Drainage Study
for
Hurrell Subdivision, Lakeside
12392 Lakeside Avenue
Lakeside CA 92040
PDS2020-TPM-21279

Date Prepared:
May 2, 2022

Prepared for:
Jim Hurrell
12392 Lakeside Ave,
Lakeside, CA 92040
Ph: (619) 519-3853

Prepared By:

ΩMEGA
ENGINEERING CONSULTANTS
4340 Viewridge Ave, Suite B
San Diego, CA 92113
Ph: (858) 634-8620

Declaration of Responsible Charge:
I hereby declare that I am the 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 standards. I understand that the check of the project drawings and specifications by the County of San Diego is confined to a review only and does not relieve me, as an engineer of work, of my responsibilities for project design.

Patric de Boer RCE 83583
Registration Expires 3-31-2021

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Appendices

Site & Project Description

This drainage study has been prepared for the proposed subdivision of the lot at 12392 Lakeside Ave. The site is 1,000 ft west of Highway 67 and 500 ft north of the upper reach of San Diego River.

The project will involve the widening of an existing private access road and the regrading of portions of the site to add 2 new house pads. The existing house and improvements will remain in place.

This analysis includes portions of the property that will be disturbed by the project as well as portions that drain to disturbed areas of the project. A long thin strip of land will be disturbed to allow the installation of sewer and water pipes. The area above these will be returned to natural conditions. This area is not included in this report as it does not have the potential to change stormwater flowrates in the proposed conditions.

A thin strip of new pervious pavement will be constructed on the private access road that connects the project site to Lakeside Avenue.

The area included in this analysis is 13.52 acres.

Methodology

This drainage report has been prepared in accordance with current county regulations and procedures. The Modified Rational Method was used to determine the peak flowrates generated by the existing and proposed site conditions.

The flowrates generated by sub-basins were confluenced according to the junction equations as detailed on page 3-24 of the San Diego County Hydrology Manual.

The proposed storm drain pipes and channels were sized using Manning's Equation as specified for circular and trapezoidal channels on page 7-78 & 7-18 of *The Handbook of Hydraulics,* by Brater & King.

See the attached calculations for particulars. The following references have been used in preparation of this report:

(1) Handbook of Hydraulics, E.F. Brater & H.W. King, 6th Ed., 1976.
(2) County of San Diego Hydrology Manual, 2003

Existing Conditions

The existing site is located on a hill approximately 300 ft high. An existing house, garage and barn are located along the crest of the hill. The site drains via surface flow. Areas north of the crest of the hill drain to the north to the neighboring property at a point referred to in this report as Discharge Point #1. Areas south of the crest drain south to natural drainage path located on the south facing hillside. This is Discharge Point #2.

The offsite portion of the private access road and the areas tributary to it drain to the frontage of Lakeside Avenue. The south end of the access road is the location of Discharge Point #3

The existing site slopes at an average of 20-40% and is underlain by type 'D' Soil.

The project is not located within a 100-year flood hazard zone according to FEMA Firm Map # 060284 Panel 1656G. The project is not located in an area that would expose people or structures to significant risk of loss, injury, or death involving flooding as a result of the failure of a levee or dam. See Existing Hydrology Exhibit for details.

Proposed Conditions

In the proposed conditions, the access road will be widened, and two-house pads will be graded near the crest of the hill. A cul-de-sac will be built at the point where the existing access road makes a 90-degree turn to the east. Brow ditches will be built across the site to convey runoff to riprap energy dissipaters at the same two discharge points that the existing site drains to. No houses are currently proposed for the two new pads, but placeholder impervious footprints are assumed to enable the calculations to approximate the built-out conditions.

The portion of the onsite access road that will be widened will drain to a row of street trees along the east side of the road. The road will not be built with curb and gutter. Flow from the road will sheet flow directly into the street trees and then into a concrete ditch drainage of the existing access road near the existing houses will remain unchanged. Runoff will continue to drain to the center of the road and then drained off the north side of the road to a proposed concrete ditch.

Existing Rational Analysis

The existing area of site was modeled as three basins, containing all the onsite improvements and the offsite areas tributary to the improvements.

The C-value of the basins was determined by taking the area weighted average of a value of 0.35 for natural D type soil, and 0.9 for impervious surfaces. See table 3-1 of the county hydrology manual, included as Appendix 5 of this report.

The initial time of concentration (Ti) and maximum overland flow length (Lm) were determined using Table 3-2 of the Hydrology Manual. A Ti of 5.6 mins and Lm value of 100 ft were chosen. This corresponds to low density residential land use at 10% slope.

The 100-yr, 6-hr storm depth (P_6) of 2.6 inches was determined using the isopluvial maps included as Appendix 2 and 3 of this report.

The total time of concentration was determined by adding the Ti value to the travel time (Tt). Tt was determined via the Kirpich Formula as described in Figure 3-4 of the county hydrology manual.

$$\mathbf{Tc = Ti + Tt}$$

The Tc and the P_6 values were entered into the peak intensity formula from page 3-7 of the hydrology manual to determine the intensity of the rainfall during the peak of the 100-year, 6-hr storm.

$$\mathbf{I = 7.44 \times P_6 \times Tc^{-0.645}}$$

The peak discharge rate was determine using the Rational Method Formula.

$$\mathbf{Q = C \times I \times A}$$

The C value of Type D soil is 0.35, the C value of impervious surfaces is 0.9
The weighted C values were determined using the following formula.

$$\mathbf{C = (\% \text{ impervious} \times C_{imperviuos}) + (\% \text{ pervious} \times C_{pervious})}$$
$$\mathbf{C = (\% \text{ impervious} \times 0.9) + (\% \text{ pervious} \times 0.35)}$$

Existing Rational Calculation Summary

Basin	Area (ac)	% Impervious	C	Tc	I_{100} (in/hr)	Q_{100} (cfs)	Discharge Point	Discharge Point Q_{100}
E-1	2.03	19.8	0.46	8.1	5.01	4.66	1	4.66
E-2	2.64	12.5	0.42	6.8	5.61	6.20	2	6.20
E-3	8.85	13.1	0.42	10.8	4.16	15.52	3	15.52

Proposed Rational Analysis

The proposed site was modeled as eight separate basins, containing the disturbed area onsite areas and offsite area that drain across the disturbed area. The proposed basins are referred to as P-1 through P-8 in this report. The average slopes of the basins vary from 3% to 25%. Weighted runoff coefficients vary from 0.35 to 0.73.

The initial time of concentration (Ti) and maximum overland flow length (Lm) were determined using Table 3-2 of the Hydrology Manual. The total time of concentration was determined by adding the Ti value to the travel time (Tt). Tt was determined using the Kirpich Formula.

