Appendix I

Preliminary Drainage Study

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PRELIMINARY DRAINAGE STUDY

San Diego Gas & Electric
Ocean Ranch Substation

Oceanside, CA
February, 2015

Prepared For: San Diego Gas & Electric

Prepared By: Fuscoe Engineering, Inc.

Job Number: 02752.001.01

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PRELIMINARY DRAINAGE STUDY

San Diego Gas & Electric
Ocean Ranch Substation

City of Oceanside, California

REGISTERED PROFESSIONAL ENGINEER
PAUL D. HAALAND
C 63656
EXP. 9-30-16
CIVIL
STATE OF CALIFORNIA

Prepared By James Moser Under the Responsible Charge of:

2/27/15

Paul D. Haaland, P.E. RCE 63656 EXP: 09-30-16
Fuscoe Engineering, San Diego, Inc.
6390 Greenwich Dr., Ste 170
San Diego, CA 92122

For

San Diego Gas & Electric Company
8326 Century Park Court
San Diego, CA 92123-1582

February, 2015

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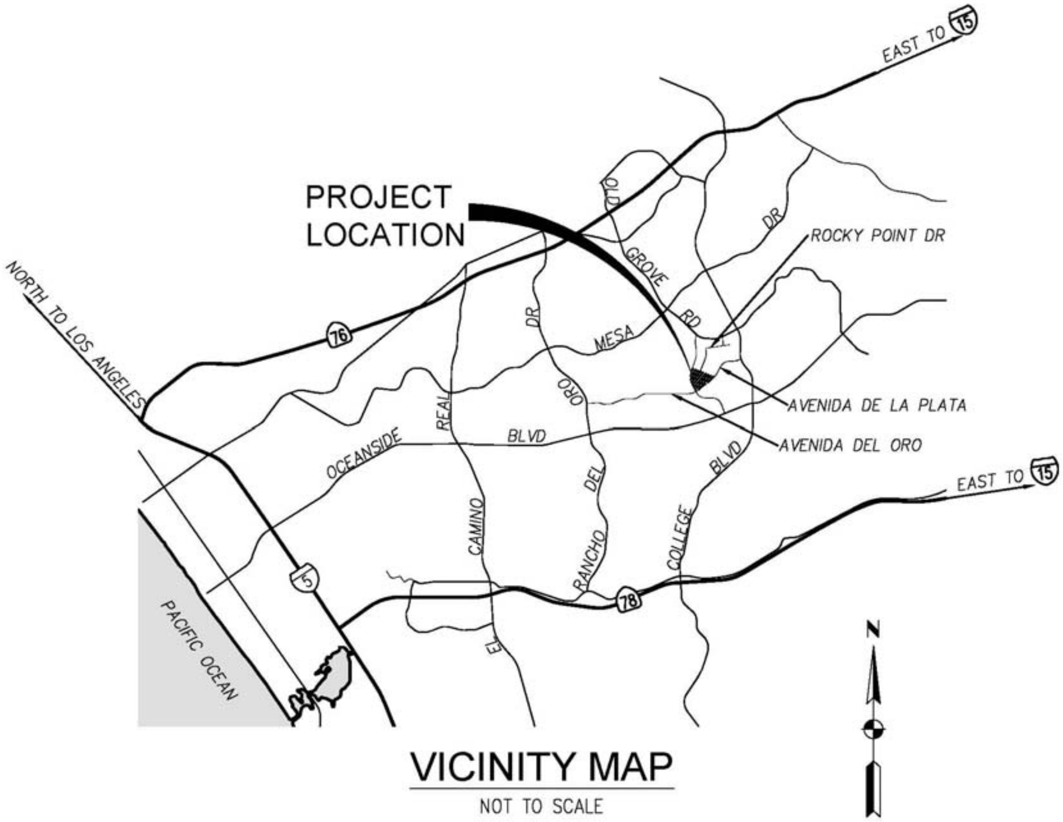


Figure 1 Vicinity Map

1. INTRODUCTION

This preliminary drainage study was performed to analyze the Ocean Ranch Substation Development project for the final developed condition. The following is a summary of the analysis which was performed in accordance with the City of Oceanside Engineering Standards and the 2003 edition of the *San Diego County Hydrology Manual* (*SDCHM*).

1.1 Project Description

The 9.66 acre project site is located at the end of a cul-de-sac on the 1300 block of Rocky Point Drive in Oceanside, CA. The project is legally described as Parcels 16 & 17 of Parcel Map No. 20306, in the City of Oceanside. The site is bordered to the north, south, and east by light industrial properties and to the west by Avenida Del Oro. The immediate surrounding area is comprised primarily of industrial properties.

The existing site consists of two previously mass-graded pads, each with a temporary desilting basin that connects to the public storm drain system. The pads will be regraded to create one pad suitable for electric substation equipment and additional future use. The project will also include a new private access drive that connects to Avenida Del Oro on the southern edge of the property to satisfy the requirement to have two access locations to the substation and to enable substation access without driving through the existing business park to the north. In addition, the following private utilities will be constructed: storm drain, irrigation, & electrical.

1.2 Existing Conditions

The existing site currently consists of two mass-graded pads and two temporary desilting basins. The western pad is approximately 4 feet lower than the eastern pad. The desilting basins are located approximately in the middle third of each parcel. The site primarily sheet flows towards these two desilting basins. The desilting basins collect and convey onsite drainage to the public storm drain system located within Avenida Del Oro. Discharge from each of the basins flows through a series of structural stormwater treatment devices prior to leaving the site.

A portion of the southern edge of the project sheet flows to the south, where runoff is then collected by a concrete swale that is connected to the public storm drain system in Avenida Del Oro. The western edge of the property is a 2:1 (H:V) vegetated slope that varies in height between 5 and 20 feet; this slope drains to the west and into Avenida Del Oro. An additional area around the cul-de-sac of Rocky Point Drive drains to the north and into the street, where it is then collected by a public storm drain system that conveys flow west to Avenida Del Oro. As such, all flow from the site is ultimately collected and conveyed in the existing storm drain system in Avenida Del Oro. The location of the ultimate confluence of flow from the site is shown on the Pre-Development Drainage Exhibit in Appendix 1.

1.3 Proposed Conditions

The proposed site will be regraded within the limits of the development to make one large pad that is suitable for all of the substation equipment and future use area. As a result, the existing temporary desilting basin on the west pad will be regraded and a permanent flow-through planter and detention basin will be constructed in its place. Similarly, the desilting basin on the east pad will be modified to serve as a permanent flow-through planter and detention basin. Site drainage will consist primarily of sheet flow from east to west consistent with existing conditions. Runoff from the northeastern corner of the site outside the limits of development will be collected by a series of catch basins and directed into the east flow-through planter/detention basin.

The project's layout and grading design divided the site into seven (7) major drainage basins. The site will have a private drainage system which will discharge into the two flow-through planter/detention basins that are included in the proposed site design.

The majority of runoff will be conveyed to the two basins for stormwater quality treatment, hydromodification management purposes, and peak flow attenuation. A portion of the project's drainage areas cannot be conveyed to the flow-through planter/detention basins due to elevation constraints. These areas include the slope on the western edge of the site, a portion of the access road to Avenida Del Oro, and a small fraction around the Rocky Point Drive cul-de-sac. As a result, the proposed flow-through planter/detention basin on the west side of the property will be sized large enough to capture both the treatment volume and the 100-Year attenuation volume that these areas, as well as the areas that are directly draining into the basin, will generate in the proposed site condition.

