PRELIMINARY HYDROLOGY AND DRAINAGE BASIN CALCULATIONS

for

Grading & Improvements

at

Independent Energy Solutions, Inc. (IES) /San Diego Gas & Electric (SDG&E) Solar Energy Project – Ramona

1049 Creelman Lane, Ramona, CA 92065

PREPARED FOR:

Independent Energy Solutions, Inc.
1090 Joshua Way
Vista, CA 92081

PREPARED BY:

BergerABAM
10525 Vista Sorrento Parkway, Suite 350
San Diego, CA 92121
(858) 500-4500 FAX: (858) 500-4501

REGISTERED PROFESSIONAL ENGINEER
WILLIAM RYAN LUND
NO. 36812
Expires 6/30/2016
CIVIL
STATE OF CALIFORNIA

BergerABAM# A13.0324
January 2014
Revised May 2015

TABLE OF CONTENTS

TAB A

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

William Ryan Lund   R.C.E 36812   Date

1.0 General Project Information

A. Project Site Information

Project Name: IES/SDG&E Solar Energy Project - Ramona
Hydrology Area: 32.50 Acres
Area of Construction: 18.3 Acres
Project Address: 1049 Creelman Lane, Ramona, CA 92065
Latitude/Longitude: 33.019414, -116.860253
Expected Duration of the project: 120 days

Flood Plain Status: The FEMA Panel 06073C1140G was not printed per FEMA website. According to the Floodplain Management Plan – County of San Diego, California, prepared for FEMA Region IX and dated August 2007: "The Downtown Ramona study area is outside the SFHA mapped by FEMA. It is designated as an "X Zone," which means that there are no floodplain management regulations that would require new construction or substantial improvements to buildings to be protected from the 1% annual chance (100-year), or base, flood."
The approximate 100-year flood plan boundary on Exhibit A and Exhibit B (Tab F) shows that the project site is located outside this 100-year flood plan

B. Project Description

The IES/SDG&E Solar Energy Project - Ramona project site is located 1049 Creelman Lane, in the City of Ramona, San Diego County, California. The project location is shown on the Vicinity Map included under Tab B.

The existing site is currently developed as a palm tree farm. The existing project site is bounded by undeveloped land to the north, Creelman Lane to the south, Ashley Road to the east, and residential developments to the west.

C. Existing Conditions

The existing site is currently developed as a palm tree farm.

Topographically, the planned improvement area slopes in the eastern and northeastern directions with a total elevation difference of less than 10 feet over a span of about 500 feet. Vegetation at site consists of trees, shrubs and grasses.

The runoff coefficient, C, for the existing conditions was calculated for the hydrology area (32.50 acres) and not for the project boundary. The runoff coefficient is selected from the San Diego County Hydrology Manual, corresponding Soils Hydrologic Groups Map and site soils report.

D. Proposed Conditions

The proposed project includes the removal demolition of the existing vegetation and the installation of multiple ground-mounted photovalic solar panels with an associated decomposed granite road.

The proposed site improvements result in 0.35 % impervious* and 99.65% pervious area. *(Please note that the photovalic solar panels are not considered impervious. Please see below.)

*Impervious surfaces are mainly constructed surfaces such as rooftops, sidewalks, roads, and parking lots. They are covered by impermeable materials such as asphalt, concrete, and stone. These materials effectively seal surfaces, repel water and prevent precipitation from infiltrating soils. Surfaces covered by such materials are hydrologically active, meaning they generate surface runoff. The proposed photovalic solar panels are not considered impervious because runoff will drain off and into the soil.

E. Project Site Soils

The following site soils information has been provided according to the "Geotechnical Investigation Photovoltaic Energy Facility Creelman Site, San Diego County, California", prepared by Southern California Soil & Testing, Inc., dated December 11, 2012 and according to the "Addendum Geotechnical Report Photovoltaic Energy Facility Creelman Site, San Diego County, California", prepared by Southern California Soil & Testing, Inc., dated May 1, 2013.

Subsurface Conditions:

"Materials encountered in the test borings consist of older alluvium underlain by weathered granitic rock. The older alluvium is comprised of medium dense to dense silty and clayey sand. This material extends to depths of between about 4 feet and 10 feet below the ground surface. The weathered granitic rock was encountered below the older alluvium in all test borings except test boring B-5. Granitic rock is the bedrock unit in the area. The weathered granitic rock is dense to very dense; however, it is moderately to highly weathered and can be broken down to poorly graded sand with silt with hand pressure when excavated." (Page 2 of Geotechnical Investigation Photovoltaic Energy Facility Creelman Site)

Groundwater:

"Based on readily available information within the general site vicinity, groundwater is anticipated to exist at a depth of greater than 50 feet below the existing ground surface. It should be recognized that groundwater conditions can develop at a site where none were previously present. These are often the result of alteration of the permeability characteristics of the soil, an alteration in drainage patterns, and/or increased precipitation or irrigation water. These types of conditions can be most effectively corrected on an individual basis if and when they develop." (Page 2 of Addendum Geotechnical Report Photovoltaic Energy Facility Creelman Site)

2.0 Design Criteria

The Rational Method (RM) is a mathematical formula used to determine the maximum runoff rate from a given rainfall. The RM is used for analyzing drainage areas up to 1 square mile (640 acres) in size to calculate conservative flows. However, it should not be used in instances where there is a junction of independent drainage systems. In these instances, the Modified Rational Method (MRM) is used to route the conservative flows through junction analysis. The process for the MRM differs from the RM only when a junction of independent drainage systems is reached. The RM is used below for each independent drainage system then the MRM will follow with junction analysis.

The Rational Method

The Rational Method can be applied using any design storm frequency. The 100-year 6 hour storm event is analyzed for the IES/SDG&E Solar Energy Project – Ramona project.

The RM formula estimates the peak rate of runoff at any location in a watershed as a function of the drainage area (A), runoff coefficient (C), and rainfall intensity (I) for a duration equal to the time of concentration (T_C) which is the time required for water to flow from the most remote point of the basin to the location being analyzed.

$$Q = CIA$$

Where:

Q= peak discharge, cfs
C= runoff coefficient, proportion of the rainfall that runs off the surface
I= average rainfall intensity for a duration equal to the Time of Concentration for the area, inches per hour
A= drainage area contributing to the design location, acres

<u>Runoff Coefficient:</u>

The soil type can be determined from the soil type map provided in the most recent San Diego County Hydrology Manual, dated June 2003 (see Tab E), but also based on the information given in the geotechnical report.

The project site contains soils types B and D. The average of the more conservative runoff coefficients will be used, where C=0.25 and C=0.35 for Group B and D respectively. The average of the two soil types yields C=0.30. A runoff coefficients of C=0.87 will be used for impervious areas.

Post-developed weighted runoff coefficient C is determined as follows:

<u>Soil Type B:</u>

C= (0.25 * Pervious Area + 0.87 * impervious Area)/ Total Area

C_B= (0.25 * 32.50 Acres + 0.87 * 0.00 Acres)/ 32.50 Acres = 0.25

<u>Soil Type D:</u>

C= (0.35 * Pervious Area + 0.87 * impervious Area)/ Total Area

C_D= (0.35 * 32.50 Acres + 0.87 * 0.00 Acres)/ 32.50 Acres = 0.35

Weighted C = (C_B*area)/32.5)+(C_D*area)/32.5) = ((0.25*2.690/32.50)+((0.35*29.8) / 32.5) = 0.34

Table 3-1 (from the San Diego County Hydrology Manual, See Tab C) lists the estimated runoff coefficients for urban areas.

"C" is calculated by tabulating the weighted value of the pervious and impervious areas for each drainage basin. The weighted "C" value can then be determined for each basin with the following equation:

Weighted Runoff Coefficient formula:

$$C = ((PerviousArea(Acres) * C_{vegetated} + (imperviousArea(Acres) * C_{impervious}) / TotalArea(acres)$$

Soil Type B

Where:

C = Weighted Coefficient of Runoff
Pervious Area = Calculated Pervious Area within a Drainage Basin, acres
$C_{pervious}$ = 0.25 (from Table 3-1 in the San Diego County Hydrology Manual)
Impervious Area = Calculated Impervious Area within a Drainage Basin, acres
$C_{impervious}$ = 0.87 (from Table 3-1 in the San Diego County Hydrology Manual)

Soil Type D

Where:

C = Weighted Coefficient of Runoff
Pervious Area = Calculated Pervious Area within a Drainage Basin, acres
$C_{pervious}$ = 0.35 (from Table 3-1 in the San Diego County Hydrology Manual)
Impervious Area = Calculated Impervious Area within a Drainage Basin, acres
$C_{impervious}$ = 0.87 (from Table 3-1 in the San Diego County Hydrology Manual)

Rainfall Intensity I:

The rainfall intensity (I) is the rainfall in inches per hour (in/hr) for a duration equal to the Time of Concentration for a selected storm frequency. The rainfall intensity can be determined from the Intensity-Duration Design Chart and Isopluvial maps (Figure 3-1 in the San Diego County Hydrology Manual, Intensity-Duration Design).

$I = 7.44 * P_6 * D^{-0.645}$

Where:

I = Intensity (in/hr)
P_6 = 6-hour precipitation (in)
D = Duration (min)

Time of Concentration Tc:

The Time of Concentration is the time required for runoff to flow from the most remote part of the drainage area to the point of interest. The Time of Concentration is composed of two components: initial time of concentration and travel time.

Methods of calculation differ for natural watersheds and for urban drainage systems.

The Initial Time of Concentration (T_i) for natural watersheds can be determined for up to the initial 100 feet of a watercourse using the Overland Time of Flow Nomograph, (Figure 3-3 in the San Diego County Hydrology Manual, Tab C), or the following equation. (Note: Use of the following equation is limited to correspond to sheet flow condition only.)

$$T_i = \left[\frac{1.8(1.1 - C)\sqrt{D}}{\sqrt[3]{s}} \right]$$

Where:

D = Distance, feet
s = Slope, (%)
C = Runoff Coefficient
T_i = Overland Flow Time, min.

The Secondary Time of Concentration (T_t) for the natural watershed was calculated using the following equation. (Figure 3-4, Tab C)

$$T_t = 11.9 \left[\frac{(L / 5280\, ft / mi)^3}{\Delta H} \right]^{0.385} * 60 \min / hr$$

Where:

T_t= Time of concentration, minutes
L= Hydraulic length of drainage basin, ft

ΔH= Change in elevation along the hydraulic length, ft

The total Time of Concentration for natural watersheds is then the Initial plus the Secondary as described above.

The calculations for the Time of Concentration use a minimum value of five minutes for calculations that results in values less than five minutes. To assist with this, smaller sized drainage areas were combined where feasible to reduce the number of drainage basins that generated short hydraulic lengths.

The hydraulic lengths are used to develop corresponding Time of Concentrations as seen in Tab C. The Time of Concentrations and intensities were tabulated for the 100-year 6-hour storm event to predict the corresponding maximum flow rates. (Tab C.)