The time of concentration, runoff coefficient, peak intensity and the peak flowrate were determined using the same formulas and methods as in the existing conditions.

Proposed Rational Calculation Summary

Basin	Area (ac)	% Impervious	C	Tc	I_{100} (in/hr)	Q_{100} (cfs)	Discharge Point	Discharge Point Q_{100}
P-1	0.42	69.9	0.73	7.2	5.43	1.67	1	3.83
P-2	0.76	0.0	0.35	9.9	4.41	1.18		
P-3	0.32	24.8	0.49	6.8	5.62	0.88		
P-4	0.24	0.0	0.35	7.2	5.42	0.46		
P-5	1.80	6.7	0.39	7.5	5.28	3.68	2	6.09
P-6	0.45	0.0	0.35	13.6	3.58	0.56		
P-7	0.67	54.3	0.65	7.9	5.09	2.22		
P-8	8.85	13.1	0.42	10.8	4.16	15.52	3	15.52

The peak flowrates determined for each basin were confluenced according to the junction equations from page 3-24 of the San Diego County Hydrology Manual.

Junction Equations:

$$T_1 < T_2 < T_3$$

Equation 1.) $$Q_{T1} = Q_1 + \frac{T_1}{T_2} Q_2$$

Equation 2.) $$Q_{T2} = Q_2 + \frac{I_1}{I_2} Q_1$$

Proposed Flow Junction Calculation Summary

Confluence Pt.	Tributary Flows	I_{100} (in/hr)	Tc (mins)	Q_{100} (cfs)	Confluenced Flow (cfs)
CP-1	P-1	5.43	7.2	1.67	2.52
	P-2	4.41	9.9	1.18	
CP-2	CP-1	5.43	7.2	2.52	3.37
	P-3	5.62	6.8	0.88	
CP-3	CP-2	5.43	7.2	3.37	3.83
	P-4	5.42	7.2	0.46	
CP-4	P-5	5.28	7.5	3.68	3.99
	P-6	3.58	13.6	0.56	
CP-5	CP-4	5.28	7.5	3.99	6.09
	P-7	5.09	7.9	2.22	

Results and Conclusions

The redevelopment of the project site will modify the onsite drainage patterns, but the discharge point locations will remain unchanged. The proposed improvements result in a decrease in peak flowrates for the 6-hr, 100-yr storm despite an increase in impervious area for Discharge Point #1 and #2. This is due to the increased times of concentration that occur as a result of flattening of portions of the site. Discharge Point #3 will see no change in flow.

Project is not anticipated to alter runoff in a manner that would result in substantial erosion of siltation onsite or offsite.

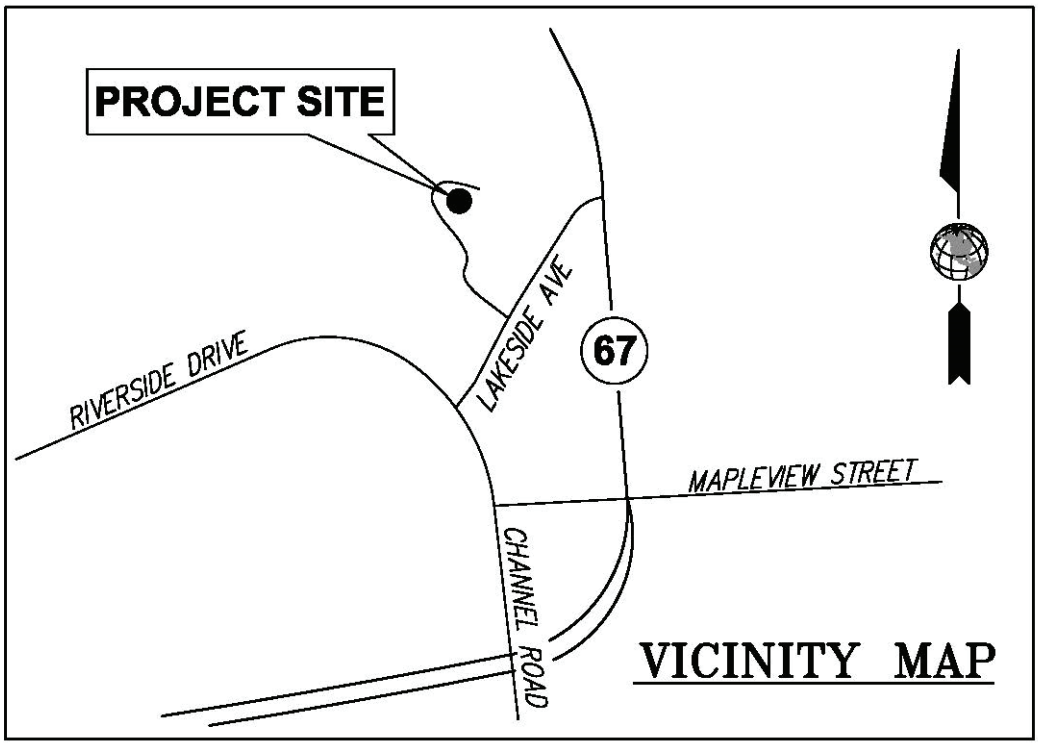
The peak flowrate at Discharge Point #1 is 4.66 cfs in the existing conditions and 3.83 in the proposed. This is a 0.83 cfs decrease.

