVC Pipes, Table A-2 San Diego County Hydraulic Design manual, 2014)

Channel type	Circle
Q [cfs]	1.98
n	0.013
s [ft/ft]	0.01
Radius [ft]	0.50

CALCULATIONS	
Flow depth, D [ft]	0.53
Flow area, A [sf]	0.42
Wetted perimeter, P [ft]	1.63
Hydraulic Radius, R [ft]	0.26
AR^2/3	0.17
Top width [ft]	1.00
Flow Velocity [fps]	4.67

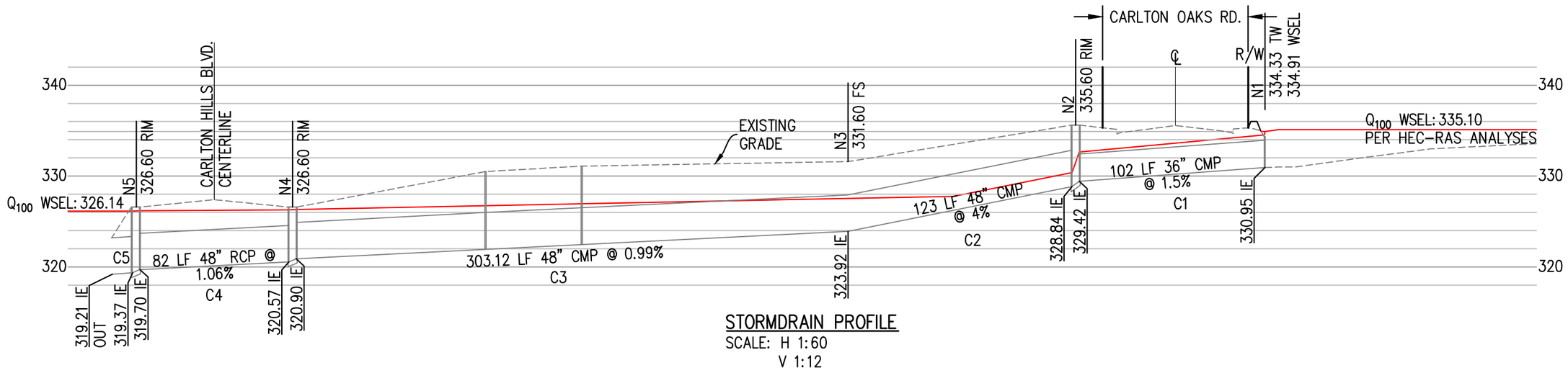
4.2 Offsite Basin

4.2.1 Existing Stormdrain

Per City of Santee Citywide Drainage study and Hydrology Master Plan, Plate 2, January 1990, a 100-year runoff of 49 cfs flow through the existing seasonal creek and discharges into the existing headwall and 36" CMP pipe at the southwest corner of the site (concentration point f-20, conduit f15e) which has a capacity of 44 cfs. (5 cfs deficit).
Per FEMA National Flood Hazard Layer FIRMette (attached) the existing storm drain discharges (621 feet downstream approximately) into the Zone AE of San Diego River on a water surface elevation of 326.14 (interpolated between 323 and 327) which mean that the outlet is submerged and the capacity of the stormdrain will be obtained based on tail water elevation.

Headwater depth for the existing stormdrain and headwall will be calculate using Section 3.3.6 of San Diego County Hydraulic Design Manual 2014, Table 3-11 for clean-out head loss coefficient K=0.15 and Table 3-15 for corrugated metal pipe with headwall entrance loss coefficient $K_E = 0.5$

For capacity and HGL calculation see next page.



STORMDRAIN PROFILE
SCALE: H 1:60
V 1:12

Sf %	(Q*n/0.46*Dia^8/3)^2
Hf [ft]	L*Sf
HL [ft]	Vo2/2g - K Vi2/2g
HL [ft]	KVo^2/2g

FULL CAPACITY
V=Q/A

Element		Invert elevation	Q [cfs]	n	Diameter [ft]	L [ft]	Slope %	Vo [ft/sec]	d [ft]	dc [ft]	(d+dc)/2 [ft]	Sf%	Hf [ft]	K	HL [ft]	Normal depth elev	WSELEV	IE + (d+dc)/2	HGL	Top Grade
Node O (Outlet)	out	319.21				-	-	3.90	-	-	-	-	-		-	-	326.14	326.14	326.14	326.60
Conduit 5	out	319.21	49	0.013	4	11.3	1.42	3.90	1.46	2.08	1.77	0.0012	0.01		-	320.67	326.14	-	326.14	326.60
	in	319.37														320.83	326.15	-	326.15	
Node N5	out	319.37				-	-	-	-	-	-	-	-	0.15	0.04	320.83	326.15	-	326.15	326.60
	in	319.70														321.28	326.19	321.53	326.19	
Conduit 4	out	319.70	49	0.013	4	82	1.06	3.90	1.58	2.08	1.83	0.0012	0.10		-	321.28	326.19	-	326.19	326.60
	in	320.57														322.15	326.29	-	326.29	
Node N4	out	320.57				-	-	-	-	-	-	-	-	0.15	0.04	322.15	326.29	-	326.29	326.60
	in	320.90														323.20	326.32	323.09	326.32	
Conduit 3	out	320.90	49	0.024	4	303.12	1.00	3.90	2.30	2.08	2.19	0.0040	1.21		-	323.20	326.32	-	326.32	331.10
	in	323.92														326.22	327.54	-	327.54	
Node N3	out	323.92				-	-	-	-	-	-	-	-		0.00	326.22	327.54	-	327.54	331.60
	in	323.92														325.46	327.54	325.73	327.54	
Conduit 2	out	323.92	49	0.024	4	123	4.00	3.90	1.54	2.08	1.81	0.0040	0.49		-	325.46	327.54	-	327.54	331.60
	in	328.84														330.38	328.03	-	330.38	
Node N2	out	328.84				-	-	-	-	-	-	-	-	0.15	0.04	330.38	330.38	-	330.38	335.60
	in	329.42														332.42	330.42	332.64	332.64	
Conduit 1	out	329.42	49	0.024	3	102	1.50	6.93	3.00	3.44	3.22	0.0186	1.90		-	332.42	332.64	-	332.64	335.60
	in	330.95														333.95	334.54	-	334.54	
Node N1	out	330.95				-	-	-	-	-	-	-	-	0.5	0.37	333.95	334.54	-	334.54	334.33 TW
	in	331.28															334.91	-	334.91	

4.2.2 Natural Creek Hydraulic Calculations – HEC-RAS Analysis

The Hydraulic analysis for the natural creek was performed using HEC-RAS software V. 5.0.7. The data used in the analysis was imported from the project topographic map. The Manning's "n" values along the channel were determined based on field observations and in accordance with Table A-3 of San Diego County Hydraulic Design Manual, 2014.

The boundary conditions to be used as follows:
Upstream: Normal depth. Slope 0.985% obtained from Topographic map.
Downstream: Known Water surface elevation (334.91 per HGL calculations, Section 4.2.1).

The Downstream Boundary (Station 0) is located at the existing culvert with headwall.

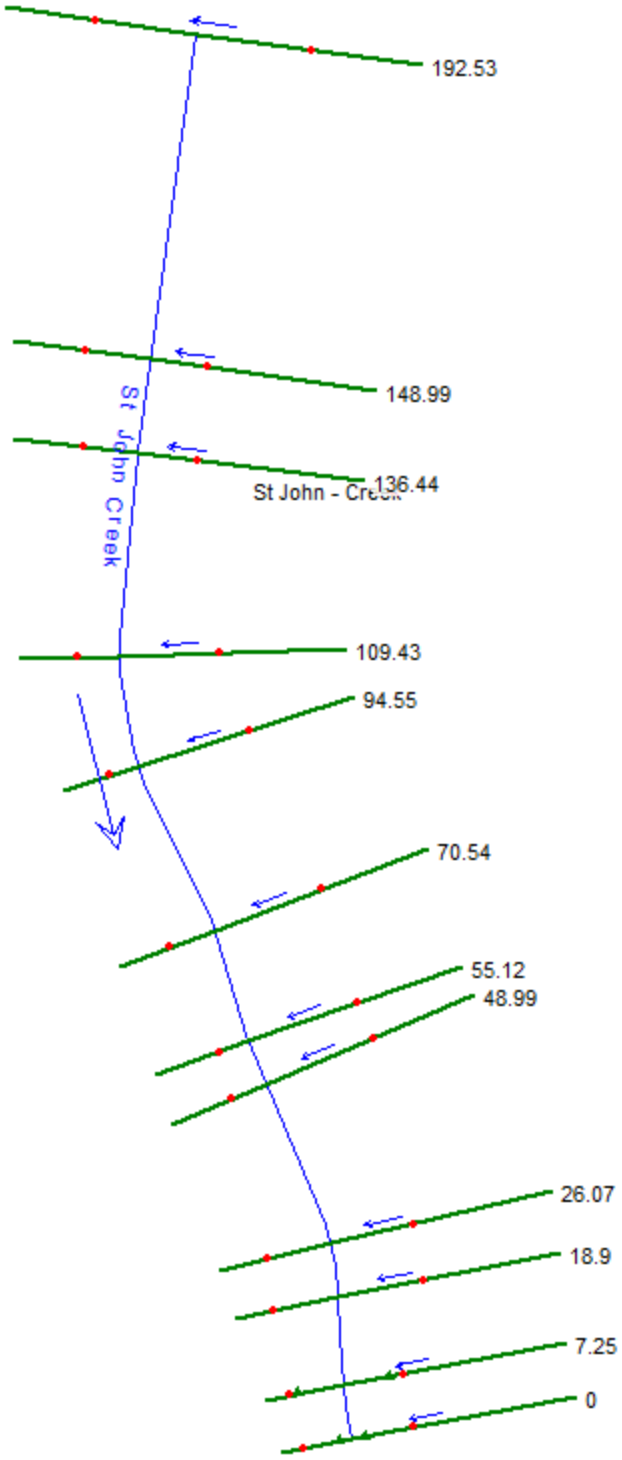
The Runoff rates to used will be the value described in Section 4.2.1 of this report and will be added in the upstream boundary (Station 192.53)

Offsite Basin: Q=49 cfs.

The Analysis was run for Pre and Post developed condition.

