DRAINAGE STUDY

FOR

HOOPER TENTATIVE PARCEL MAP

2409 NORTH BROADWAY
ESCONDIDO, CALIFORNIA 92025

TPM 20960, LOG NO. 05-08-025
APN : 224-290-73

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EXP. 12-31-07
CIVIL
STATE OF CALIFORNIA

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P.N. 03083
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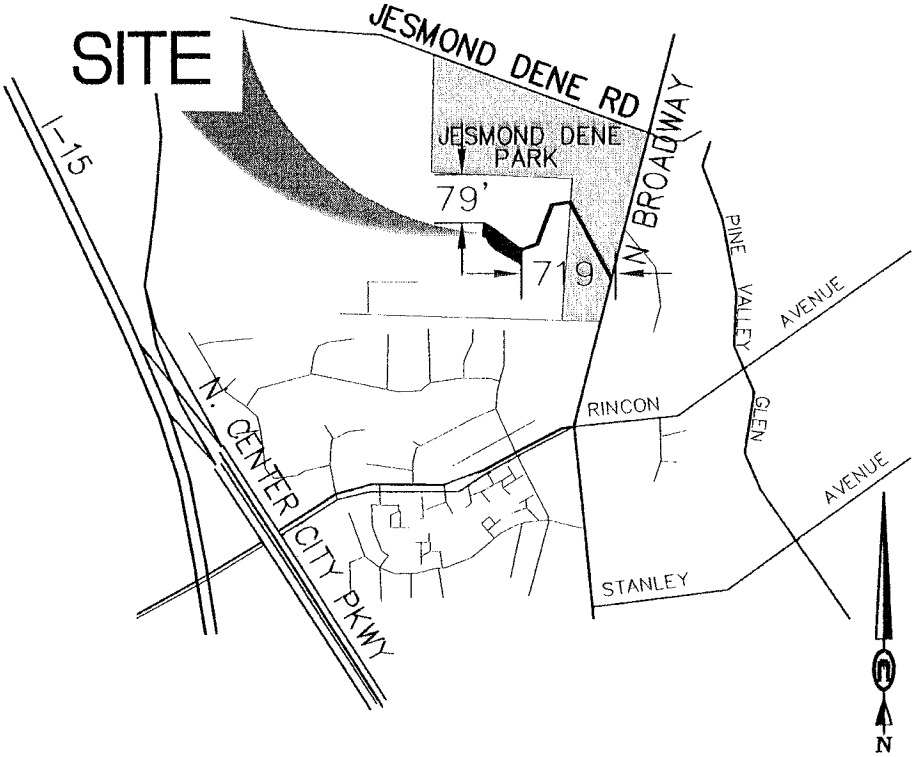


VICINITY MAP

NOT TO SCALE

INTRODUCTION:

The proposed project consists of a Tentative Parcel Map on 4.8 acres with 2 lots, each minimum one acre and private driveway approximate 1250 LF connecting to North Broadway. The project is located east of North Broadway and South of Jesmond Dene Road in Escondido, California.

PURPOSE:

The purpose of this study is to determine the peak runoff rates for the pre-development and post-development conditions. Comparisons will be made at the same discharge points for each drainage basin affecting the site and adjacent properties. The Rational Method as outlined in the County of San Diego Hydrology Manual dated August 2003 was used to determine the runoff flow rate. A 100-year frequency storm event has been analyzed to determine the pre-development and post-development discharges from the site. The project area consists of soil group C. The proposed project will not have slopes steeper than 2:1. All slopes will include slope protection for construction and post-construction conditions.

PRE-DEVELOPMENT CONDITIONS:

A pre-development hydrology map has been prepared for the site and is located in the back of this report as Exhibit A. The irregular shaped site currently has one single family dwelling on the eastern half. The project contains a hilltop however it generally slopes east and south.

The existing on-site drainage area covers approximately 4.8 acres plus 4.7 acres covering existing dirt road and surrounding area. Basin 1.0 runoff currently drains westerly via natural swales and an existing access road granted to the vista irrigation district. Basin 2.0 drains in a south easterly direction via natural swales. Basin 3.0 drains south easterly towards North Broadway. Offsite runoff discharges to the Basin 3.0 from the west side in the existing condition.

POST-DEVELOPMENT CONDITIONS:

A post-development hydrology map has been prepared for the site and is located in the back of this report as Exhibit B. The new housing development is under construction on the south of project site. The proposed project site covers drainage area of approximately of 4.8 acres with 2 lots, each minimum one acre and private driveway approximate 1250 LF connecting to North Broadway.

The runoff from Basin 1.0 drains westerly via natural swales and an existing access road granted to the vista irrigation district. Basin 2.0 drains in a south easterly direction via proposed driveway, exiting access road granted SDCWA and natural swales. Basin 3.0 drains along the private driveway and discharges to the curb and gutter in North Broadway. Off-site runoff that discharges onto the west side of Basin 3.0 will bypass the site through the brow ditch running along the road.

On-site street runoff will be discharged to natural areas via downdrains. The existing natural environment serves as a bio-filter for the runoff generated from the pads and driveway.

CONCLUSION:

The proposed project will not significantly alter drainage patterns on the site. Wherever possible, overall existing drainage patterns throughout the project and the natural drainage basins will be maintained. As a result of significant amounts of natural drainage patterns being retained along with the introduction of flat pad areas, there will be a minor increase in peak runoff from the site. The table below provides a summary of flow before and after development.

Hydrology Summary – Pre-Development

Basin	Area	Pre-Development Q_{100} (cfs)
1.0	0.59	1.2
2.0	4.14	8.6
3.0	4.87	10.1
Total:	**9.6**	**19.9**

Hydrology Summary – Post-Development

Basin	Area	Post-Development Q_{100} (cfs)
1.0	0.49	0.9
2.0	4.12	8.1
3.0	5.00	13.0
Total:	**9.6**	**21.1**