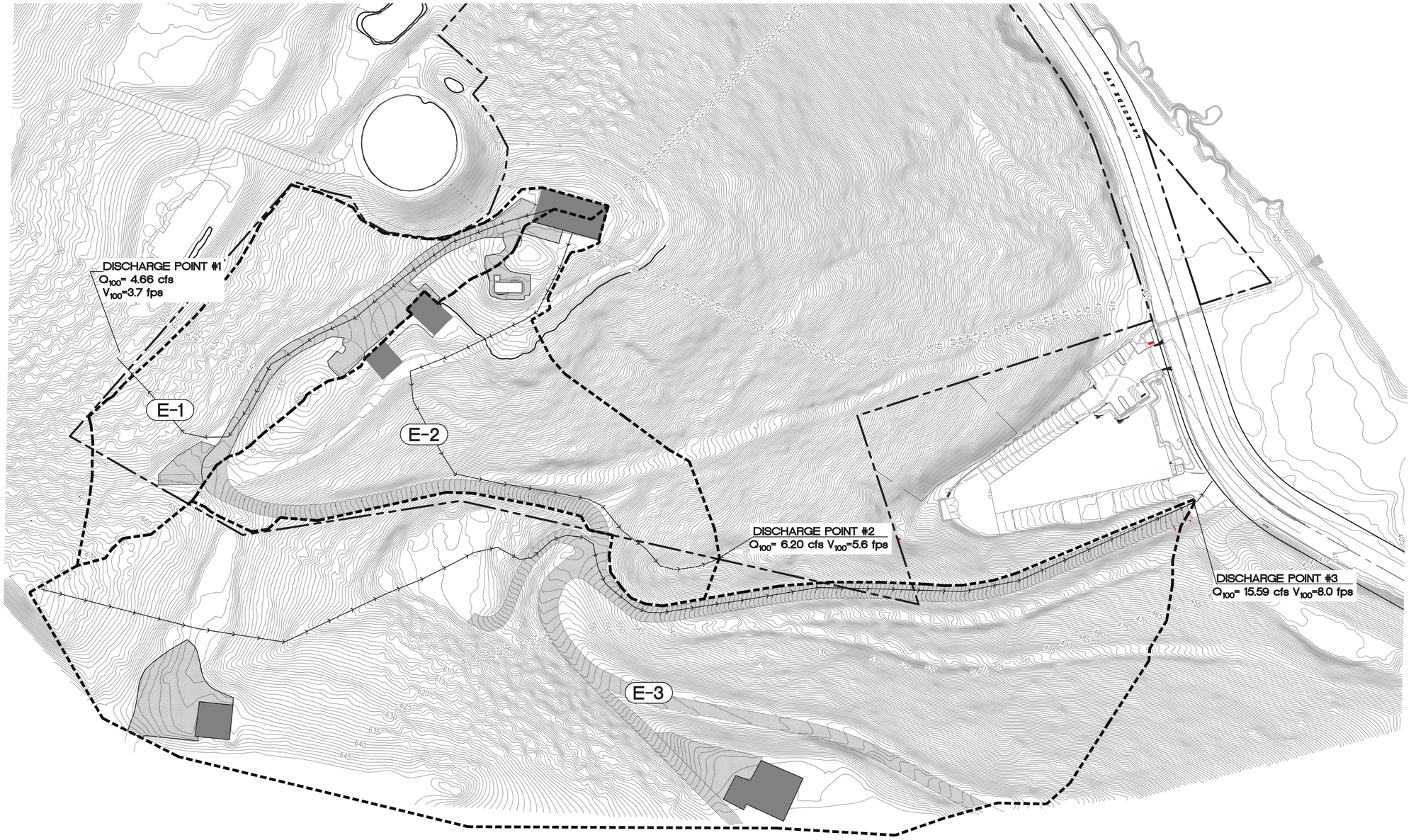
The peak flowrate at Discharge Point #2 is 6.20 cfs in the existing conditions and 6.09 in the proposed. This is a 0.10 cfs decrease.

The peak flowrate at Discharge Point #3 is 15.52 cfs in the existing condition and 15.52 in the proposed condition. This flow is unchanged.

Project will not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site

It is the opinion of Omega Engineering Consultants that the project will not create new adverse flooding conditions to the downstream facilities or receiving waters as a result of increased peak flowrate during the 100-yr, 6-hr storm. Due to the proposed decrease in peak flowrates at Discharge Points #1 and #2 and no change at Discharge Point #3, the project is not anticipated to exceed the capacity of existing or proposed drainage conveyances. A separate Storm Water Quality Management Plan has been prepared to discuss the water quality impacts for the proposed development.


PROJECT SITE
LAKESIDE AVE
67
RIVERSIDE DRIVE
MAPLEVIEW STREET
CHANNEL ROAD
VICINITY MAP



LEGEND

BASIN NUMBER	E-#
AREA LIMITS	
DRAINAGE FLOW PATH	
BUILDING AREA	
PAVEMENT AREA	
PERVIOUS AREA	

DRAINAGE BASIN DATA

BASIN #	AREA (AC)	C-VALUE	T_c (MINS)	I_{100} (IN/HR)	Q_{100} (CFS)
E-1	2.03	0.46	8.1	5.01	4.66
E-2	2.64	0.42	6.8	5.61	6.20
E-3	8.85	0.42	10.8	4.16	15.52

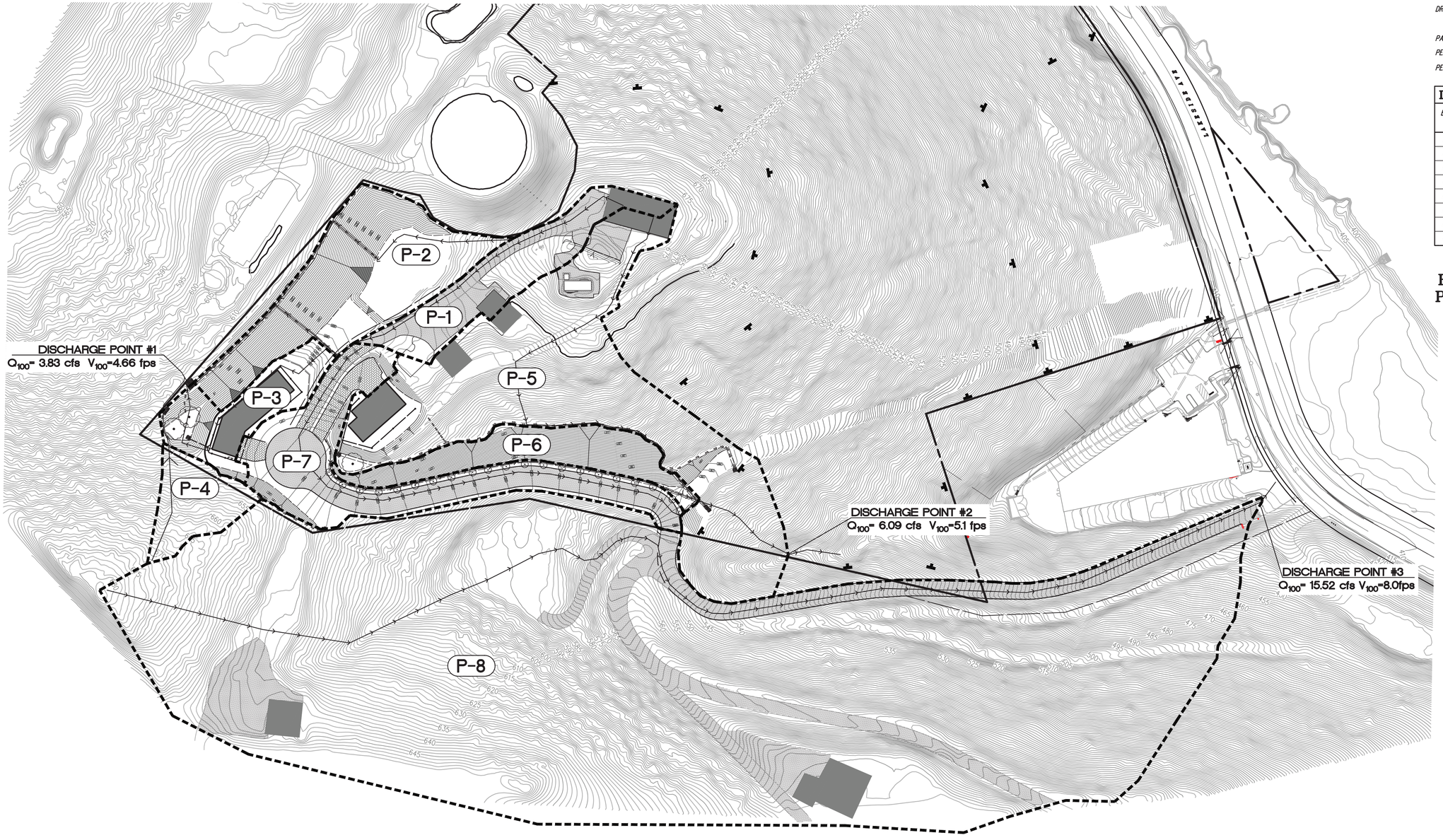
GRAPHICAL SCALE: 1" = 60'