As in the existing condition, all flow from the site is ultimately collected and conveyed by the storm drain system in Avenida Del Oro. Therefore, there is no significant change to drainage patterns resulting from the proposed project. The attenuation of peak flow that will occur in the proposed flow-through planter/detention basins will ensure that the project will lead to neither an exceedance in downstream storm drain or receiving waterbody capacity nor an increase in downstream erosion or flooding.

Please refer to Appendix 2 for the Post-Development Drainage Exhibit.

2. METHODOLOGY

Hand calculations and an Excel spreadsheet were used to calculate the peak runoff the 100-Year, 6-Hour storm event using the Modified Rational Method as described in the *SDCHM*. Please refer to Appendix 5 for the results of these calculations.

2.1 Rational Method

As mentioned above, runoff on the project site was calculated for the 100-Year storm event. Runoff was calculated using the Modified Rational Method which is given by the following equation:

$Q = CIA$

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)

Modified Rational Method calculations were performed using Microsoft Excel. To perform the hydrology calculations, the total watershed area is divided into sub-areas that drain to a specific point on the site. The procedure for the sub-area summation model is as follows:

(1) Subdivide the watershed into sub-areas, which are generally less than 5 acres in size.

(2) Calculate the Time of Concentration, T_c, by using an overland flow velocity estimation. The minimum T_c considered is 5.0 minutes. The equation for T_c is the following:

$T_c = [1.8(1.1\text{-}C)(D^{1/2})]/(S^{1/3})$

Where:
D = Watercourse Distance in feet (ft)
S = Slope along Watercourse Distance
C = Runoff Coefficient

(3) Using T_c, determine the corresponding value of I according to the formula on Page 3-7 of the *SDCHM*:

$I = 7.44 P_6 T_c^{-0.645}$

Where:
P_6 = 6-Hour precipitation depth in inches (in) for the storm event considered

Note that the *SDCHM* requires that the 6-Hour precipitation be between 45% and 65% of the 24-Hour precipitation (P_{24}.) For the project site, P_6 and P_{24} for the 100-Year storm events are 2.9 in and 5.3 in, respectively. The ratio of P_6/P_{24} is 55%, so no adjustment to the precipitation depth is required.

(4) Then Q = CIA.

2.2 Runoff Coefficient

A weighted runoff coefficient was calculated for each sub-area. According to the Soil Hydrologic Groups exhibit in the *SDCHM*, the expected Soil Group for the project site is Group D. Group D soils are described as having a "very slow infiltration rate when thoroughly wetted; chiefly clays that have a high shrink-swell potential, soils that have a high permanent water table, soils that have a claypan or clay layer at or near the surface, or soils that are shallow over nearly impervious material. Rate of water transmission is very slow (4-16)."

For the existing condition, the entire site is pervious. For Type D soils, the corresponding runoff coefficient is 0.35, as given in Table 3-1 of the *SDCHM*. As such, all five drainage areas are assigned a C value of 0.35. Due to the unique nature of the proposed land use (electrical substation), which is not classified in the Hydrology Manual, three separate C factors were selected for the proposed areas of compacted base surfacing (C = 0.75), hardscape surfacing (C = 0.90), and landscaped areas (C = 0.35) to be representative of the anticipated drainage conditions. A Weighted C factor was calculated for each Drainage Area based upon the percentage of each type of surfacing in the Drainage Area. Please refer to Appendix 4 for the results of these calculations.

2.3 Rainfall Intensity

Rainfall intensity was determined using the formula on Page 3-7 of *SDCHM*, given on the preceding page in Section 2.1.

2.4 Tributary Areas

Drainage Areas are delineated on the Drainage Exhibits enclosed in Appendices 1 and 2, and graphically portray the tributary area for each drainage area.

3. CALCULATIONS/RESULTS

3.1 Pre & Post Development Peak Flow Comparison

Below are a series of tables which summarize the calculations provided in the Appendix of this report.

EXISTING DRAINAGE FLOWS					
DRAINAGE AREA	**C**	**T_c (min)**	**I (in/hr)**	**A (ac)**	**Q_{100} (cfs)**
A	0.35	19.4	3.19	4.86	5.5
B	0.35	25.5	2.67	3.88	3.7
C	0.35	5.0	7.64	0.77	2.1
D	0.35	5.0	7.64	0.11	0.3
E	0.35	5.3	7.37	0.13	0.3
				Total	11.8

Table 1. Existing Condition Peak Drainage Flow Rates

Table 1 above lists the calculated peak flow rates for the project site in the existing configuration for the 100-Year, 6-Hour rainfall event.

PROPOSED DRAINAGE FLOWS					
DRAINAGE AREA	C	Tc (min)	I (in/hr)	A (ac)	Q_{100} (cfs)
1	0.57	20.2	3.10	3.39	6.1
2	0.59	19.1	3.22	4.74	9.0
3	0.62	7.8	5.72	0.50	1.8
4	0.60	6.3	6.55	0.27	1.1
5	0.35	5.0	7.64	0.71	1.9
6	0.35	5.0	7.64	0.02	0.1
7	0.35	5.0	7.64	0.11	0.3
			Total	20.2	

Table 2. Proposed Condition Peak Drainage Flow Rates

Table 2 above lists the peak flow rates for the project site for the proposed condition for the 100-Year, 6-Hour rainfall event.

PEAK DRAINAGE FLOW COMPARISON			
RAINFALL EVENT	EXISTING CONDITION	PROPOSED CONDITION	COMPARISION
Q_{100} (CFS)	11.8	20.2	+8.4

Table 3. Proposed Condition Peak Drainage Flow Rates

Table 3 shows the comparison between the peak flow rates for the proposed project and the ultimate, cumulative flow rate for the project site for the proposed condition for the 100-Year, 6-Hour rainfall event. The flow-through planter/detention basins will provide peak flow attenuation of runoff such that the peak discharge from the site in the proposed condition will be equal to or less than the peak flow from the site in the existing condition. The increase in flow from the site will be attenuated by routing runoff through the flow-through planter/detention basins as described in Section 3.2 below.

3.2 Detention Basin Design

As discussed previously, the existing temporary desilting basins will be regraded to serve as permanent flow-through planters (to provide stormwater quality and hydromodification management) and detention basins (to provide peak flow attenuation.) Please see the Stormwater Management Plan for additional information on flow-through planters and hydromodification management.

Basin 1 will receive flow from Drainage Area 1 and attenuate the peak flow rate to be at or below existing condition levels. Basin 2 will receive flow from Drainage Area 2 and will attenuate flows from this Area. Drainage Areas 3 through 7 are not tributary to either Basin 1 or 2. The increase in flow from these areas will be managed by increasing the detention volume provided in Basin 2 accordingly.

Table 4 provides the 100-Year volume of runoff for both the existing and proposed conditions. Runoff volume was given by the following equation:

$V = (1/12)CP_6A$

Where:
V = Volume of runoff, cubic feet (ft^3)
C = Runoff coefficient
P_6 = 6-Hour precipitation depth in inches (in) for the storm event considered
A = Drainage basin area in square feet, (ft^2)

The storage volume provided is equal to or greater than the increase in flow volume resulting from the project. Note that Basin 2 will provide storage volume for peak flow attenuation based on the total increase in runoff volume from Drainage Areas 2 through 7.