APPENDIX A

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

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

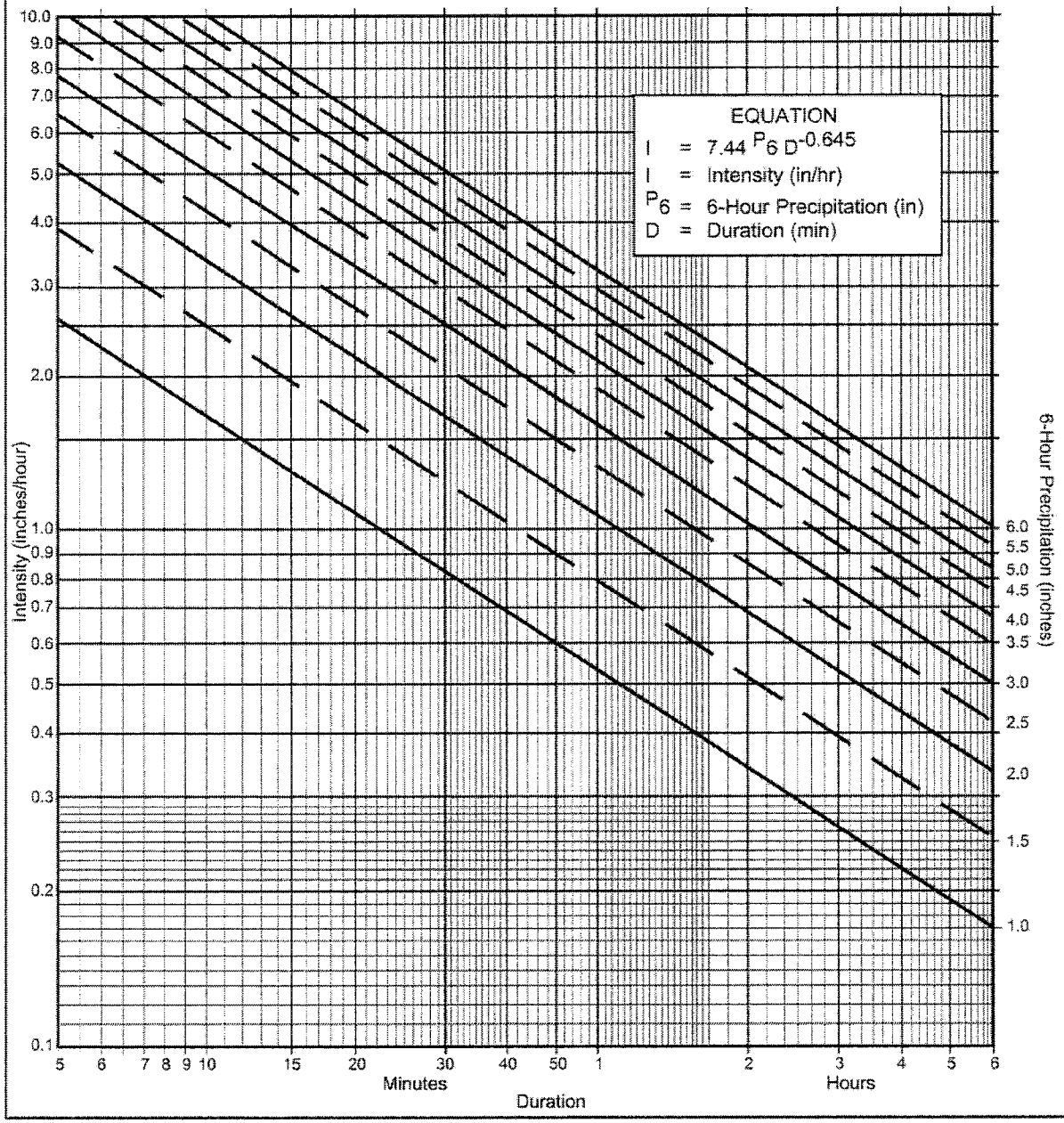
Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M) & INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 3.6 in., P_{24} = 8, $\frac{P_6}{P_{24}}$ = 45 %(2)

(c) Adjusted $P_6^{(2)}$ = _____ in.

(d) t_x = _____ min.

(e) I = _____ in./hr.

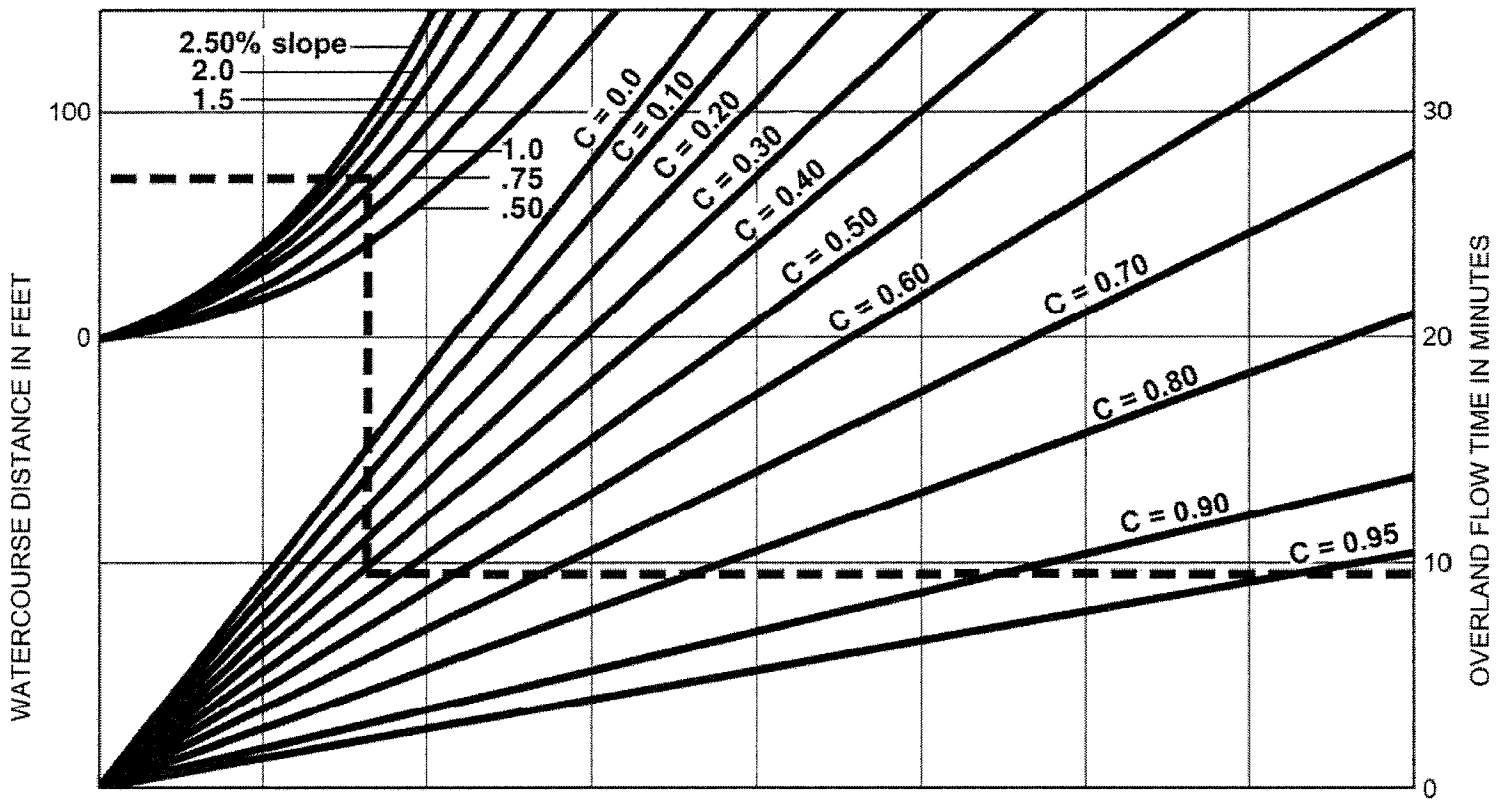
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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	2.63	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



EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
Slope (s) = 1.3%
Runoff Coefficient (C) = 0.41
Overland Flow Time (T) = 9.5 Minutes