3.0 Hydrology Calculations

Rational Method Peak Flow Calculation for Pre-Developed Conditions - 100-yr 6h Storm Conditions for Drainage Basin B

Total Drainage Basin B= 7.43 acres

C= (Pervious Area * 0.30 + Impervious area * 0.87)/ Total Area
C = (0.30 * 7.43 acres + 0.87 * 0.00 acres)/ 7.43 Acres = **0.35**

Initial T_i
Watercourse Distance (D) = 70 ft
Slope (s) = 1.4%

$$T_i = \left[\frac{1.8 * (1.1 - C) * \sqrt{D}}{\sqrt[3]{s}} \right]$$

$$T_i = \left[\frac{1.8 * (1.1 - 0.30) * \sqrt{100}}{\sqrt[3]{1.4}} \right]$$ **= 9.6 min**

Secondary T_t
Watercourse Distance (D) = 800 ft
Change in Elevation (ΔH) = 4.2 ft

$$T_t = 11.9 \left[\frac{(L / 5280 ft / mi)^3}{\Delta H} \right]^{0.385} * 60 \min/ hr$$

$$T_t = 11.9 \left[\frac{(800 / 5280\ ft / mi)^3}{4.2} \right]^{0.385} * 60 \min/ hr$$

= **10.13 min**
Total T_C= 9.6+10.13= 19.72 **min**

I_{100} = Intensity (in/hr)
100-yr storm: P_6 = 6-hour Precipitation (in) = 3.5 inches
D = Duration (min) = 19.72 min

$I_{100} = 7.44*P_6*D^{-0.645}$
$I_{100} = 7.44 * 3.5 * 19.72^{-0.645}$ = **3.81 inches/hour**

Peak Flow, Q_{100}, cfs = C*I*A
Q_{100} = 0.30 * 3.81 in/hr * 7.43 acres = **8.49 cfs**

3.0 Conclusions

As reflected in the Existing Drainage Conditions map in Tab F, runoff from Basin A originates on the southeast end of the site and flows northwesterly towards its discharge point located at the northwest end of the site. Runoff from Basin B begins to flow from the east end of the site and runs northwesterly towards its discharge point. The proposed project entails the removal and demolition of the existing vegetation and installation of ground-mounted photovalic solar panels and an associated decomposed granite road. Looking at the Proposed Drainage Conditions map in Tab F, Basins 1 and 2 correspond with Basins A and B from the existing conditions. The installation of the solar panels does not alter the existing flow paths in any way, shown on the drainage maps.

Existing Conditions

Drainage Area	ΔH (ft)	L (ft)	Tc (min)	I (in/hr)	A (acres)	Q_{100} (cfs)
A	13	2,075	28.26	3.02	25.06	25.71
B	4.2	800	19.72	3.81	7.43	8.49

∑=34.20

Proposed Conditions

Drainage Area	ΔH (ft)	L (ft)	Tc (min)	I (in/hr)	A (acres)	Q_{100} (cfs)
1	13	2,075	28.26	3.02	25.06	25.71
2	4.2	800	19.72	3.81	7.43	8.49

∑=34.20

	Existing Conditions (cfs)	Proposed Conditions (cfs)	Reduction (cfs)
100-Year Storm	34.20	34.20	0

The installation of the proposed ground-mounted photovalic solar panels with the associated decomposed granite road will not increase the runoff rate and volume generated by the 100 year 6-hour storm event, as shown in the tables above. The 100 year 6-hour runoff rate using the rational method described in section 2, was calculated to be 34.20 cfs for existing and 34.20 cfs proposed conditions, resulting in no change in cfs. The project does not propose any wet utilities.

There is no floodway/flood plain map produced by FEMA for this area. Drainage maps produced by the county of San Diego show the flood plain limits within the site and have been plotted per GIS on the plans.

The approximate 100-year flood plan boundary governed from the Floodplain Management Plan mentioned above, is shown on Exhibit A and Exhibit B (Tab F). The limit of work is situated outside the 100-Year flood plain boundary, no improvements are being done within the 100-year floodplain boundary and the Independent Energy Solutions, INC (IES)/San Diego Gas and Electric (SDG&E)/Solar Energy Project-Ramona does not place housing within the 100-year flood hazard area.

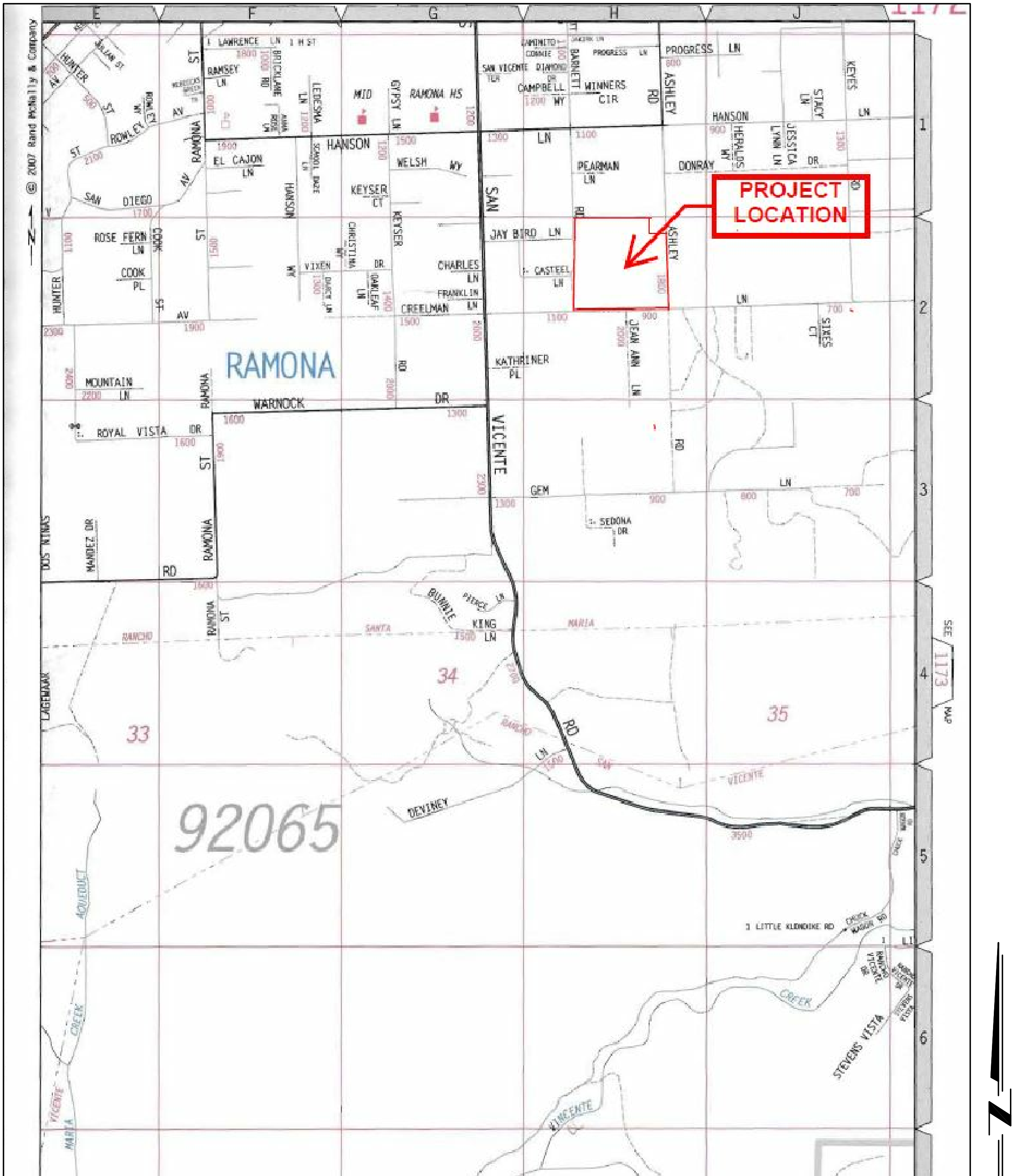
There are currently no signs of substantial erosion or siltation within the limits of work and downstream of the project site. Since the project's runoff rate and volume will not increase and since the drainage patterns will not change, no substantial siltation of erosion is anticipated as a result of the proposed improvements.

References

1. Geotechnical Investigation Photovoltaic Energy Facility Creelman Site, San Diego County, California", prepared by Southern California Soil & Testing, Inc., dated December 11, 2012.

2. Addendum Geotechnical Report Photovoltaic Energy Facility Creelman Site, San Diego County, California", prepared by Southern California Soil & Testing, Inc., dated May 1, 2013.
3. Chow, Ven Te, Ph.D., *Open Channel Hydraulic*, McGraw-Hill Book Company, Illinois, 1959.
4. San Diego County Department of Public Works Flood Control Section, *San Diego County Hydrology Manual*, June 2003.
5. Floodplain Management Plan – County of San Diego, CA, dated August 2007.

TAB B



VICINITY MAP

IES/SDG&E ENERGY PROJECT –RAMONA
CREELMANN LANE
RAMONA, CALIFORNIA 92065

BergerABAM
10525 Vista Sorrento Parkway, Suite 350
San Diego, CA 92121
(858) 500-4500 FAX: (858) 500-4501