FLOW ATTENUATION REQUIRED STORAGE		
PROPOSED DRAINAGE AREA	EXISTING 100-YR RUNOFF (FT^3)	PROPOSED 100-YR RUNOFF (FT^3)
1	14,284	20,497
Basin 1 Required Storage for Flow Attenuation:		6,213
2	17,892	29,185
3	474	3,242
4	--	1,745
5	2,853	2,633
6	--	80
7	388	388
TOTAL	21,606	37,274
Basin 2 Required Storage for Flow Attenuation:		15,667

Table 4. Flow Attenuation Required Storage

As mentioned previously, the Basins will provide water quality treatment, hydromodification, and peak flow attenuation. Water quality and hydromodification management is discussed in greater detail in the Storm Water Management Plan (SWMP), however the water quality storage volume requirement is summarized below in Table 5 to provide the minimum required storage volume for each basin. Table 5 also provides the actual storage volume provided for each basin. Note that each basin also has 1 foot of freeboard that is not included in the Storage Provided column shown in the table.

REQUIRED/PROVIDED STORAGE				
BASIN	WATER QUALITY/ HYDROMODIFICATION STORAGE (ft^3)	100-YEAR PEAK FLOW ATTENUATION STORAGE (ft^3)	TOTAL REQUIRED STORAGE (ft^3)	STORAGE PROVIDED (ft^3)
1	12,900	6,213	19,113	24,212
2	23,000	15,667	38,667	46,249

Table 5. Drainage Basin Storage Volumes

As shown in Table 3, the project increases the peak runoff rate for the 100-Year, 6-Hour rainfall event. However, both the flow rate and volume of stormwater runoff will continue to match existing conditions via stormwater facilities incorporated into the proposed design. Outlet controls will be constructed into the basins in order to govern the release rate of the basin outfalls.

Design of the outlet controls will be provided at the time of final design. Under proposed conditions, the following drainage areas will discharge the unattenuated peak flows given in Table 6.

UNATTENUATED DRAINAGE AREAS	
DRAINAGE AREA	Q_{100} (cfs)
3	1.8
4	1.1
5	1.9
6	0.1
7	0.3
TOTAL	5.2

Table 6. Unattenuated Peak Flows

The total peak flow from the site will be equal to or less than the existing condition peak flow of 11.8 cfs for the 100-Year event. As such, the total discharge combined from Basins 1 and 2 will be equal to or less than 6.6 cfs (the total allowable flow rate, 11.8 cfs, less the unattenuated flow rate of 5.2 cfs.)

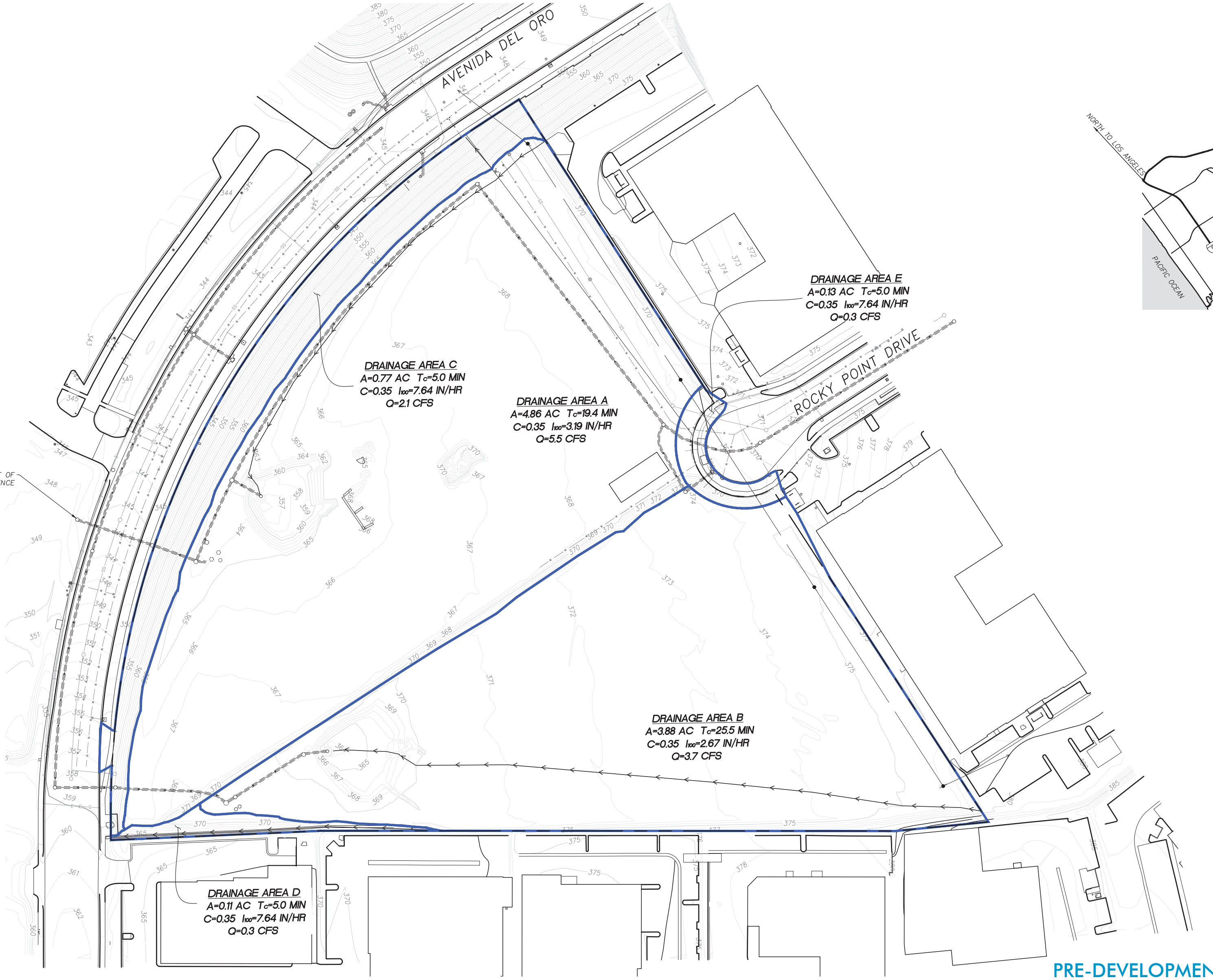
4. CONCLUSION

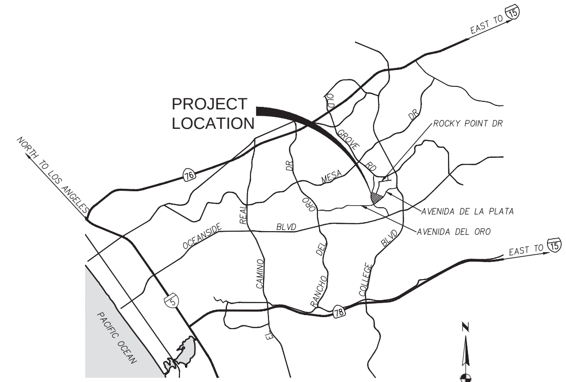
As shown in Table 3 in Section 3, the proposed project yields higher peak flow rates for the design storm analyzed than what was calculated for existing conditions. However, the peak flow rate of stormwater runoff will continue to match existing conditions via stormwater facilities incorporated into the proposed design. Outlet controls will be constructed into the basins in order to govern the release rate of the basins. Therefore, the proposed project is not anticipated to negatively affect any downstream facilities when compared to the assumed ultimate condition.

At the time of final design, the outlet structures for each basin will be analyzed and detailed completely. In addition, during the final design existing and proposed condition hydrographs will be developed and flow through the detention basins will be modeled for the 100-Year storm event to ensure peak flow from the site will not exceed that of existing conditions.