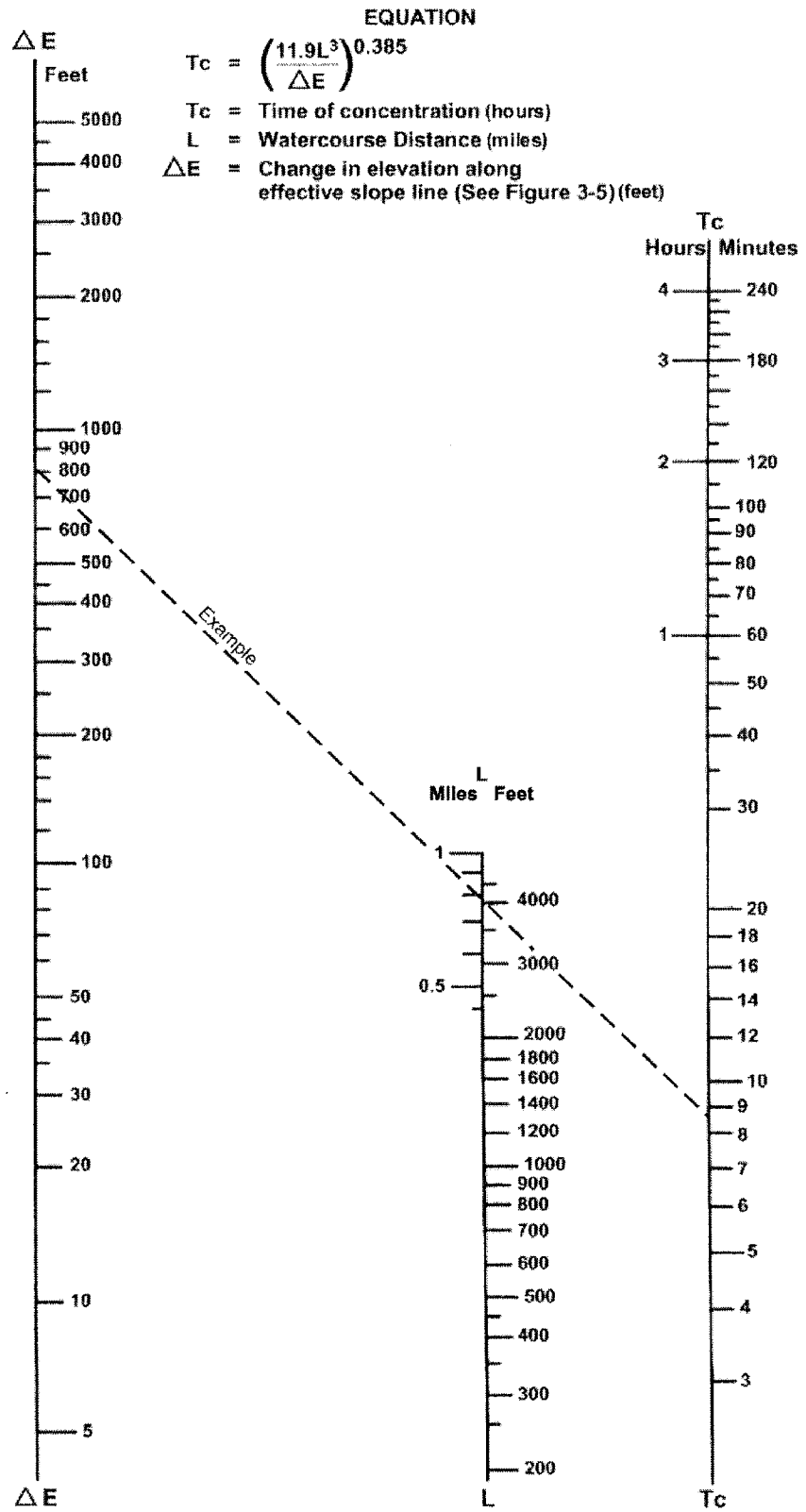
$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

Rational Formula - Overland Time of Flow Nomograph

FIGURE

3-3

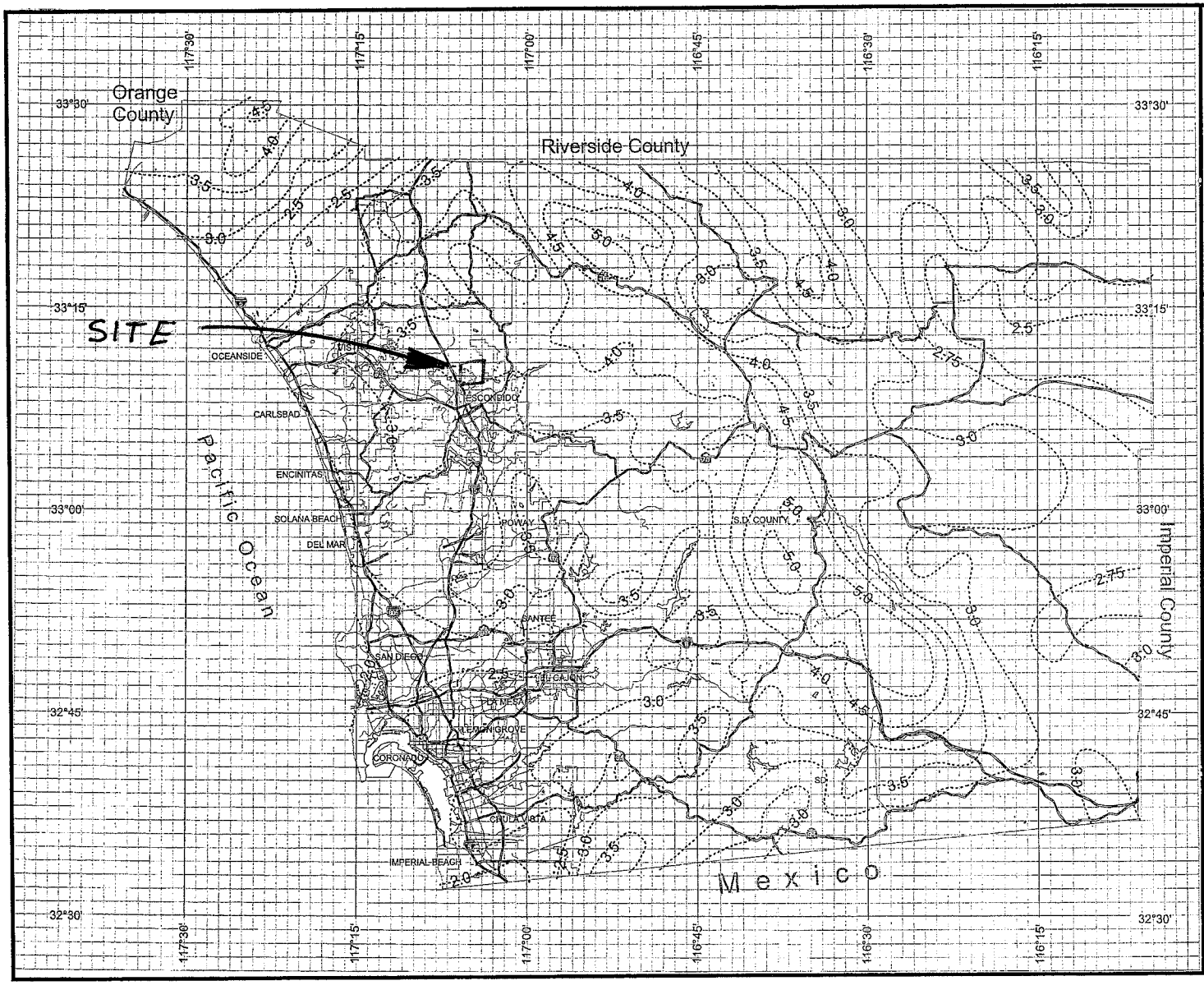


SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

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

3-4



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

$P_6 = 3.6$

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Department of Public Works Geographic Information Services