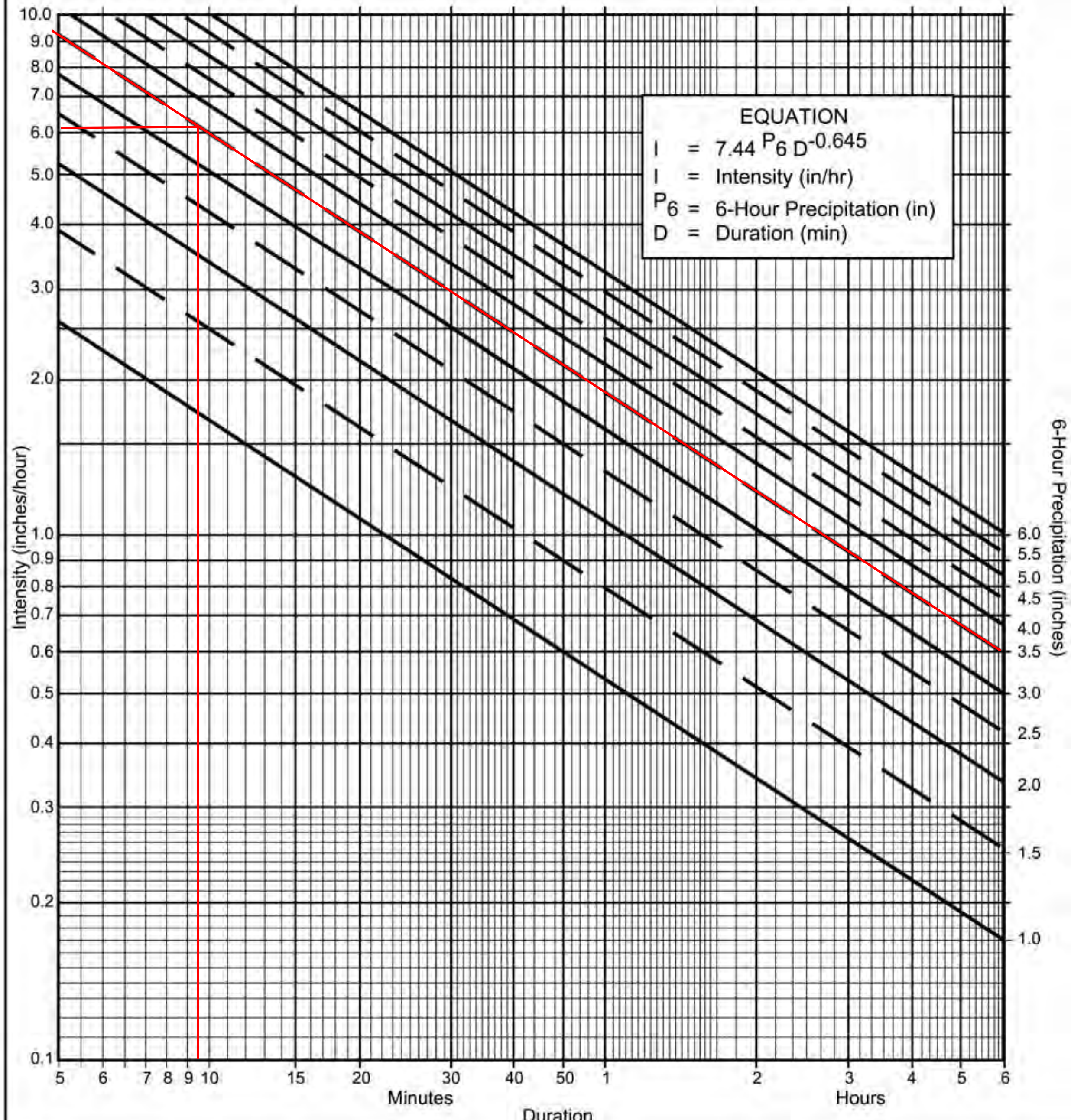
SG		PLOT NO: 1	DATE: JANUARY, 2014	PROJECT NUMBER: A14.0142	FIG 1

TAB C

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



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 applicable 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 = 3.5 in., P_{24} = 6.0, $\frac{P_6}{P_{24}}$ = 58 %(2)

(c) Adjusted $P_6^{(2)}$ = 3.5 in.

(d) t_x = 9.5 min.

(e) I = 6.1 in./hr.

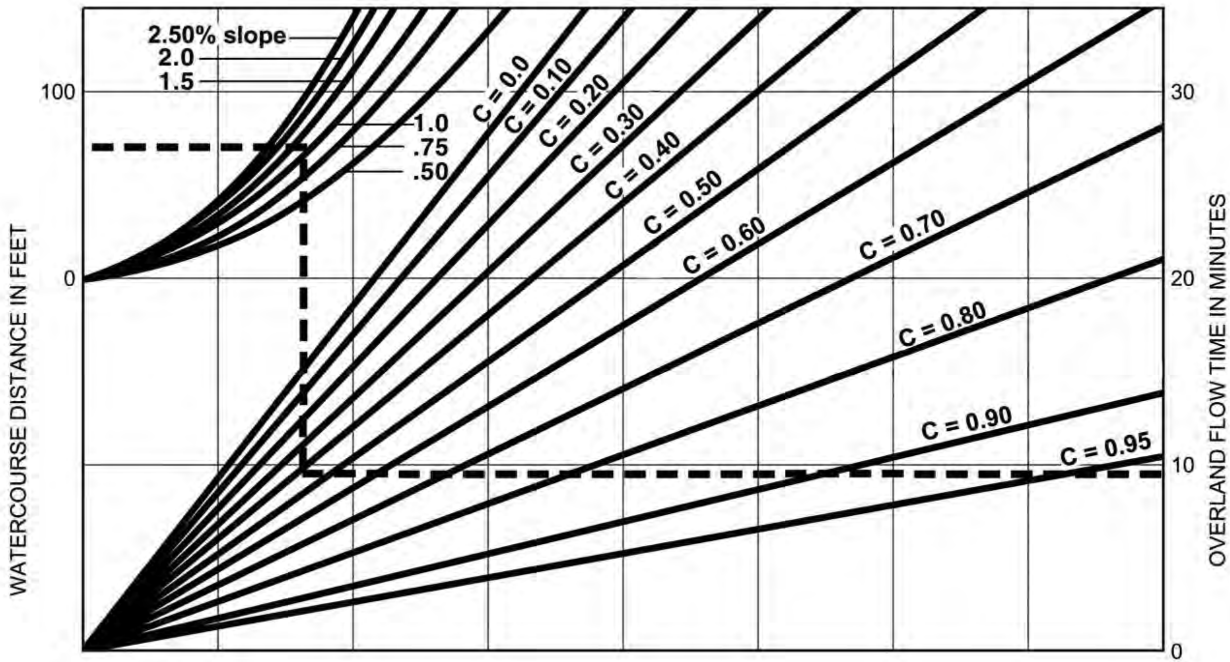
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

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

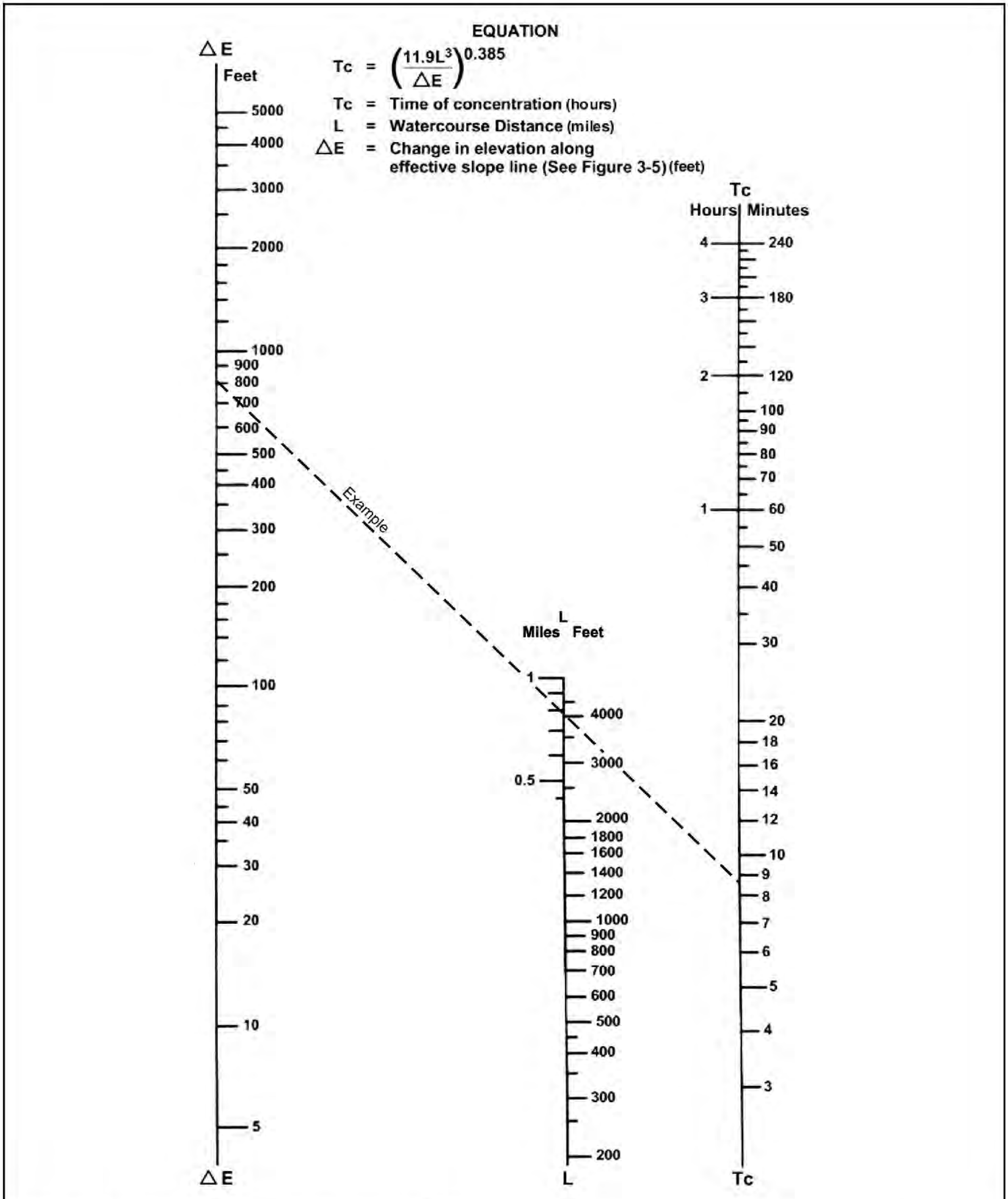
$$T = \frac{1.8\,(1.1-C)\sqrt{D}}{\sqrt[3]{s}}$$

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

FIGURE

3-3

Rational Formula - Overland Time of Flow Nomograph



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

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

FIGURE 3-4

100-Year
Storm Event

A14.0142 IES/SDG&E Solar Energy Project – Ramona
Existing Drainage Basin Hydrology
100-Year, 6-Hour Storm

Reference: San Diego County Hydrology Manual dated June 2003

Drainage Basin	Total Area (sf)	Total Area (acres)	Pervious Area (sf)	Pervious Area (acres)	Pervious Area (%)	Impervious Area (sf)	Impervious Area (acres)	Impervious Area (%)	*Runoff Coefficient, C	Hydraulic Length for Initial Time of Concentration (ft)	Change in Elevation (DH) for Initial Time of Concentration (ft)	Slope of Basin for Initial Time of Concentration (%)	Initial Time of Concentration, T_c (min.)	Hydraulic Length for Secondary Time of Concentration (ft)	Hydraulic Length Secondary Time of Concentration (mi)	Change in Elevation Secondary Time of Concentration (ΔH)	Slope of Basin for Secondary Time of Concentration (%)	Secondary Time of Concentration, T_c (hours)	Secondary Time of Concentration, T_c (min.)	Total Time of Concentration, T_c (min.)	$P_{6,}$ 100-yr Storm	Intensity, I_{100} (in/hr)	Flow, Q_{100} (cfs)
Basin A	1,091,771	25.06	1,091,771	25.06	100.0	0	0.00	0.0	0.34	70.00	1.7	2.4	8.5	2,075	0.39	13.0	0.63	0.33	19.72	28.26	3.50	3.02	25.71
Basin B	323,830	7.43	323,830	7.43	100.0	0	0.00	0.0	0.35	70.00	1.4	2.0	9.6	800	0.15	4.2	0.53	0.17	10.13	19.73	3.50	3.88	8.49
	1,415,602	32.50	1,415,602	32	100.0	-	0.00	0.0											average Total Tc	24.0		Q Total=	34.20

APPLICABLE EQUATIONS:

Rain Fall Intensity (inches/hour):
I= 7.44*P_6*T_C^-0.645

P_6 3.50 in
P_{24} 6.00 in
P_6/P_{24} 58% within the range of 45% and 65%

Initial Time of Concentration:
$T_C=(1.8*(1.1-C)*(L)^{0.5})/(S)^{0.33}$
Minimum allowable T_C= 5.0 minutes