Plan view Existing condition - NTS

4.2.2.1 Pre-Developed Condition

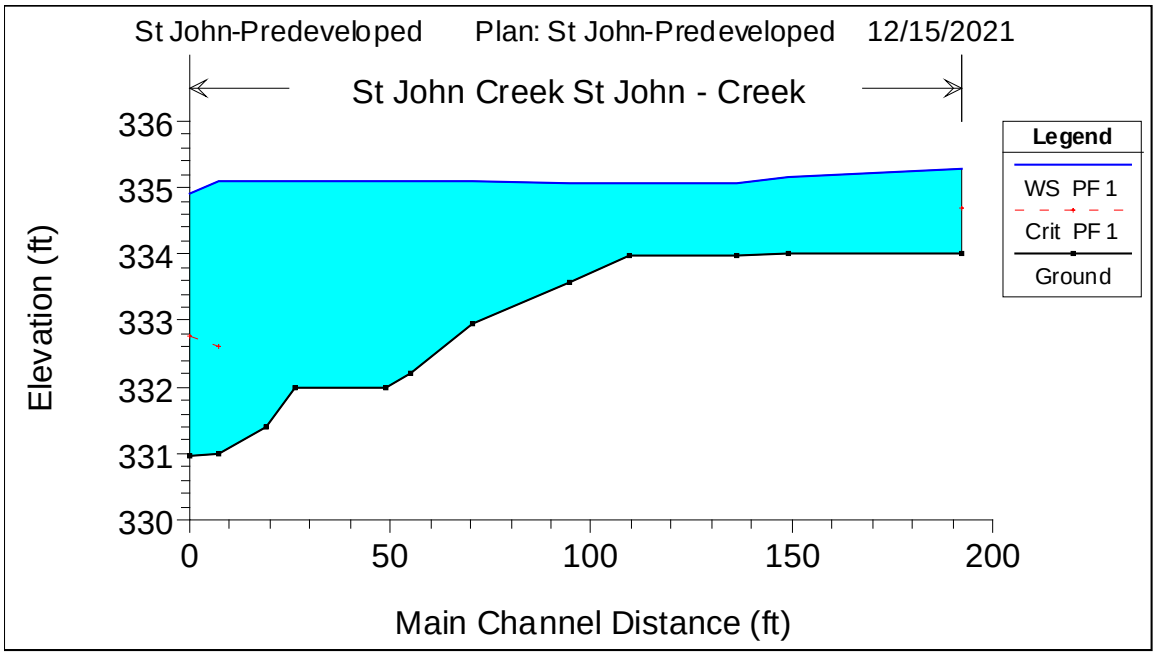


Pre-Developed Condition Plan - NTS

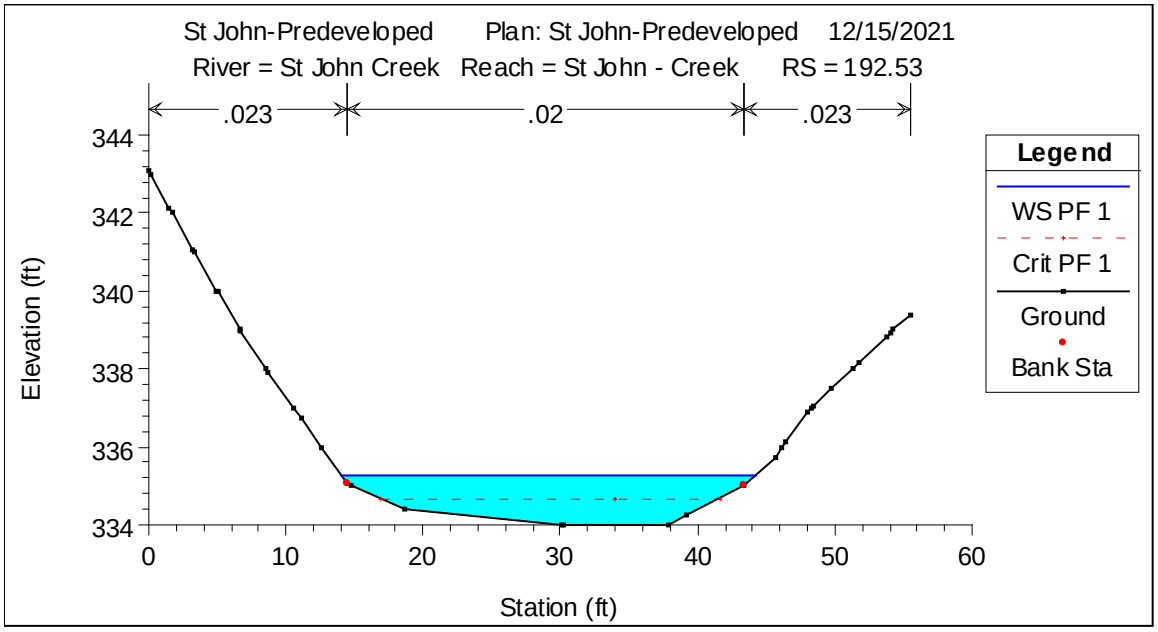
n values per Table A-3, as shown bellow

	River Station	Frctn (n/K)	n #1	n #2	n #3
1	192.53	n	0.023	0.02	0.023
2	148.99	n	0.023	0.02	0.023
3	136.44	n	0.023	0.02	0.023
4	109.43	n	0.023	0.02	0.023
5	94.55	n	0.023	0.02	0.023
6	70.54	n	0.023	0.02	0.023
7	55.12	n	0.023	0.02	0.023
8	48.99	n	0.023	0.02	0.023
9	26.07	n	0.023	0.02	0.023
10	18.9	n	0.023	0.04	0.023
11	7.25	n	0.023	0.013	0.023
12	0	n	0.023	0.013	0.023