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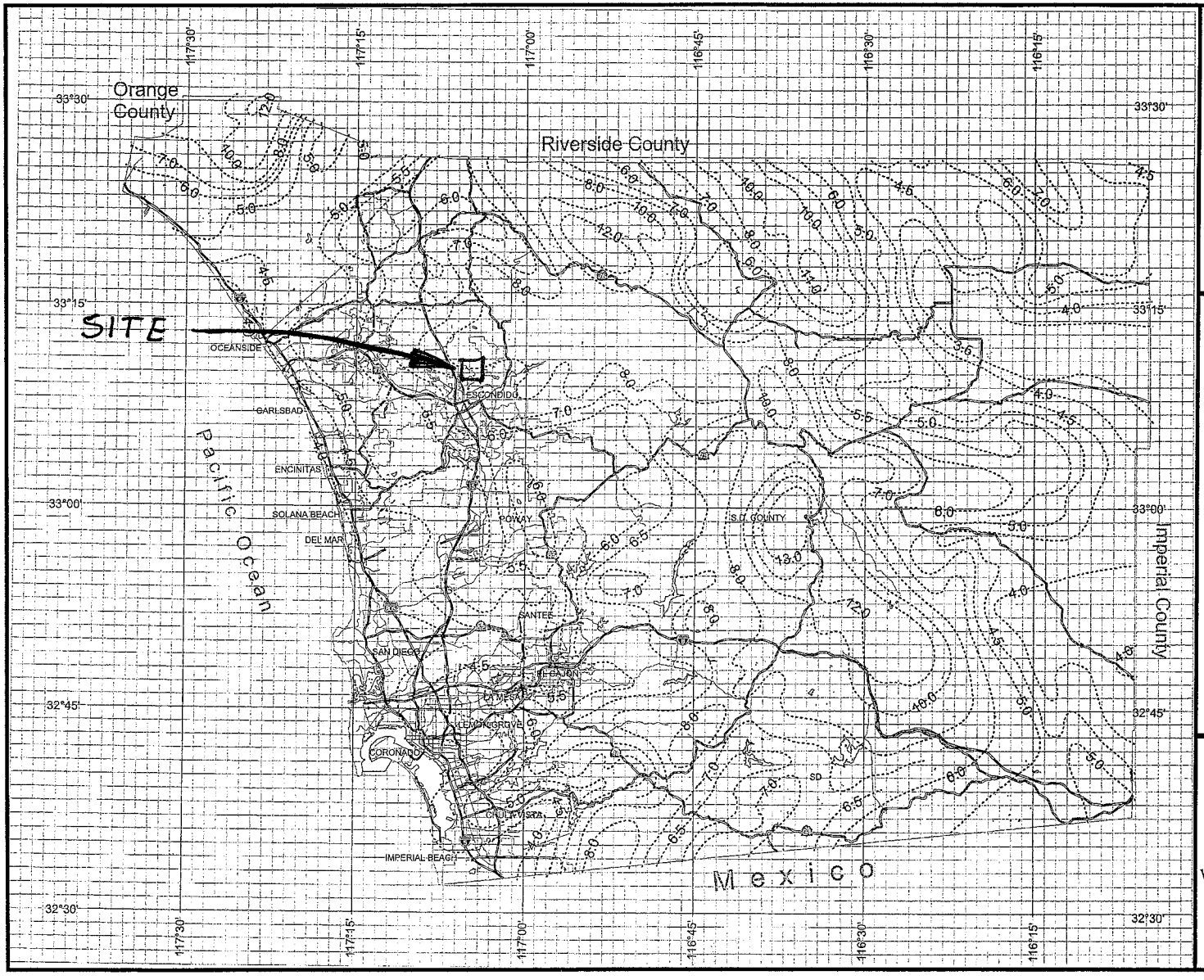

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

$P_{24} = 8.$

DPW GIS
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3 0 3 Miles

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APPENDIX B

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/27/07

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

BASIN 1.01
PRE-DEVELOPMENT CONDITION

Program License Serial Number 4065

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.600
24 hour precipitation(inches) = 8.000
P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 1.011 to Point/Station 1.012
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 407.000(Ft.)
Highest elevation = 919.000(Ft.)
Lowest elevation = 904.000(Ft.)
Elevation difference = 15.000(Ft.) Slope = 3.686 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 3.69 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 8.62 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(3.686^(1/3)]= 8.62
The initial area total distance of 407.00 (Ft.) entered leaves a
remaining distance of 307.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 2.29 minutes
for a distance of 307.00 (Ft.) and a slope of 3.69 %
with an elevation difference of 11.32(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 2.289 Minutes

Tt=[(11.9*0.0581^3)/(11.32)]^.385= 2.29
Total initial area Ti = 8.62 minutes from Figure 3-3 formula plus
2.29 minutes from the Figure 3-4 formula = 10.91 minutes
Rainfall intensity (I) = 5.734(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 1.218(CFS)
Total initial stream area = 0.590(Ac.)
End of computations, total study area = 0.590 (Ac.)

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/27/07

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

BASIN 2.01
PRE-DEVELOPMENT CONDITION

Program License Serial Number 4065

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.600
24 hour precipitation(inches) = 8.000
P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 2.011 to Point/Station 2.012
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 100.000(Ft.)
Highest elevation = 914.000(Ft.)
Lowest elevation = 904.000(Ft.)
Elevation difference = 10.000(Ft.) Slope = 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 10.00 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 6.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(10.000^(1/3)]= 6.18
Rainfall intensity (I) = 8.271(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.357(CFS)
Total initial stream area = 0.120(Ac.)

++
Process from Point/Station 2.012 to Point/Station 2.013
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 4.522(CFS)
Depth of flow = 0.268(Ft.), Average velocity = 3.159(Ft/s)

******* Irregular Channel Data ***********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	1.00
2	20.00	0.00
3	40.00	1.00

Manning's 'N' friction factor = 0.045

Sub-Channel flow = 4.522(CFS)
' ' flow top width = 10.701(Ft.)
' ' velocity= 3.159(Ft/s)
' ' area = 1.431(Sq.Ft)
' ' Froude number = 1.522

Upstream point elevation = 904.000(Ft.)
Downstream point elevation = 787.000(Ft.)
Flow length = 873.000(Ft.)
Travel time = 4.61 min.
Time of concentration = 10.79 min.
Depth of flow = 0.268(Ft.)
Average velocity = 3.159(Ft/s)
Total irregular channel flow = 4.522(CFS)
Irregular channel normal depth above invert elev. = 0.268(Ft.)
Average velocity of channel(s) = 3.159(Ft/s)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 5.776(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 1.490
Subarea runoff = 8.251(CFS) for 4.020(Ac.)
Total runoff = 8.608(CFS) Total area = 4.140(Ac.)
Depth of flow = 0.341(Ft.), Average velocity = 3.711(Ft/s)
End of computations, total study area = 4.140 (Ac.)

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/27/07

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

BASIN 3.01-3.02
PRE-DEVELOPMENT CONDITION

Program License Serial Number 4065

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.600
24 hour precipitation(inches) = 8.000
P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 3.011 to Point/Station 3.012
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 207.000(Ft.)
Highest elevation = 852.000(Ft.)
Lowest elevation = 819.000(Ft.)
Elevation difference = 33.000(Ft.) Slope = 15.942 %
Top of Initial Area Slope adjusted by User to 15.000 %
Bottom of Initial Area Slope adjusted by User to 16.900 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 15.00 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.40 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(15.000^(1/3)]= 5.40
The initial area total distance of 207.00 (Ft.) entered leaves a
remaining distance of 107.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.57 minutes
for a distance of 107.00 (Ft.) and a slope of 16.90 %
with an elevation difference of 18.08(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 0.566 Minutes
Tt=[(11.9*0.0203^3)/(18.08)]^.385= 0.57
Total initial area Ti = 5.40 minutes from Figure 3-3 formula plus
0.57 minutes from the Figure 3-4 formula = 5.97 minutes
Rainfall intensity (I) = 8.463(In/Hr) for a 100.0 year storm

Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 1.066(CFS)
Total initial stream area = 0.350(Ac.)

