APPENDIX F.2

Preliminary Drainage Study

PRELIMINARY DRAINAGE STUDY

Fairmount Avenue Fire Station

APN 541-190-16
Parcel Map 283
47th Street
City of San Diego, CA 92105

January 29, 2020

Prepared By:

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REFERENCES

City of San Diego Drainage Design Manual, January 2017
City of San Diego Stormwater Standards, August 2015

1 INTRODUCTION

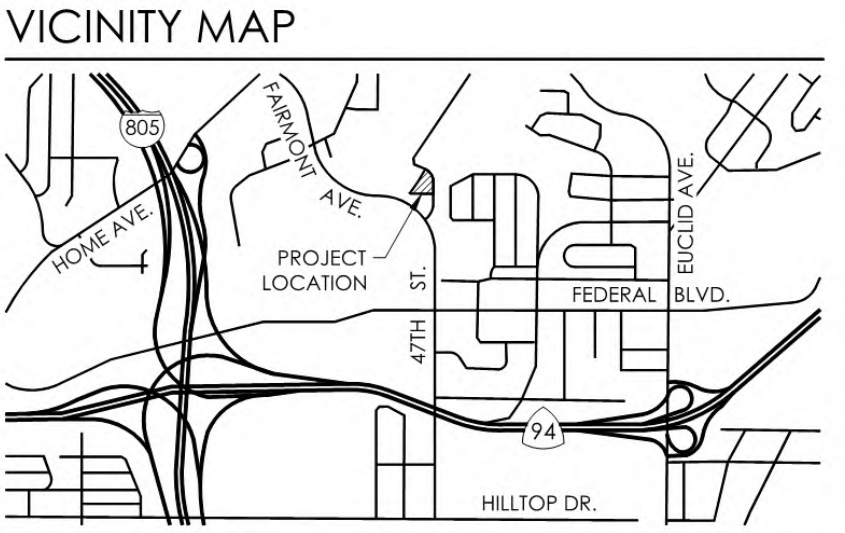
1.1 PROJECT DESCRIPTION

The project site is located off Fairmount Avenue on 47th Street in San Diego, California. The site is located between the confluence of Fairmount Avenue in the south, 47th Street in the east and north, and Chollas Creek in the west. The existing site is vacant, natural open space.

The project proposed is a 0.45-acre 4-story fire station. To minimize the land disturbance to 30, the site is confined by retaining walls. The fire station is loaded from a single driveway to the apparatus bay. The 17-stall parking lot under the building overhang is accessed from a separate driveway. The proposed fire station includes a 3-story station with 2 apparatus bays, exercise room, kitchen, and 10 bunk rooms. The station will also be serviced by a trash enclosure.

All impacts associated with the proposed project would occur within upland land covers and vegetation communities. Therefore, the project would not be required to obtain Clean Water Act (CWA) Section 401 or 404 permits since it would not impact any aquatic resources under the jurisdiction of either US Army Corp of Engineers or San Diego Regional Water Quality Control Board.

1.2 VICINITY MAP



2 WATERSHED DESCRIPTIONS

2.1 EXISTING

The project is located within the Chollas Creek watershed. The Chollas Creek Watershed is divided into the North Fork and South Fork of Chollas Creek. The North Fork of Chollas Creek crosses 300-ft northwest from the site under Fairmount Avenue. The project encroaches on the 100-year (Zone AE)

and 500-year (Zone X) floodplains at the north corner of the site. Where encroachments occur, the proposed improvements will be filled to ensure that the building is above the 500-year (Zone X) floodplain.

The entire 1.28-acre site drains north to Chollas Creek. The existing topography is generally sloped from 194.0 in the southeast to 140.0 in the northwest. The existing site has an existing impervious area of 0%. Over 40% of the slopes onsite have a grade over 25%. An existing storm drain from 47th St. daylights at the bottom of the site slope at the north of the site and drains offsite towards Chollas Creek.

2.2 PROPOSED

In the proposed conditions, only 30% of the site will be disturbed. The topography for the other 70% of the site will remain unaltered. The topography of the area disturbed will be mostly flat with grades between 1% and 5%. The impervious areas will be increased due to the new building, parking, and hardscape areas. The impervious area of the disturbed area will be increase to 84%. Water quality detention is proposed for the Design Capture Volume (DCV) and Hydromodification Management Plan (HMP) facilities will be implemented to mitigate retention requirements and the potential increase in stormwater runoff rates due to the proposed increase in impervious areas. Please see the Detention / Hydromodification section of this report for more details.

PROPOSED DRAINAGE MANAGEMENT AREA 1

Drainage Management Area (DMA) 1 will consist of the building footprint and the driveway apron. Runoff from DMA 1 area will be captured by a property-line trench drain at the bottom of the driveway and conveyed via underground storm drain to the biofiltration system. The treated runoff then is stored in the underground detention vault. The detention system will daylight the DCV volume and the HMP volume to Chollas Creek via the existing drainage path.

PROPOSED DRAINAGE MANAGEMENT AREA 2

Drainage Management Area (DMA) 2 will consist of the parking lot, trash enclosure, and lobby entrance. Runoff from DMA 2 area will be captured by trench drains and a drainage inlet and conveyed to the biofiltration system. The treated runoff then is stored in the underground detention vault. The detention system will daylight the DCV volume and the HMP volume to Chollas Creek via the existing drainage path.

PROPOSED DRAINAGE MANAGEMENT AREA 3

Drainage Management Area (DMA) 3 will consist of the self-treating area between the building and the retaining wall. Runoff from DMA 3 area will be contained within the drainage area.

3 HYDROLOGY RESULTS

3.1 EXISTING CONDITIONS

Calculations were performed to determine the existing condition discharge during a storm event. The 50-year and 100-year design storms were selected in accordance with the City of San Diego Drainage Design Manual, Section 2.2. The following table summarizes the peak discharge at the major point of concentration. Please refer to the Existing Hydrology exhibit in the appendix.

TABLE 1: EXISTING HYDROLOGY SUMMARY

BASIN	POINT OF CONCENTRATION	AREA (AC)	AVERAGE RUNOFF COEFFICIENT	TIME OF CONCENTRATION (MIN)	Q_{50} (CFS)	Q_{100} (CFS)
SITE	POC 2	1.28	0.30	9.0	2.25	2.60

For detailed hydrology calculations please see Appendix A.

3.2 PROPOSED CONDITIONS

Calculations were performed to determine the proposed condition discharge during a storm event. The 50-year and 100-year design storms were selected in accordance with the City of San Diego Drainage Design Manual, Section 2.2. See the Methodology section in this report for more details. The following table summarizes the peak discharge at the major points of concentration. Please refer to the Proposed Hydrology exhibit in Appendix B.