St John rear creek profile

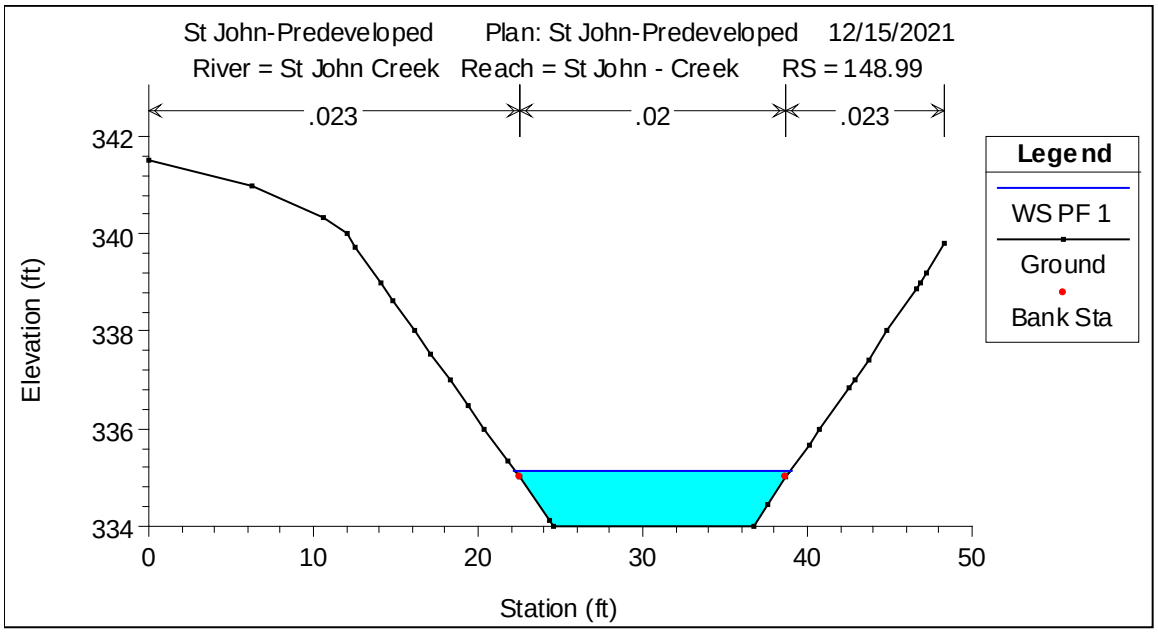


Station 192.53 Northern property line



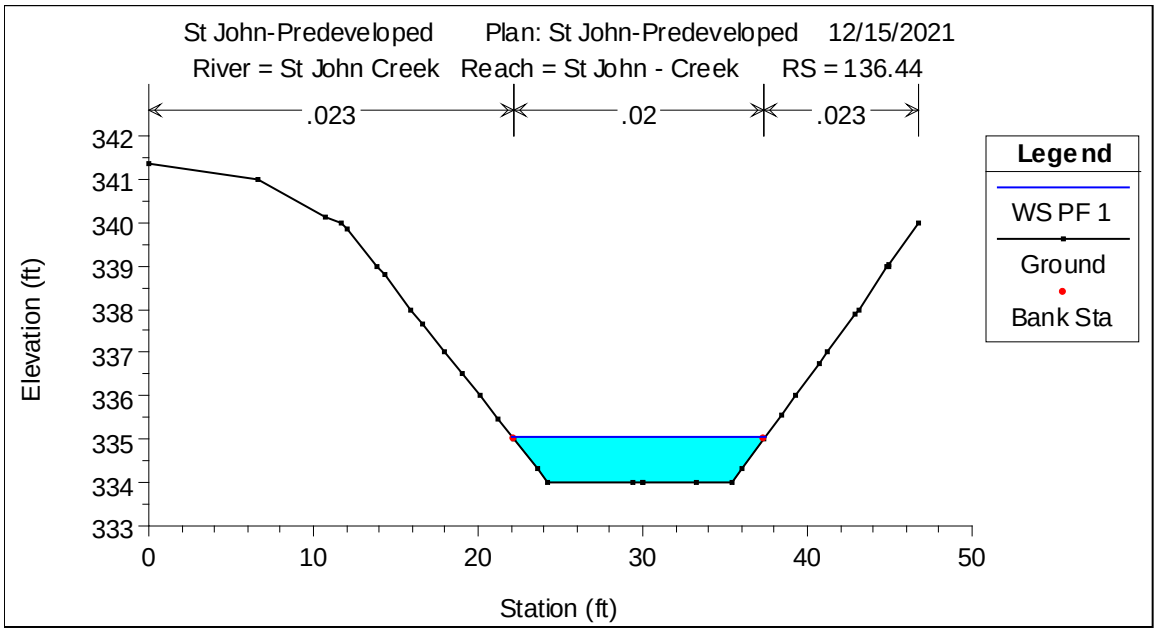
Water surface elevation = 335.29

Station 148.99



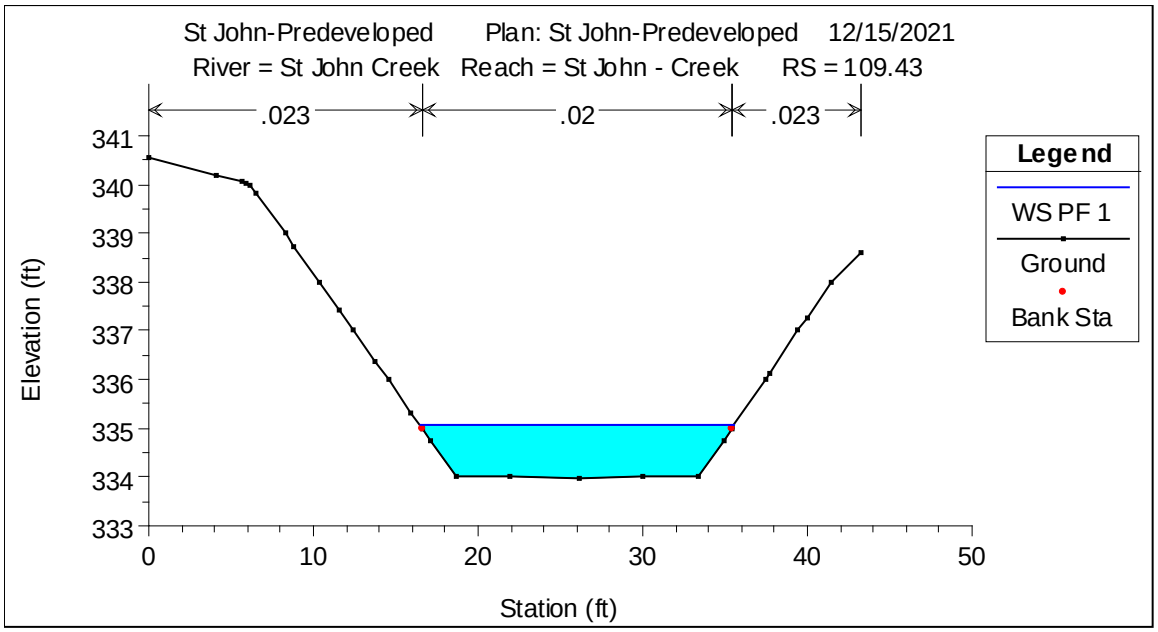
Water surface elevation = 335.15

Station 136.44



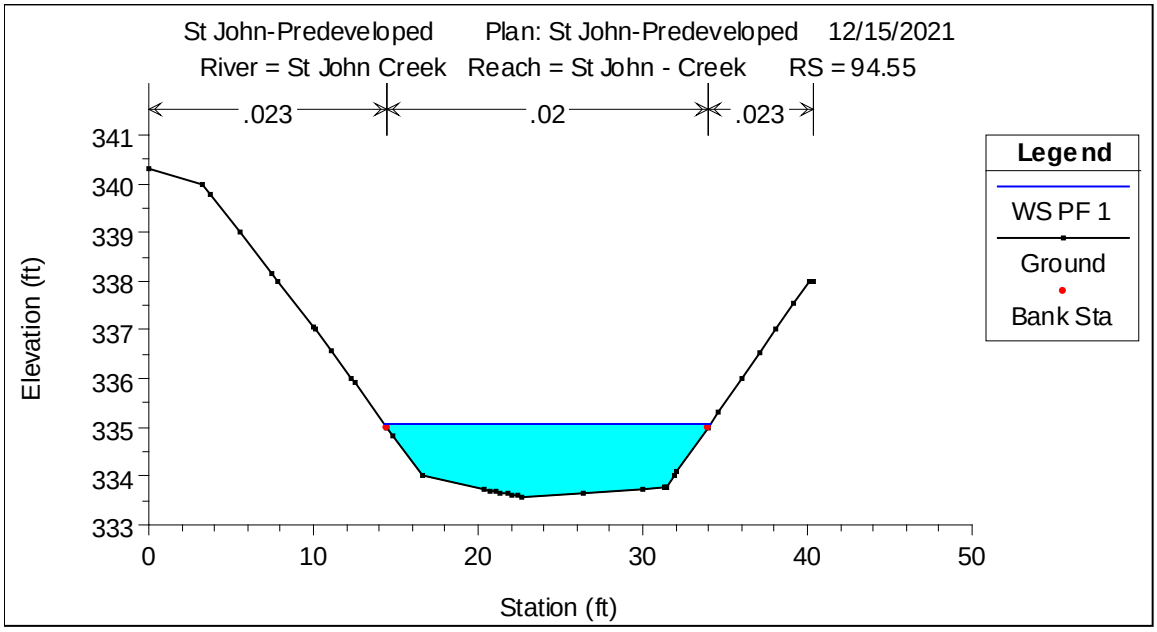
Water surface elevation = 335.07

Station 109.43



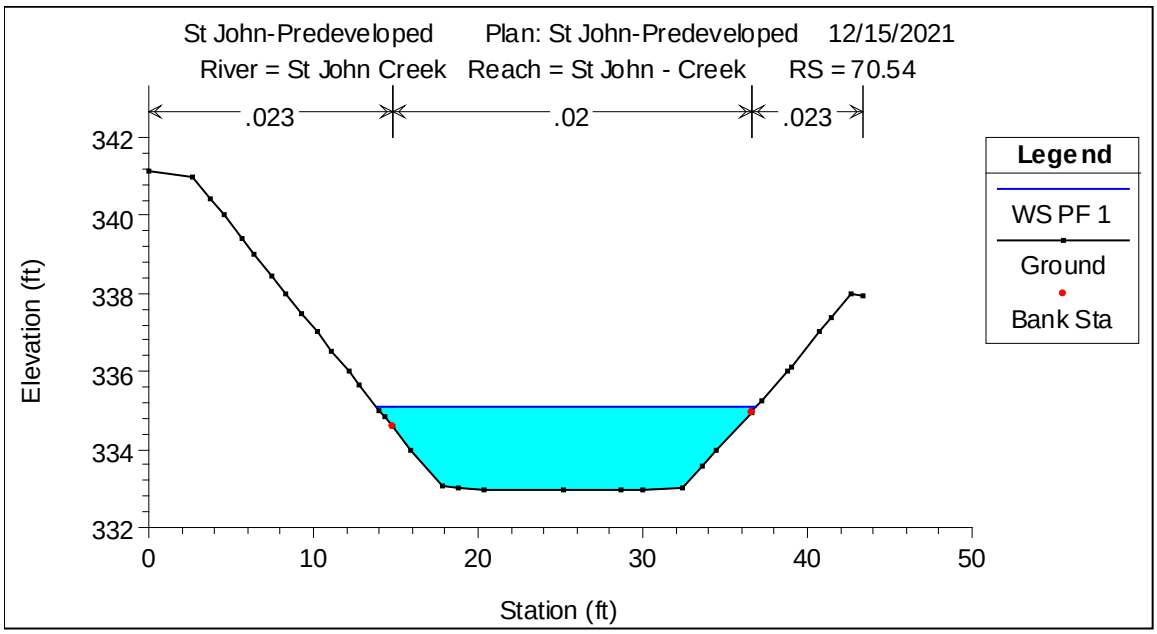
Water surface elevation = 335.06

Station 94.55



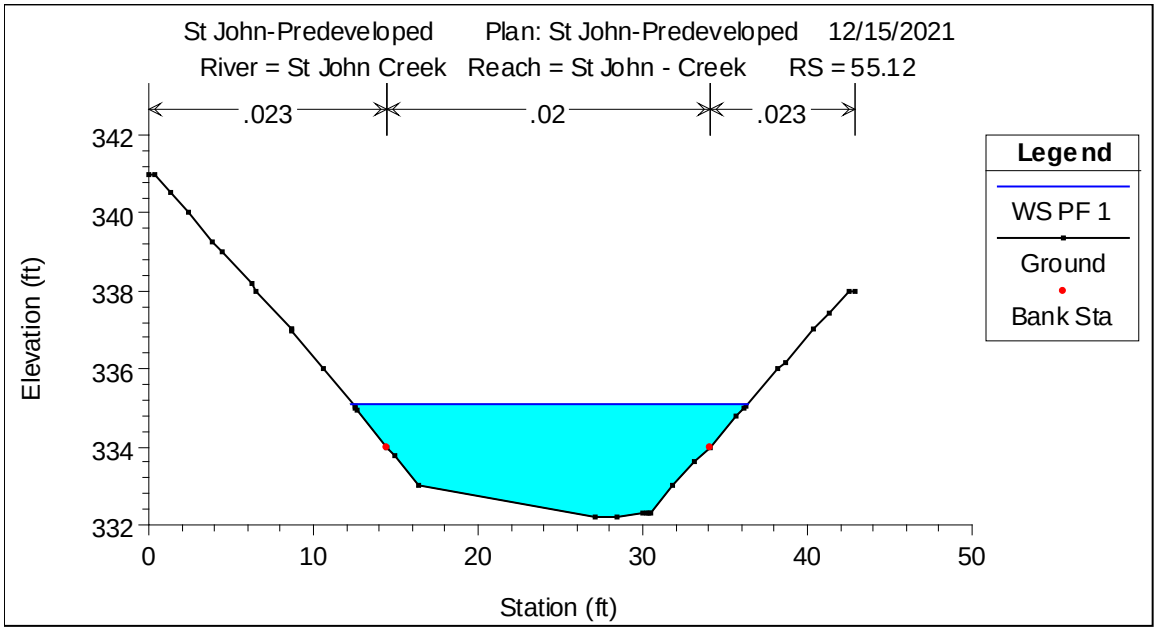
Water surface elevation = 335.08

Station 70.54



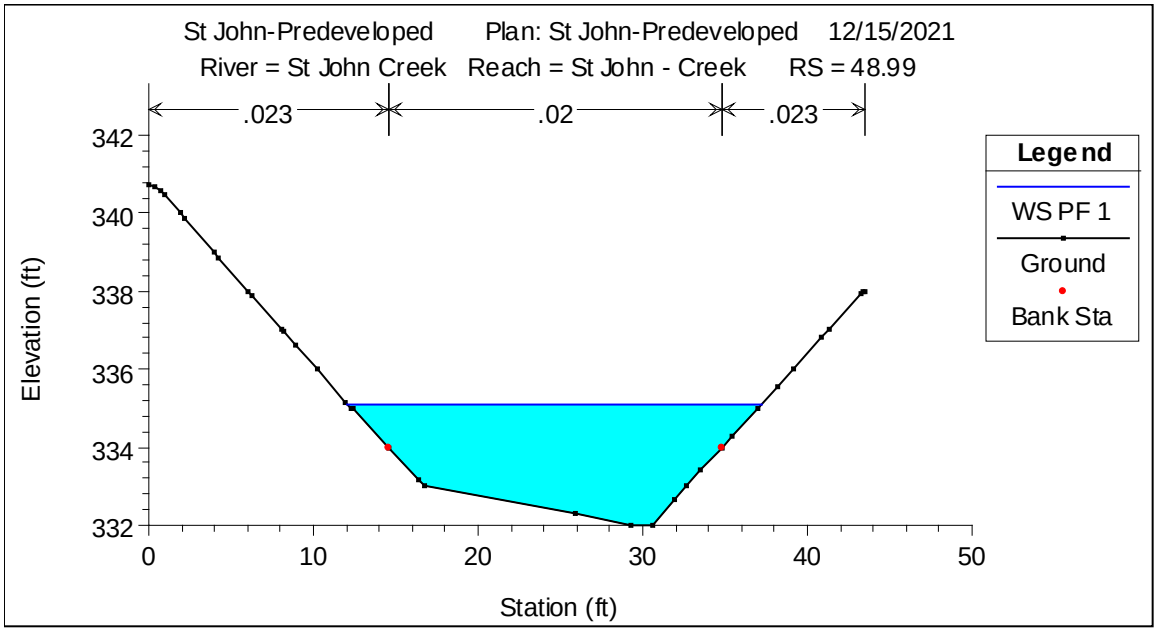
Water surface elevation = 335.11

Station 55.12



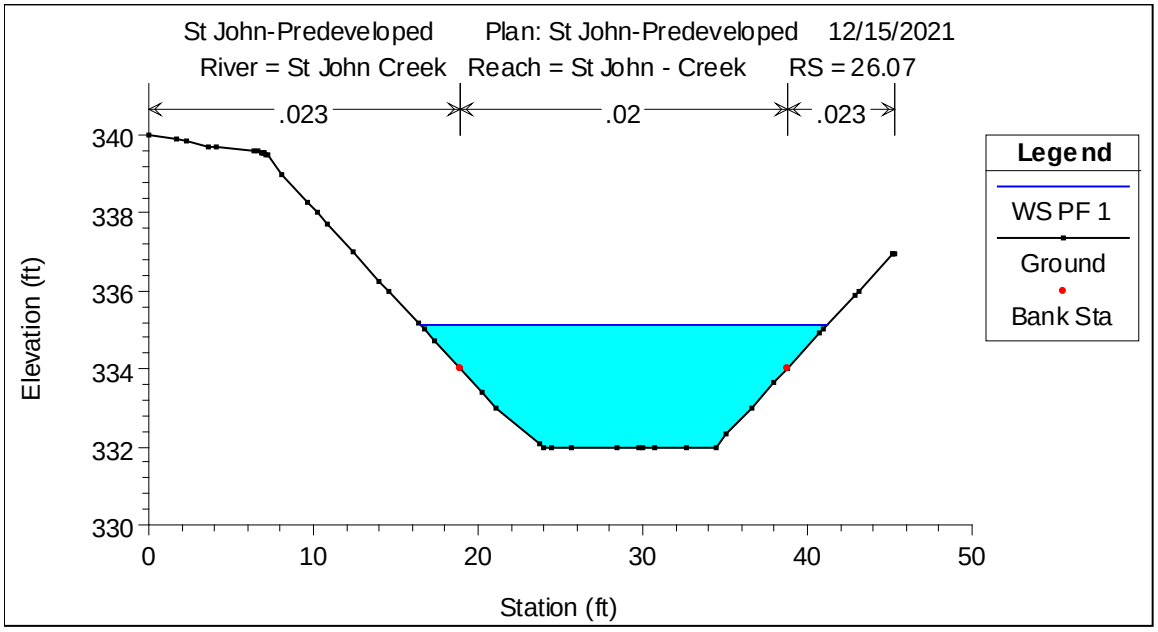
Water surface elevation = 335.11

Station 48.99



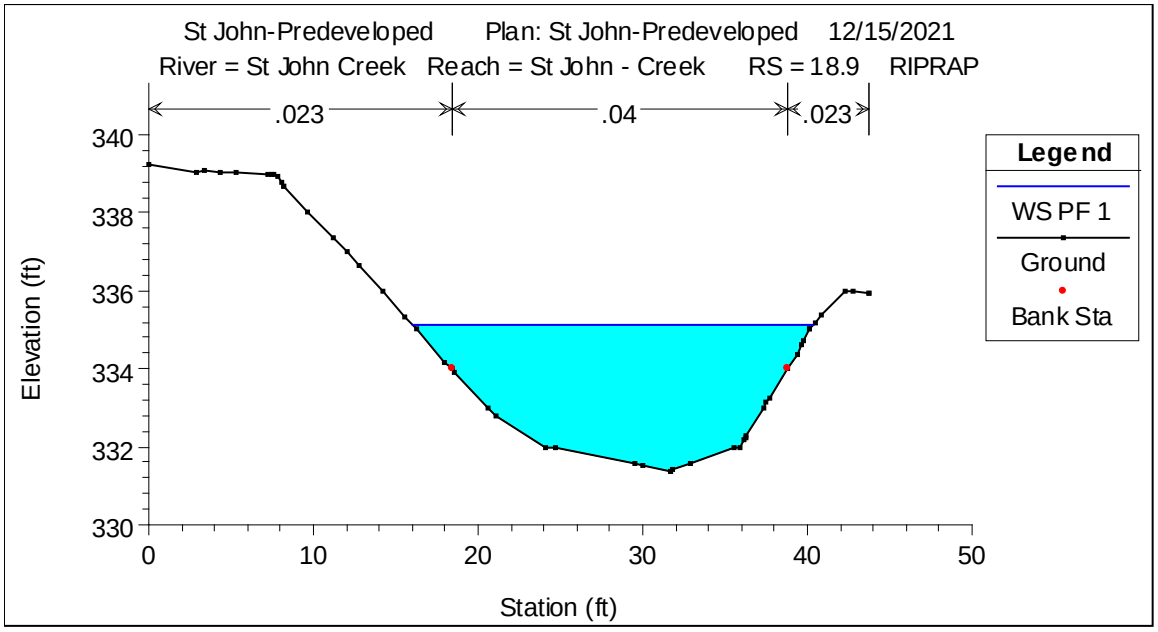
Water surface elevation = 335.11

Station 26.07



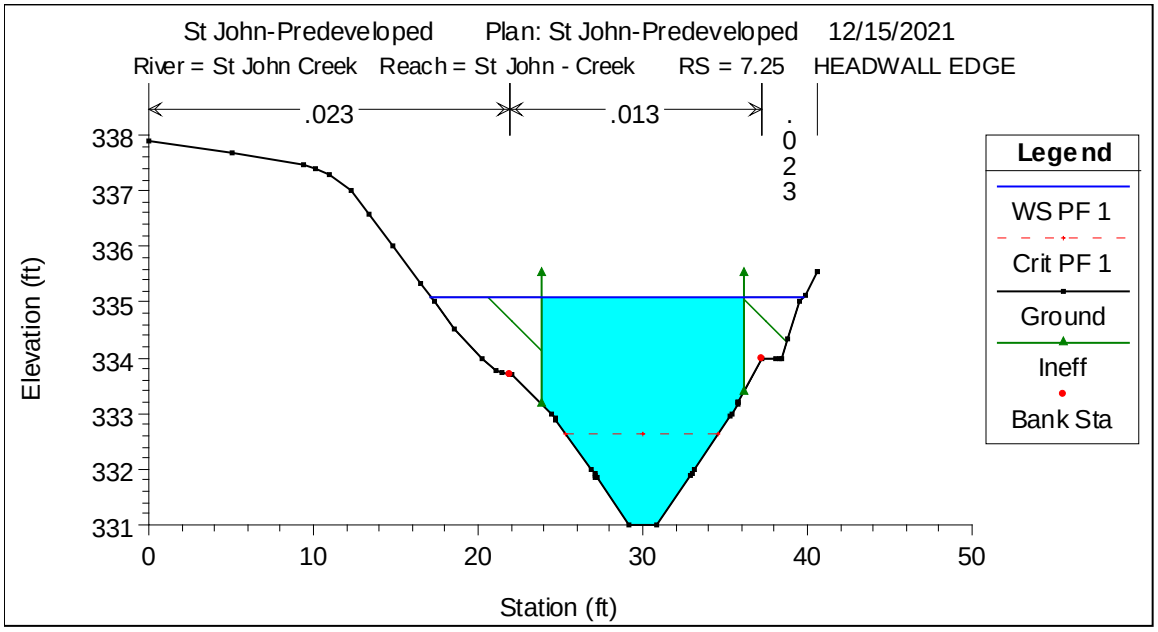
Water surface elevation = 335.11

Station 18.9



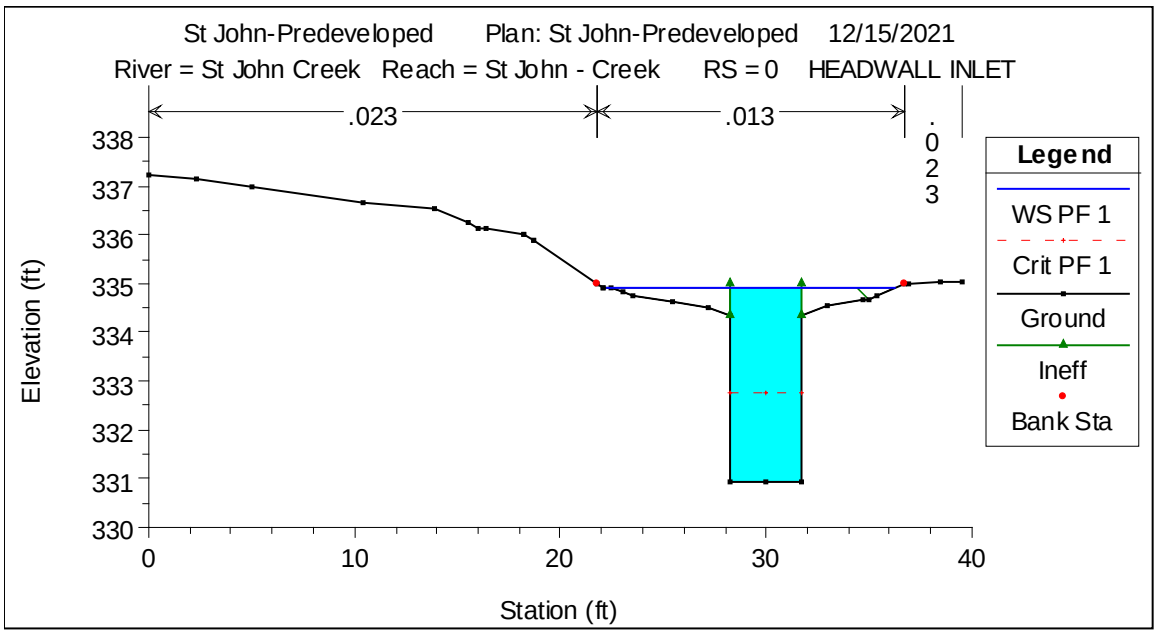
Water surface elevation = 335.11

Station 7.25



Water surface elevation = 335.10

Station 0



Water surface elevation = 334.91

Summary Table for Pre-Developed Condition

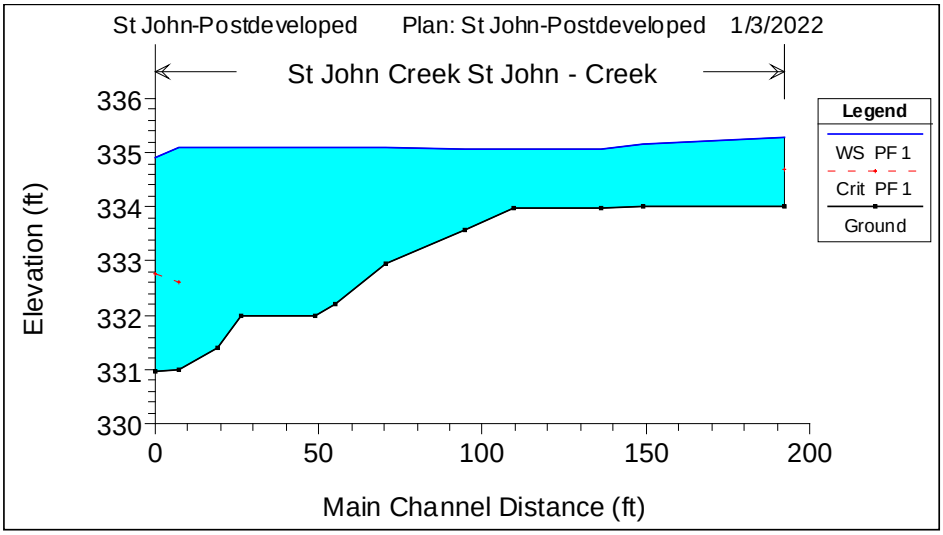
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
St John - Creek	192.53	PF 1	49.00	334.00	335.29	334.68	335.33	0.000523	1.69	29.06	30.18	0.30
St John - Creek	148.99	PF 1	49.00	334.00	335.15		335.28	0.001607	2.96	16.58	16.83	0.52