Secondary Time of Concentration:
$T_C=((11.9*L^3)/\Delta E)^{0.385}$

Total Time of Concentration:
T_c=Initial T_c + Secondary T_c

Expected Runoff/Flow from Drainage Basin (cfs):
Q=C*I*A

adjusted P_6 (in) **N/A**

Soil Type: B and D

A14.0142 IES/SDG&E Solar Energy Project – Ramona
Proposed Drainage Basin Hydrology
100-Year, 6-Hour Storm

Reference: San Diego County Hydrology Manual dated June 2003

Drainage Basin	Total Area (sf)	Total Area (acres)	Pervious Area (sf)	Pervious Area (acres)	Pervious Area (%)	Impervious Area (sf)	Impervious Area (acres)	Impervious Area (%)	*Runoff Coefficient, C	Hydraulic Length for Initial Time of Concentration (ft)	Change in Elevation (DH) for Initial Time of Concentration (ft)	Slope of Basin for Initial Time of Concentration (%)	Initial Time of Concentration, T_c (min.)	Hydraulic Length for Secondary Time of Concentration (ft)	Hydraulic Length Secondary Time of Concentration (mi)	Change in Elevation Secondary Time of Concentration (ΔH)	Slope of Basin for Secondary Time of Concentration (%)	Secondary Time of Concentration, T_c (hours)	Secondary Time of Concentration, T_c (min.)	Total Time of Concentration, T_c (min.)	$P_{6,}$ 100-yr Storm	Intensity, I_{100} (in/hr)	Flow, Q_{100} (cfs)
1	1,091,771	25.06	1,091,771	25.06	100.0	0	0.00	0.0	0.34	70.00	1.7	2.4	8.5	2,075	0.39	13.0	0.63	0.33	19.72	28.26	3.50	3.02	25.71
2	323,830	7.43	322,698	7.41	99.7	1,132	0.03	0.3	0.35	70.00	1.4	2.0	9.6	800	0.15	4.2	0.53	0.17	10.13	19.73	3.50	3.80	8.49
	1,415,602	32.50	1,414,469	32.47	99.9	1,132	0.03	0.1											average Total Tc	24.0		Q Total=	34.20

APPLICABLE EQUATIONS:

Rain Fall Intensity (inches/hour):
I= 7.44*P_6*T_C^-0.645

P_6 3.50 in
P_{24} 6.00 in
P_6/P_{24} 58% within the range of 45% and 65%

Initial Time of Concentration:
$T_C=(1.8*(1.1-C)*(L)^{0.5})/(S)^{0.33}$
Minimum allowable T_C= 5.0 minutes

Secondary Time of Concentration:
$T_C=((11.9*L^3)/\Delta E)^{0.385}$

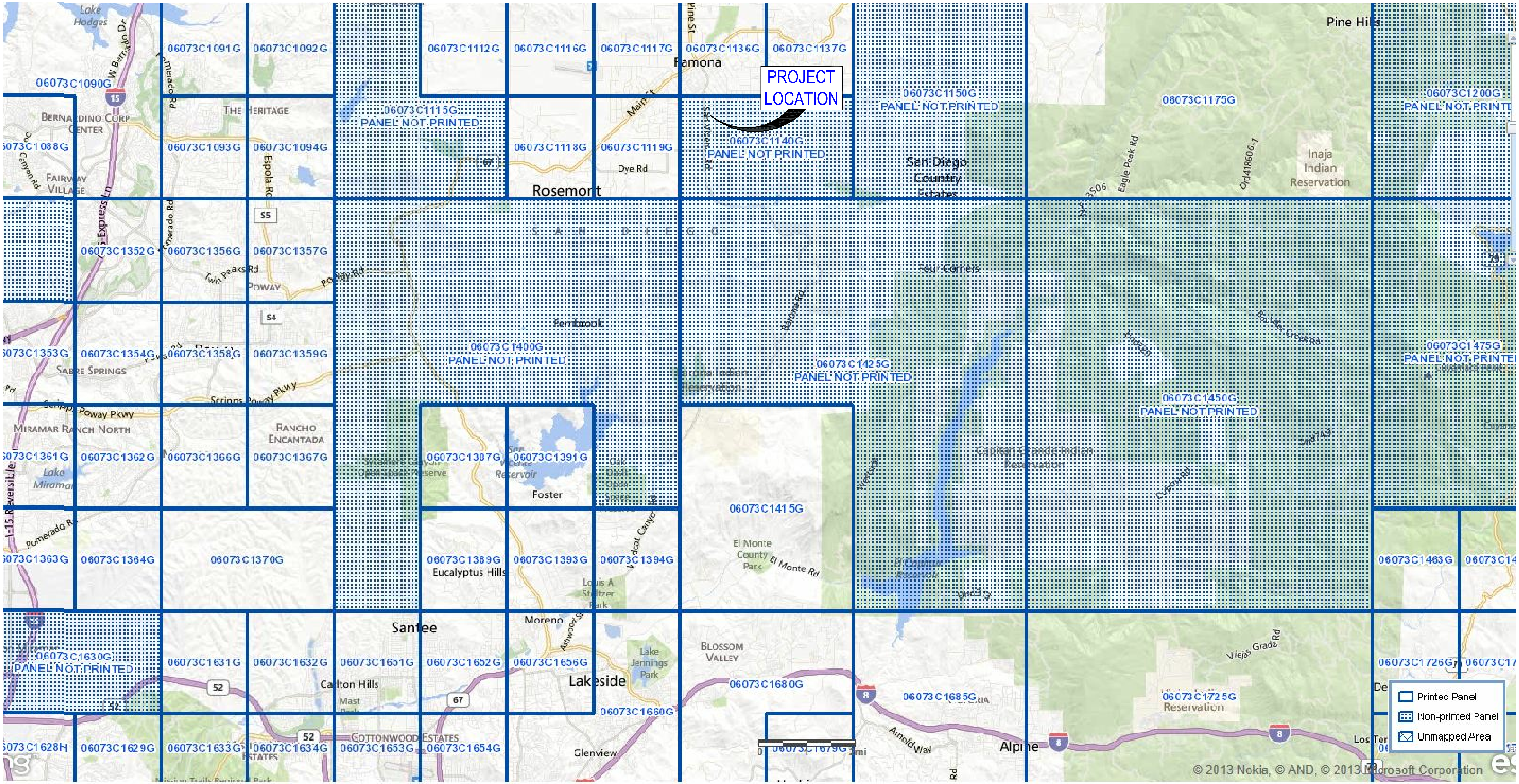
Total Time of Concentration:
T_c=Initial T_c + Secondary T_c