TABLE 2: PROPOSED HYDROLOGY SUMMARY

BASIN	POINT OF CONCENTRATION	AREA (AC)	AVERAGE RUNOFF COEFFICIENT	TIME OF CONCENTRATION (MIN)	Q_{50} (CFS) Q_{100} (CFS) (UNDETAINED)	Q_{50} (CFS) Q_{100} (CFS) (DETAINED)
SITE	POC 2	0.46	0.87	12	2.29 *[50-YR]* 2.65 *[100-YR]*	1.77 *[50-YR]* 2.32 *[100-YR]*
1	POC 1	0.22	0.90	6.5	1.21 *[50-YR]* 1.40 *[100-YR]*	0.90 *[50-YR]* 1.04 *[100-YR]*
2	POC 1	0.20	0.84	17	0.88 *[50-YR]* 1.02 *[100-YR]*	0.71 *[50-YR]* 0.82 *[100-YR]*
3	Self-Treating	0.04	0.30	5.6	0.07 *[50-YR]* 0.08 *[100-YR]*	0.02 *[50-YR]* 0.02 *[100-YR]*

As shown above, the proposed project would result in an undetained increase in peak runoff rates for all basins, if not properly mitigated. Therefore, a detention system will be implemented to provide hydromodification management and reduce the peak runoff rates for the design storm to match the existing conditions. For information on the detention system, please see the Detention / Hydromodification section in this report. For detailed hydrology calculations, please see Appendix B.

4 DETENTION / HYDROMODIFICATION

The proposed project will result in an increase in impervious surfaces from existing conditions. This would potentially result in an increase in stormwater runoff rate and volume, if left unmitigated. Thus, the project will be required to detain the increase in runoff to minimize the impacts to public drainage facilities. This detention requirement with work in conjunction with the Hydromodification Management Plan (HMP) requirements as described in the Stormwater Standards Manual.

To fulfill the HMP requirements, the project has been designed so that runoff rates and durations are controlled to maintain or reduce pre-project downstream erosion conditions and protect stream habitat. The project will mitigate the increase in runoff by implementing stormwater Best Management Practices (BMPs) and a detention facility, which has been specifically designed for both detention and hydromodification management.

Due to the preliminary nature of this study, the detention facility has been assumed to be an underground vault, which is fully lined with concrete or an impermeable liner, 6 feet deep, and installed with a 6" orifice. For detailed hydrology calculations, please see the orifice calculations in Appendix B. During final engineering, other types of detention facilities may be selected, and detailed final design of the detention systems will be performed. Types of detention facilities which may be selected during final design, include cast-in-place concrete vaults, precast concrete vaults, large-diameter HDPE, PVC, or RCP pipes, arched detention chambers, or any proprietary products designed to facilitate underground detention. The outlet structures, including low-flow orifice opening and high-flow by-pass, will also undergo detailed design during final engineering.

5 CONCLUSION

The proposed project will be designed to minimize the effects of the development to downstream drainage facilities and drainage channels. The proposed project will increase the impervious areas from existing conditions due to the proposed building, parking, and hardscape areas. The increase in impervious areas would potentially result in an increase in stormwater runoff rates, if left unmitigated as shown in Table 2 of the Hydrology Results section. Therefore, detention and HMP facilities will be implemented to reduce runoff rates to match existing conditions for the HMP and 50-year and 100-year design storm requirements. The calculations and conclusions prove compliance to Hydromodification Management Plan Controls.

The final design of HMP, Water Quality BMPs, and onsite storm drain facilities will be presented in subsequent reports during final engineering.

6 METHODOLOGY

6.1 RUNOFF CALCULATIONS

The design criteria, as found in the City of San Diego Drainage Design Manual Appendix A, specifies the design runoff conditions be based on the 50-year and 100-year storm frequency. Runoff was calculated using the Modified Rational Method as described in pages A-1 to A-9 of the Drainage Design Manual. The rational method equation is as follows:

$$Q = C \times I \times A$$

Where:
$Q = Flow\ rate\ in\ cubic\ feet\ per\ second\ (cfs)$
$C = Runoff\ coefficient$
$I = Rainfall\ intensity\ in\ inches\ per\ hour\ (^{in}/_{hr})$
$A = Drainage\ basin\ area\ in\ acres\ (ac)$

RUNOFF COEFFICIENT

An average runoff coefficient was used over each entire basin unless the sub-basin area differed significantly from the average. Soil Type D was assumed for the entire study per the City of San Diego Drainage Design Manual, page A-2. Average runoff coefficients were calculated in accordance with the Drainage Design Manual, page A-2, by adjusting the tabulated impervious ratios to match the actual impervious ratios of the site as shown in the following sample calculation:

SAMPLE RUNOFF COEFFICIENT CALCULATION:

Actual Impervious Percentage = 100%
Tabulated Impervious Percentage = 90% (C=0.95)

$$Revised\ C = {}^{87}/_{90} \times 0.95 = 0.92$$

The runoff coefficients for each basin area summarized in the Appendix.

TIME OF CONCENTRATION

Time of concentration was calculated per page A-5 of the Drainage Design Manual as follows:

$$T_c = T_i + T_f$$

Where T_i is in the inlet time, T_f is the travel time, and T_c is the time of concentration. The inlet time (T_i) was calculated according the Drainage Design Manual page A-6, "Urban Areas Overland Time of Flow Curves." Additional travel time (T_f) was calculated by estimating velocity using Manning's formula for open channel flow. The travel time was calculated by dividing the flow length by the flow velocity as described on page A-1 of the Drainage Design Manual.

RAINFALL INTENSITY

Rainfall intensity was calculated in accordance with the City of San Diego Drainage Design Manual. The intensity-duration chart on page A-3 of the Drainage Design Manual was used to calculated

corresponding intensities for each time of concentration. This data was input into the IDF Curve Table for the 2-year, 10-year, and 50-year design storm events. The time of concentration-intensity data pairs can be seen in the Appendix.

ORIFICE FLOW DISCHARGE

Orifice flow discharge was calculated in accordance with the City of San Diego Drainage Design Manual Section 8.3.3. The calculation for a single submerged orifice per page 8-16 of the Drainage Design Manual is as follows:

$$Q_O = C_O A_O \sqrt{2g(H_O)}$$

Where Q_O is in the orifice flow discharge, C_O is the orifice discharge coefficient, A_O is the orifice area, g is the gravitational acceleration (assumed to be 32.2. ft/s^2), and H_O is effective head above the orifice. CO is assumed to be 0.60 for sharp, clean-edge orifice per Table 8-2 in the Drainage Design Manual. And g is assumed to be 32.2 ft/s^2.

6.2 DETENTION CALCULATIONS

To design the proposed detention facilities, the 50-year, 6-hour storm was routed through the detention facility, and the detention volume and outlet configuration were iteratively sized until the proposed peak flow rate was 10% of the existing peak flow rate. This was done using the following procedures.