0 30 60 120

HURRELL SUBDIVISION
EXISTING HYDROLOGY EXHIBIT

OMEGA

EX. HYDROLOGY EXHIBIT



LEGEND

BASIN NUMBER	P-#
AREA LIMITS	
DRAINAGE FLOW PATH	
PAVEMENT AREA	
PERVIOUS PAVEMENT AREA	
PERVIOUS AREA	

DRAINAGE BASIN DATA

BASIN #	AREA (AC)	C-VALUE	T_C (MINS)	I_{100} (IN/HR)	Q_{100} (CFS)
P-1	0.42	0.73	7.2	5.43	1.67
P-2	0.76	0.35	9.9	4.41	1.18
P-3	0.32	0.49	6.8	5.62	0.88
P-4	0.24	0.35	7.2	5.42	0.46
P-5	1.80	0.39	7.5	5.28	3.68
P-6	0.45	0.35	13.6	3.58	0.56
P-7	0.67	0.65	7.9	5.09	2.22
P-8	8.85	0.42	10.8	4.16	15.52

HURRELL SUBDIVISION
PROPOSED HYDROLOGY
EXHIBIT

GRAPHICAL SCALE: 1" = 60'

0 30 60 120

HURRELL SUBDIVISION
PROPOSED HYDROLOGY
EXHIBIT

OMEGA

PROP. HYDROLOGY EXHIBIT

HURRELL SUBDIVISION
HYDROLOGY AND HYDRAULICS CALCS (Table No. 1)

5/2/2022

BASIN	AREA (SF)	AREA (AC)	% Imp	"C" Value
E-1	88,442	2.03	19.8%	0.46
E-2	114,993	2.64	12.5%	0.42
E-3	385,323	8.85	13.1%	0.42
EX. TOTAL	**588,758**	**13.52**		
P-1	18,200	0.42	69.9%	0.73
P-2	33,223	0.76	0.0%	0.35
P-3	14,091	0.32	24.8%	0.49
P-4	10,479	0.24	0.0%	0.35
P-5	78,562	1.80	6.7%	0.39
P-6	19,546	0.45	0.0%	0.35
P-7	29,334	0.67	54.3%	0.65
P-8	385,323	8.85	13.1%	0.42
PROP TOTAL	**588,758**	**13.52**		

Notes: ECP # - Existing Confluence Point

CP # - Proposed Confluence Point

C value for bare ground is 0.35 (Table 3-1 County Hydrology Manual)
(Type 'D' soil)

C value for impervious surfaces is 0.9

Basins with mixed surface type use a weighted average
of these 2 values. (impervious % x 0.9)+(pervious % x 0.35)

HURRELL SUBDIVISION 5/2/2022

HYDROLOGY AND HYDRAULICS CALCS (Table No. 2)

Sub-Basin	AREA Ac.	"C"	Overland flow length	Concentrated Flow Length, (ft)	S(%) (avg.)	Ti mins	Tt mins	T_c mins	I in/hr	Q cfs	Q tot cfs	NOTES 85th % STORM
E-1	2.03	0.46	100.0	550.0	7.7%	5.60	2.53	8.1	0.20	0.19	0.19	
								Existing Flow at Discharge Pt. 1			**0.19**	
E-2	2.64	0.42	100.0	400.0	26.0%	5.60	1.21	6.8	0.20	0.22	0.22	
								Existing Flow at Discharge Pt. 2			**0.22**	
E-3	8.85	0.42	100.0	1461.0	16.7%	6.70	4.15	10.8	0.20	0.75	0.75	
								Existing Flow at Discharge Pt. 3			**0.75**	
P-1	0.42	0.73	100.00	307.00	0.07	5.60	1.57	7.2	0.20	0.06	0.06	
P-2	0.76	0.35	80.00	410.00	0.10	8.10	1.80	9.9	0.20	0.05	0.05	
								7.2	0.20		0.10	Confluence Pt. -1
P-3	0.32	0.49	100.00	150.00	0.03	5.60	1.20	6.8	0.20	0.03	0.03	
								7.2	0.20		0.13	Confluence Pt.-2
P-4	0.24	0.35	100.00	80.00	0.25	6.90	0.28	7.2	0.20	0.02	0.02	
								7.2	0.20		0.15	Confluence Pt.-3
								Proposed Flow at Discharge Pt. 1			**0.15**	
P-5	1.80	0.39	100.00	500.00	0.13	5.60	1.89	7.5	0.20	0.14	0.14	
P-6	0.45	0.35	70.00	580.00	0.14	11.50	2.15	13.6	0.20	0.03	0.03	
								7.5	0.20		0.16	Confluence Pt. -4
P-7	0.67	0.65	100.00	600.00	0.13	5.70	2.23	7.9	0.20	0.09	0.09	
								7.5	0.20		0.24	Confluence Pt. -4
								Proposed Flow at Discharge Pt. 2			**0.24**	
P-8	8.85	0.42	100.0	1461.0	16.7%	6.70	4.15	10.8	0.20	0.75	0.75	
								Existing Flow at Discharge Pt. 3			**0.75**	