++
Process from Point/Station 3.012 to Point/Station 3.013
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 5.643(CFS)
Depth of flow = 0.741(Ft.), Average velocity = 4.109(Ft/s)
******* Irregular Channel Data **********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	2.00
2	5.00	0.00
3	10.00	2.00

Manning's 'N' friction factor = 0.045

Sub-Channel flow = 5.643(CFS)
' ' flow top width = 3.706(Ft.)
' ' velocity= 4.109(Ft/s)
' ' area = 1.373(Sq.Ft)
' ' Froude number = 1.190

Upstream point elevation = 819.000(Ft.)
Downstream point elevation = 742.500(Ft.)
Flow length = 1191.000(Ft.)
Travel time = 4.83 min.
Time of concentration = 10.80 min.
Depth of flow = 0.741(Ft.)
Average velocity = 4.109(Ft/s)
Total irregular channel flow = 5.643(CFS)
Irregular channel normal depth above invert elev. = 0.741(Ft.)
Average velocity of channel(s) = 4.109(Ft/s)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 5.773(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 1.753
Subarea runoff = 9.055(CFS) for 4.520(Ac.)
Total runoff = 10.121(CFS) Total area = 4.870(Ac.)
Depth of flow = 0.923(Ft.), Average velocity = 4.756(Ft/s)
End of computations, total study area = 4.870 (Ac.)

APPENDIX C

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/27/07

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

BASIN 1.01
POST-DEVELOPMENT CONDITION

Program License Serial Number 4065

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.600
24 hour precipitation(inches) = 8.000
P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 1.011 to Point/Station 1.012
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 100.000(Ft.)
Highest elevation = 911.000(Ft.)
Lowest elevation = 906.000(Ft.)
Elevation difference = 5.000(Ft.) Slope = 5.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 5.00 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 7.79 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(5.000^(1/3)]= 7.79
Rainfall intensity (I) = 7.126(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.154(CFS)
Total initial stream area = 0.060(Ac.)

++
Process from Point/Station 1.012 to Point/Station 1.013
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 0.575(CFS)
Depth of flow = 0.447(Ft.), Average velocity = 0.959(Ft/s)
******* Irregular Channel Data ***********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	1.00
2	3.00	0.00
3	6.00	1.00

Manning's 'N' friction factor = 0.045

Sub-Channel flow = 0.575(CFS)
' ' flow top width = 2.683(Ft.)
' ' velocity= 0.959(Ft/s)
' ' area = 0.600(Sq.Ft)
' ' Froude number = 0.357

Upstream point elevation = 906.000(Ft.)
Downstream point elevation = 904.000(Ft.)
Flow length = 300.000(Ft.)
Travel time = 5.21 min.
Time of concentration = 13.00 min.
Depth of flow = 0.447(Ft.)
Average velocity = 0.959(Ft/s)
Total irregular channel flow = 0.575(CFS)
Irregular channel normal depth above invert elev. = 0.447(Ft.)
Average velocity of channel(s) = 0.959(Ft/s)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 5.120(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 0.176
Subarea runoff = 0.749(CFS) for 0.430(Ac.)
Total runoff = 0.903(CFS) Total area = 0.490(Ac.)
Depth of flow = 0.530(Ft.), Average velocity = 1.073(Ft/s)
End of computations, total study area = 0.490 (Ac.)

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/27/07

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

BASIN 2.01-2.03
POST-DEVELOPMENT CONDITION

Program License Serial Number 4065

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.600
24 hour precipitation(inches) = 8.000
P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 2.011 to Point/Station 2.012
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 286.000(Ft.)
Highest elevation = 916.500(Ft.)
Lowest elevation = 911.000(Ft.)
Elevation difference = 5.500(Ft.) Slope = 1.923 %
Top of Initial Area Slope adjusted by User to 2.000 %
Bottom of Initial Area Slope adjusted by User to 2.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 85.00 (Ft)
for the top area slope value of 2.00 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 9.75 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(85.000^.5)/(2.000^(1/3)]= 9.75
The initial area total distance of 286.00 (Ft.) entered leaves a
remaining distance of 201.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 2.09 minutes
for a distance of 201.00 (Ft.) and a slope of 2.00 %
with an elevation difference of 4.02(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 2.090 Minutes
Tt=[(11.9*0.0381^3)/(4.02)]^.385= 2.09
Total initial area Ti = 9.75 minutes from Figure 3-3 formula plus
2.09 minutes from the Figure 3-4 formula = 11.84 minutes
Rainfall intensity (I) = 5.440(In/Hr) for a 100.0 year storm

Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 0.862(CFS)
Total initial stream area = 0.440(Ac.)

++
Process from Point/Station 2.012 to Point/Station 2.013
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Estimated mean flow rate at midpoint of channel = 1.038(CFS)
Depth of flow = 0.093(Ft.), Average velocity = 4.811(Ft/s)
******* Irregular Channel Data ***********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	0.32
2	16.00	0.00
3	0.13	0.50

Manning's 'N' friction factor = 0.017

Sub-Channel flow = 1.038(CFS)
' ' flow top width = 4.645(Ft.)
' ' velocity= 4.811(Ft/s)
' ' area = 0.216(Sq.Ft)
' ' Froude number = 3.934

Upstream point elevation = 911.000(Ft.)
Downstream point elevation = 824.000(Ft.)
Flow length = 467.000(Ft.)
Travel time = 1.62 min.
Time of concentration = 13.45 min.
Depth of flow = 0.093(Ft.)
Average velocity = 4.811(Ft/s)
Total irregular channel flow = 1.038(CFS)
Irregular channel normal depth above invert elev. = 0.093(Ft.)
Average velocity of channel(s) = 4.811(Ft/s)
Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity = 5.009(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360 CA = 0.223
Subarea runoff = 0.256(CFS) for 0.180(Ac.)
Total runoff = 1.118(CFS) Total area = 0.620(Ac.)
Depth of flow = 0.096(Ft.), Average velocity = 4.901(Ft/s)

++
Process from Point/Station 2.013 to Point/Station 2.014
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Depth of flow = 0.184(Ft.), Average velocity = 2.478(Ft/s)
******* Irregular Channel Data ***********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	1.50
2	20.00	0.00

```
        3          40.00          1.50
Manning's 'N' friction factor =  0.045
----------------------------------------------------------
Sub-Channel flow  =     1.118(CFS)
 '   '    flow top width =     4.905(Ft.)
 '   '   velocity=   2.478(Ft/s)
 '   '    area =     0.451(Sq.Ft)
 '   '    Froude number =    1.440

Upstream point elevation =  824.000(Ft.)
Downstream point elevation =  786.000(Ft.)
Flow length =  279.000(Ft.)
Travel time  =   1.88 min.
Time of concentration =  15.33 min.
Depth of flow =  0.184(Ft.)
Average velocity =  2.478(Ft/s)
Total irregular channel flow =    1.118(CFS)
Irregular channel normal depth above invert elev. =  0.184(Ft.)
Average velocity of channel(s) =  2.478(Ft/s)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       2.013 to Point/Station       2.014
**** CONFLUENCE OF MINOR STREAMS ****
______________________________________________________________________
Along Main Stream number: 1 in normal stream number 1
Stream flow area =     0.620(Ac.)
Runoff from this stream =     1.118(CFS)
Time of concentration =  15.33 min.
Rainfall intensity =    4.604(In/Hr)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       2.031 to Point/Station       2.032
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance  =  100.000(Ft.)
Highest elevation =  914.000(Ft.)
Lowest elevation =  904.000(Ft.)
Elevation difference =  10.000(Ft.) Slope = 10.000 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of  10.00 %, in a development type of
 1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration =  6.18 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*( 100.000^.5)/(  10.000^(1/3)]=  6.18
Rainfall intensity (I) =     8.271(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =     0.357(CFS)
Total initial stream area =       0.120(Ac.)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       2.032 to Point/Station       2.014
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
```

```
Estimated mean flow rate at midpoint of channel =     3.886(CFS)
Depth of flow =  0.281(Ft.), Average velocity =  3.277(Ft/s)
        ******* Irregular Channel Data ***********
-------------------------------------------------------------
Information entered for subchannel number 1 :
Point number     'X' coordinate    'Y' coordinate
        1          0.00            1.50
        2         20.00            0.00
        3         40.00            1.20
Manning's 'N' friction factor =  0.045
-------------------------------------------------------------
Sub-Channel flow  =     3.886(CFS)
 '   '    flow top width =     8.435(Ft.)
 '   '   velocity=   3.277(Ft/s)
 '   '    area =     1.186(Sq.Ft)
 '   '    Froude number =    1.540

Upstream point elevation =  904.000(Ft.)
Downstream point elevation =  786.000(Ft.)
Flow length =  873.000(Ft.)
Travel time  =   4.44 min.
Time of concentration =  10.62 min.
Depth of flow =  0.281(Ft.)
Average velocity =  3.277(Ft/s)
Total irregular channel flow =     3.886(CFS)
Irregular channel normal depth above invert elev. =  0.281(Ft.)
Average velocity of channel(s) =  3.277(Ft/s)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less      )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =     5.834(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     1.260
Subarea runoff =     6.994(CFS) for     3.380(Ac.)
Total runoff =     7.351(CFS)     Total area =     3.500(Ac.)
Depth of flow =  0.357(Ft.), Average velocity =  3.844(Ft/s)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       2.031 to Point/Station       2.014
**** CONFLUENCE OF MINOR STREAMS ****
-------------------------------------------------------------
Along Main Stream number: 1 in normal stream number 2
Stream flow area =     3.500(Ac.)
Runoff from this stream =     7.351(CFS)
Time of concentration =  10.62 min.
Rainfall intensity =    5.834(In/Hr)
Summary of stream data:

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

1       1.118    15.33            4.604
2       7.351    10.62            5.834
Qmax(1) =
            1.000 *    1.000 *    1.118) +
```

```
          0.789 *   1.000 *   7.351) + =      6.920
Qmax(2) =
          1.000 *   0.693 *   1.118) +
          1.000 *   1.000 *   7.351) + =      8.125
```