RUNOFF HYDROGRAPHS

Based on the proposed hydrology calculations, a runoff hydrograph was generated for the 50-year, 6-hour storm event and the 100-year, 6-hour storm event. This was done using the Rational Method Hydrograph Program for use in San Diego County. Based on inputs including the time of concentration, 6-hour rainfall, basin area, runoff coefficient, and peak discharge, this program developed a runoff hydrograph with time steps corresponding to the time of concentration. Output from this program can be found in Appendix C.

APPENDIX

A. EXISTING HYDROLOGY MAP AND CALCULATIONS

LEGEND

- PROPERTY LINE
- DMA LIMITS
- SD STORM DRAIN LATERAL

DMA TABLE

DMA NUMBER	AREA (ACRES)	IMPERVIOUS AREA (ACRES)	% IMPERVIOUS	HSG	WEIGHTED RUNOFF COEFFICIENT
TOTAL	1.28	0.00	0%	TYPE D	0.30

EXISTING STORM WATER DRAINAGE PLAN

FAIRMOUNT AVE FIRE STATION

CORNER OF FAIRMOUNT AVE AND 47TH ST.

CITY OF SAN DIEGO, CALIFORNIA

PROJECT NO. 300-02-C117

FOR CITY ENGINEER _____ DATE _____

V.T.M. _____

DESCRIPTION	BY	APPROVED	DATE	FILMED
AS-BUILTS				

CONTRACTOR _____ DATE STARTED _____

INSPECTOR _____ DATE COMPLETED _____

NAD83 COORDINATES

LAMBERT COORDINATES

C–5.1

REGISTERED PROFESSIONAL ENGINEER
BRIAN S. REDSUN
No. C 85505
exp. 9/30/20
CIVIL
STATE OF CALIFORNIA

NOT FOR CONSTRUCTION

BRYAN REDSUN R.C.E. NO. 85505 EXP. 09-30-20

07/12/2019
DATE

rrm design group
rrmdesign.com | (949) 361-7950
32332 Camino Capistrano, Suite 205
San Juan Capistrano, CA 92675

0 20 40 60 feet
1" = 20'

NORTH

Time of Concentration Calculations

Using the "Urban Areas Overland Time of Flow Curves" from the City of San Diego Drainage Design Manual:

Where:

$T_C = Time\ of\ Concentration\ in\ minutes\ (min)$
$C = Runoff\ Coefficient\ (0.6\ assumed)$
$S = Effective\ Slope\ in\ percent\ (\%)$
$D = Distance\ in\ feet\ (ft)$

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

BASIN	DISTANCE (FT)	C	SLOPE (%)	TIME OF CONCENTRATION (MIN)	PIPE TIME OF CONCENTRATION (MIN))	TOTAL TIME OF CONCENTRATION (MIN))
EX SITE	290	0.30	20	9.0	0	9.0

Flow Calculations

Using the City of San Diego Drainage Design Manual (Appendix A):

Where:

$Q = Flow\ rate\ in\ cubic\ feet\ per\ second\ (cfs)$
$C = Runoff\ Coefficient$
$I = Rainfall\ Intensity\ in\ inches\ per\ hour\ (in/hr)$
$A = Basin\ Area\ in\ acres\ (ac)$

$$Q = C\ \times I \times A$$

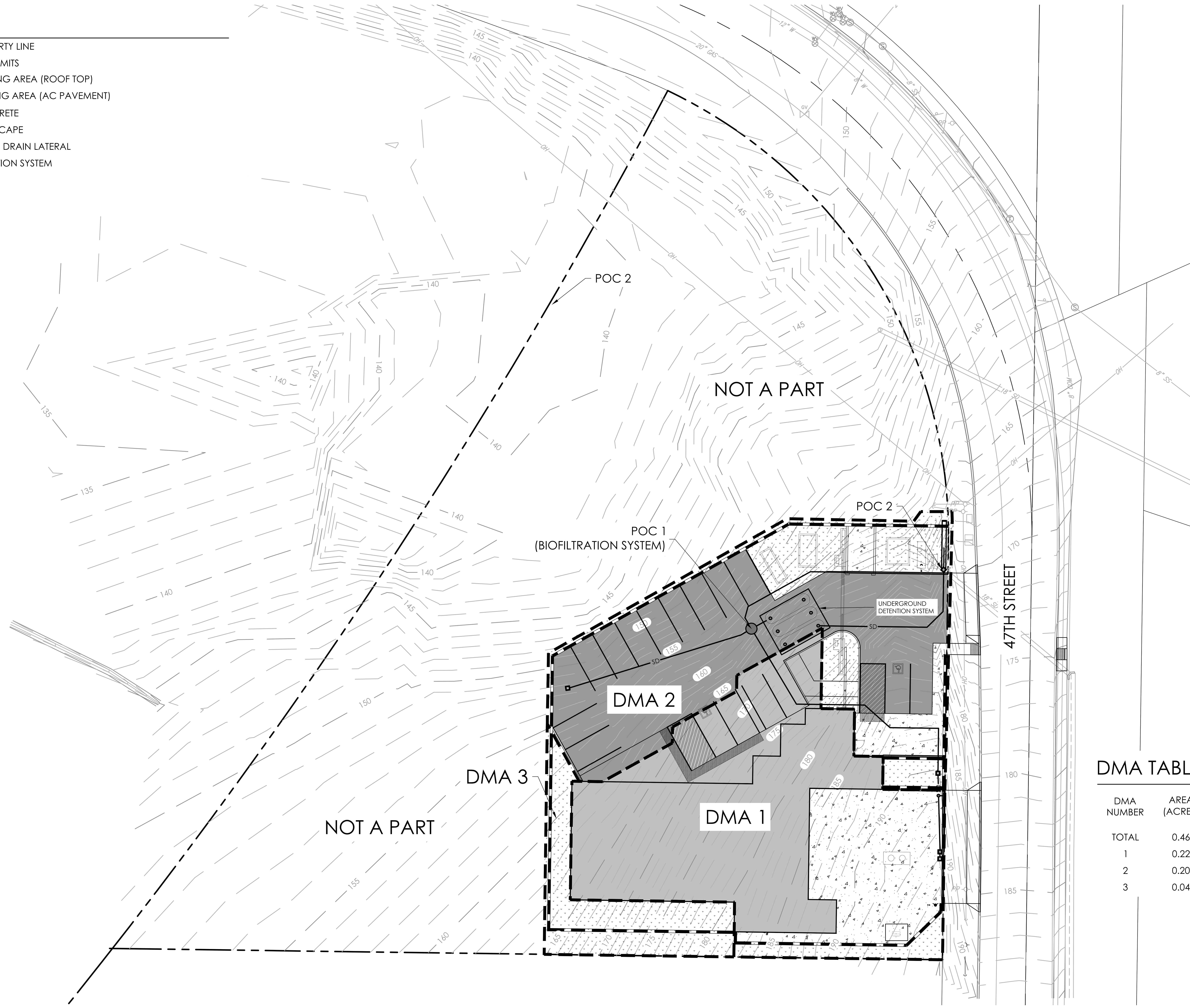
BASIN	YEAR	C	I (IN/HR)	AREA (AC)	Q (CFS)
EX SITE	2	0.30	2.90	1.28	1.11
	10	0.30	4.45	1.28	1.71
	50	0.30	5.85	1.28	2.25
	100	0.30	6.76	1.28	2.60