HURRELL SUBDIVISION 5/2/2022

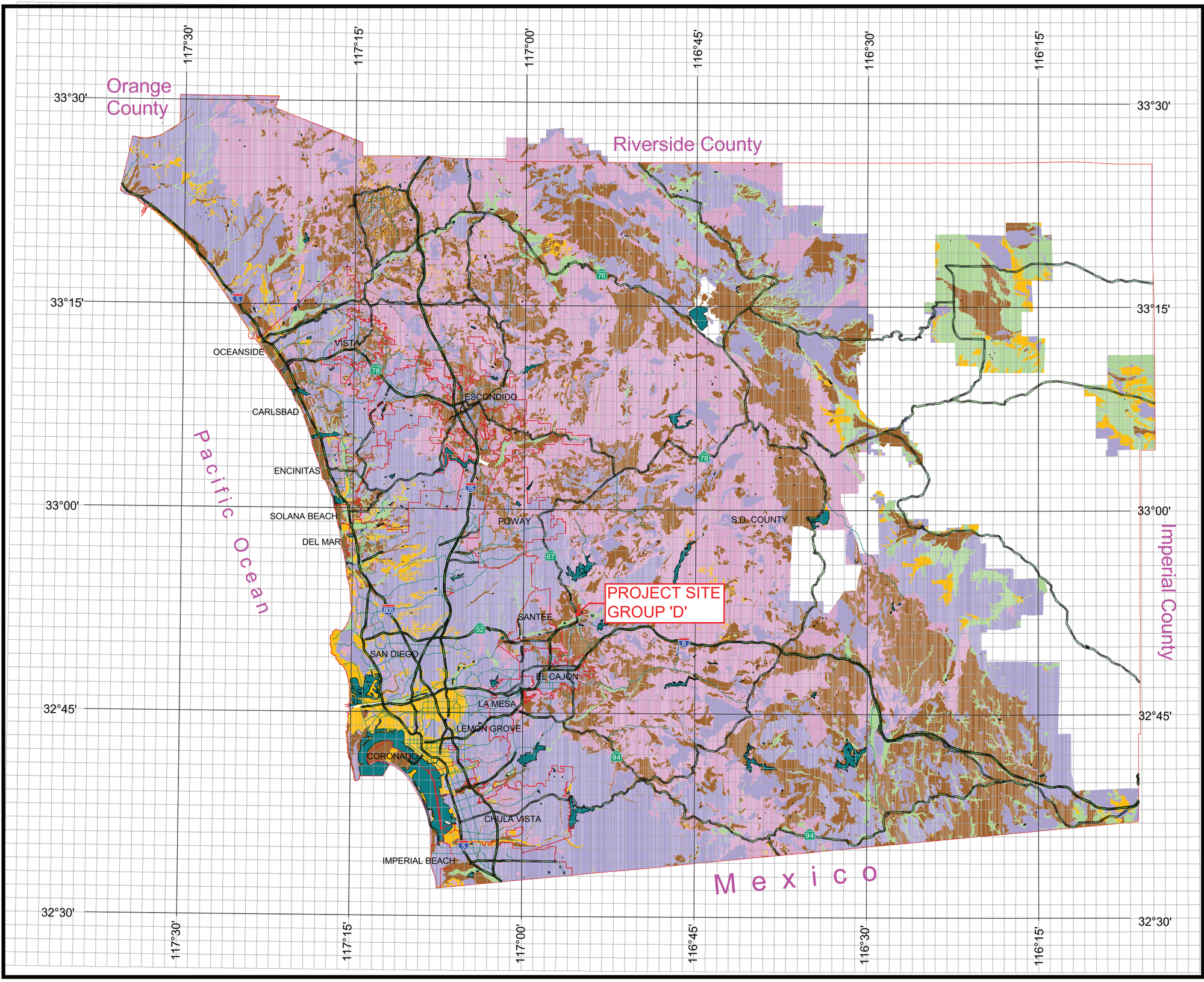
HYDROLOGY AND HYDRAULICS CALCS (Table No. 2)

Sub-Basin	AREA Ac.	"C"	Overland flow length	Concentrated Flow Length, (ft)	S(%) (avg.)	Ti mins	Tt mins	T_c mins	I in/hr	Q cfs	Q tot cfs	NOTES
												100-year, 6 hr storm (mitigated)
												P6-hr (inches) 2.6
E-1	2.03	0.46	100.0	550.0	7.7%	5.60	2.53	8.1	5.01	4.66	4.66	
							Existing Flow at Discharge Pt. 1				**4.66**	
E-2	2.64	0.42	100.0	400.0	26.0%	5.60	1.21	6.8	5.61	6.20	6.20	
							Existing Flow at Discharge Pt. 2				**6.20**	
E-3	8.85	0.422	100.0	1461.0	16.7%	6.70	4.15	10.8	4.16	15.52	15.52	
							Existing Flow at Discharge Pt. 3				**15.52**	
P-1	0.42	0.73	100.00	307.00	0.07	5.60	1.57	7.2	5.43	1.67	1.67	
P-2	0.76	0.35	80.00	410.00	0.10	8.10	1.80	9.9	4.41	1.18	1.18	
								7.2	5.43		2.52	Confluence Pt. -1
P-3	0.32	0.49	100.00	150.00	0.03	5.60	1.20	6.8	5.62	0.88	0.88	
								7.2	5.43		3.37	Confluence Pt.-2
P-4	0.24	0.35	100.00	80.00	0.25	6.90	0.28	7.2	5.42	0.46	0.46	
								7.2	5.43		3.83	Confluence Pt.-3
							Proposed Flow at Discharge Pt. 1				**3.83**	
P-5	1.80	0.39	100.00	500.00	0.13	5.60	1.89	7.5	5.28	3.68	3.68	
P-6	0.45	0.35	70.00	580.00	0.14	11.50	2.15	13.6	3.58	0.56	0.56	
								7.5	5.28		3.99	Confluence Pt. -4
P-7	0.67	0.65	100.00	600.00	0.13	5.70	2.23	7.9	5.09	2.22	2.22	
								7.5	5.28		6.09	Confluence Pt. -5
							Proposed Flow at Discharge Pt. 2				**6.09**	
P-8	8.85	0.422	100.0	1461.0	16.7%	6.70	4.15	10.8	4.16	15.52	15.52	
							Existing Flow at Discharge Pt. 3				**15.52**	