Total of 2 streams to confluence:
Flow rates before confluence point:
1.118 7.351
Maximum flow rates at confluence using above data:
6.920 8.125
Area of streams before confluence:
0.620 3.500
Results of confluence:
Total flow rate = 8.125(CFS)
Time of concentration = 10.622 min.
Effective stream area after confluence = 4.120(Ac.)
End of computations, total study area = 4.120 (Ac.)

San Diego County Rational Hydrology Program

CIVILCADD/CIVILDESIGN Engineering Software,(c)1991-2005 Version 7.5

Rational method hydrology program based on
San Diego County Flood Control Division 2003 hydrology manual
Rational Hydrology Study Date: 11/27/07

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

BASIN 3.01-3.03
POST-DEVELOPMENT CONDITION

Program License Serial Number 4065

Rational hydrology study storm event year is 100.0
English (in-lb) input data Units used

Map data precipitation entered:
6 hour, precipitation(inches) = 3.600
24 hour precipitation(inches) = 8.000
P6/P24 = 45.0%
San Diego hydrology manual 'C' values used

++
Process from Point/Station 3.011 to Point/Station 3.012
**** INITIAL AREA EVALUATION ****

Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL]
(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 234.000(Ft.)
Highest elevation = 852.000(Ft.)
Lowest elevation = 816.000(Ft.)
Elevation difference = 36.000(Ft.) Slope = 15.385 %
Top of Initial Area Slope adjusted by User to 15.000 %
Bottom of Initial Area Slope adjusted by User to 16.900 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 15.00 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 5.40 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(15.000^(1/3)]= 5.40
The initial area total distance of 234.00 (Ft.) entered leaves a
remaining distance of 134.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.67 minutes
for a distance of 134.00 (Ft.) and a slope of 16.90 %
with an elevation difference of 22.65(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 0.673 Minutes
Tt=[(11.9*0.0254^3)/(22.65)]^.385= 0.67
Total initial area Ti = 5.40 minutes from Figure 3-3 formula plus
0.67 minutes from the Figure 3-4 formula = 6.07 minutes
Rainfall intensity (I) = 8.367(In/Hr) for a 100.0 year storm

```
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff =     0.994(CFS)
Total initial stream area =       0.330(Ac.)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       3.012 to Point/Station       3.031
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
Estimated mean flow rate at midpoint of channel =      1.711(CFS)
Depth of flow =  0.127(Ft.), Average velocity =  4.129(Ft/s)
        ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number     'X' coordinate    'Y' coordinate
        1          0.00            0.48
        2         23.90            0.00
        3         24.00            0.00
Manning's 'N' friction factor =  0.017
----------------------------------------------------------------
Sub-Channel flow  =     1.711(CFS)
 '   '    flow top width =     6.425(Ft.)
 '   '   velocity=   4.129(Ft/s)
 '   '    area =     0.414(Sq.Ft)
 '   '    Froude number =     2.865

Upstream point elevation =  816.000(Ft.)
Downstream point elevation =  750.000(Ft.)
Flow length =  765.000(Ft.)
Travel time  =   3.09 min.
Time of concentration =   9.16 min.
Depth of flow =  0.127(Ft.)
Average velocity =  4.129(Ft/s)
Total irregular channel flow =     1.711(CFS)
Irregular channel normal depth above invert elev. =  0.127(Ft.)
Average velocity of channel(s) =  4.129(Ft/s)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Rainfall intensity =     6.418(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     0.364
Subarea runoff =     1.340(CFS) for     0.680(Ac.)
Total runoff =     2.334(CFS)     Total area =     1.010(Ac.)
Depth of flow =  0.143(Ft.), Average velocity =  4.462(Ft/s)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       3.031 to Point/Station       3.032
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****
______________________________________________________________________
!!Warning: Water is above left or right bank elevations
Estimated mean flow rate at midpoint of channel =      2.383(CFS)
Depth of flow =  1.209(Ft.), Average velocity =  0.577(Ft/s)
        ******* Irregular Channel Data ***********
----------------------------------------------------------------
Information entered for subchannel number 1 :
Point number     'X' coordinate    'Y' coordinate
```

```
        1          0.00          1.25
        2          2.50          0.00
        3          3.50          0.00
        4          6.00          1.25
Manning's 'N' friction factor =  0.250
----------------------------------------------------------------
Sub-Channel flow  =     2.383(CFS)
 '    '    flow top width =     5.836(Ft.)
 '    '   velocity=   0.577(Ft/s)
 '    '    area =     4.132(Sq.Ft)
 '    '    Froude number =    0.121

Upstream point elevation =  750.000(Ft.)
Downstream point elevation =  742.500(Ft.)
Flow length =  444.000(Ft.)
Travel time  =  12.83 min.
Time of concentration =  21.99 min.
Depth of flow =  1.209(Ft.)
Average velocity =  0.577(Ft/s)
Total irregular channel flow =    2.383(CFS)
Irregular channel normal depth above invert elev. =  1.209(Ft.)
Average velocity of channel(s) =  0.577(Ft/s)
 Adding area flow to channel
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
(1.0 DU/A or Less       )
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
The area added to the existing stream causes a
a lower flow rate of Q =     1.773(CFS)
therefore the upstream flow rate of Q =     2.334(CFS) is being used
Rainfall intensity =     3.648(In/Hr) for a   100.0 year storm
Effective runoff coefficient used for total area
(Q=KCIA) is C = 0.360  CA =     0.486
Subarea runoff =     0.000(CFS) for     0.340(Ac.)
Total runoff =     2.334(CFS)     Total area =     1.350(Ac.)
Depth of flow =  1.198(Ft.), Average velocity =  0.574(Ft/s)

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       3.031 to Point/Station       3.032
**** CONFLUENCE OF MAIN STREAMS ****
______________________________________________________________________
The following data inside Main Stream is listed:
In Main Stream number: 1
Stream flow area =     1.350(Ac.)
Runoff from this stream =     2.334(CFS)
Time of concentration =  21.99 min.
Rainfall intensity =    3.648(In/Hr)
Program is now starting with Main Stream No. 2

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station       3.041 to Point/Station       3.042
**** INITIAL AREA EVALUATION ****
______________________________________________________________________
Decimal fraction soil group A = 0.000
Decimal fraction soil group B = 0.000
Decimal fraction soil group C = 1.000
Decimal fraction soil group D = 0.000
[LOW DENSITY RESIDENTIAL                    ]
```