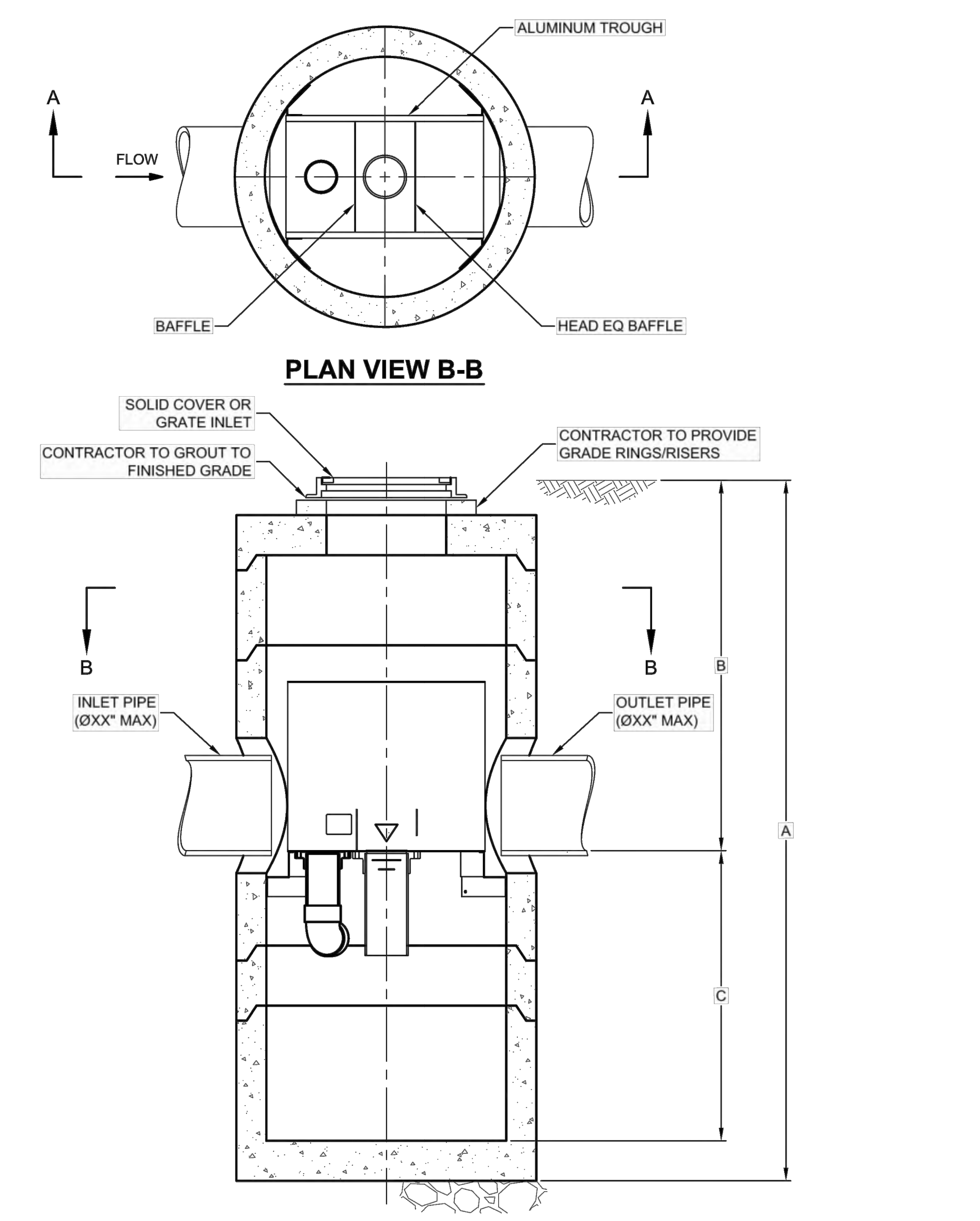
APPENDIX

B. PROPOSED HYDROLOGY MAP AND CALCULATIONS

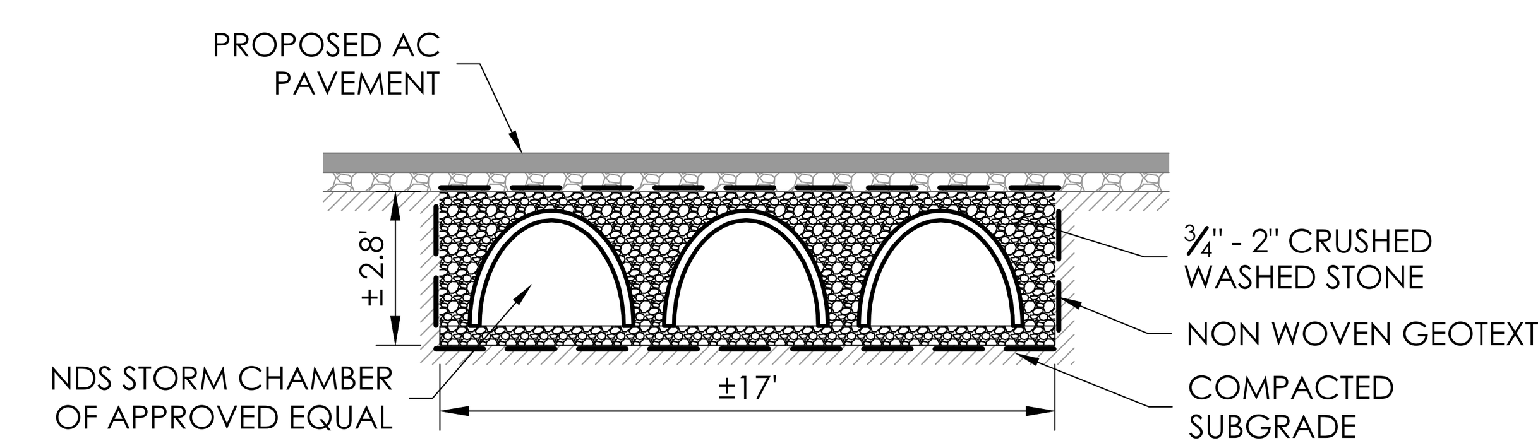
LEGEND

- PROPERTY LINE
- DMA LIMITS
- BUILDING AREA (ROOF TOP)
- PARKING AREA (AC PAVEMENT)
- CONCRETE
- LANDSCAPE
- SD — STORM DRAIN LATERAL
- DETENTION SYSTEM





A BIO-FILTRATION SYSTEM
N.T.S.