St John - Creek	136.44	PF 1	49.00	333.99	335.07		335.25	0.002464	3.46	14.19	15.45	0.63
St John - Creek	109.43	PF 1	49.00	333.99	335.06		335.18	0.001475	2.73	17.98	19.06	0.49
St John - Creek	94.55	PF 1	49.00	333.58	335.08		335.15	0.000666	2.11	23.20	19.85	0.34
St John - Creek	70.54	PF 1	49.00	332.95	335.11		335.13	0.000130	1.23	40.00	23.09	0.16
St John - Creek	55.12	PF 1	49.00	332.20	335.11		335.13	0.000064	1.03	49.03	24.02	0.12
St John - Creek	48.99	PF 1	49.00	332.00	335.11		335.13	0.000057	0.98	51.66	25.11	0.11
St John - Creek	26.07	PF 1	49.00	331.98	335.11		335.13	0.000043	0.92	55.47	24.67	0.10
St John - Creek	18.9	PF 1	49.00	331.39	335.11		335.12	0.000124	0.81	61.28	24.38	0.08
St John - Creek	7.25	PF 1	49.00	331.00	335.10	332.62	335.12	0.000031	1.28	38.20	22.68	0.13
St John - Creek	0	PF 1	49.00	330.95	334.91	332.77	335.10	0.000641	3.54	13.86	13.98	0.31

4.2.2.2 Post-Developed Condition

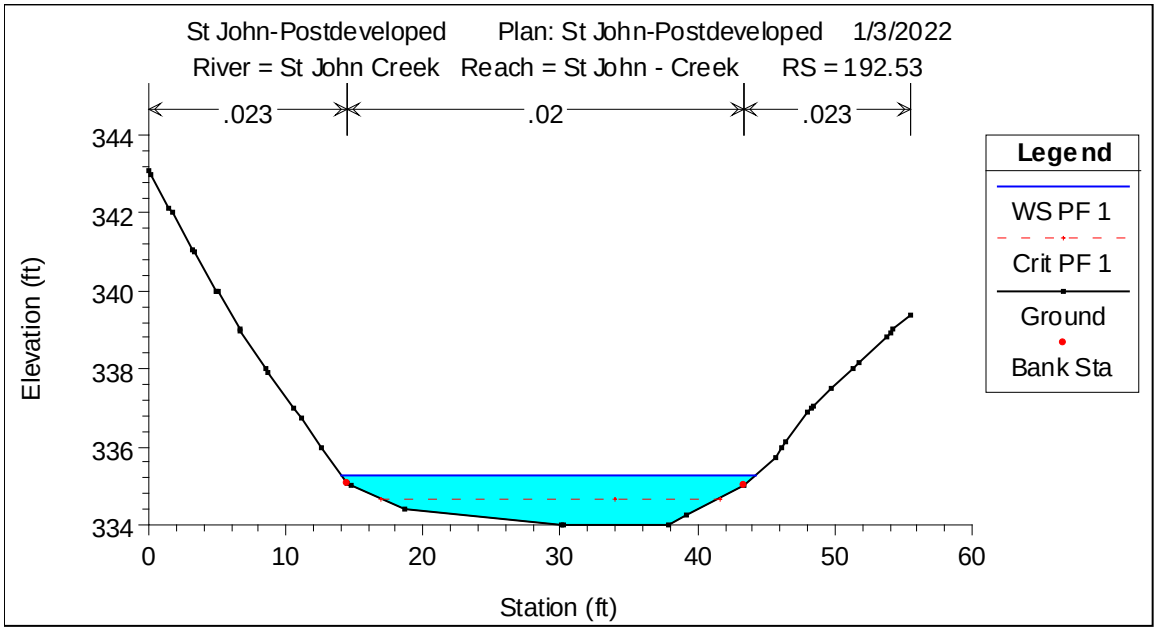
For the post-developed condition, a fill with a retaining wall will be placed in the east side of the creek between station 94.55 and station 0
n values per Table A-3, as shown bellow

	River Station	Frctn (n/K)	n #1	n #2	n #3
1	192.53	n	0.023	0.02	0.023
2	148.99	n	0.023	0.02	0.023
3	136.44	n	0.023	0.02	0.023
4	109.43	n	0.023	0.02	0.023
5	94.55	n	0.023	0.02	0.023
6	70.54	n	0.013	0.02	0.023
7	55.12	n	0.013	0.02	0.023
8	48.99	n	0.013	0.02	0.023
9	26.07	n	0.013	0.02	0.023
10	18.9	n	0.013	0.04	0.023
11	7.25	n	0.013	0.013	0.023
12	0	n	0.013	0.013	0.023