Expected Runoff/Flow from Drainage Basin (cfs):
Q=C*I*A

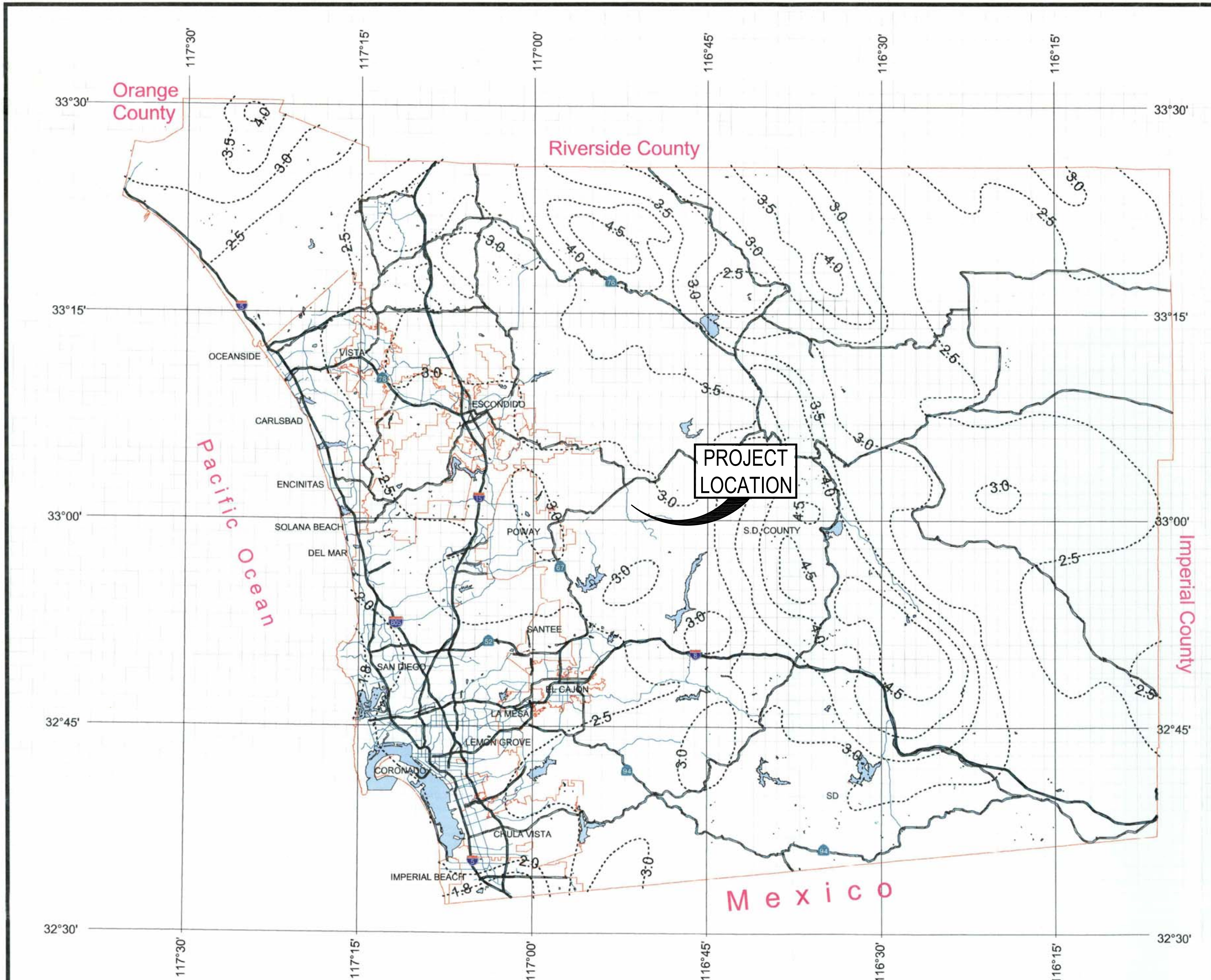
adjusted P_6 (in) **N/A**

Soil Type: B and D

TAB D


PROJECT LOCATION
06073C1090G
06073C1091G
06073C1092G
06073C1112G
06073C1116G
06073C1117G
06073C1136G
06073C1137G
06073C1088G
06073C1093G
06073C1094G
06073C1115G PANEL NOT PRINTED
06073C1118G
06073C1119G
06073C1140G PANEL NOT PRINTED
06073C1150G PANEL NOT PRINTED
06073C1175G
06073C1200G PANEL NOT PRINTED
06073C1352G
06073C1356G
06073C1357G
06073C1353G
06073C1354G
06073C1358G
06073C1359G
06073C1400G PANEL NOT PRINTED
06073C1425G PANEL NOT PRINTED
06073C1450G PANEL NOT PRINTED
06073C1475G PANEL NOT PRINTED
06073C1361G
06073C1362G
06073C1366G
06073C1367G
06073C1387G
06073C1391G
06073C1415G
06073C1363G
06073C1364G
06073C1370G
06073C1389G
06073C1393G
06073C1394G
06073C1463G
06073C1630G PANEL NOT PRINTED
06073C1631G
06073C1632G
06073C1651G
06073C1652G
06073C1656G
06073C1680G
06073C1685G
06073C1725G
06073C1726G
06073C1660G
06073C1628H
06073C1629G
06073C1633G
06073C1634G
06073C1653G
06073C1654G
Ramona
Rosemont
Pine Hills
San Diego Country Estates
Inaja Indian Reservation
Poway
Sabre Springs
Miramar Ranch North
Rancho Encantada
Fairway Village
Bernardino Corp Center
The Heritage
Lake Hodges
Foster
El Monte County Park
Eucalyptus Hills
Santee
Moreno
Lakeside
Lake Jennings Park
Blossom Valley
Carlton Hills
Cottonwood Estates
Glenview
Alpine
Dye Rd
Main St
Scripps Poway Pkwy
Poway Pkwy
El Monte Rd
Eagle Peak Rd
Viejas Grade Rd
Arnold Way
Printed Panel
Non-printed Panel
Unmapped Area
© 2013 Nokia, © AND, © 2013 Microsoft Corporation

TAB E



County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 6 Hours

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

P_6 = 3.00 in

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

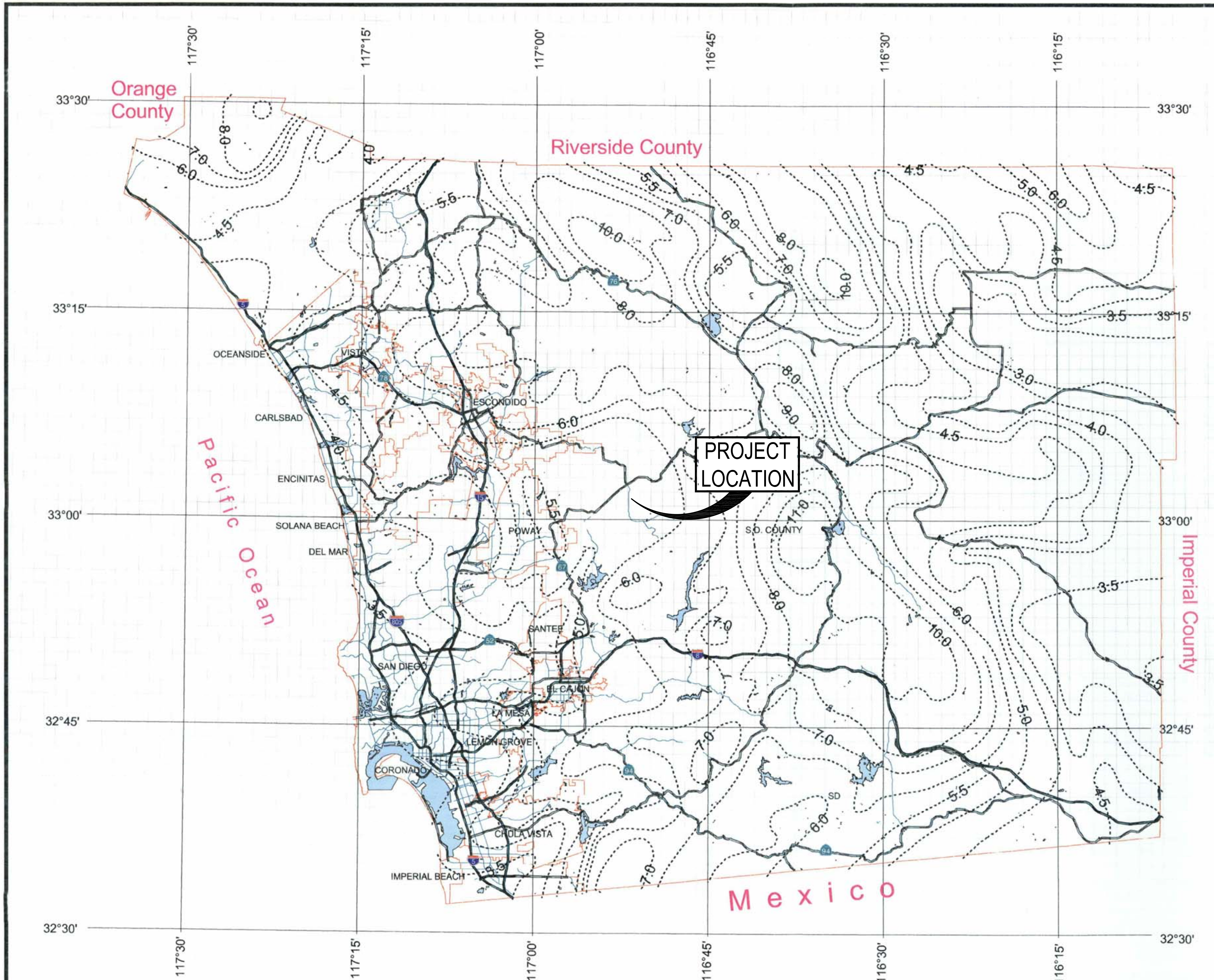
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

N
W E
S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

50 Year Rainfall Event - 24 Hours

.... Isopluvial (inches)

P_{24} = 5.50 in

DPW GIS
Department of Public Works Geographic Information Services

SanGIS
We Have San Diego Covered!

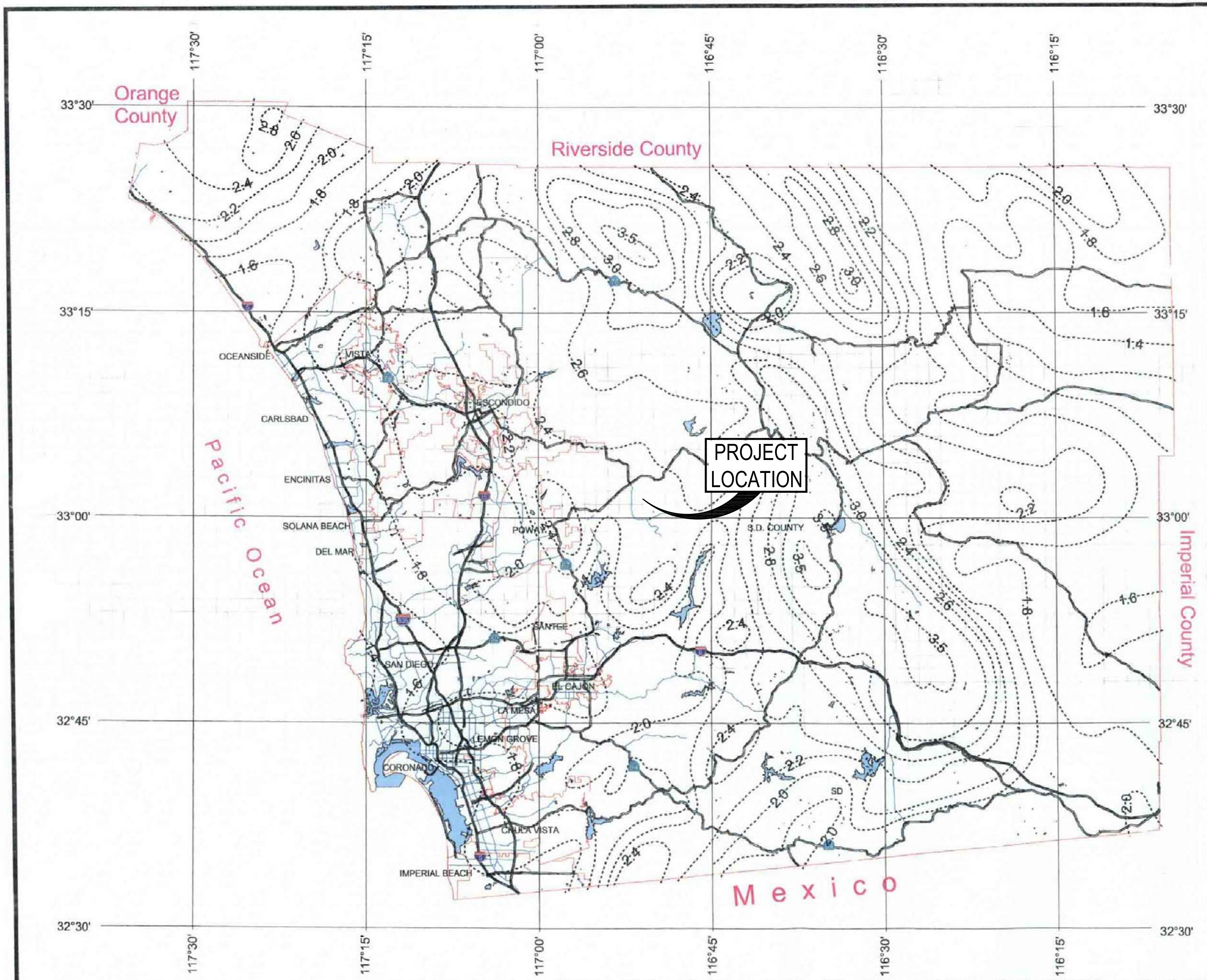
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

N W E S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours

Isopluvial (inches)

P_6 = 2.40 in

DPW GIS

Department of Public Works Geographic Information Services

SanGIS

We Have San Diego Covered!