Appendix 1

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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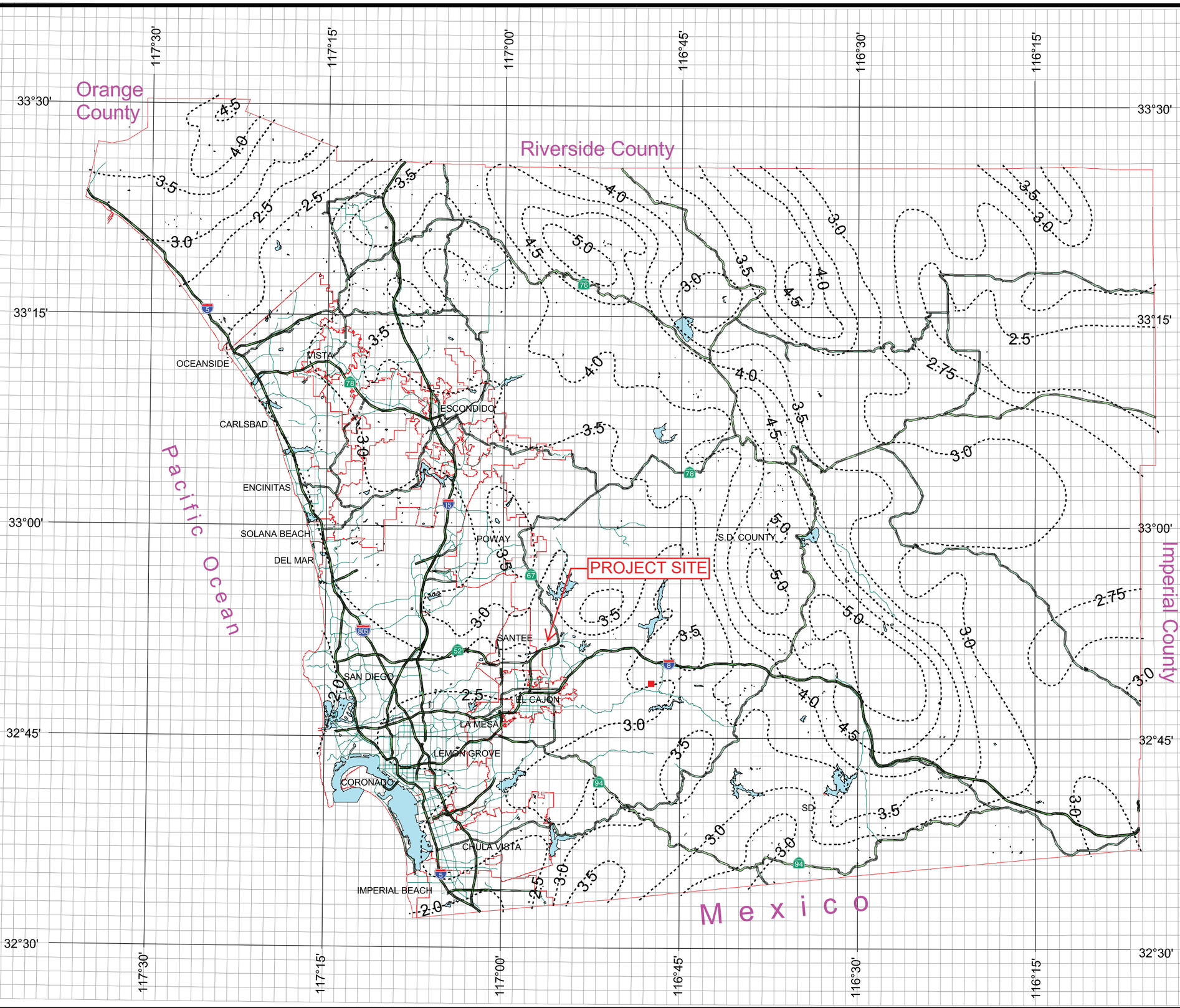
Appendix 2

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)



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Appendix 3

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Mexico

Pacific Ocean

PROJECT SITE

OCEANSIDE
VISTA
CARLSBAD
ESCONDIDO
ENCINITAS
SOLANA BEACH
DEL MAR
POWAY
S.D. COUNTY
SANTEE
SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH
SD

117°30' 117°15' 117°00' 116°45' 116°30' 116°15'
33°30' 33°15' 33°00' 32°45' 32°30'

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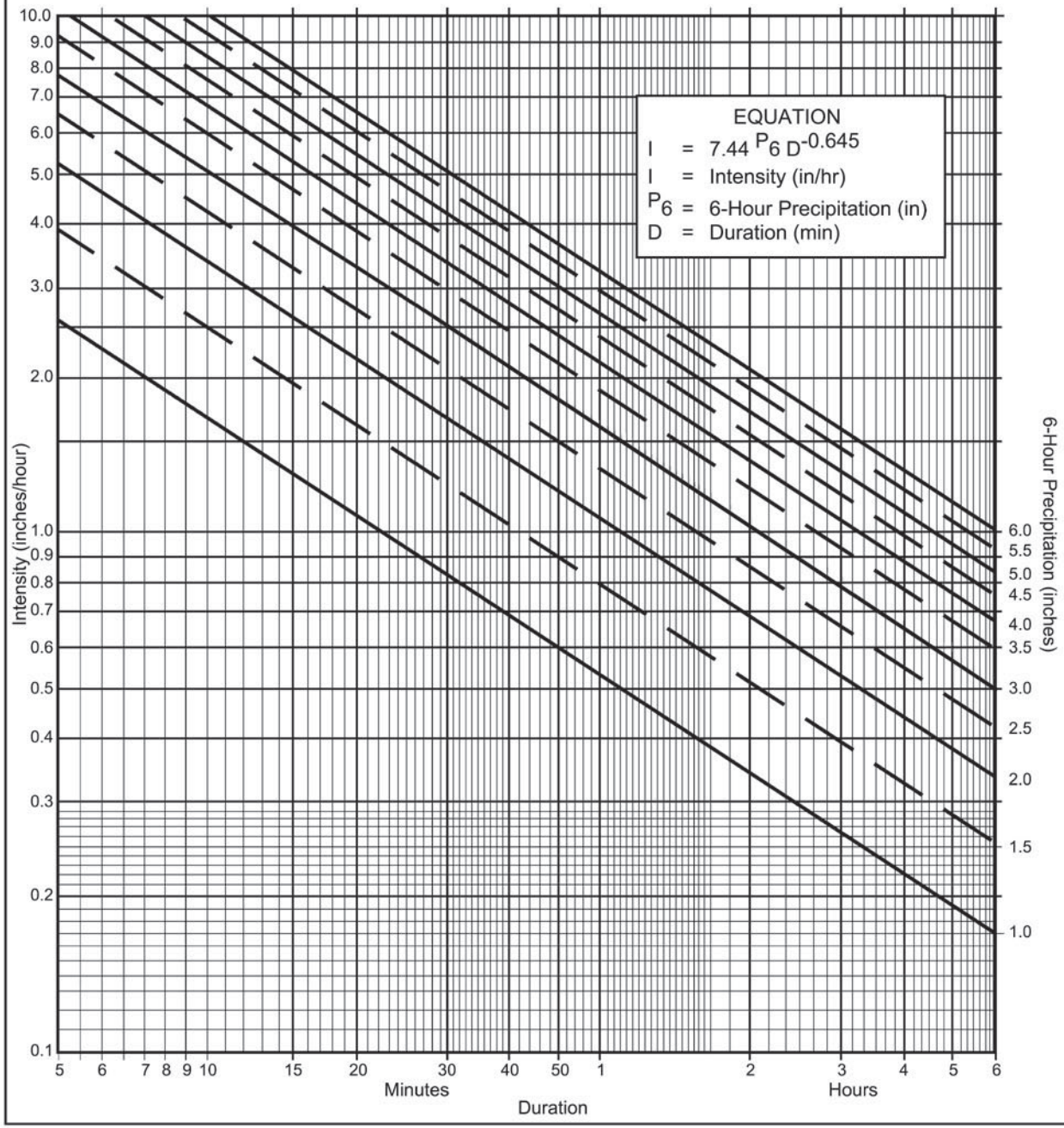
Appendix 4