B UNDERGROUND DETENTION SYSTEM
N.T.S.

DMA TABLE

DMA NUMBER	AREA (ACRES)	IMPERVIOUS AREA (ACRES)	% IMPERVIOUS	HSG	WEIGHTED RUNOFF COEFFICIENT	DCV (CUBIC FEET)	TREATED BY (BMP ID)	POLLUTANT CONTROL TYPE	DRAINS TO (POC ID)
TOTAL	0.46	0.37	80%	TYPE D	0.83	620	BF-1	BIOFILTRATION	POC 2
1	0.22	0.21	95%	TYPE D	0.96	345	BF-1	BIOFILTRATION	POC 1
2	0.20	0.16	80%	TYPE D	0.82	268	BF-1	BIOFILTRATION	POC 1
3	0.04	0	0%	TYPE D	0.10	7	SELF-TREATING	NA	NA

STORM WATER QUALITY MANAGEMENT PLAN

FAIRMOUNT AVE FIRE STATION

CORNER OF FAIRMOUNT AVE AND 47TH ST.

CITY OF SAN DIEGO, CALIFORNIA

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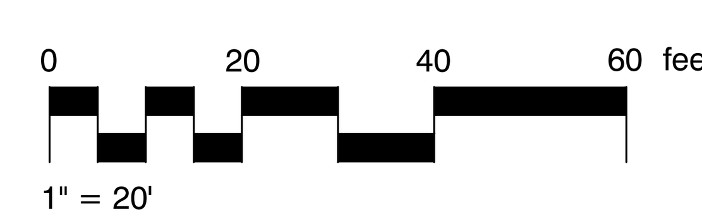

REGISTERED PROFESSIONAL ENGINEER BRYAN S. REDSUN No. C 85505 exp. 9/30/20 CIVIL STATE OF CALIFORNIA

NOT FOR CONSTRUCTION

BRYAN REDSUN R.C.E. NO. 85505 EXP. 09-30-20

07/12/2019
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Time of Concentration Calculations

Using the "Urban Areas Overland Time of Flow Curves" from the City of San Diego Drainage Design Manual:

Where:

$T_C = Time\ of\ Concentration\ in\ minutes\ (min)$
$C = Runoff\ Coefficient\ (0.6\ assumed)$
$S = Effective\ Slope\ in\ percent\ (\%)$
$D = Distance\ in\ feet\ (ft)$

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

BASIN	DISTANCE (FT)	C	SLOPE (%)	TIME OF CONCENTRATION (MIN)	PIPE TIME OF CONCENTRATION (MIN))	TOTAL TIME OF CONCENTRATION (MIN))
SITE	290	0.87	20	12	20	32
1	50	0.90	6	6.5	6.5	13
2	100	0.84	2	17	12	29
3	9	0.30	45	5.6	0	5.6

Flow Calculations

RATIONAL METHOD CALCULATION

Using the City of San Diego Drainage Design Manual (Appendix A):

Where:

$Q = Flow\ rate\ in\ cubic\ feet\ per\ second\ (cfs)$
$C = Runoff\ Coefficient$
$I = Rainfall\ Intensity\ in\ inches\ per\ hour\ (in/hr)$
$A = Basin\ Area\ in\ acres\ (ac)$

$$Q = C \times I \times A$$

BASIN	YEAR	C	I (IN/HR)	AREA (AC)	Q (CFS) UNDETAINED
SITE	2	0.87	2.90	0.45	1.14
	10	0.87	4.45	0.45	1.74
	50	0.87	5.85	0.45	2.29
	100	0.87	6.76	0.45	2.65
1	2	0.90	2.90	0.23	0.60
	10	0.90	4.45	0.23	0.92
	50	0.90	5.85	0.23	1.21
	100	0.90	6.76	0.23	1.40
2	2	0.84	2.90	0.18	0.44
	10	0.84	4.45	0.18	0.67
	50	0.84	5.85	0.18	0.88
	100	0.84	6.76	0.18	1.02
3	2	0.30	2.90	0.04	0.04
	10	0.30	4.45	0.04	0.05
	50	0.30	5.85	0.04	0.07
	100	0.30	6.76	0.04	0.08

PRELIMINARY ORIFICE CALCULATION

Using the City of San Diego Drainage Design Manual (Section 8.3.3.):

Where:

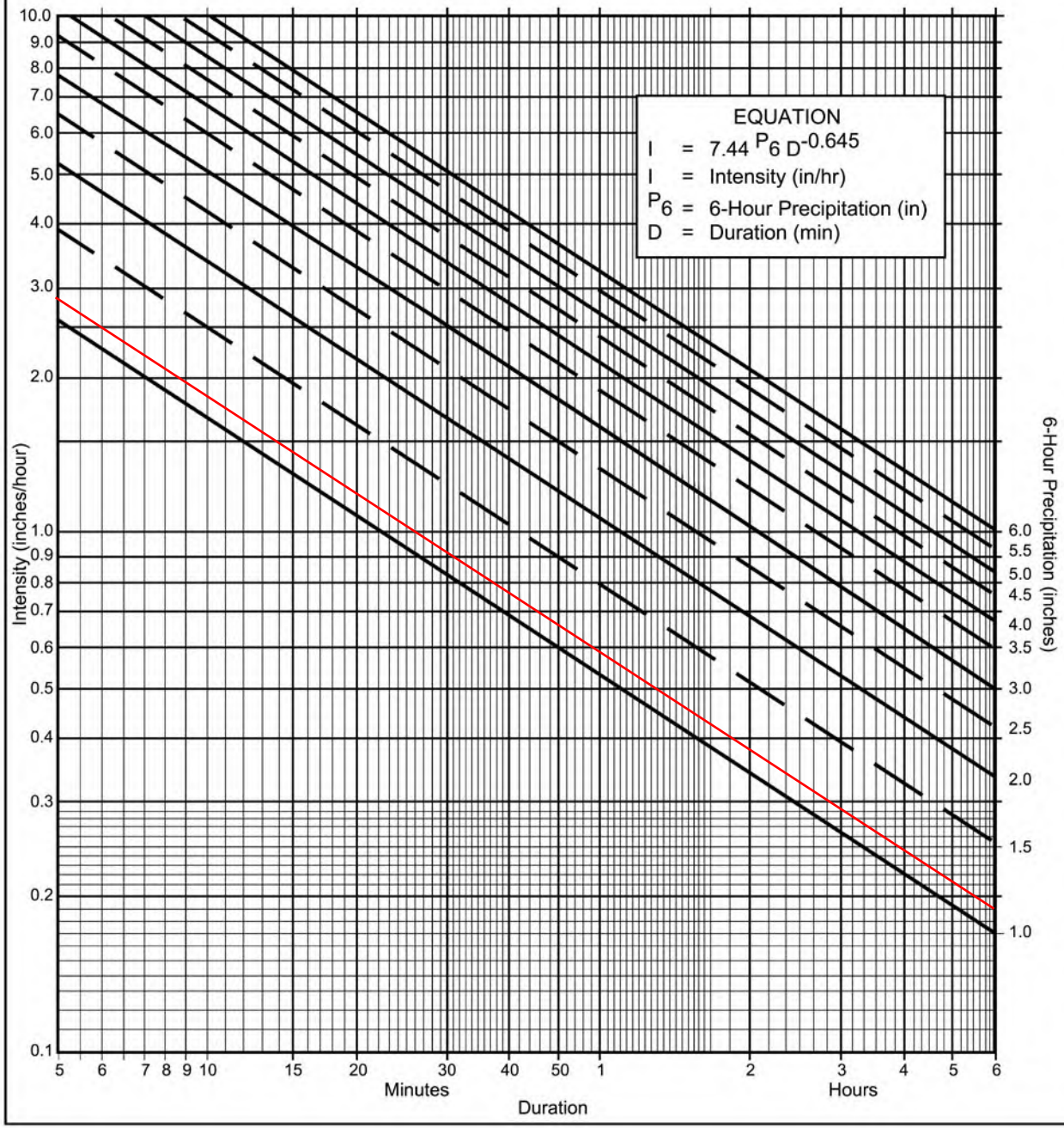
$Q_O = Orifice\ flow\ discharge\ in\ cubic\ feet\ per\ second\ (cfs)$
$C_O = Orifice\ Discharge\ Coefficient = 0.60$
$A_O = Area\ of\ flow\ through\ orifice\ (ft^2) = \pi r^2$
$g = gravitational\ acceleration = 32.2\ ft/s^2$
$H_O = Effective\ head\ above\ orifice\ (ft)$