(1.0 DU/A or Less)
Impervious value, Ai = 0.100
Sub-Area C Value = 0.360
Initial subarea total flow distance = 320.000(Ft.)
Highest elevation = 830.000(Ft.)
Lowest elevation = 754.000(Ft.)
Elevation difference = 76.000(Ft.) Slope = 23.750 %
INITIAL AREA TIME OF CONCENTRATION CALCULATIONS:
The maximum overland flow distance is 100.00 (Ft)
for the top area slope value of 23.75 %, in a development type of
1.0 DU/A or Less
In Accordance With Figure 3-3
Initial Area Time of Concentration = 4.63 minutes
TC = [1.8*(1.1-C)*distance(Ft.)^.5)/(% slope^(1/3)]
TC = [1.8*(1.1-0.3600)*(100.000^.5)/(23.750^(1/3)]= 4.63
The initial area total distance of 320.00 (Ft.) entered leaves a
remaining distance of 220.00 (Ft.)
Using Figure 3-4, the travel time for this distance is 0.86 minutes
for a distance of 220.00 (Ft.) and a slope of 23.75 %
with an elevation difference of 52.25(Ft.) from the end of the top area
Tt = [11.9*length(Mi)^3)/(elevation change(Ft.))]^.385 *60(min/hr)
= 0.864 Minutes
Tt=[(11.9*0.0417^3)/(52.25)]^.385= 0.86
Total initial area Ti = 4.63 minutes from Figure 3-3 formula plus
0.86 minutes from the Figure 3-4 formula = 5.50 minutes
Rainfall intensity (I) = 8.921(In/Hr) for a 100.0 year storm
Effective runoff coefficient used for area (Q=KCIA) is C = 0.360
Subarea runoff = 11.723(CFS)
Total initial stream area = 3.650(Ac.)

++
Process from Point/Station 3.042 to Point/Station 3.043
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Depth of flow = 1.197(Ft.), Average velocity = 5.321(Ft/s)
******* Irregular Channel Data ***********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	1.50
2	0.75	0.21
3	1.50	0.00
4	2.25	0.21
5	3.00	1.50

Manning's 'N' friction factor = 0.017

Sub-Channel flow = 11.723(CFS)
' ' flow top width = 2.647(Ft.)
' ' velocity= 5.321(Ft/s)
' ' area = 2.203(Sq.Ft)
' ' Froude number = 1.028

Upstream point elevation = 754.000(Ft.)
Downstream point elevation = 752.500(Ft.)
Flow length = 193.000(Ft.)
Travel time = 0.60 min.
Time of concentration = 6.10 min.
Depth of flow = 1.197(Ft.)
Average velocity = 5.321(Ft/s)
Total irregular channel flow = 11.723(CFS)
Irregular channel normal depth above invert elev. = 1.197(Ft.)
Average velocity of channel(s) = 5.321(Ft/s)

++
Process from Point/Station 3.043 to Point/Station 3.044
**** PIPEFLOW TRAVEL TIME (User specified size) ****

Upstream point/station elevation = 752.500(Ft.)
Downstream point/station elevation = 751.500(Ft.)
Pipe length = 41.00(Ft.) Manning's N = 0.013
No. of pipes = 1 Required pipe flow = 11.723(CFS)
Given pipe size = 18.00(In.)
Calculated individual pipe flow = 11.723(CFS)
Normal flow depth in pipe = 11.25(In.)
Flow top width inside pipe = 17.43(In.)
Critical Depth = 15.62(In.)
Pipe flow velocity = 10.09(Ft/s)
Travel time through pipe = 0.07 min.
Time of concentration (TC) = 6.17 min.

++
Process from Point/Station 3.044 to Point/Station 3.032
**** IRREGULAR CHANNEL FLOW TRAVEL TIME ****

Depth of flow = 0.790(Ft.), Average velocity = 1.877(Ft/s)
******* Irregular Channel Data ***********

Information entered for subchannel number 1 :

Point number	'X' coordinate	'Y' coordinate
1	0.00	2.00
2	20.00	0.00
3	40.00	2.00

Manning's 'N' friction factor = 0.045

Sub-Channel flow = 11.723(CFS)
' ' flow top width = 15.807(Ft.)
' ' velocity= 1.877(Ft/s)
' ' area = 6.247(Sq.Ft)
' ' Froude number = 0.526

Upstream point elevation = 751.500(Ft.)
Downstream point elevation = 744.000(Ft.)
Flow length = 669.000(Ft.)
Travel time = 5.94 min.
Time of concentration = 12.11 min.
Depth of flow = 0.790(Ft.)
Average velocity = 1.877(Ft/s)
Total irregular channel flow = 11.723(CFS)
Irregular channel normal depth above invert elev. = 0.790(Ft.)
Average velocity of channel(s) = 1.877(Ft/s)

++
Process from Point/Station 3.044 to Point/Station 3.032
**** CONFLUENCE OF MAIN STREAMS ****

The following data inside Main Stream is listed:
In Main Stream number: 2
Stream flow area = 3.650(Ac.)
Runoff from this stream = 11.723(CFS)
Time of concentration = 12.11 min.
Rainfall intensity = 5.360(In/Hr)
Summary of stream data:

Stream	Flow rate	TC	Rainfall Intensity

No.	(CFS)	(min)	(In/Hr)
1	2.334	21.99	3.648
2	11.723	12.11	5.360

Qmax(1) =
1.000 * 1.000 * 2.334) +
0.681 * 1.000 * 11.723) + = 10.312

Qmax(2) =
1.000 * 0.551 * 2.334) +
1.000 * 1.000 * 11.723) + = 13.008

Total of 2 main streams to confluence:
Flow rates before confluence point:
2.334 11.723
Maximum flow rates at confluence using above data:
10.312 13.008
Area of streams before confluence:
1.350 3.650

Results of confluence:
Total flow rate = 13.008(CFS)
Time of concentration = 12.112 min.
Effective stream area after confluence = 5.000(Ac.)
End of computations, total study area = 5.000 (Ac.)