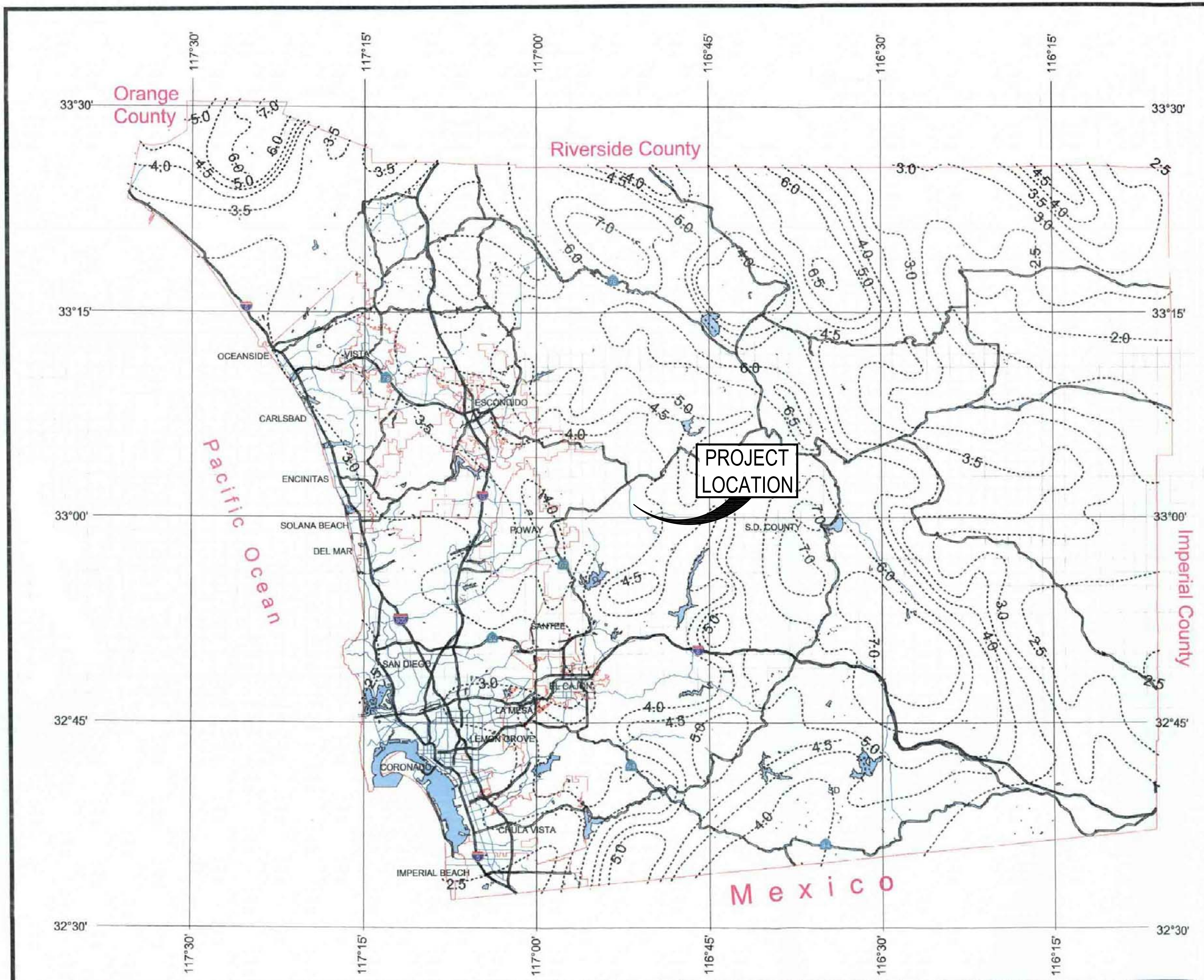
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps

N S W E

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

10 Year Rainfall Event - 24 Hours

Isopluvial (inches)

P_{24} = 4.00 in

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

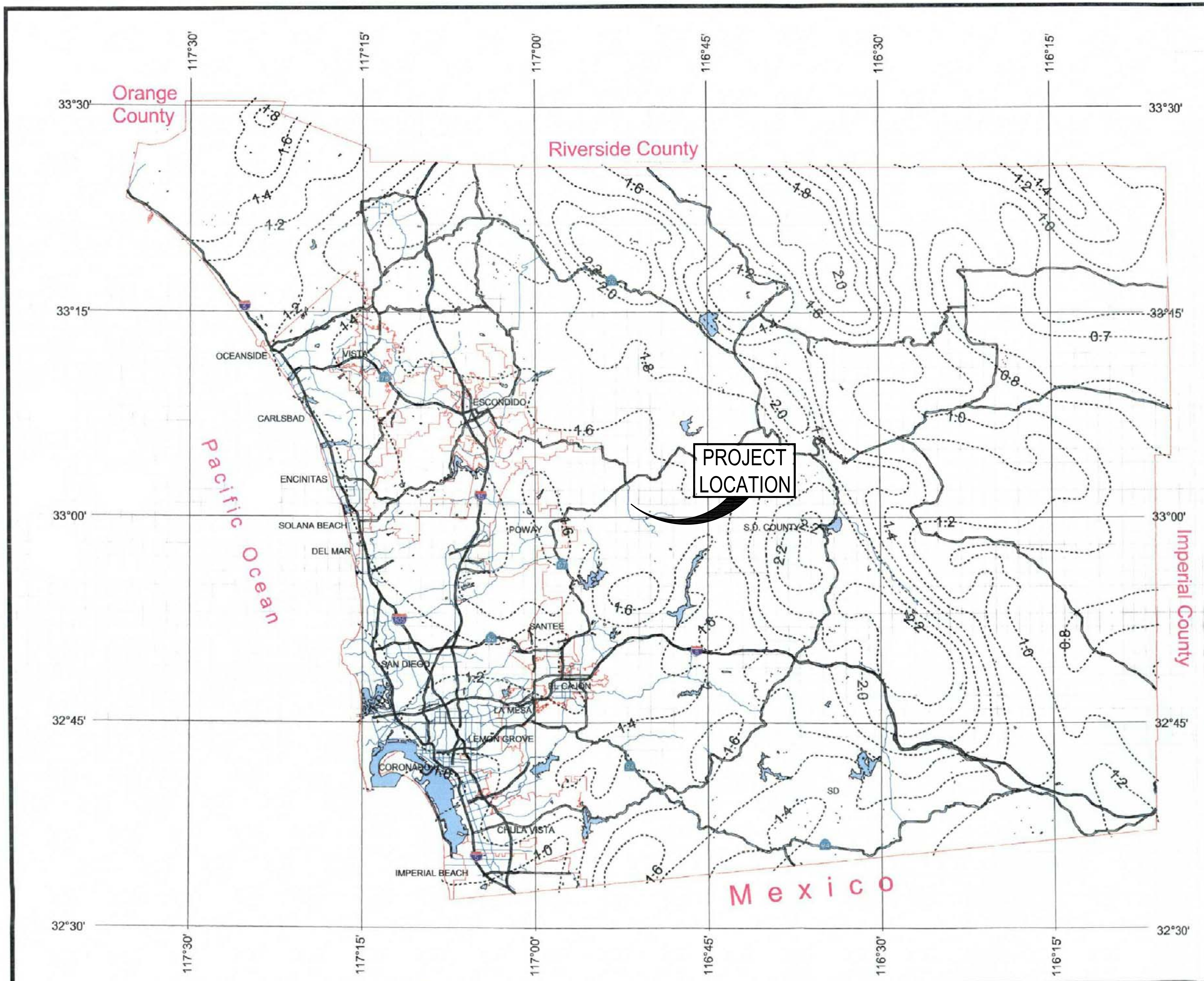
N
W E
S

THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 6 Hours

------- Isopluvial (inches)

P_6 = 1.60 in

DPW GIS
Department of Public Works Geographic Information Services

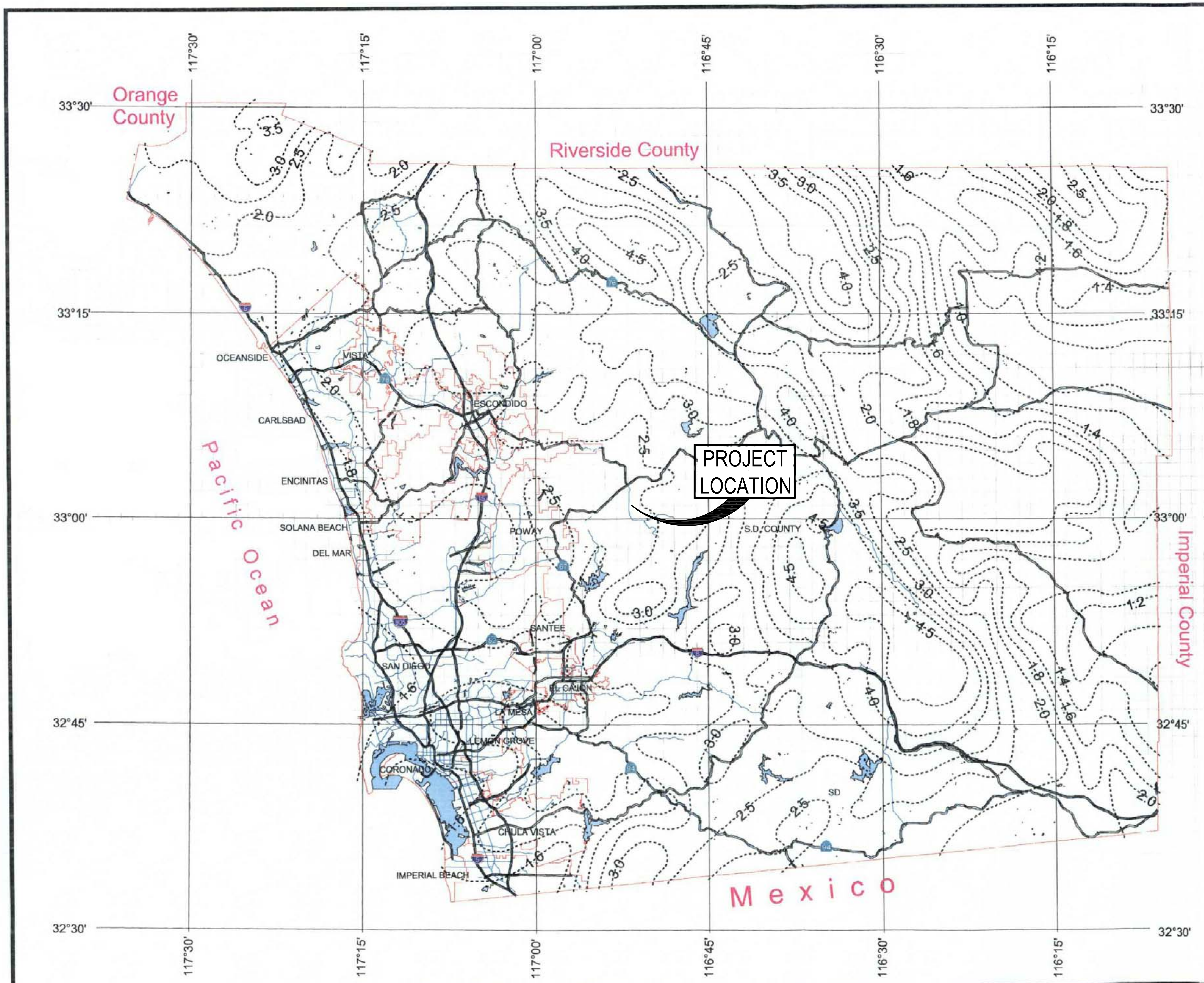
SanGIS
We Have San Diego Covered!

THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

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

P_{24} = 2.50 in

DPW GIS Department of Public Works Geographic Information Services

SanGIS We Have San Diego Covered!