$$Q_O = C_O A_O \sqrt{2g(H_O)} = 0.60 \times \pi r^2 \sqrt{2 \times 32.2 \times H_O} = 1.89 \times 8.02 \times r^2 \sqrt{H_O} = 15.13 \times r^2 \sqrt{H_O}$$

BASIN	YEAR	C_O	PIPE DIAMETER (IN)	HEAD (FT)	Q_{100} (CFS)		Q_{100} (CFS) DETAINED
SITE	100	0.60	4”	4	2.60	>	0.84
		0.60	4”	6	2.60	>	1.03
		0.60	4”	8	2.60	>	1.19
		0.60	4”	10	2.60	>	1.33
		0.60	4”	12	2.60	>	1.46
		0.60	6”	4	2.60	>	1.89
		0.60	**6”**	**6**	**2.60**	**>**	**2.32**
		0.60	6”	8	2.60	<	2.67
		0.60	6”	10	2.60	<	2.99
		0.60	6”	12	2.60	<	3.28
		0.60	8”	4	2.60	<	3.36
		0.60	8”	6	2.60	<	4.12
		0.60	8”	8	2.60	<	4.75
		0.60	8”	10	2.60	<	5.31
		0.60	8”	12	2.60	<	5.82

APPENDIX

C. HYDROLOGY ANALYSIS AND MAPS



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 2 year

(b) P_6 = 1.22 in., P_{24} = 1.80, $\frac{P_6}{P_{24}}$ = 68 %(2)

(c) Adjusted P_6(2) = 1.22 in.

(d) t_x = 6.00 min.

(e) I = 2.90 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

County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 6 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

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

Site
1.22 in

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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N
W E
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3 0 3 Miles

County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

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

Site
1.8 in

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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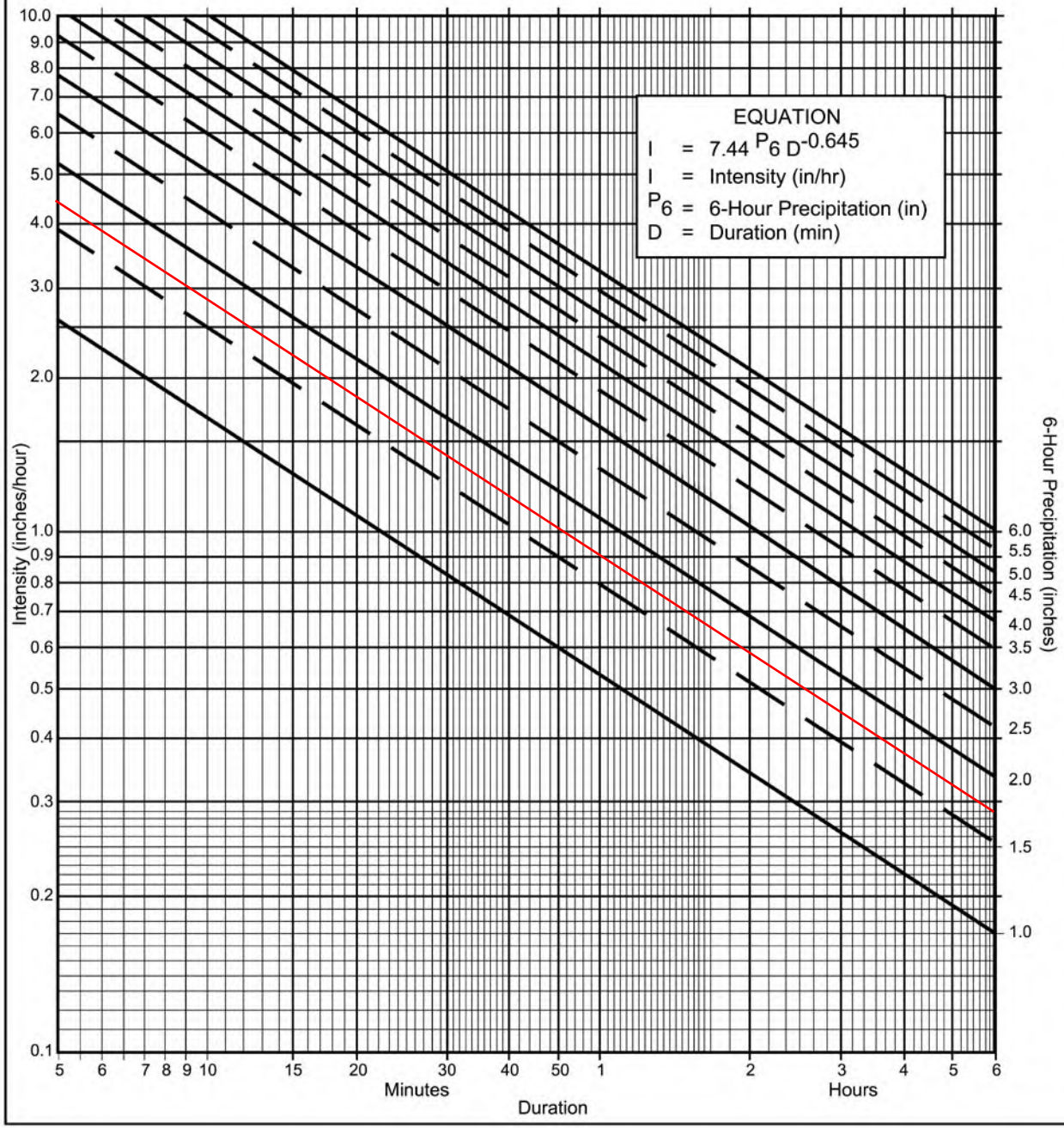


Directions for Application:

(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 10 year

(b) P_6 = 1.82 in., P_{24} = 2.90, $\frac{P_6}{P_{24}}$ = 63 %(2)

(c) Adjusted P_6(2) = 1.82 in.