Appendix 1

Pre-Development Drainage Exhibit





VICINITY MAP

NOT TO SCALE

LEGEND

PROPERTY LINE / PROJECT LIMITS
RIGHT-OF-WAY
EXISTING PUBLIC STORM DRAIN EASEMENT
EXISTING STORM DRAIN
EXISTING CONCRETE BROW DITCH
MAJOR BASIN BOUNDARY
SUB-BASIN BOUNDARY
PROPOSED STORM DRAIN
FLOW PATH

SCALE: 1" = 50'

50' 25' 0 50' 100' 150'

GRAPHIC SCALE IN FEET

PRE-DEVELOPMENT DRAINAGE EXHIBIT

DRAINAGE STUDY
OCEAN RANCH SUBSTATION
ROCKY POINT DRIVE, OCEANSIDE, CA
PROJECT NUMBER: 02752-001-01
SCALE: 1" = 50'
DATE: FEBRUARY, 2015
SHEET 1 OF 1

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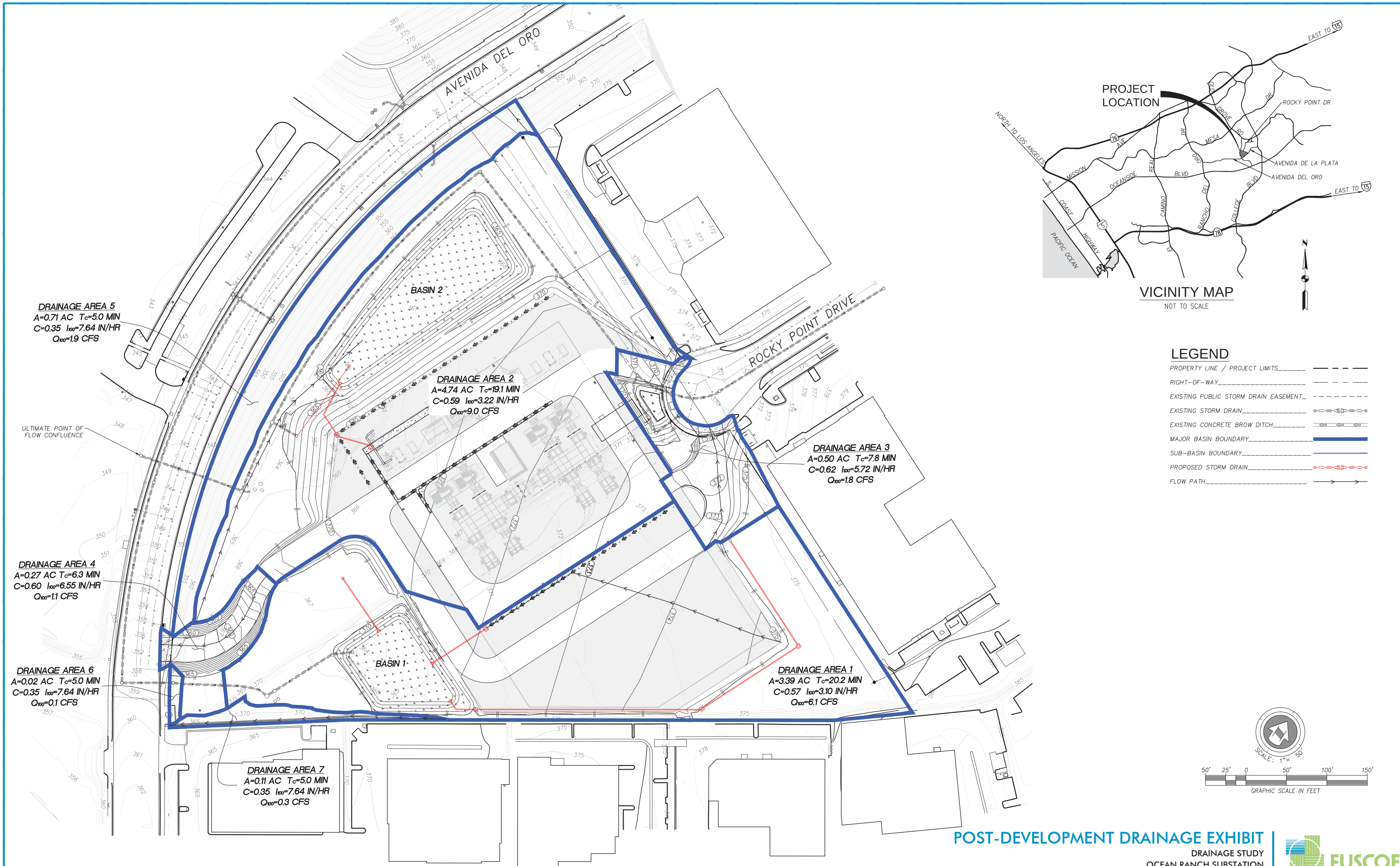
6390 Greenwich Drive, Suite 170
San Diego, California 92122
tel 858.554.1500 • fax 858.597.0335
www.fuscoe.com

Appendix 2

Post-Development Drainage Exhibit



POST-DEVELOPMENT DRAINAGE EXHIBIT

DRAINAGE STUDY
OCEAN RANCH SUBSTATION
ROCKY POINT DRIVE, OCEANSIDE, CA
PROJECT NUMBER: 02752-001-01
SCALE: 1" = 50'
DATE: FEBRUARY, 2015
SHEET 1 OF 1

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6390 Greenwich Drive, Suite 170
San Diego, California 92122
tel 858.554.1500 ∘ fax 858.597.0335
www.fuscoe.com

Appendix 3

Isopluvial Maps and Soil Hydrologic Groups

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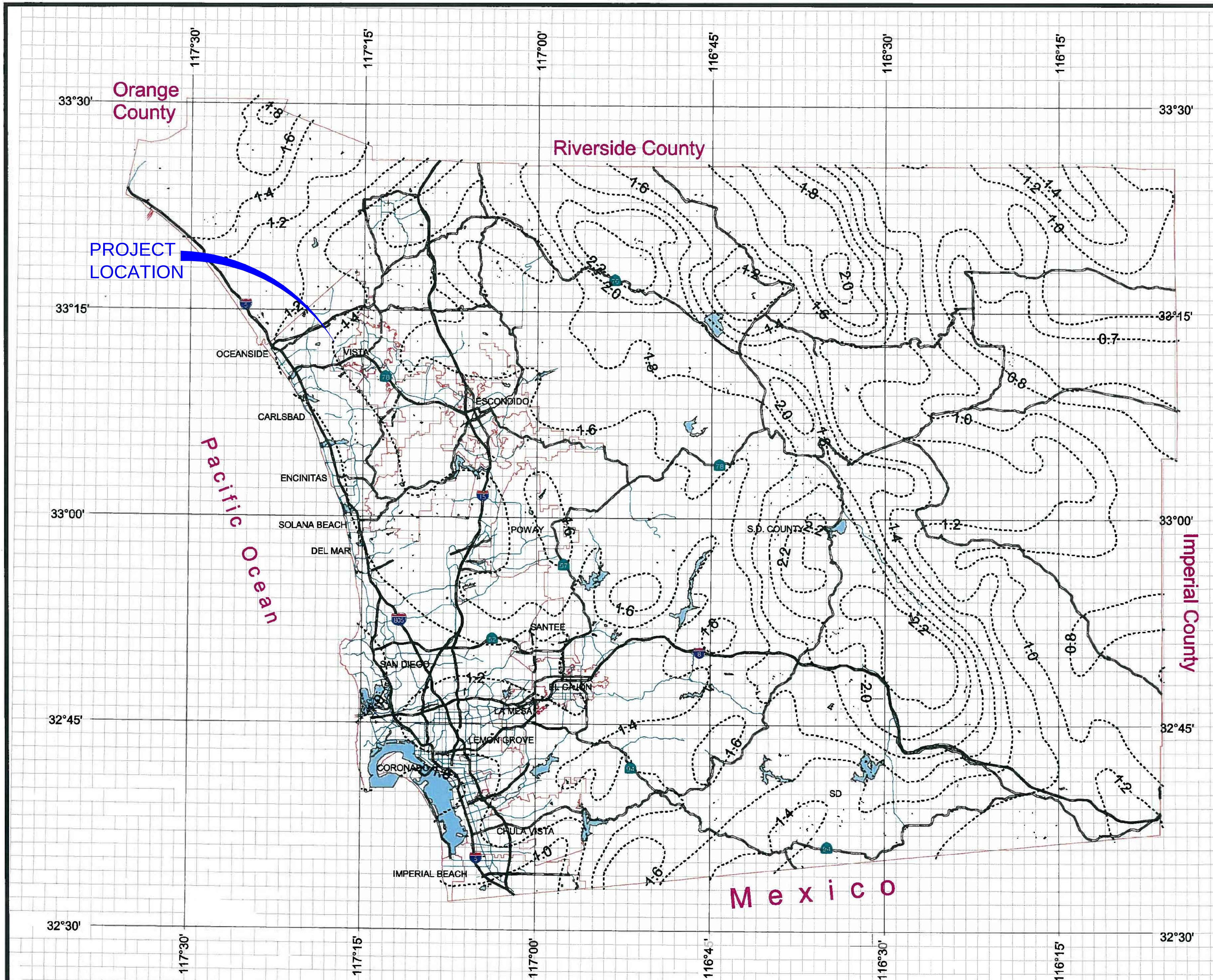
Rainfall Isopluvials