St John rear creek profile

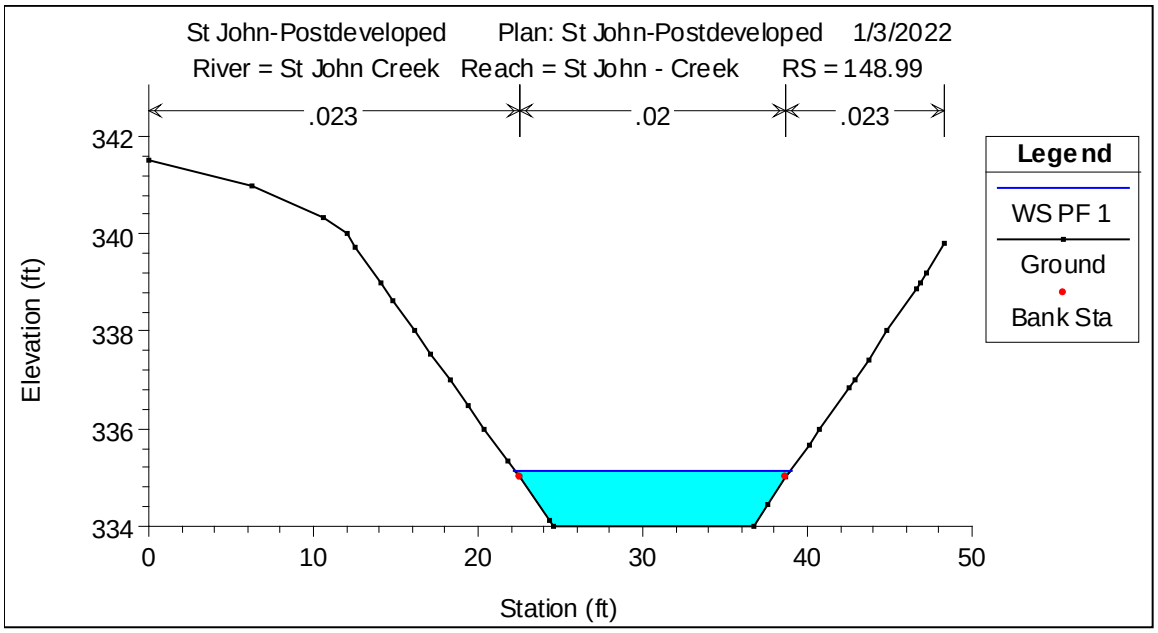


Station 192.53 Northern property line



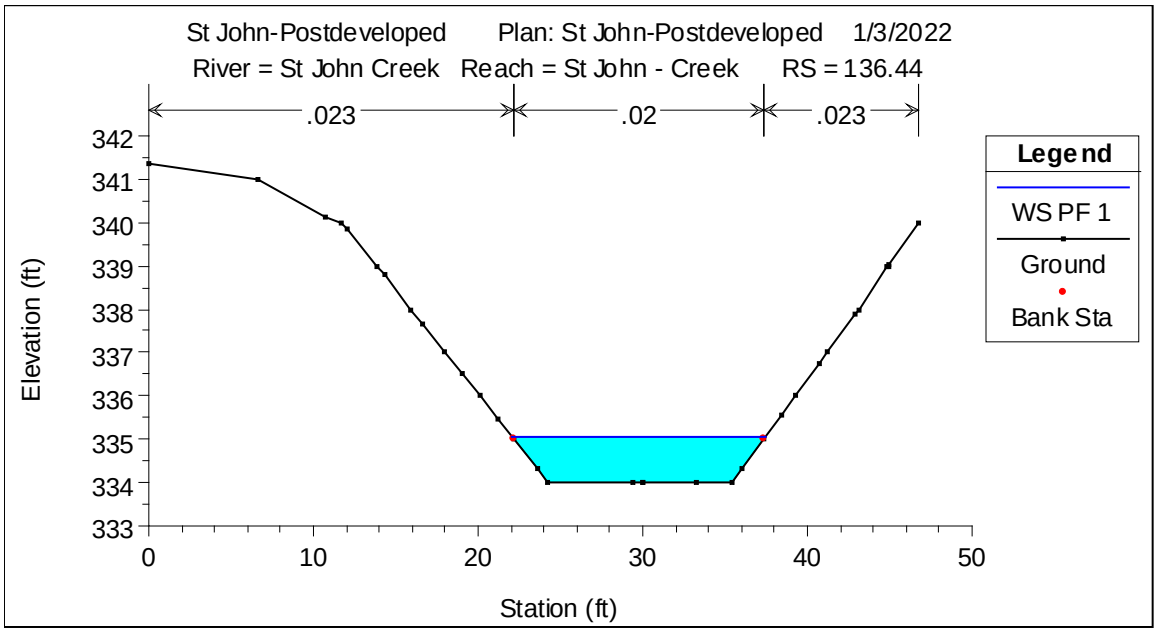
Water surface elevation = 335.29

Station 148.99



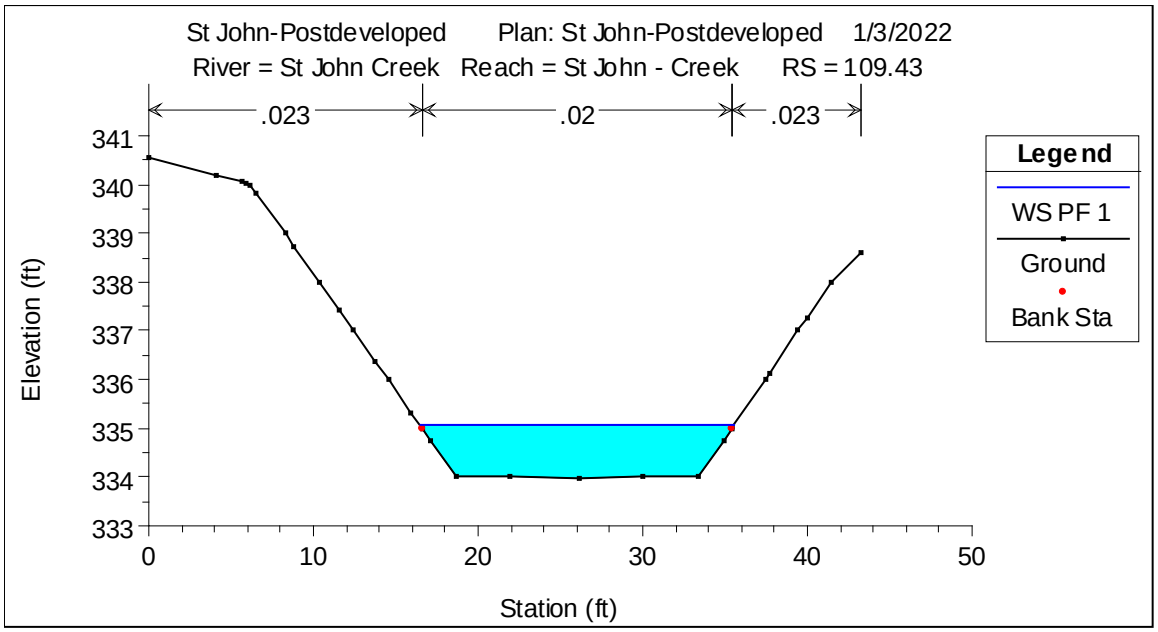
Water surface elevation = 335.15

Station 136.44



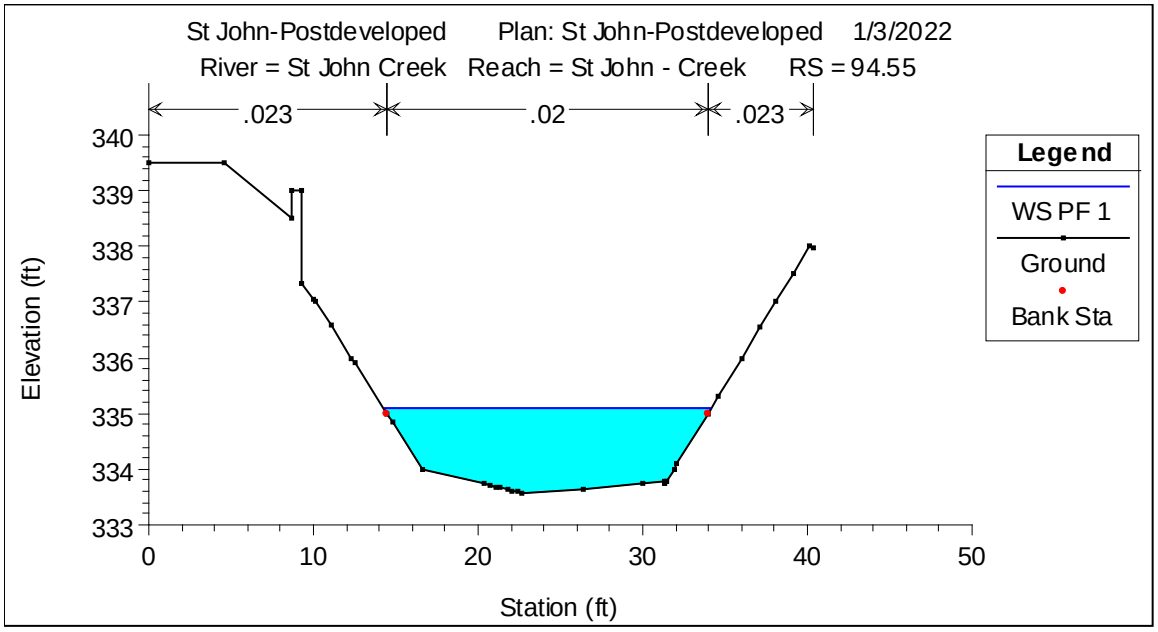
Water surface elevation = 335.07

Station 109.43



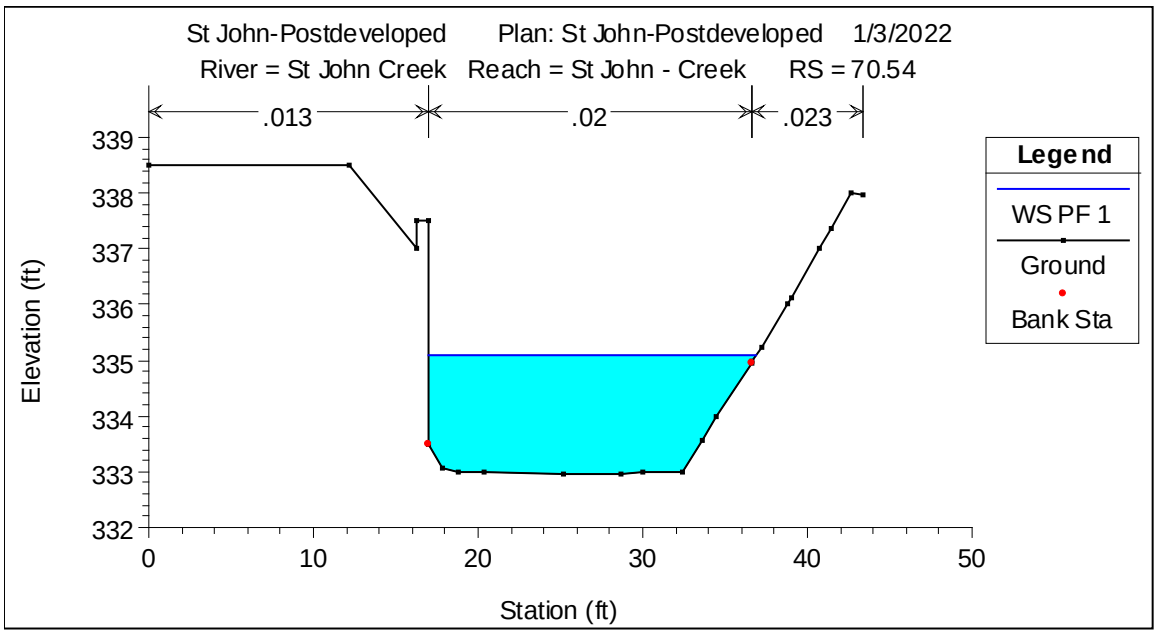
Water surface elevation = 335.07

Station 94.55



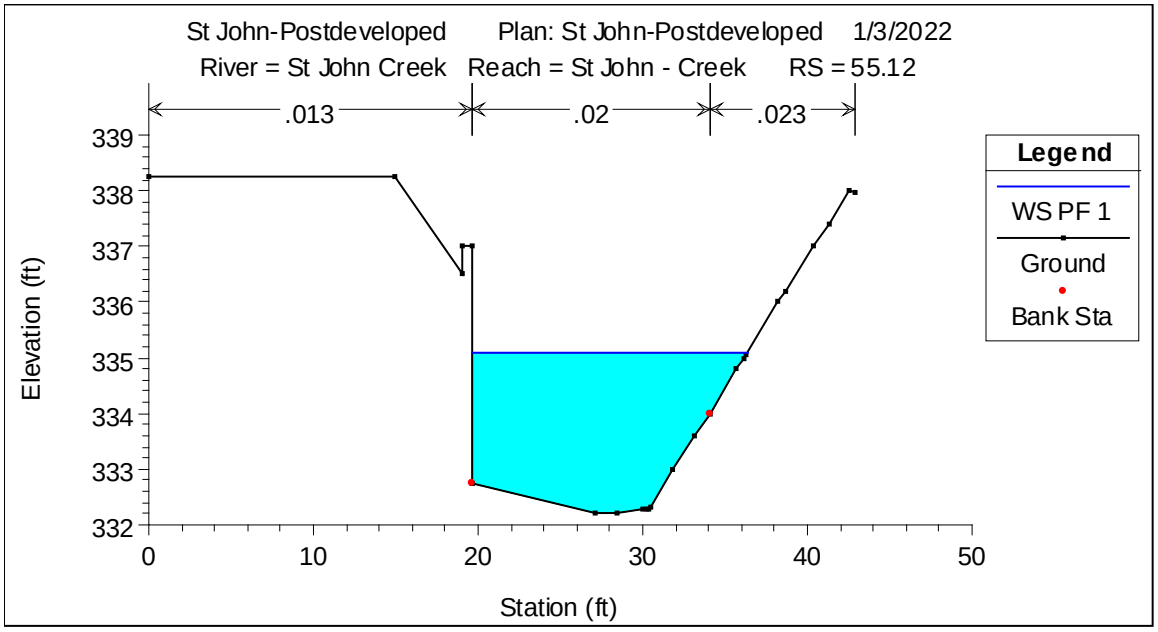
Water surface elevation = 335.08

Station 70.54



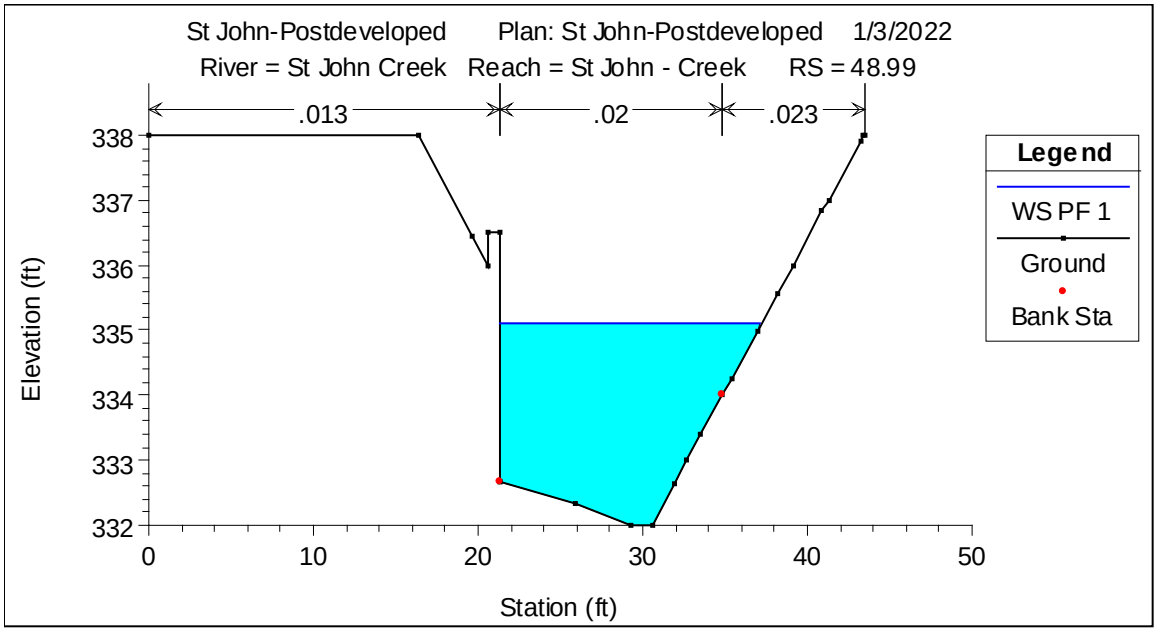
Water surface elevation = 335.11

Station 55.12



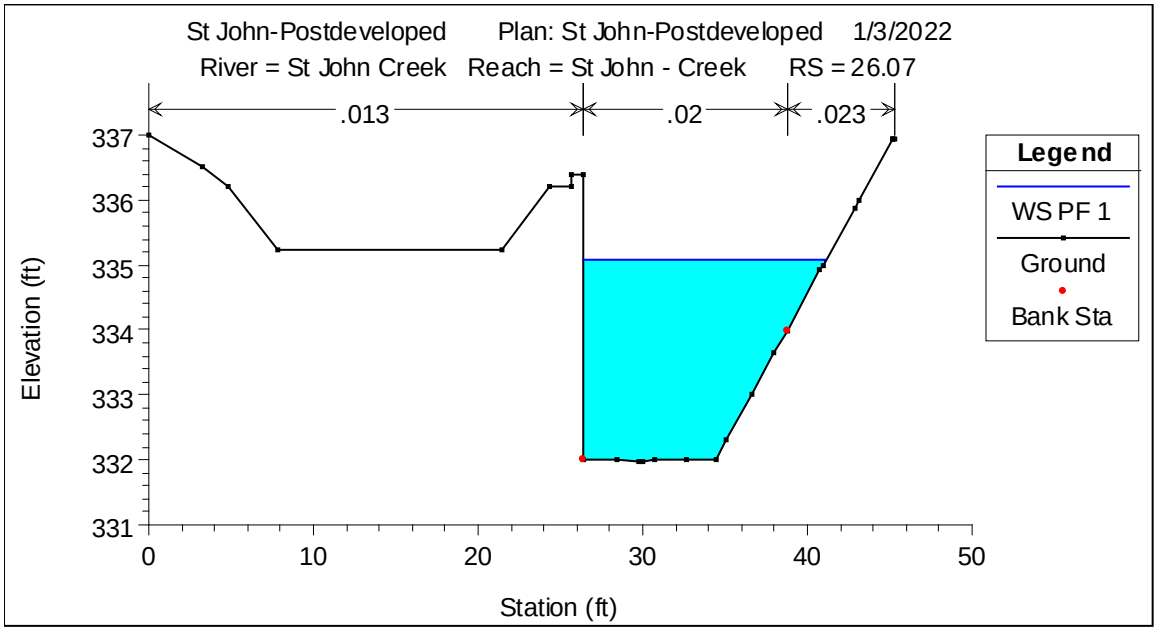
Water surface elevation = 335.10

Station 48.99



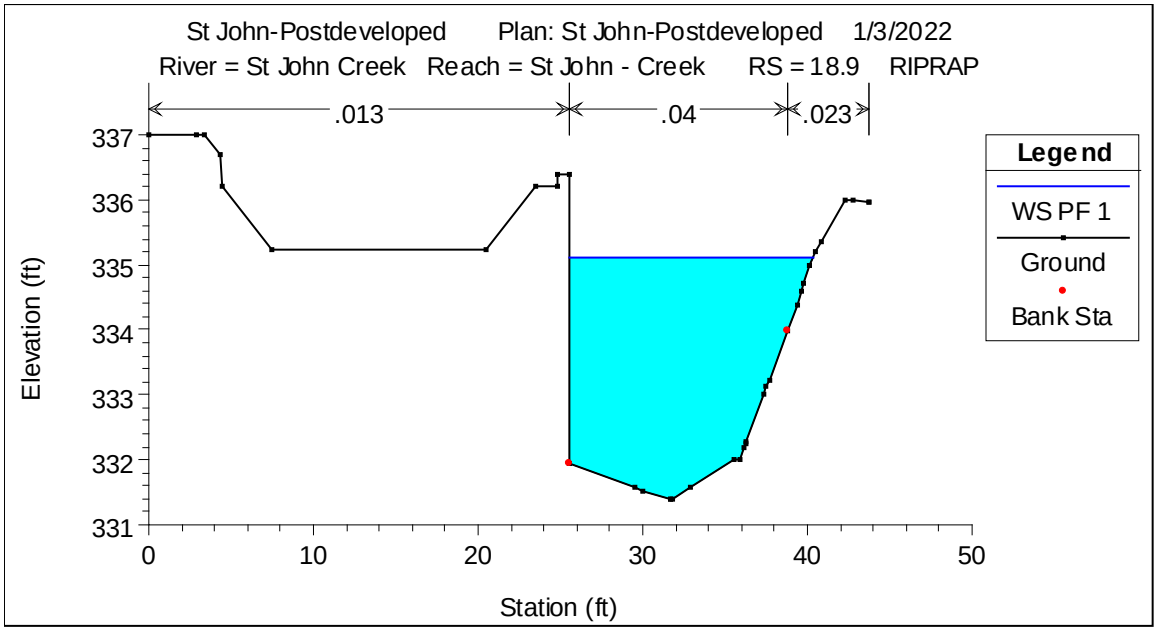
Water surface elevation = 335.10

Station 26.07



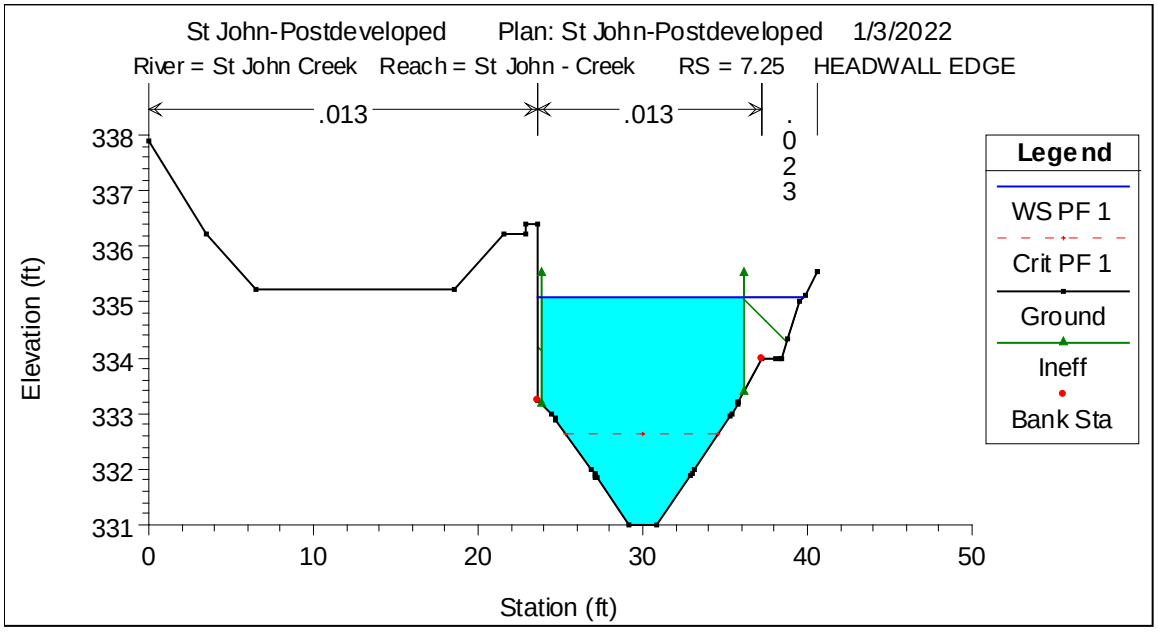
Water surface elevation = 335.10

Station 18.9



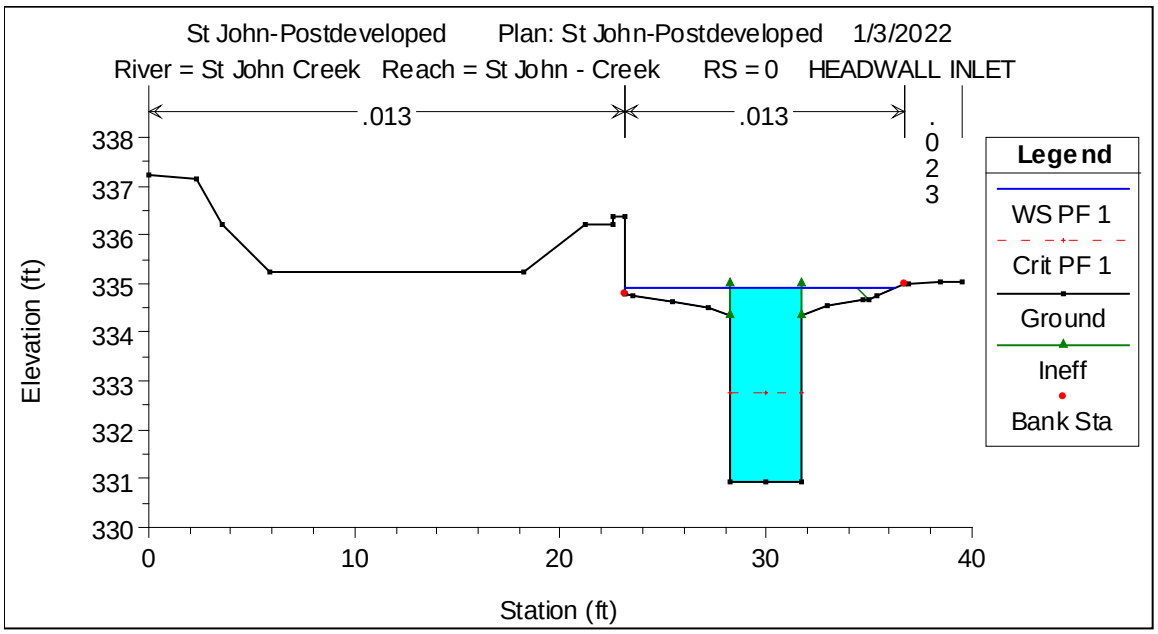
Water surface elevation = 335.10

Station 7.25



Water surface elevation = 335.10

Station 0



Water surface elevation = 334.91

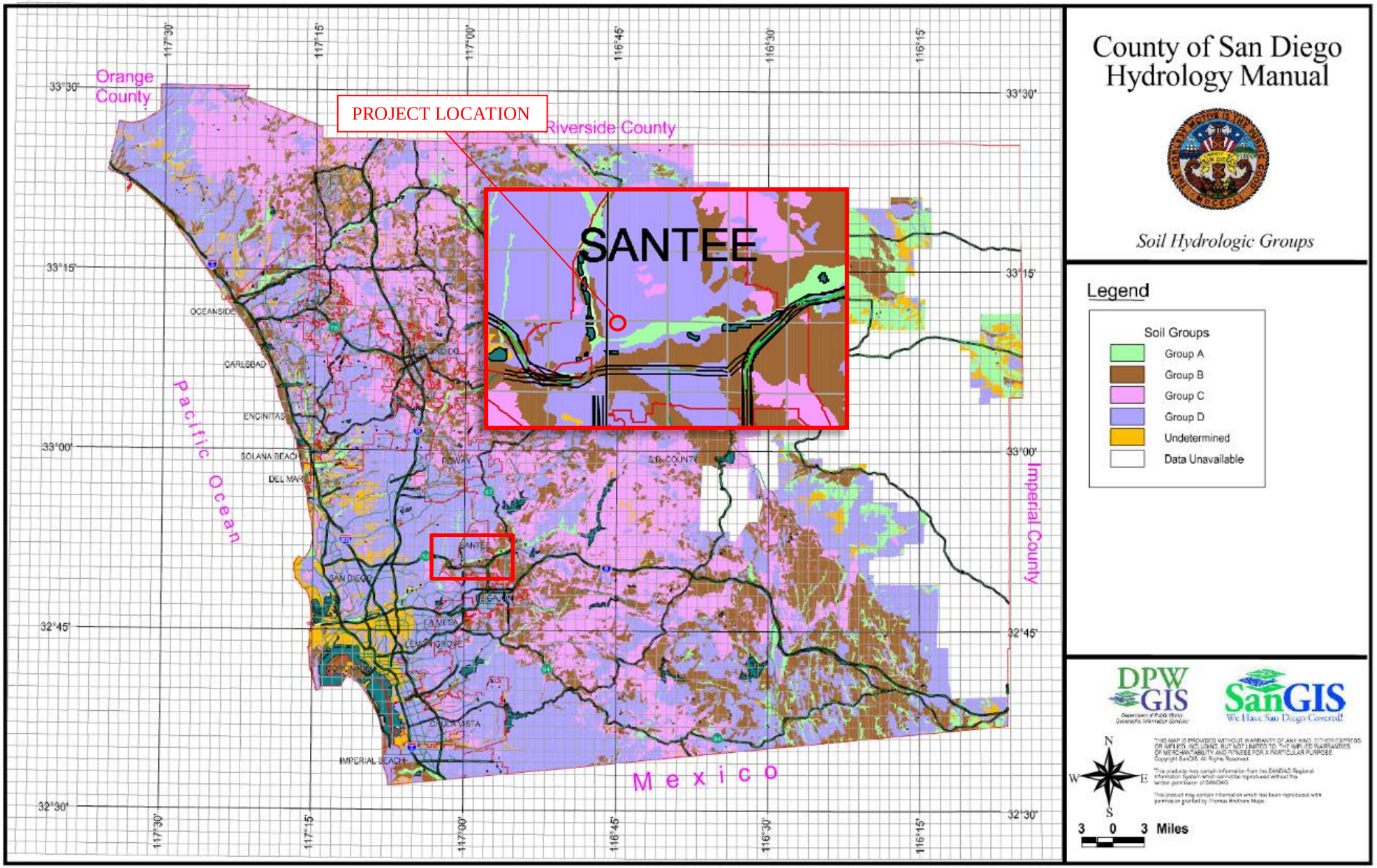
Summary Table for Post-Developed Condition

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