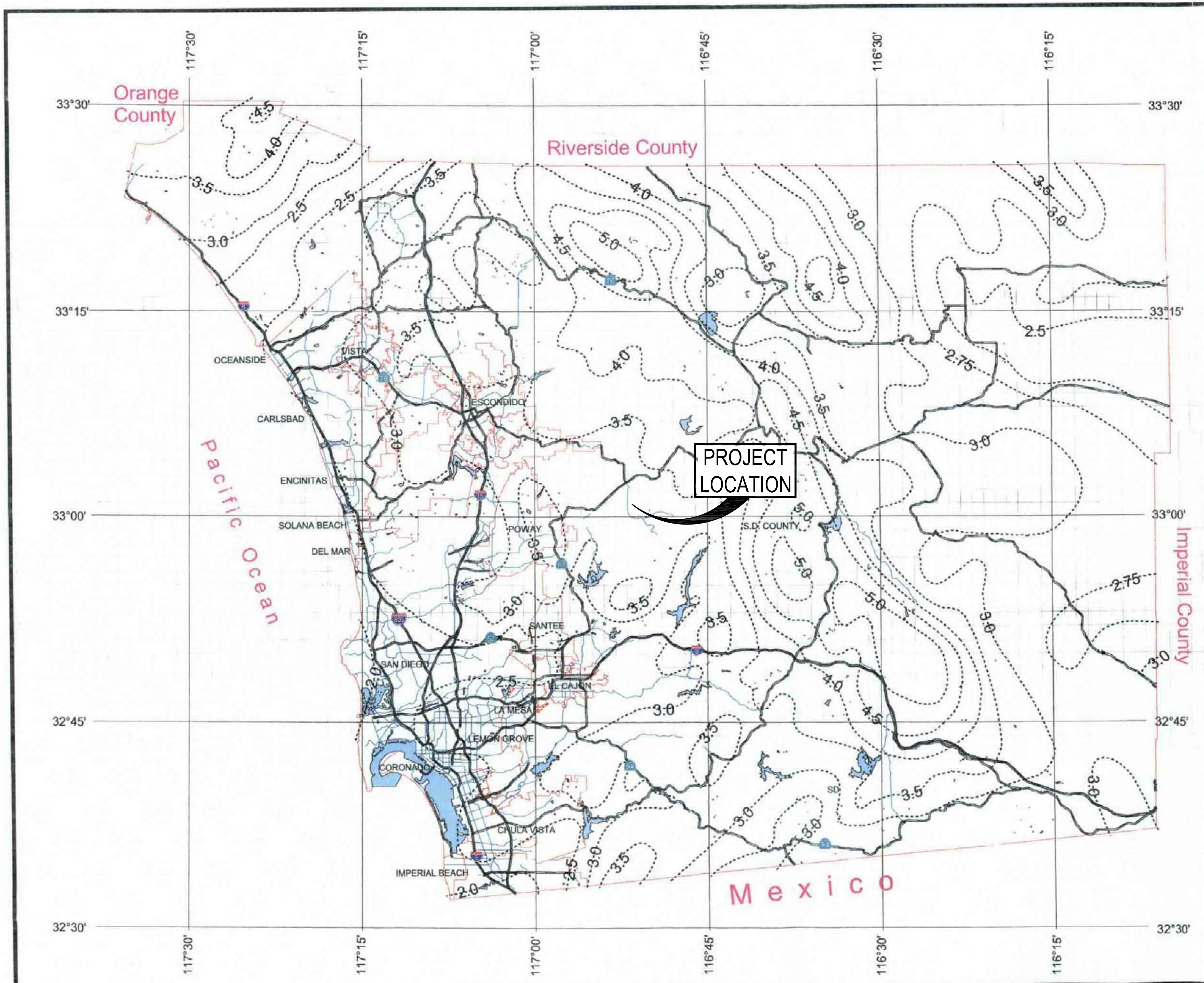
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

N S E W

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 6 Hours

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

P_6 = 3.50 in

DPW GIS
Department of Public Works
Geographic Information Services

SanGIS
We Have San Diego Covered!

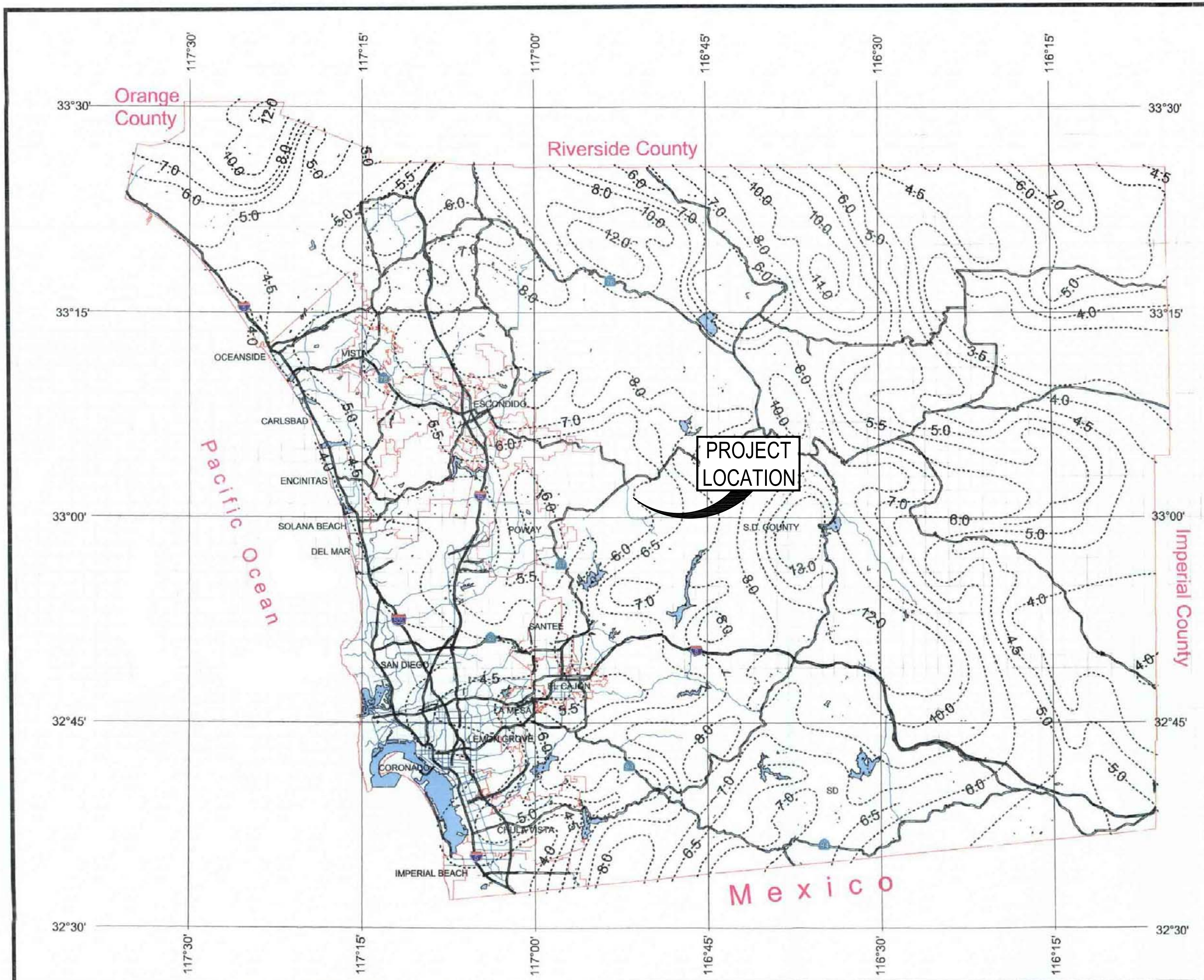
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

N
W E
S

3 0 3 Miles



County of San Diego Hydrology Manual

Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours

Isopluvial (inches)

P_{24} = 6.00 in

DPW GIS
Department of Public Works Geographic Information Services

SanGIS
We Have San Diego Covered!

THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

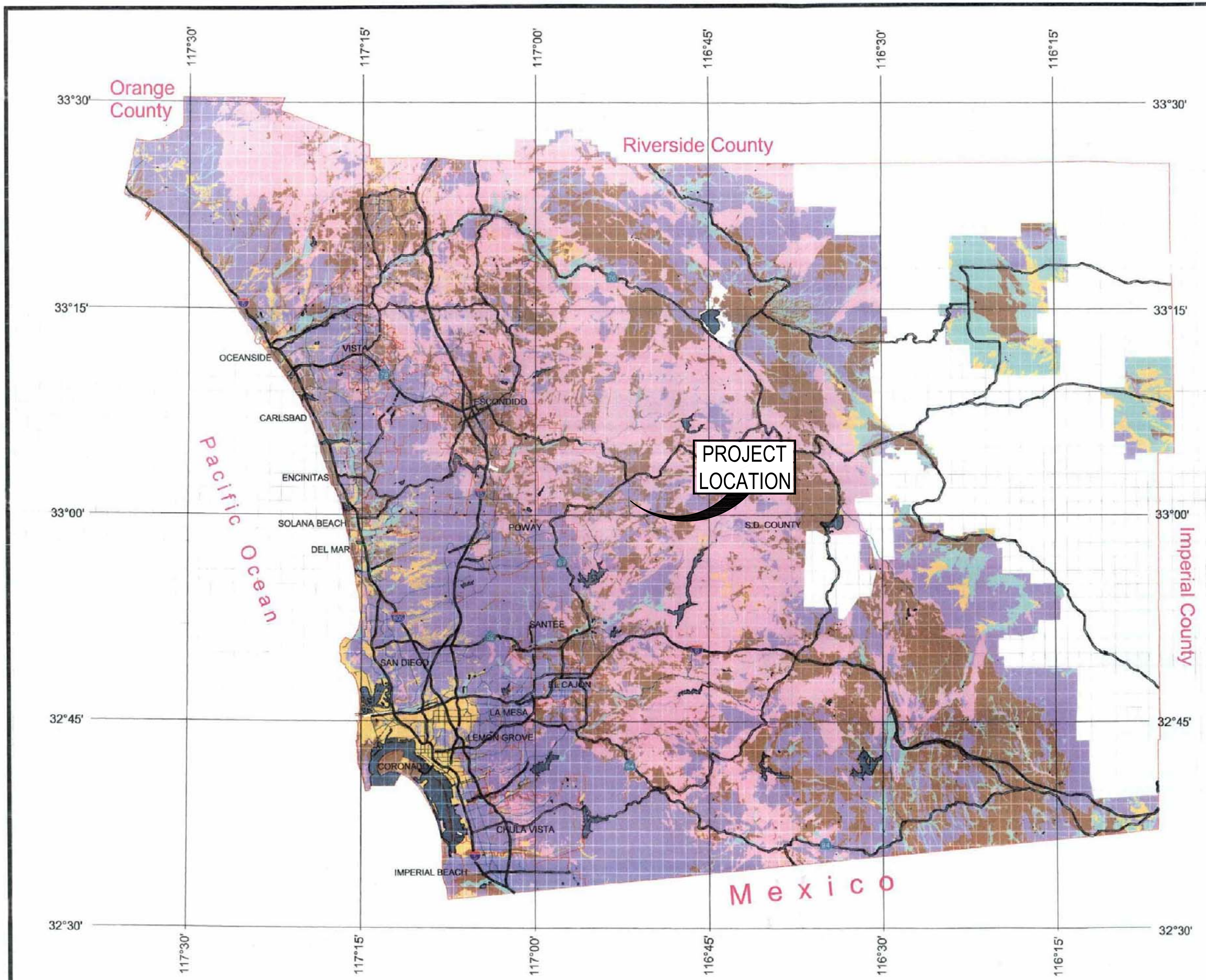
This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

N W E S

3 0 3 Miles

County of San Diego Hydrology Manual

Soil Hydrologic Groups



Legend

Soil Groups

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

DPW GIS
Department of Public Works Geographic Information Services

SanGIS
We Have San Diego Covered!

THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Copyright SanGIS. All Rights Reserved.

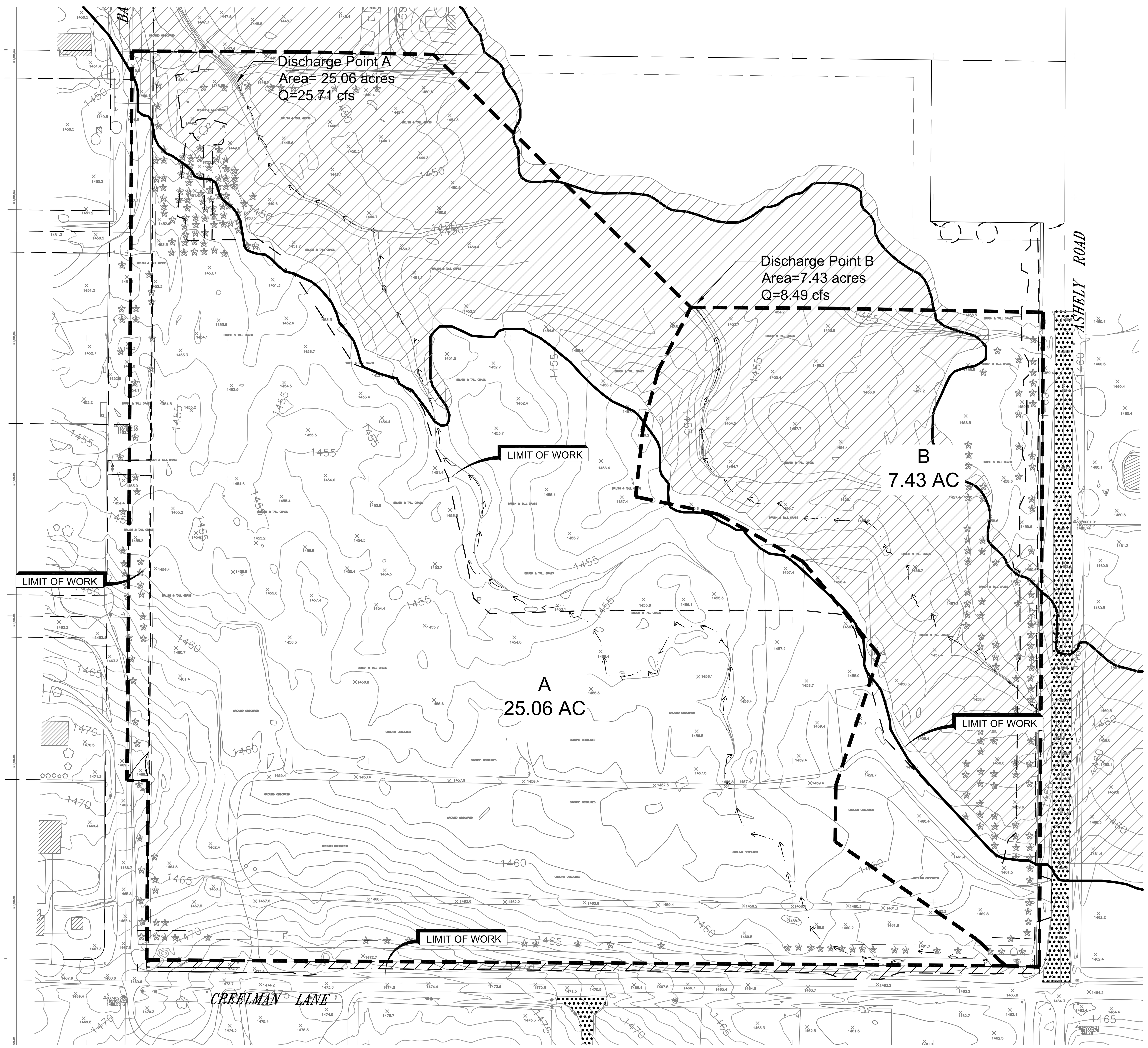
This products may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

N S E W

3 0 3 Miles

TAB F



LEGEND

EXIST. PCC CONCRETE
EXIST. ASPHALT PAVEMENT
EXIST. STORM DRAIN LINE — SD —
EXIST. CONTOURS — 10 —
HYDROLENGTH
EXIST. DRAINAGE BASINS/ LIMIT OF DRAINAGE CALCULATIONS
EXIST. DRAINAGE AREA TEXT A
LIMITS OF WORK
100 YEAR FLOOD PLAIN BOUNDARY

1" = 80'
80 0 80 160
scale feet

BergerABAM
10525 Vista Sorrento Parkway, Suite 350
San Diego, California 92121-2745
(858) 500-4500 Fax: (858) 500-4501

Copyright © BergerABAM. All Rights Reserved.

Last Saved by: Sven.gierlichs on: Feb 11, 2015 11:18 AM File: Q:\SanDiego\2014\A14.0142\CADD\Dwgs\Hydrology\EXISTING CONDITIONS-latest.dwg

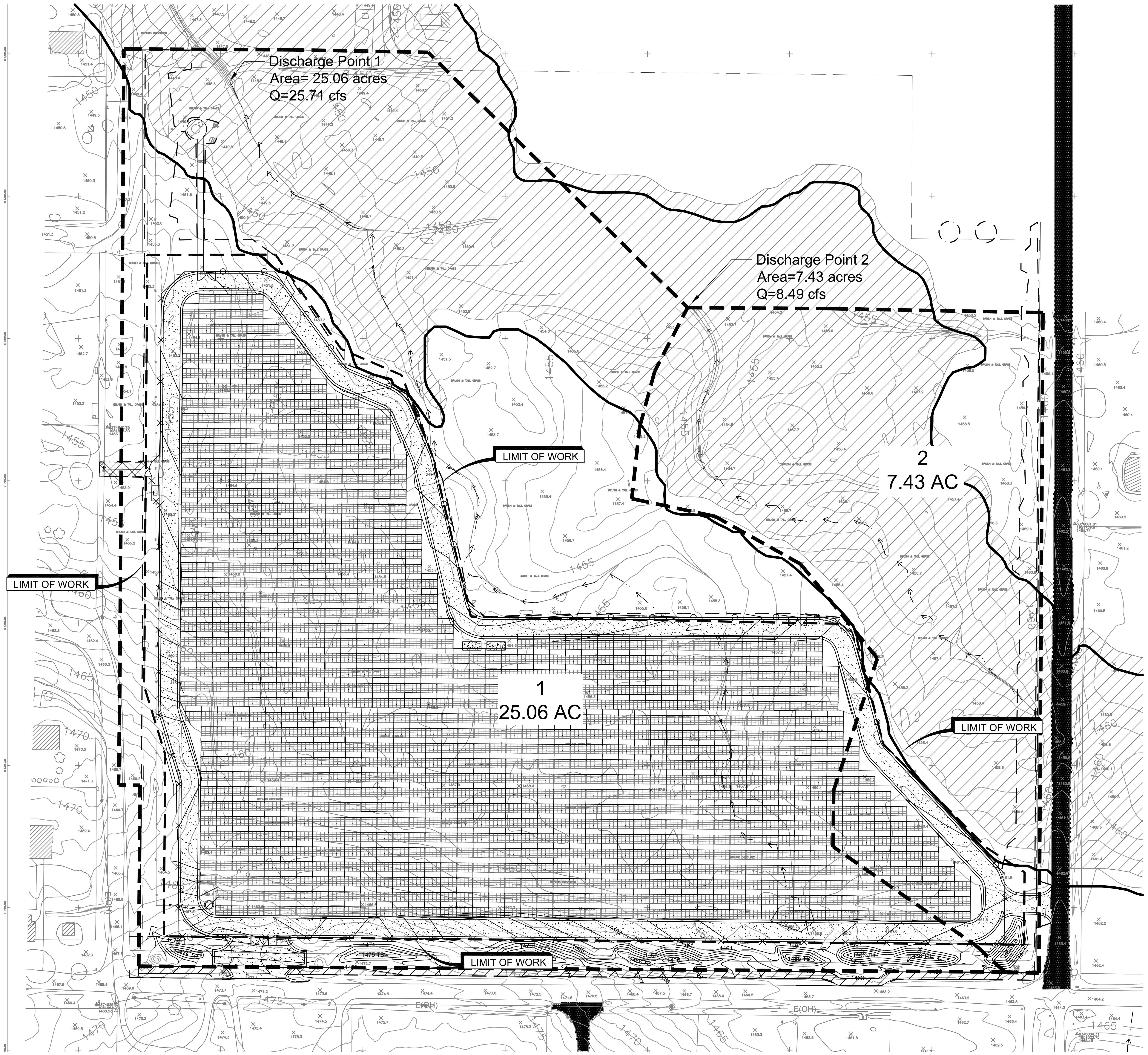
Drawn by		No.	DATE	BY	REMARKS
Checked by		△			
Date	12/06/13	△			
Commission No.		△			

SDG&E CREELMAN SITE PHOTOVALIC SOLAR PANEL FARM

EXISTING DRAINAGE CONDITIONS

Sheet Number
EXHIBIT A

Copyright © BergerABAM. All Rights Reserved.



LEGEND

- EXIST. PCC CONCRETE
- EXIST. ASPHALT PAVEMENT
- EXIST. STORM DRAIN LINE — SD —
- EXIST. CONTOURS — 10 —
- HYDROLENGTH
- PROP. DRAINAGE BASINS/ LIMIT OF DRAINAGE CALCULATIONS
- PROP. DRAINAGE AREA TEXT — 1
- LIMITS OF WORK
- 100 YEAR FLOOD PLAIN BOUNDARY
- PROP. CONTOURS — 10 —
- PROP. GROUND-MOUNTED PHOTOVALIC SOLAR PANELS
- PROP. DECOMPOSITE ROAD

1" = 80'

80 0 80 160

scale feet

BergerABAM
10525 Vista Sorrento Parkway, Suite 350
San Diego, California 92121-2745
(858) 500-4500 Fax: (858) 500-4501

Last Saved by: Mike.magee on: May 7, 2015 1:07 PM File: Q:\SanDiego\2014\A14.0142\CADD\Dwgs\Hydrology\PROPOSED CONDITIONS-2015.dwg

Drawn by	ES
Checked by	MM
Date	03/07/14
Commission No.	

No.	DATE	BY	REMARKS
1	08/18/14	MM	COUNTY COMMENTS
2	03/13/15	MM	COUNTY COMMENTS
3	05/15/15	MM	COUNTY COMMENTS

IES/SDG&E SOLAR ENERGY PROJECT - RAMONA

PROPOSED DRAINAGE CONDITIONS

Sheet Number

EXHIBIT B