2 Year Rainfall Event - 6 Hours

Isopluvial (inches)

$P_6 = 1.4$

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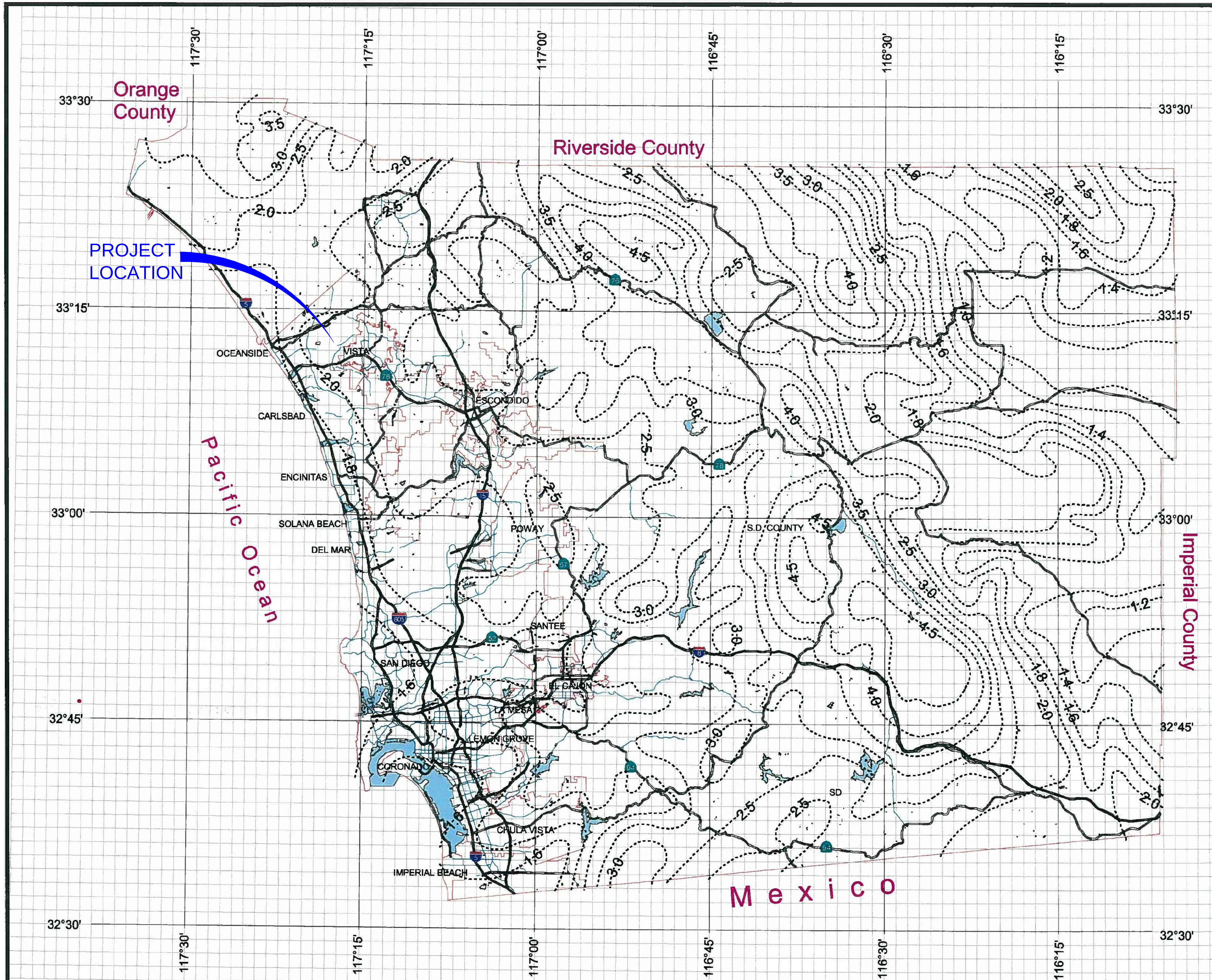
N S E W

3 0 3 Miles



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Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

Isopluvial (inches)