St John - Creek	192.53	PF 1	49.00	334.00	335.29	334.68	335.33	0.000523	1.69	29.07	30.18	0.30
St John - Creek	148.99	PF 1	49.00	334.00	335.15		335.28	0.001606	2.96	16.59	16.83	0.52
St John - Creek	136.44	PF 1	49.00	333.99	335.07		335.25	0.002463	3.45	14.19	15.45	0.63
St John - Creek	109.43	PF 1	49.00	333.99	335.07		335.18	0.001474	2.73	17.99	19.06	0.49
St John - Creek	94.55	PF 1	49.00	333.58	335.08		335.15	0.000666	2.11	23.20	19.85	0.34
St John - Creek	70.54	PF 1	49.00	332.95	335.11		335.13	0.000138	1.31	37.30	19.91	0.17
St John - Creek	55.12	PF 1	49.00	332.20	335.10		335.13	0.000100	1.35	37.29	16.66	0.15
St John - Creek	48.99	PF 1	49.00	332.00	335.10		335.13	0.000104	1.39	36.16	15.87	0.15
St John - Creek	26.07	PF 1	49.00	331.98	335.10		335.13	0.000100	1.42	35.37	14.75	0.15
St John - Creek	18.9	PF 1	49.00	331.39	335.10		335.12	0.000229	1.16	42.59	14.85	0.12
St John - Creek	7.25	PF 1	49.00	331.00	335.10	332.62	335.12	0.000031	1.28	38.20	16.18	0.13
St John - Creek	0	PF 1	49.00	330.95	334.91	332.77	335.10	0.000641	3.54	13.86	13.10	0.31

4.2.2c Pre and Post-Developed condition WSE comparison

Station	PRE-DEV	POST-DEV	Dif (2) -(1)
	WSE [ft] (1)	WSE [ft] (2)	[ft]
192.53	335.29	335.29	0
148.99	335.15	335.15	0
136.44	335.07	335.07	0