(d) t_x = 5.74 min.

(e) I = 4.45 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

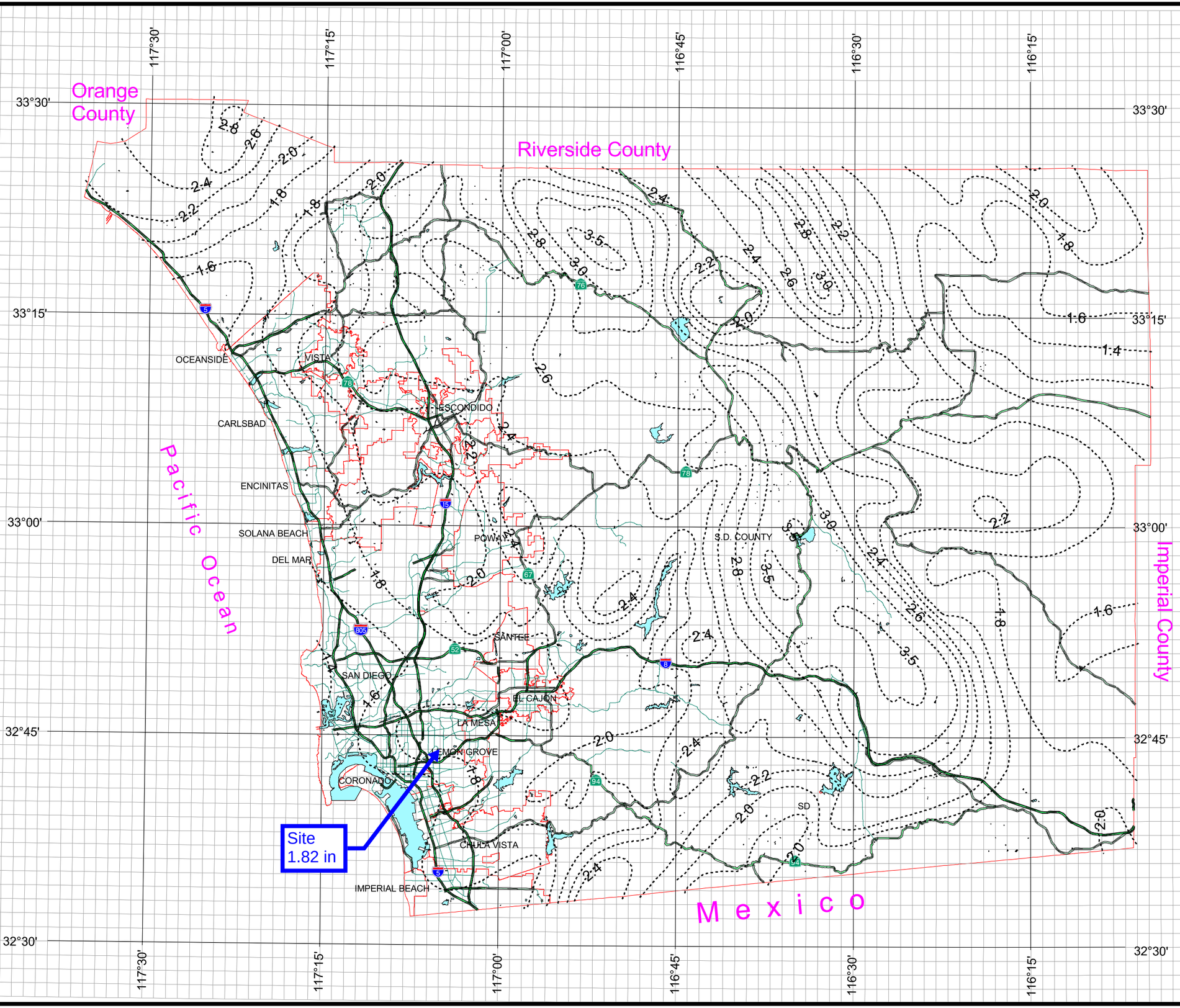
FIGURE 3-1

County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours

Isopluvial (inches)



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3 0 3 Miles

County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

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

Site
2.90 in

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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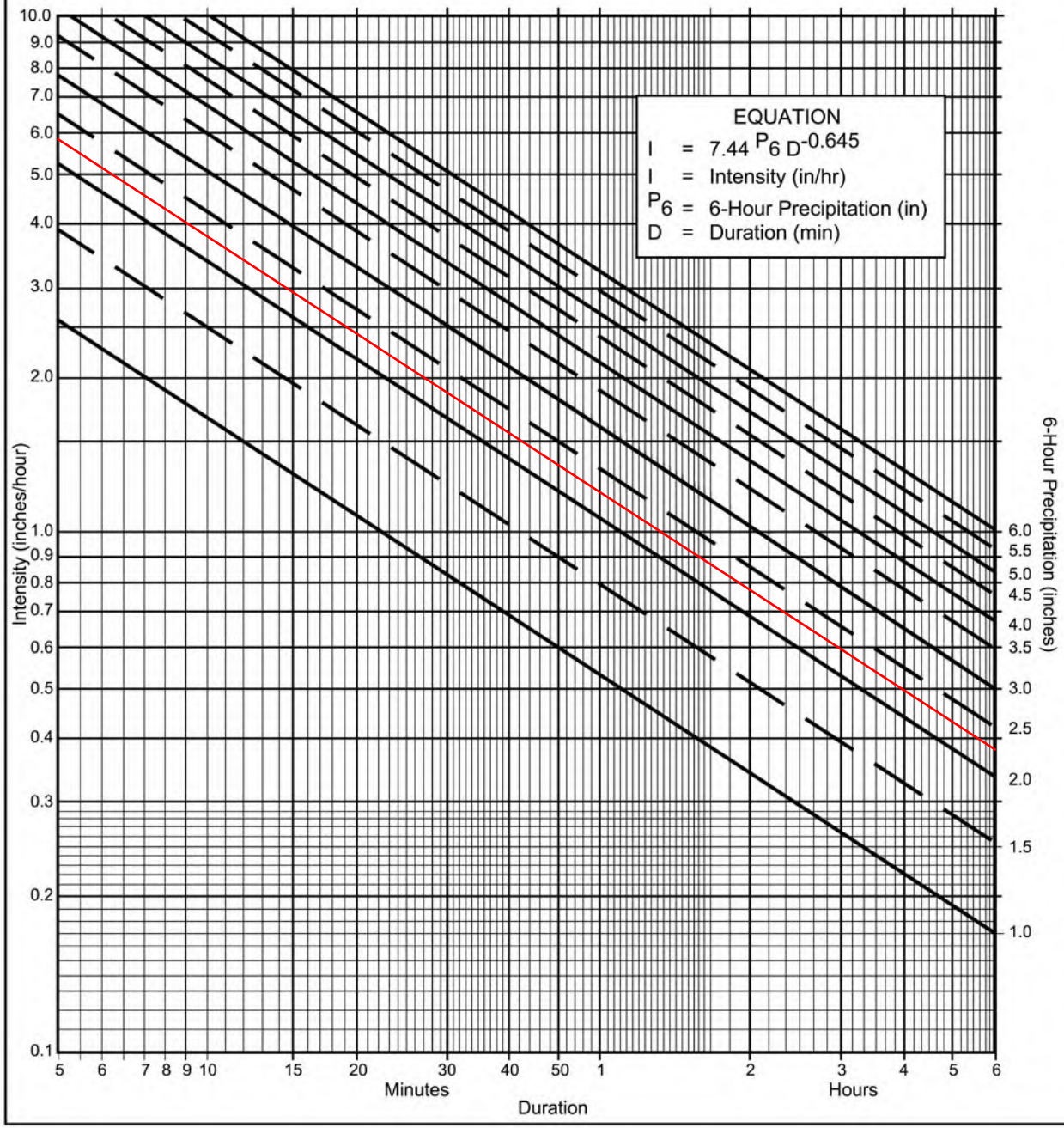
3 0 3 Miles