P_{24} = 2.2

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3 0 3 Miles

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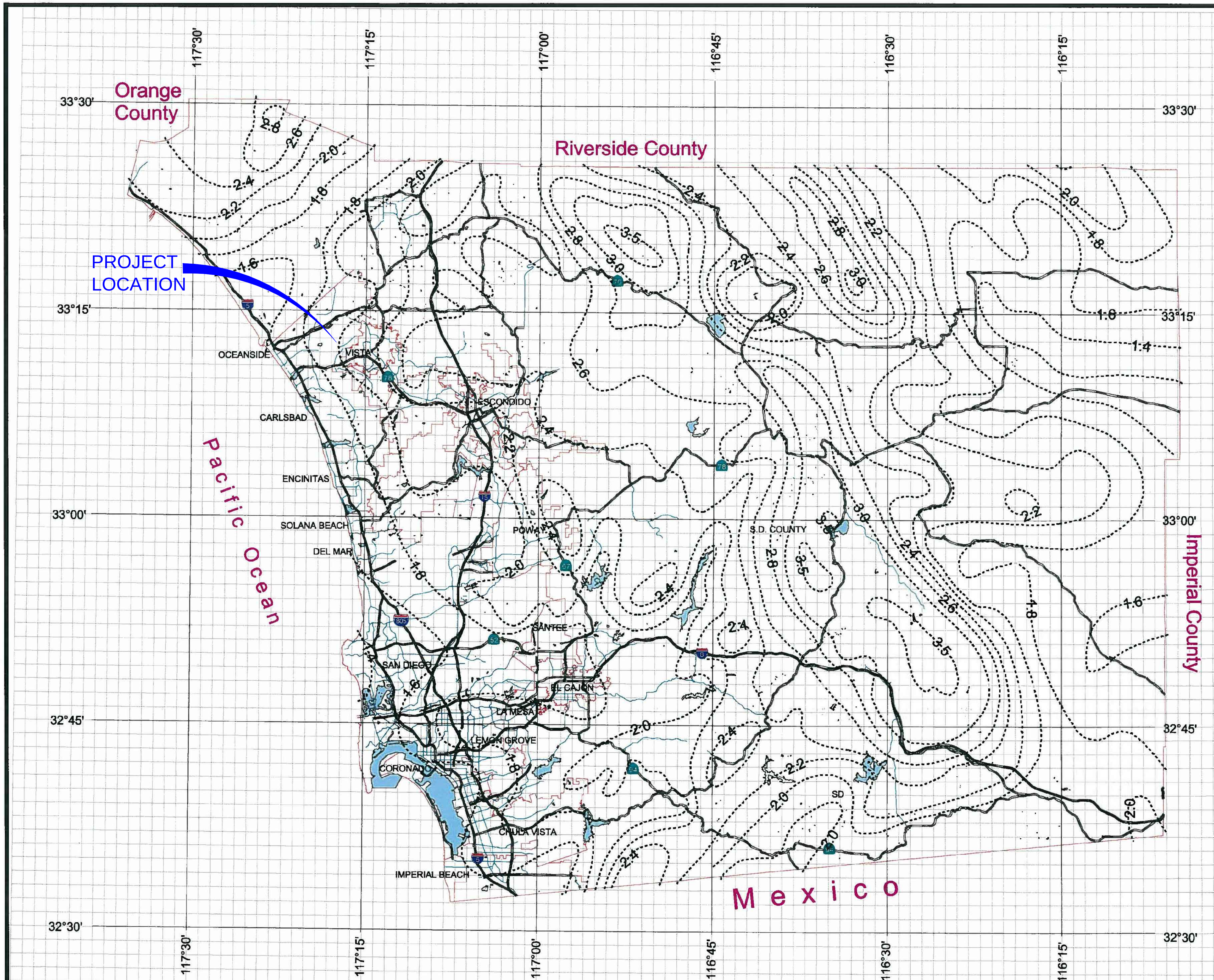
Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours



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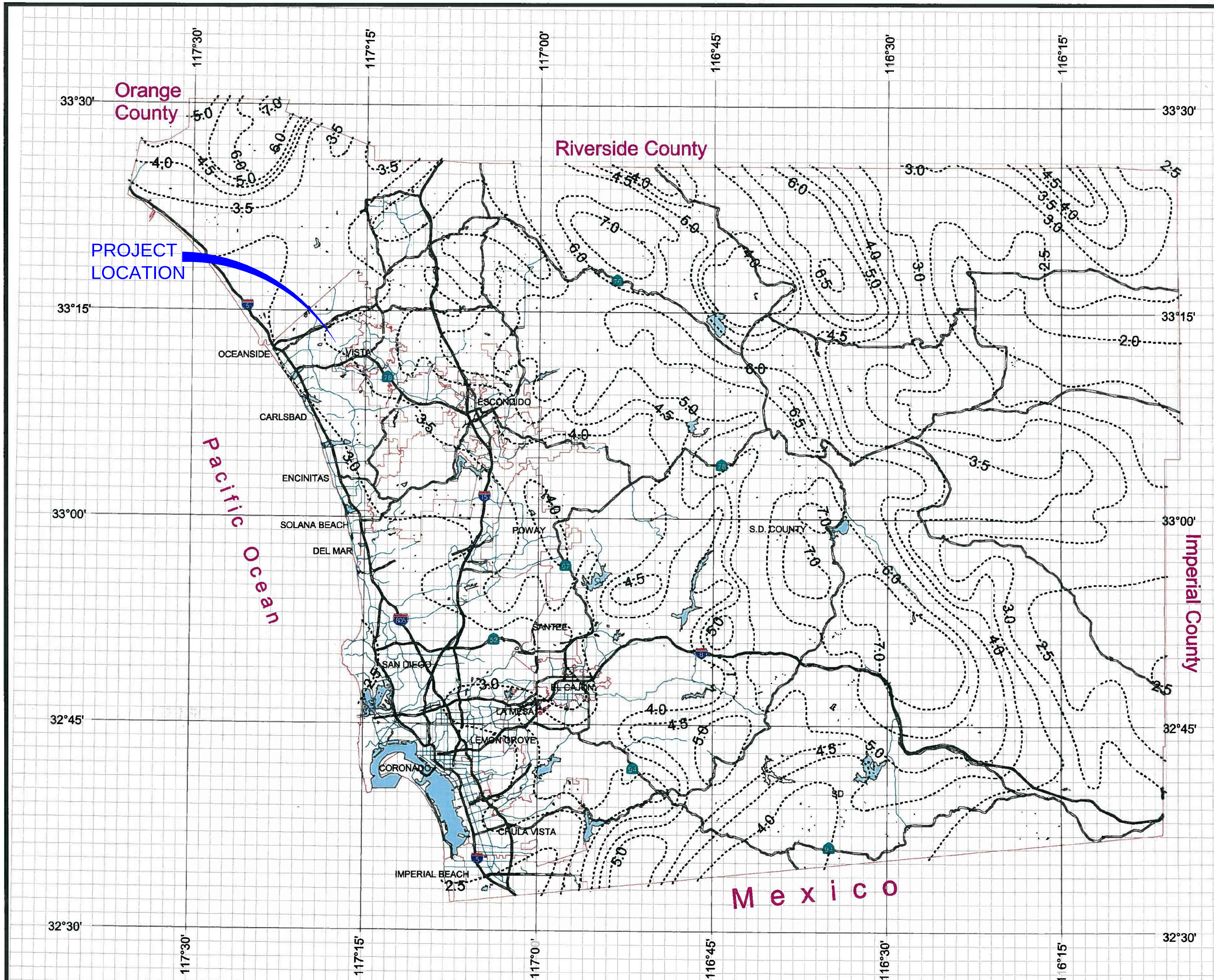
Rainfall Isopluvials



10 Year Rainfall Event - 24 Hours

....	Isopluvial (inches)