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} = 8.0, $\frac{P_6}{P_{24}}$ = 4.5 %(2)

(c) Adjusted P_6(2) = n/a in.

(d) t_x = _____ min. **T & I per Rational**

(e) I = _____ in./hr. **Calc sheet**

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

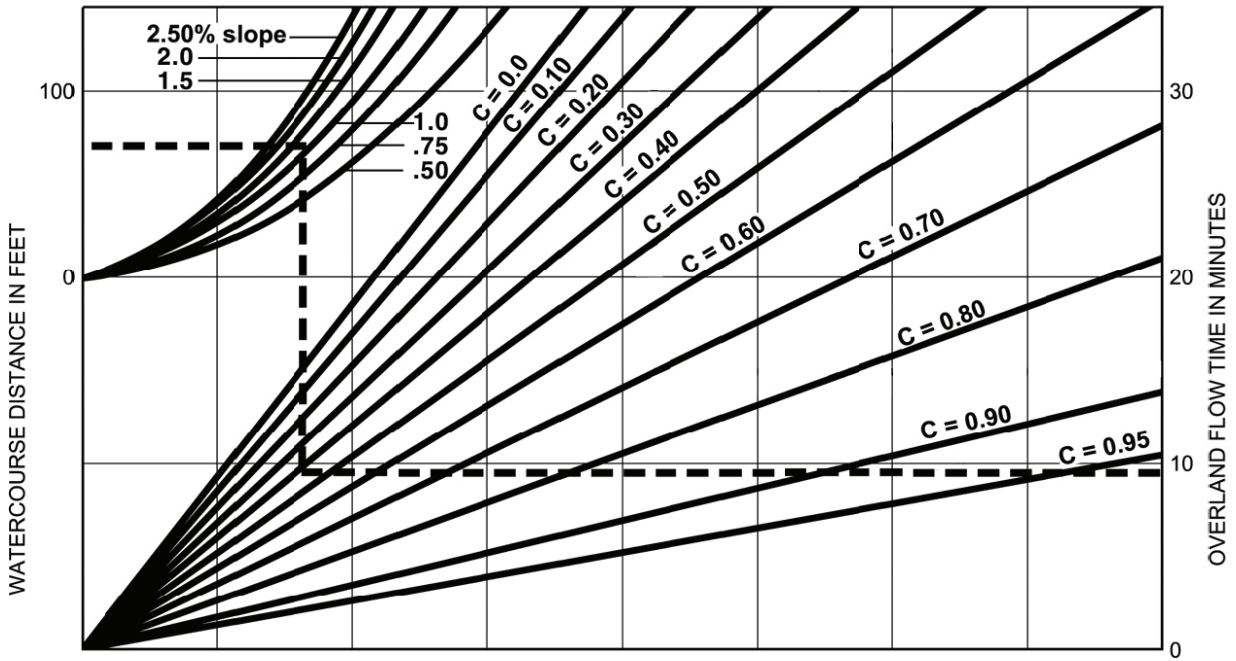
Appendix 5

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

Appendix 6



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

Appendix 7

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.