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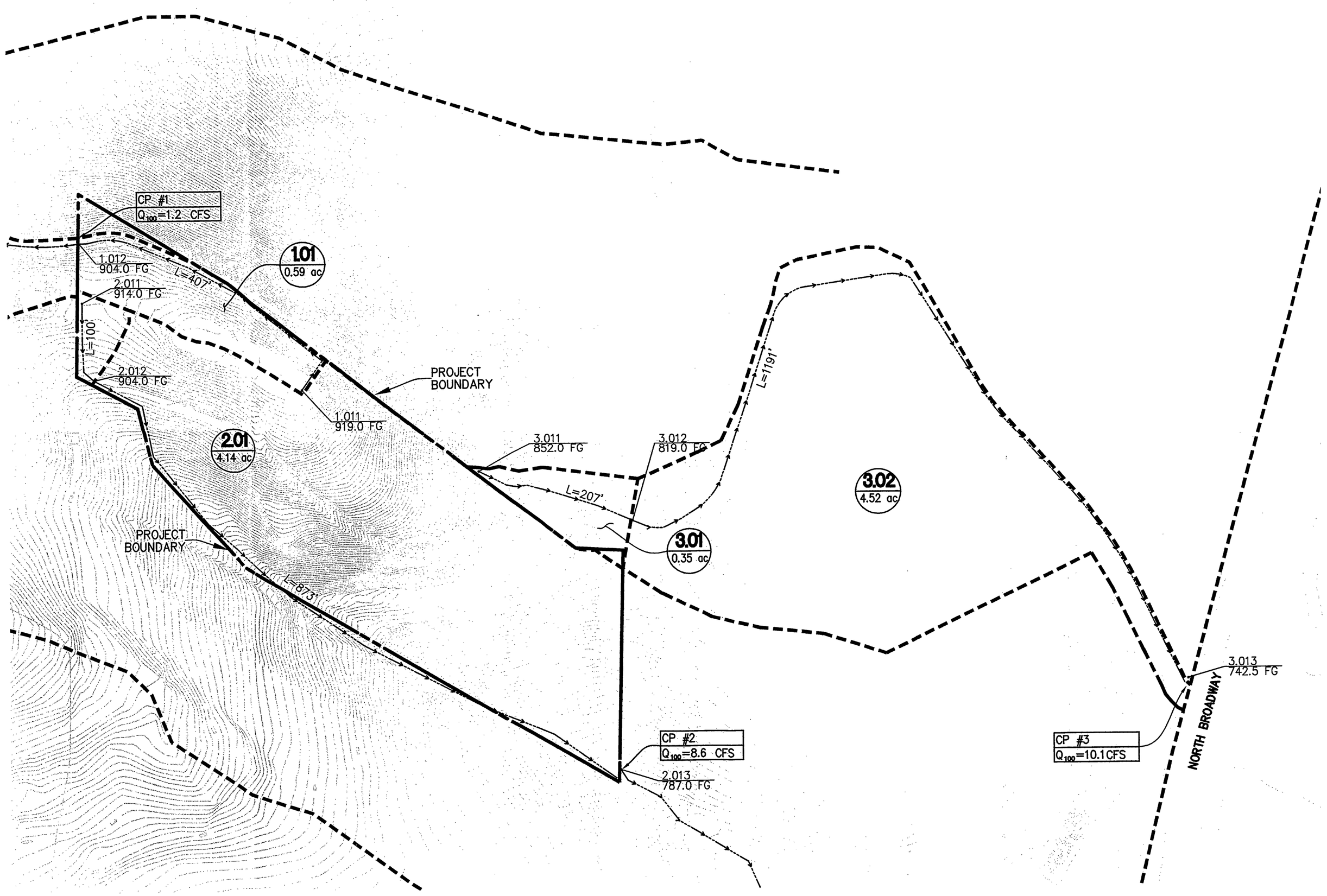

LEGEND

- 3.02 / 4.36 ac — BASIN DESIGNATION; AREA (AC)
- BASIN BOUNDARY
- FLOW PATH
- PROJECT BOUNDARY
- CP #2 / Q_{100}=6.2 CFS — CONCENTRATION POINT RUNOFF

N

100 50 0 100 200 300

SCALE IN FEET
GRAPHIC SCALE
1"=100'

EXHIBIT A
PRE-DEVELOPMENT DRAINAGE MAP

DATE: Nov 28, 07 10:36am by: mkosowska
FILE: I:\DWG\03\3083\Hydrology\Drainage\3083Pre-Hyd.dwg

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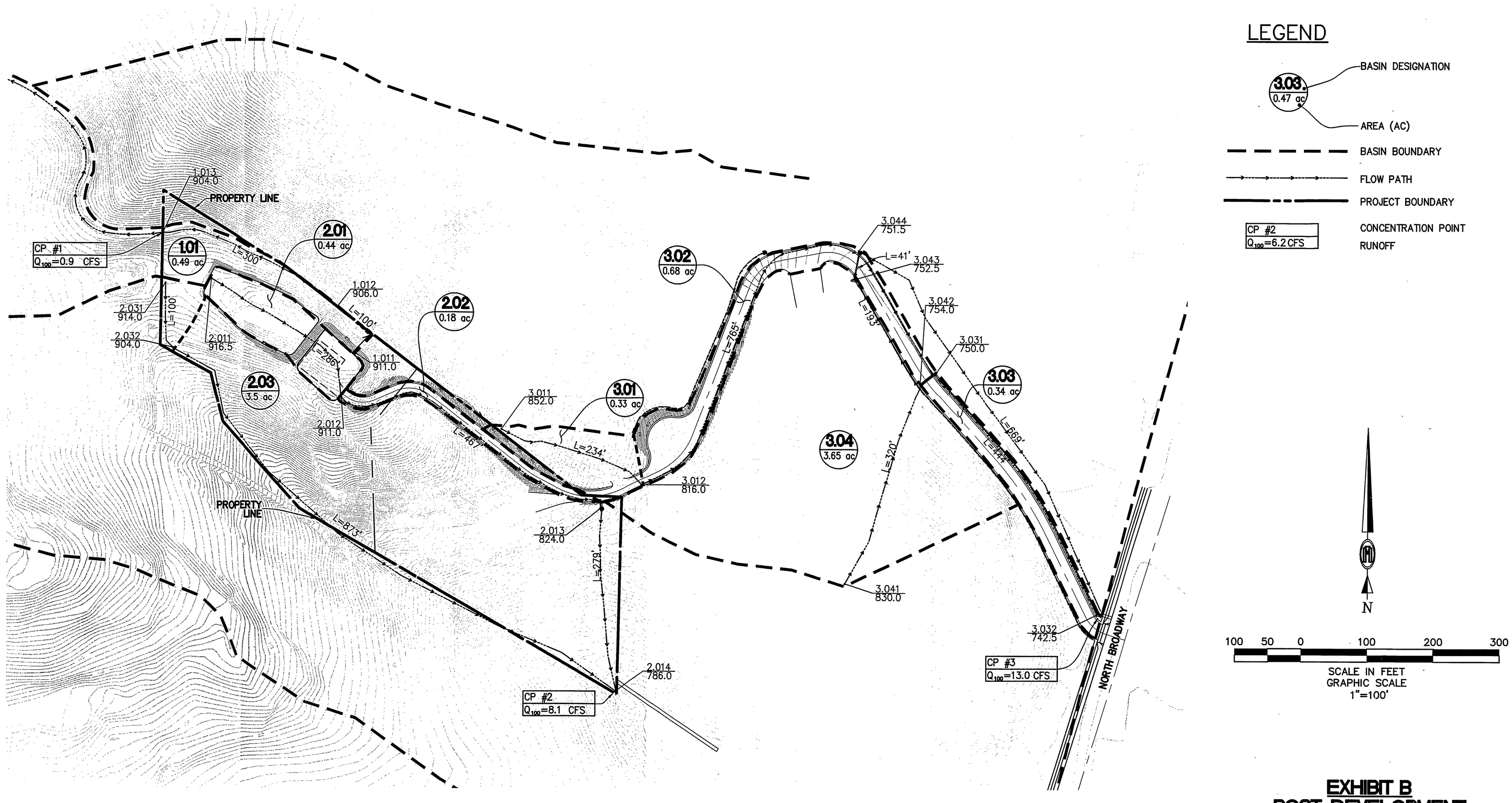

EXHIBIT B
POST-DEVELOPMENT DRAINAGE MAP

DATE: Nov 28, 07 10:36am by: mkosowska
FILE: I:\DWG\03\3083\Hydrology\Drainage\3083Post-Hyd.dwg

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