$P_{24} = 3.5$

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3 0 3 Miles

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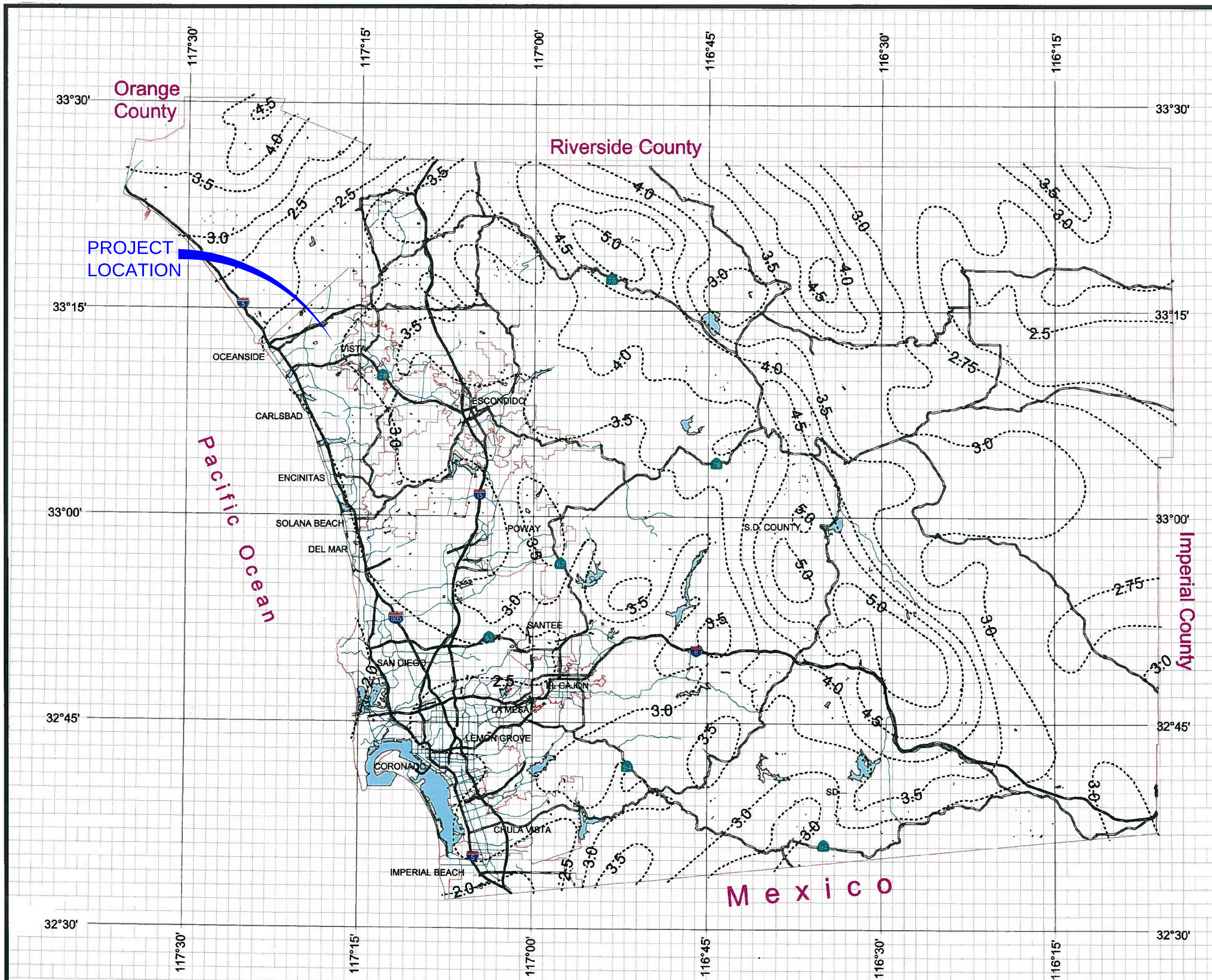
Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

Isopluvial (inches)

P_6 = 2.9



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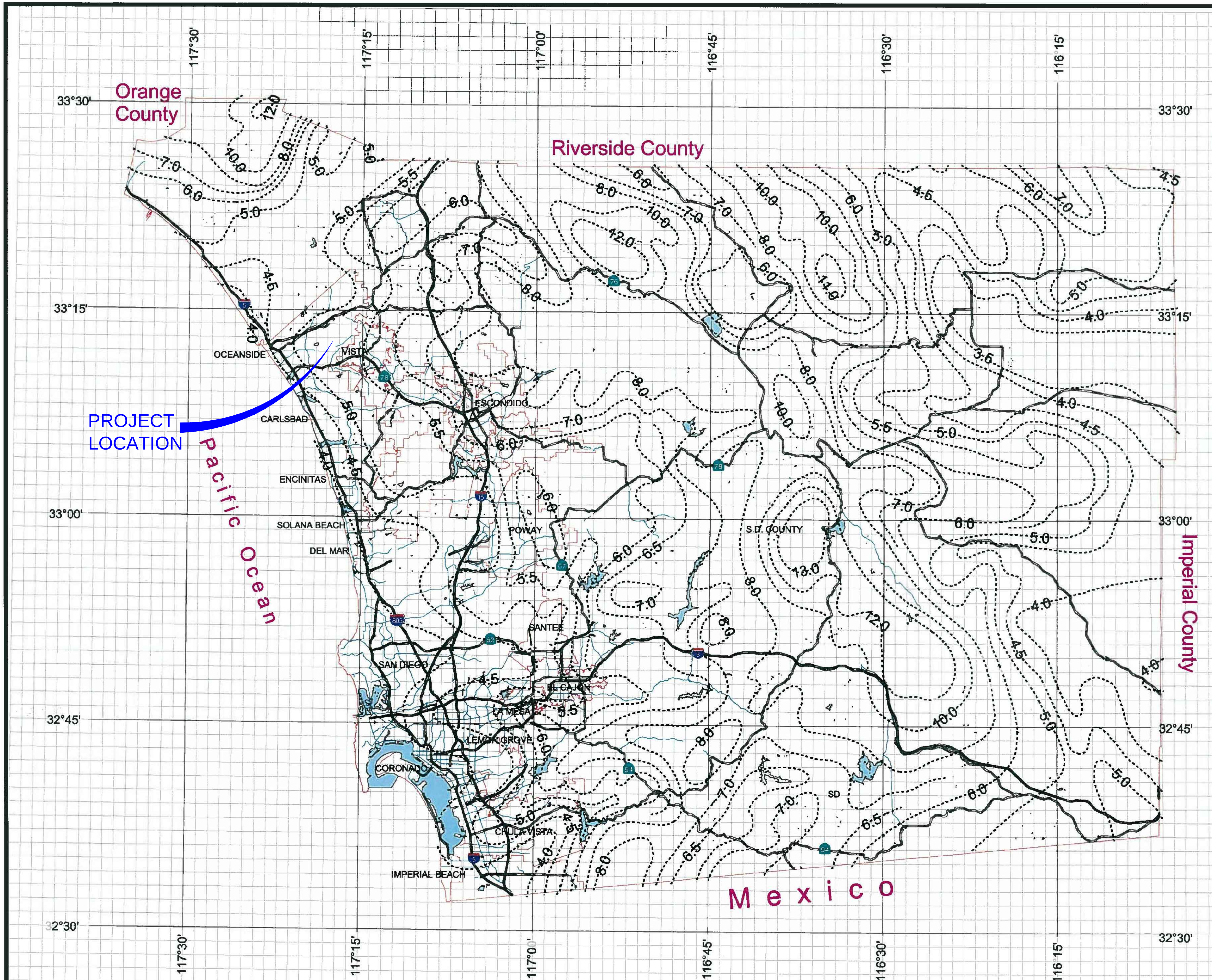
N S E W

3 0 3 Miles



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Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

-------- Isopluvial (inches)