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 50 year

(b) P_6 = 2.25 in., P_{24} = 3.75, $\frac{P_6}{P_{24}}$ = 60 %(2)

(c) Adjusted P_6(2) = 2.25 in.

(d) t_x = 5.1 min.

(e) I = 5.85 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

County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 6 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

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

Site
2.25 in

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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County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Mexico

Pacific Ocean

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

Site
3.75 in

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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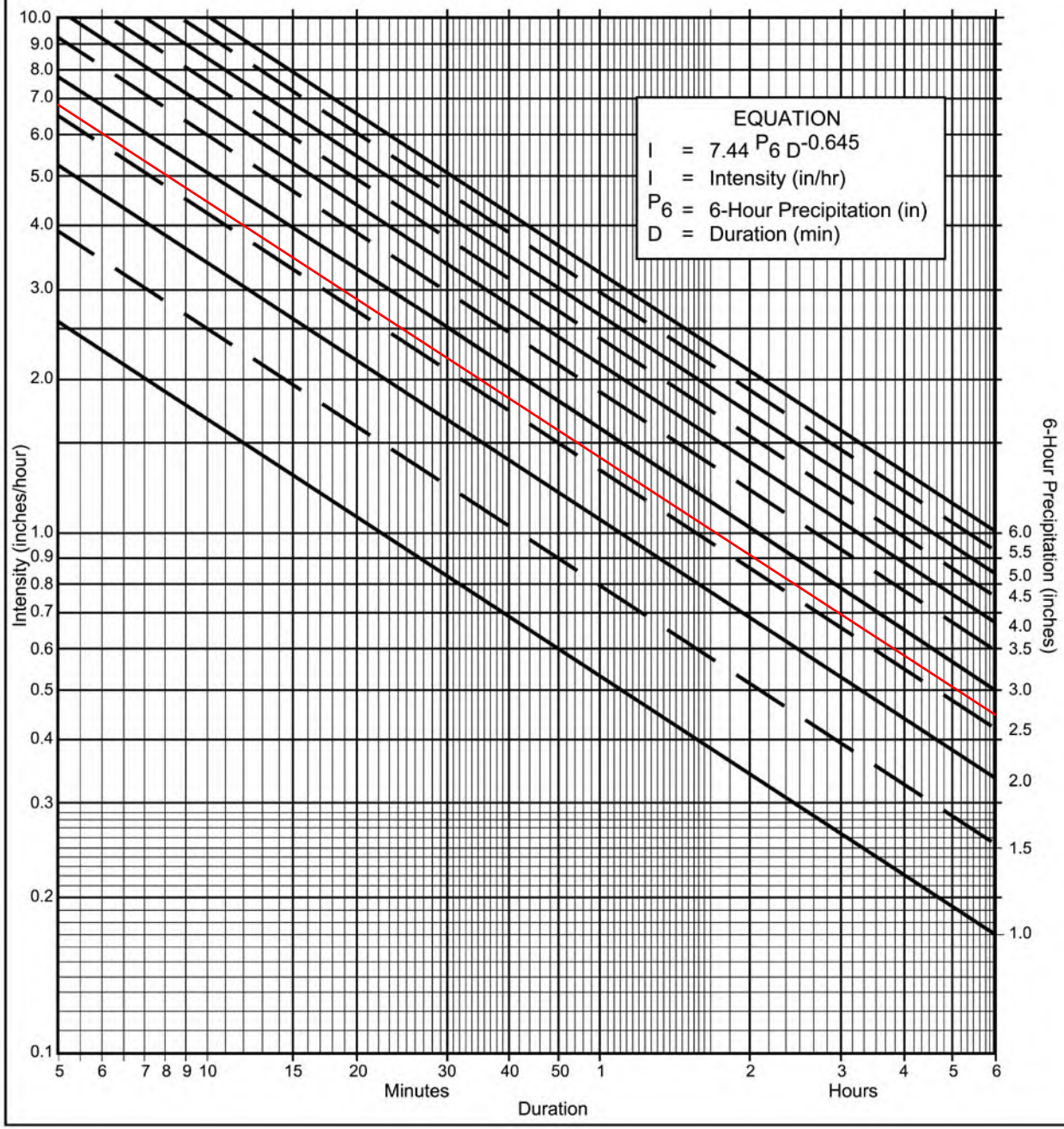
3 0 3 Miles



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(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 = 2.6 in., P_{24} = 4.25, $\frac{P_6}{P_{24}}$ = 61 %(2)

(c) Adjusted P_6(2) = 2.6 in.

(d) t_x = 5.1 min.

(e) I = 6.76 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
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20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
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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

County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

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

Site
2.6 in

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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County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

Orange County

Riverside County

Imperial County

Pacific Ocean

Mexico

OCEANSIDE
VISTA
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DEL MAR
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SAN DIEGO
EL CAJON
LA MESA
LEMON GROVE
CORONADO
CHULA VISTA
IMPERIAL BEACH
SD

Site
4.25 in

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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3 0 3 Miles