109.43	335.06	335.07	0.01
94.55	335.08	335.08	0
70.54	335.11	335.11	0
55.12	335.11	335.10	-0.01
48.99	335.11	335.10	-0.01
26.07	335.11	335.10	-0.01
18.9	335.11	335.10	-0.01
7.25	335.10	335.10	0
0	334.91	334.91	0

The proposed grading has a decrease/increase in the water surface elevation of ±0.01 ft. which value doesn't make any impact at the adjacent properties.



County of San Diego Hydrology Manual

Soil Hydrologic Groups

Legend

Soil Groups

- Group A
- Group B
- Group C
- Group D
- Undetermined
- Data Unavailable

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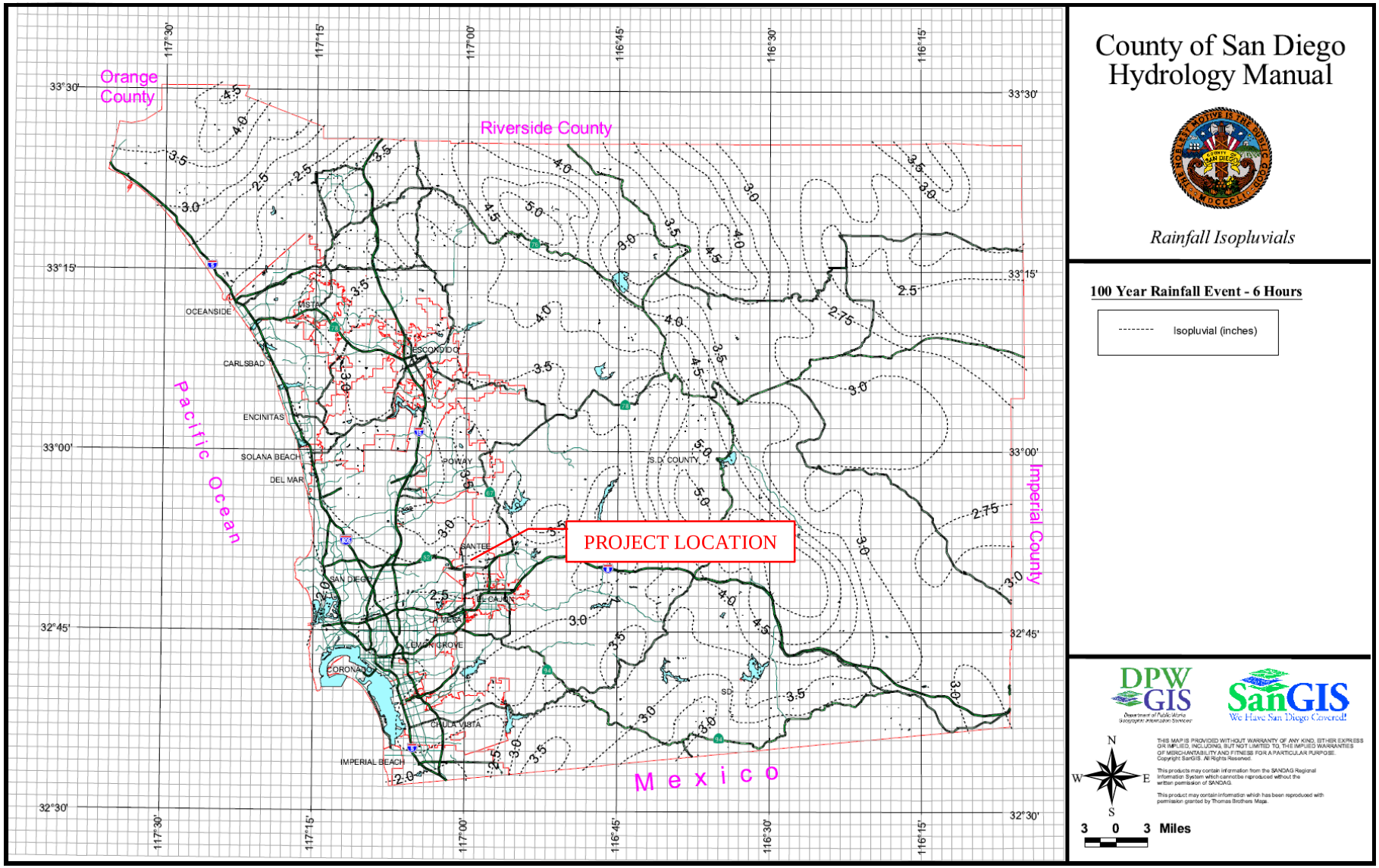
Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

Land Use		Runoff Coefficient "C"				
			Soil Type			
NRCS Elements	County Elements	% IMPER.	A	B	C	D
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, Cp, for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).
DU/A = dwelling units per acre
NRCS = National Resources Conservation Service



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

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Department of Public Works Geographic Information Services

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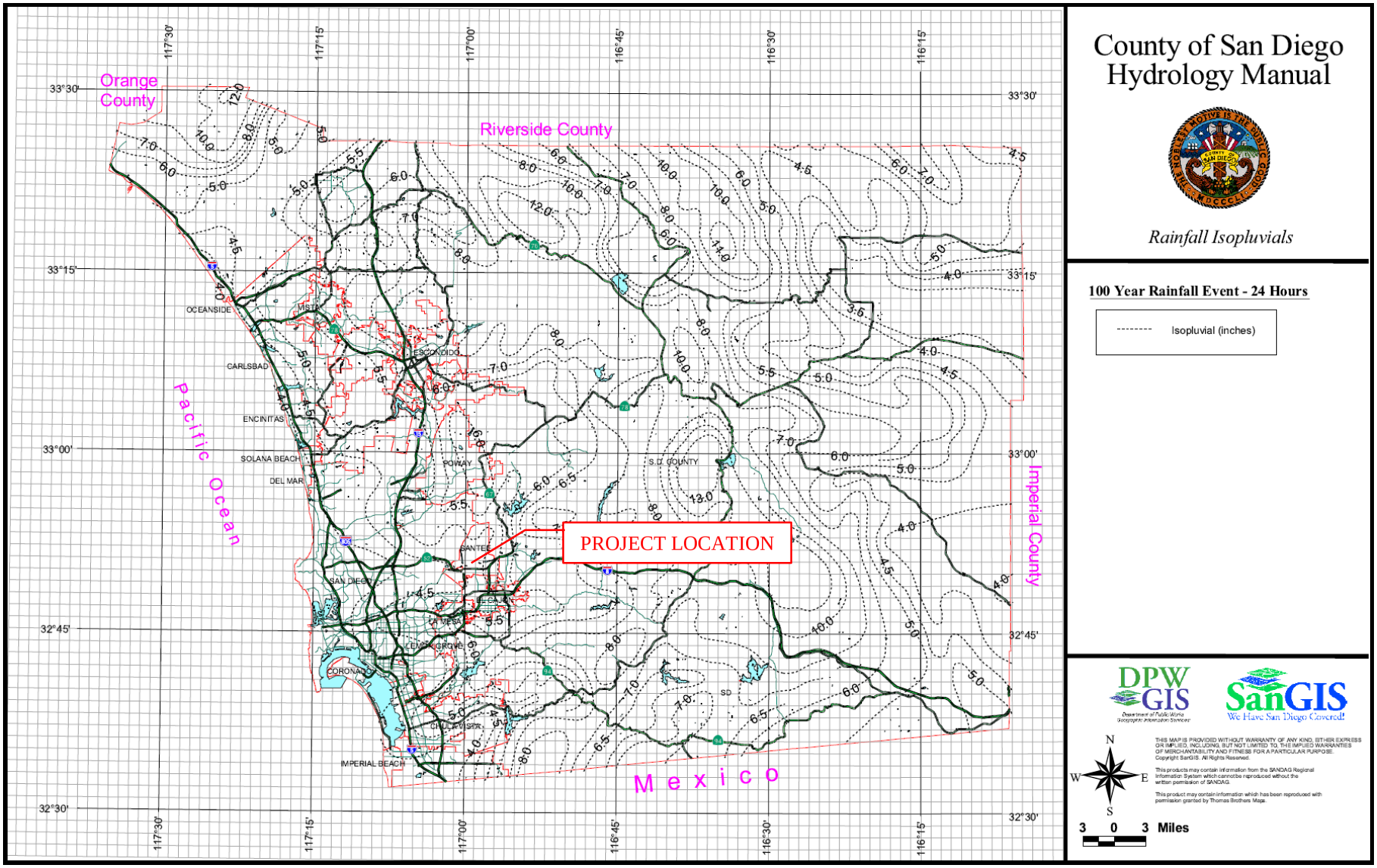