$P_{24} = 5.3$

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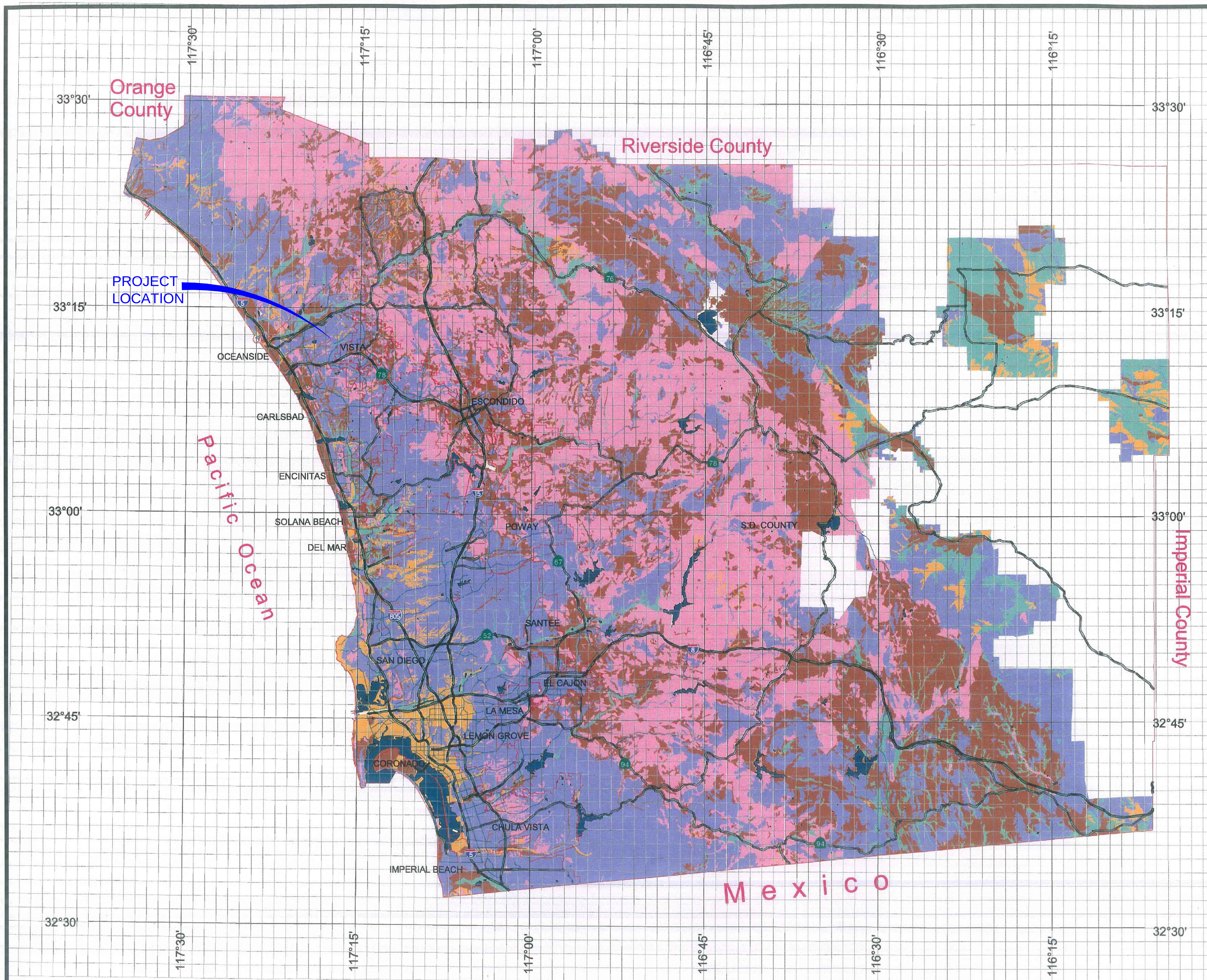
N
W E
S

3 0 3 Miles



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Soil Hydrologic Groups

Legend

Soil Groups

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

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N
W E
S

3 0 3 Miles

Appendix 4

Weighted Runoff Coefficient Calculations

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

WEIGHTED RUNOFF CALCULATIONS - PROPOSED CONDITIONS

DRAINAGE AREA		LANDSCAPING		CLASS II BASE SURFACING		HARDSCAPE SURFACING		TOTAL AREA [SF]	WEIGHTED C
NAME	SOIL TYPE	AREA [SF]	C	AREA [SF]	C	AREA [SF]	C		
1	D	93,974	0.35	53,615	0.75	13,013	0.90	147,763	**0.57**
2	D	96,743	0.35	78,661	0.75	31,013	0.90	206,416	**0.59**
3	D	11,972	0.35	760	0.75	9,618	0.90	21,591	**0.62**
4	D	6,411	0.35	0	0.75	5,528	0.90	11,939	**0.60**
5	D	31,135	0.35	0	0.75	0	0.90	31,135	**0.35**
6	D	945	0.35	0	0.75	0	0.90	945	**0.35**
7	D	4,587	0.35	0	0.75	0	0.90	4,587	**0.35**

* The following C values were used for various surface conditions. A Weighted Runoff Coefficient was then determined for each Drainage Area based upon the percentage of each type of surface condition.

C = 0.90 for asphalt and concrete paved surfaces

C = 0.75 for compacted Class II base

C = 0.35 for any unpaved or landscaped areas

Appendix 5

Modified Rational Method Calculations

EXISTING CONDITIONS, 100 YEAR STORM

NAME	AREA [SF]	AREA [ACRE]	LENGTH [FT]	FALL [FT]	SLOPE	C	FAA/OVERLAND FLOW			
							Tc [MIN]	I [IN/HR]	Q [CFS]	V [CF]
A	211,527	4.86	500.95	19.0	0.0379	0.35	19.4	3.19	5.5	17,892
B	168,871	3.88	697.44	19.0	0.0272	0.35	25.5	2.67	3.7	14,284
C	33,725	0.77	42.85	19.2	0.4481	0.35	5.0	7.64	2.1	2,853
D	4,587	0.11	341.42	4.2	0.0123	0.35	5.0	7.64	0.3	388
E	5,608	0.13	50.40	3.0	0.0595	0.35	5.3	7.37	0.3	474
									11.8	**35,890**

PROPOSED CONDITIONS, 100 YEAR STORM

NAME	AREA [SF]	AREA [ACRE]	LENGTH [FT]	FALL [FT]	SLOPE	C	FAA/OVERLAND FLOW			
							Tc [MIN]	I [IN/HR]	Q [CFS]	V [CF]
1	147,763	3.39	398.50	3.3	0.0082	0.57	20.2	3.10	6.1	20,497
2	206,416	4.74	414.30	4.0	0.0097	0.59	19.1	3.22	9.0	29,185
3	21,591	0.50	161.36	4.4	0.0273	0.62	7.8	5.72	1.8	3,242
4	11,939	0.27	176.00	11.4	0.0647	0.60	6.3	6.55	1.1	1,745
5	31,135	0.71	52.30	24.0	0.4589	0.35	5.0	7.64	1.9	2,633
6	945	0.02	15.30	6.0	0.3922	0.35	5.0	7.64	0.1	80
7	4,587	0.11	341.42	4.2	0.0123	0.35	5.0	7.64	0.3	388
									20.2	**57,770**

* All calculations are based off of the Rational Method outlined in the *San Diego County Hydrology Manual* , 2003 Edition.

* The following C values were used for various surface conditions. A Weighted Runoff Coefficient was then determined for each Drainage Area based upon the percentage of each type of surface condition. See Appendix 4 for additional information.

C = 0.90 for asphalt and concrete paved surfaces
C = 0.75 for compacted Class II base
C = 0.35 for any unpaved or landscaped areas

100 YEAR, 6 HOUR PEAK VOLUME ATTENUATION SIZING REQUIREMENTS

	BASIN CONDITION	CONTRIBUTING AREAS	ADDITIONAL AREAS	TOTAL AREA [SF]	TOTAL Q [CFS]	TOTAL V [CF]
BASIN 1	EXISTING	B	N/A	168,871	3.7	14,284
	PROPOSED	1	N/A	147,763	6.1	20,497
					Δ =	**6,213**
BASIN 2	EXISTING	A	C, D, E	255,446	8.2	21,606
	PROPOSED	2	3, 4, 5, 6, 7	276,612	14.1	37,274
					Δ =	**15,667**

* Basins 1 and 2 should be sized to hold a minimum of 6,213 CF and 15,667 CF, respectively, in order to hold the difference in volume generated by the Proposed Site.