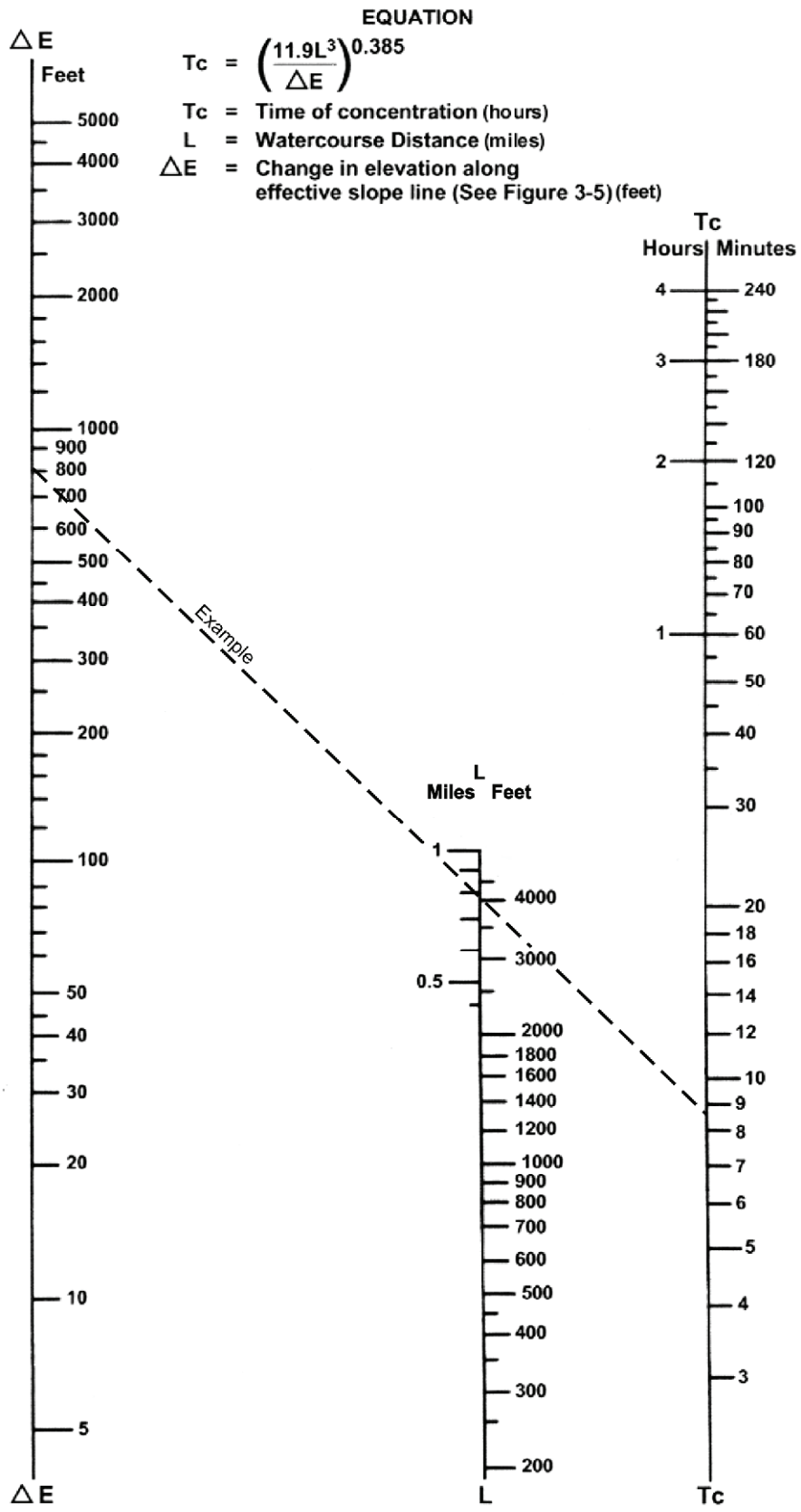
Table 3-2

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

Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		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

Appendix 8

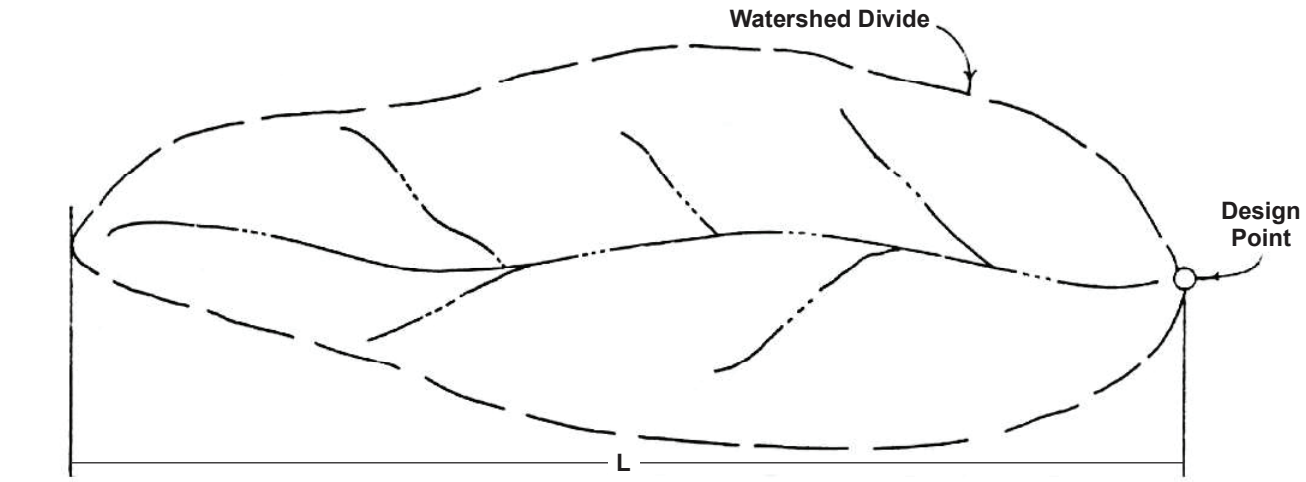


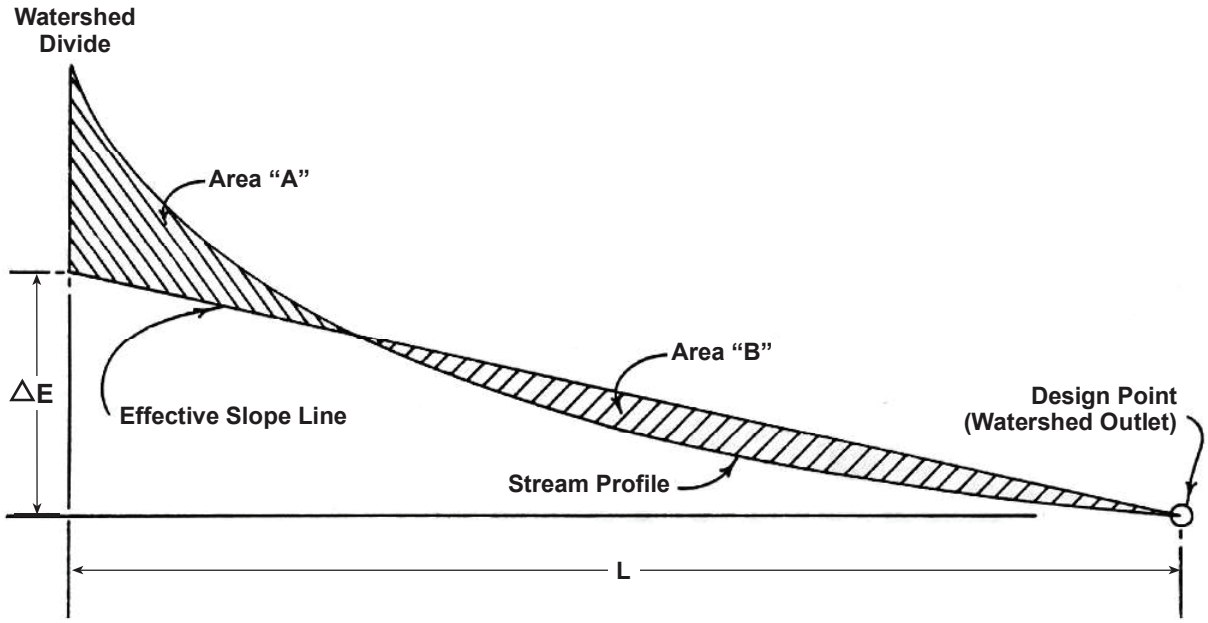
SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE 3-4

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

Appendix 9





Area "A" = Area "B"

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

FIGURE 3-5

Computation of Effective Slope for Natural Watersheds