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

DPW GIS
Department of Public Works Geographic Information Services

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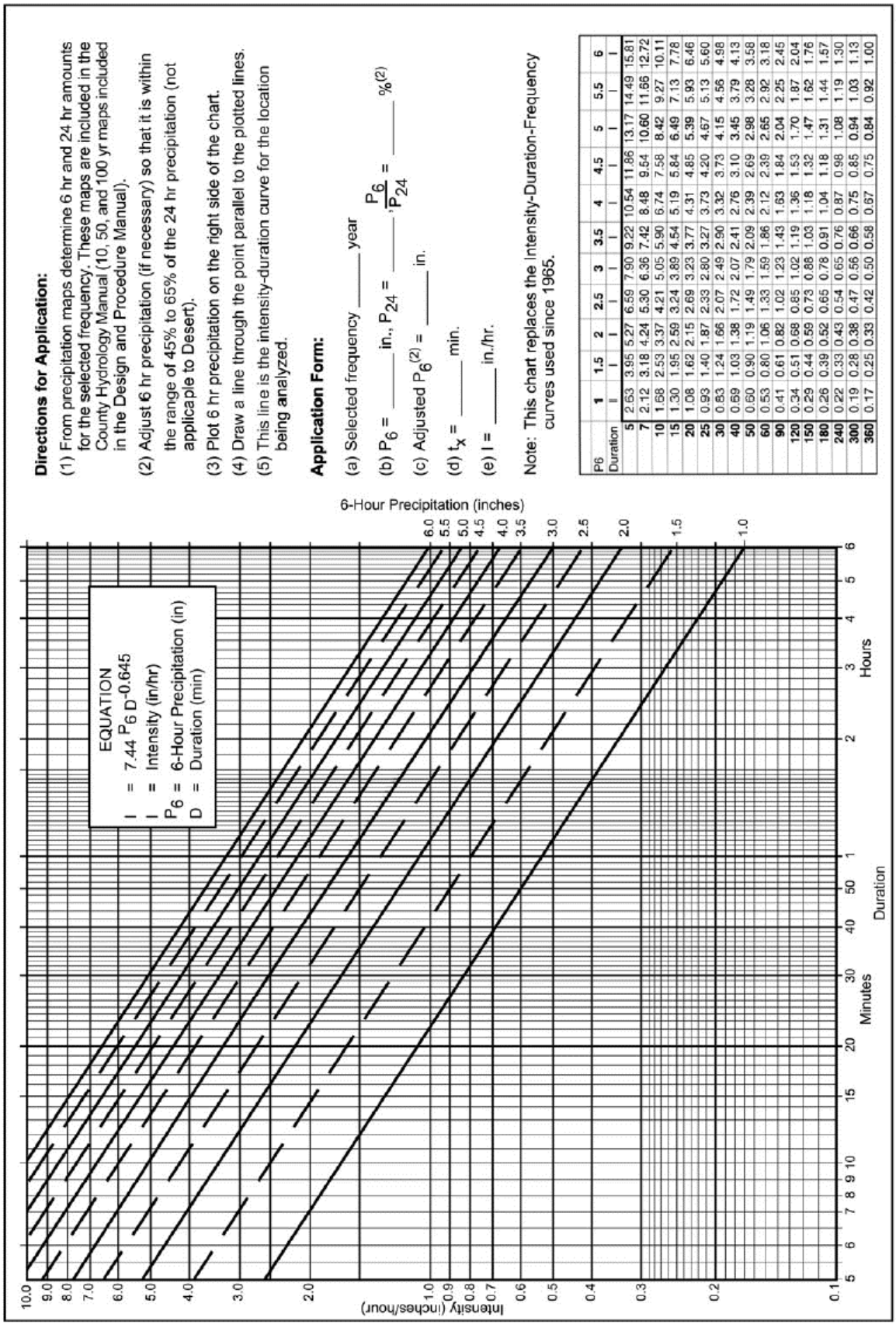
Intensity-Duration Design Chart



P6	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
Duration	I	I	I	I	I	I	I	I	I	I	I
5	2.53	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

FIGURE 3-1

Overland Time of flow Nomograph (Figure 3-3)

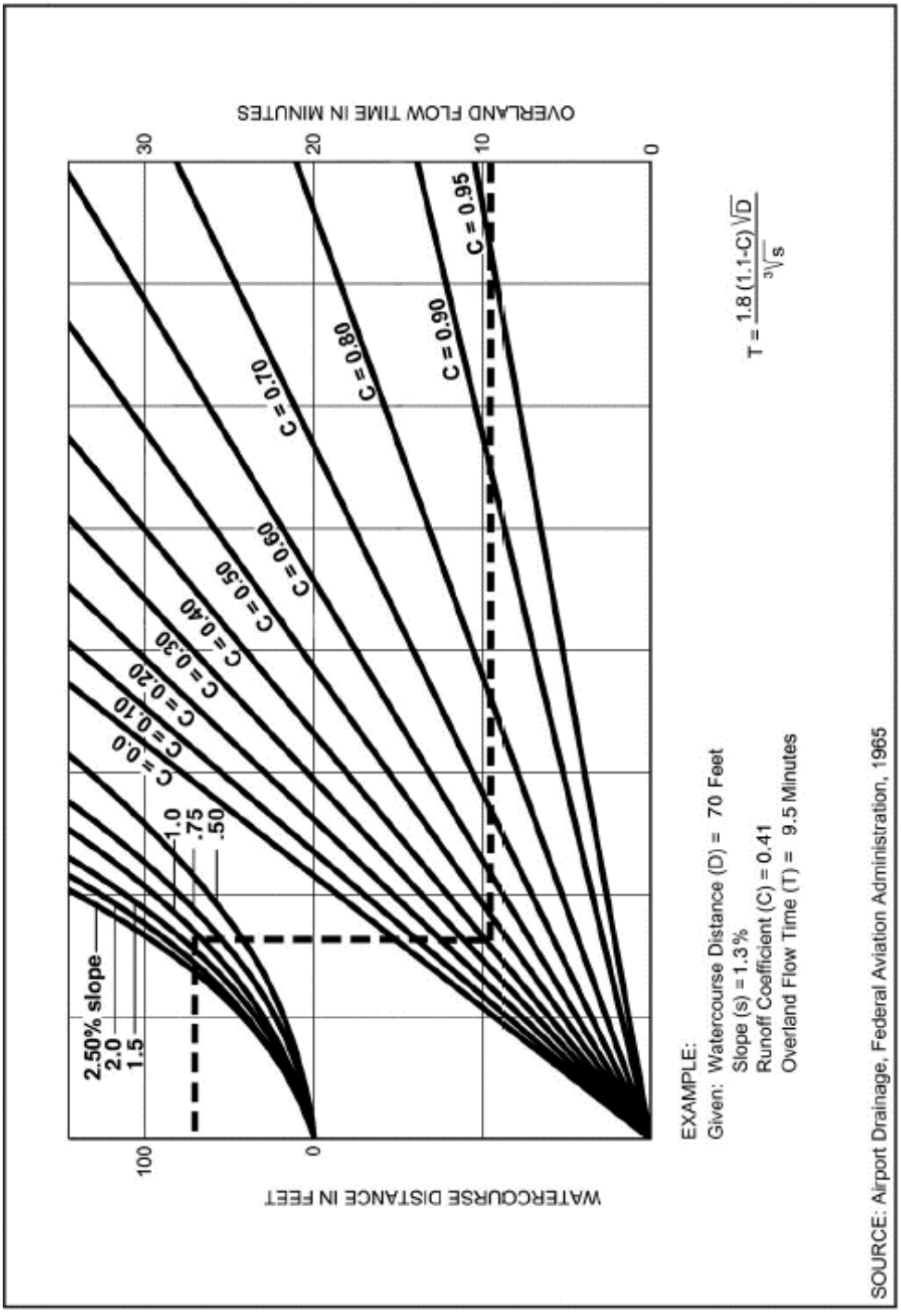
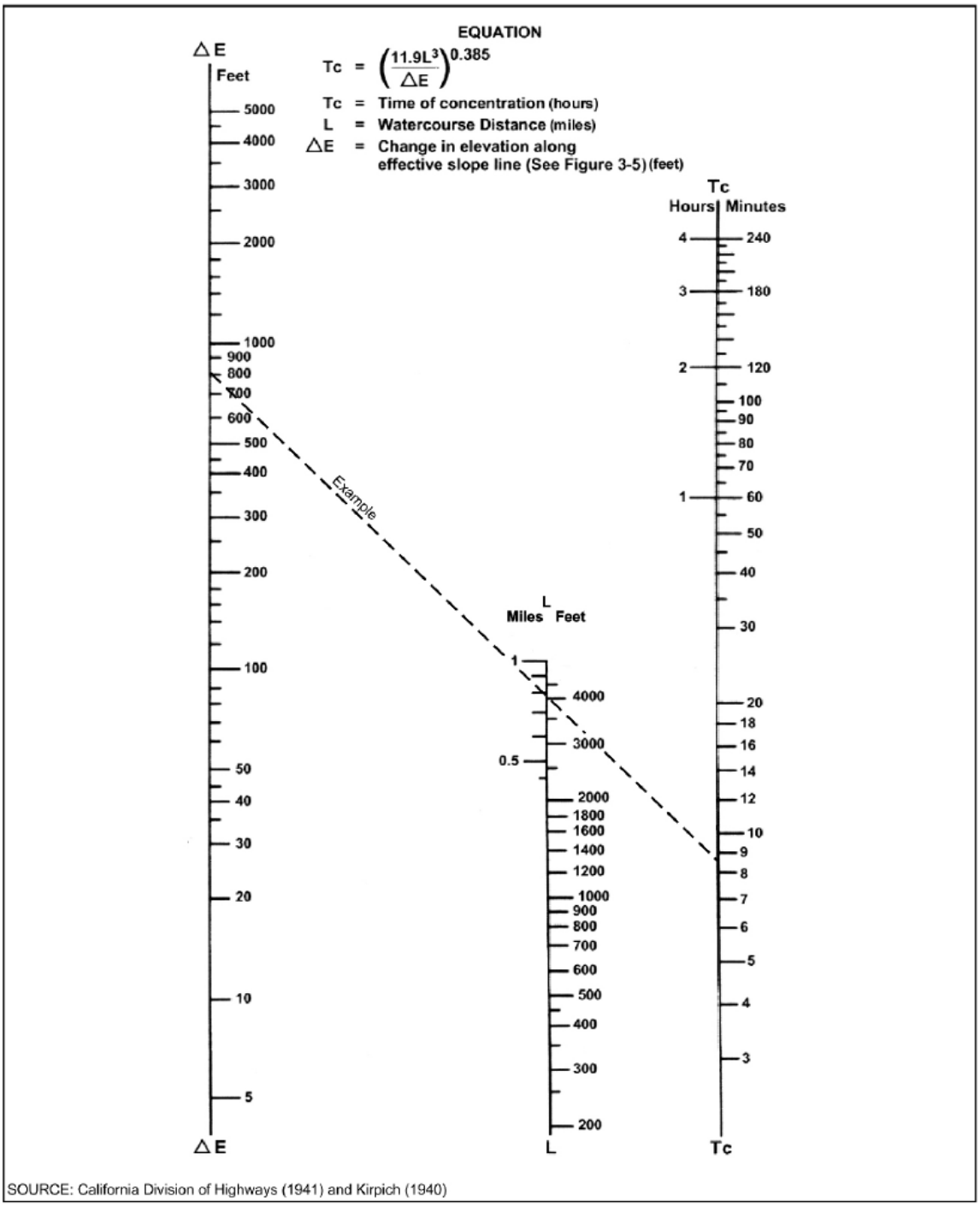


FIGURE 3-3

Rational Formula - Overland Time of Flow Nomograph

Travel Time in Natural Watershed (Figure 3-4)



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE 3-4

Nomograph for Determination of
Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds