# Preliminary Hydrology and Drainage Study

# Rugged Acres Solar Farm

Located in the County of San Diego

September 2012

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MUP 3300-12-007

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## DECLARATION OF RESPONSIBLE CHARGE

I, hereby declare that I am the Civil Engineer of work for this report, that I have exercised responsible charge over the preparation of this report as defined in section 6703 of the business and professions code, and that the report is consistent with current project concept.

I understand that the check of the project report, by the County of San Diego is confined to a review only and does not relieve me, as the Civil Engineer of work, of my responsibilities for project design.

Keri Gannon

9/7/2012

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# SECTION 1.0 EXECUTIVE SUMMARY

The Rugged Acres Solar Energy project (Project) will produce up to 84 megawatts (MW) of alternating current (AC) solar generating capacity and is located in the unincorporated community of Boulevard in east San Diego County. In total, the Project covers approximately 765 acres.

The objective of this study is to develop and evaluate the existing drainage patterns and flow rates for the runoff tributary to the Project and ensure that these patterns and flow rates are maintained after the construction of the Project. The study also identifies the 100-year inundation limits for Tule Creek within the Project.

The Project is located in the southeast portion of McCain Valley and the main watercourse within the watershed, Tule Creek, flows down the middle of the Project. The existing watershed tributary to Tule Creek was analyzed using the San Diego County Hydrology Manual's (SDCHM) NRCS hydrologic method. However, there are smaller watercourses that wind their way through the Project and the areas tributary to these smaller watercourses were analyzed using the SDCHM rational method.

The Project does very little to change the characteristics of the existing watershed and the drainage areas tributary to the Project. Minor amounts of impervious areas will be added during construction, such as transformer pads, driveways, sub-station pads, foundation posts for the solar panels, and drainage crossings. The exposed ground will be replanted with native plants or compacted to serve as access roads. However, the existing drainage patterns will be retained and the flow rates will not increase due to the minimal impervious area added. Since there is no increase in flow, the project is not subject to hydromodification or stormwater requirements. This project has no hydromodification or stormwater connectivity to the Salton Sea. The grading will also take into account the existing Tule Creek and tributaries that crisscross the proposed project site.

Due to the 100-year inundation limits developed, many of the proposed trackers will be within the 100-year flow of Tule Creek. In order to protect the trackers, the design will take into account the proposed water depth and shall ensure that there is no negative impact to the trackers and their infrastructure. Also, all underground facilities will take into account the potential scour depth of 3 to 5 ft.

This study concludes that the construction of the Project does not adversely affect or substantially alter the existing watershed, Tule Creek, and the tributaries crossing the project site.

# SECTION 2.0 PROJECT DESCRIPTION

## 2.1 Project Location

The Rugged Acres Solar Energy project (Project) is located in the unincorporated community of Boulevard in east San Diego County. The project site is located approximately 1.25 miles north of Interstate 8 (I-8) and extends roughly 2 miles between Ribbonwood Road and approximately 0.5 mile east of McCain Valley Road.

The main project site includes the following Assessor Parcel Numbers (APNs): 611-110-01-00, 611-100-02-00, 611-100-01-00, 611-090-04-00, 611-091-03-00, 611-090-02-00, 611-060-04-00, 611-091-07-00, 612-030-19-00, 611-091-09-00, and 612-030-01-00. Off-site facilities for the project would impact the following APNs: 611-110-01-00, 612-030-15-00, 612-091-12-00, 612-091-13-00, 611-110-06-00 (CA State Lands), and 612-030-13-00 (BLM).

## 2.2 Project Description

The Project includes a Major Use Permit (MUP) to authorize a Major Impact Services and Utility pursuant to Sections 1350, 2705, and 2926 of the Zoning Ordinance. The Project will produce up to 84 megawatts (MW) of alternating current (AC) solar generating capacity. The Project will consist of approximately 3,588 concentrating photovoltaic (CPV) electric generation systems utilizing dual axis tracking CPV trackers on 765 acres in southeastern San Diego County in the unincorporated community of Boulevard, California. In addition to the CPV trackers and inverter transformer units, the Project includes the following primary components:

- A collection system linking the CPV trackers to the on-site Project substation comprised of 1,000 volt (V) direct current (DC) underground conductors leading to 34.5 kV underground and overhead AC conductors.
- A 7,500-square-feet (sf) (60 feet by 125 feet) operations and maintenance (O&M) building.
- A 2-acre onsite private collector substation site with a pad area of 6000 sf (60 feet by 100 feet) with maximum height of 35 feet and includes a 450 sf (15 feet by 30 feet) control house.
- 61 Inverter/Transformer enclosures. The dimensions of each inverter unit are 10 feet by 25 or 40 feet (250 or 400 sf each) with a total structure height of up to 12 feet.
- A 69 kV overhead generator transmission line (gen-tie) connecting the on-site substation to San Diego Gas and Electric's (SDG&E) proposed new Boulevard Substation. There will be approximately 5,130 feet of 69-kV Gen-Tie line between the onsite

substation and McCain Valley Road. Approximately 3,180 feet will be onsite and 1,940 feet will be offsite. The 50 to 125 feet tall steel poles, spaced up to 300 feet apart, will also support 34.5-kV overhead conductors.

- 20.5-miles of newly-constructed, load-bearing, on-site access roads.
- 46.5-miles of graded, non load-bearing dirt service roads
- Three permanent on-site water wells for the O&M building and to facilitate washing of the CPV trackers.
- Two 20,000 gallon water storage tanks to be located at the O&M building site and to be dedicated exclusively for fire suppression.
- Three additional on-site 20,000 gallon water storage tanks to support tracker washing. Each of these three 20,000 gallon water storage tanks would include 10,000 gallons of water dedicated solely for fire suppression. The outlet on the tank for tracker washing and any other non-fire uses would be located at the midpoint on the tank making it impossible to draw the water level down below 10,000 gallons in each tank for non-fire suppression use.
- A septic tank system and leach field for the O&M building.
- 6 foot perimeter fencing topped with an additional 1 foot of security barbed wire.
- Vista Oaks Road and Roadrunner Lane are existing roadways that would be improved to a width of 24 feet to meet County fire standards for access to the western side of the project site from Ribbonwood Road. Vista Oaks Road would be constructed across APN 611-090-02-00. Roadrunner Lane would be constructed on APN 611-091-09-00. A third road, which would be newly created if Rough Acres Ranch Road were to not be constructed as part of Tule Wind Project MUP (MUP P3300-09-019), would provide an optional access route to the eastern portion of the project site, west of McCain Valley Road, from McCain Valley Road. This optional access route would cross APN 611-100-01-00.

The Proposed Project includes a total installation of 3,588 CPV trackers installed in groups or "building blocks composed of approximately 61 individual Soitec Concentrix™ CX-S530 systems (includes dual-axis tracker), with any of the following inverter combinations: two 630-kW inverters, two 680-kW inverters, or three 680-kW inverters; and either a 1.5- or 2.0-megavolt ampere (MVA) transformer.

## 2.3 Study Objective

The objective of this study is to develop and evaluate the existing drainage patterns and flow rates for the runoff tributary to the Project. The hydrology will be the base used to determine the location of the natural watercourses upstream and within the project area and the amount

of runoff that flows in the existing watercourses. The 100-year inundation limits will also be determined for the major watercourse that crosses the Project.

The proposed design of the Project will then take into account the location of the existing drainage courses and the amount of flow, as well as the 100-year flow width, depth, and velocity. This study will also show the change in runoff rates and characteristics and the 100-year inundation limits due to the development of the Project.

A Vicinity Map (Figure 1) is included in Appendix A.

# SECTION 3.0 HYDROLOGY

## 3.1 Hydrology Design Criteria

The hydrologic design for this project is based on the design criteria outlined in the San Diego County Hydrology Manual, June 2003 (SDCHM), which is based on two methods, the rational method and the NRCS hydrologic method. The rational method is the accepted methodology for watersheds up to 640 acres (1 square mile) in size and the NRCS hydrologic method is to be used for watersheds greater than 640 acres.

The Tule Creek watershed tributary to the Project is 24.25 square miles (or 15,522 acres), so the NRCS methodology will be used to determine the watershed's pre- and post-project peak runoff in Tule Creek for the 100-year storm. Please refer to Chapter 4 of the SDCHM for a more detailed description of the NRCS methodology.

The peak runoff for the Project areas also has to be determined. The Project site is divided into sub-watersheds smaller than 640 acres, except for one, and so the rational method will be used to determine the sub-watershed's pre- and post-project peak runoff for the 100-year storm. One watershed is 734 acres in size but in order to retain a consistent methodology, the rational method was used instead of the NRCS hydrologic method. Please refer to Chapter 3 of the SDCHM for a more detailed description of the rational method.

## 3.2 Software Used

### AES 2011 RATSCx

The AES software is designed with separate modules that are programmed to meet specific SDCHM requirements, which in turn meet all agency requirements. The module used for the calculations in this study will be the rational method module programmed to meet the calculation requirements set forth by Chapter 3 of the SDCHM. This program will be used to develop the runoff amounts for the pre- and post-project conditions of the Project site and tributary drainage area.

### AES 2011 FLOODSCx

The AES software is designed with separate modules that are programmed to meet specific SDCHM requirements, which in turn meet all agency requirements. The module used for the calculations in this study will be the NRCS hydrologic method module programmed to meet the calculation requirements set forth by Chapter 4 of the SDCHM. This program will be used to

develop the runoff amounts for the pre- and post-project conditions of the Tule Creek watershed tributary to the proposed project site.

**HEC-RAS 4.1.0**

HEC-RAS is a river analysis system developed by the U.S. Army Corps of Engineers that can be used for a steady flow water surface profile computation. This project utilizes HEC-RAS to analyze the conditions in the dry Tule Creek bed during the 100-year storm event to understand the existing conditions, ensure that the proposed condition does not propose an adverse effect on the properties upstream and downstream of the Project and analyze the velocities and erosion potential within the channel.

## 3.3 Pre-Project Watershed Characteristics

In the vicinity of the Project, the tributary watershed flows from northwest to southeast. The main watercourse, Tule Creek, flows down the middle of the watershed within McCain Valley. The northwest end of the watershed is fairly mountainous with rugged and steep watercourses. As the runoff from the watershed flows southeast, the terrain becomes less steep and the smaller watercourses merge and form the main watercourse, Tule Creek. Tule Creek eventually becomes a wide open area, between 500' and 1,000' in width, with a slope of 1%. This is the portion of the watercourse that extends across the majority of the Project from the northwest corner of the site to the southeast.

In total, the Project covers approximately 765 acres. Site elevations range from approximately 3,510 feet above mean sea level (MSL) in the easternmost portion of the site, east of McCain Valley Road, to approximately 3,680 feet MSL in the northern portion of the site.

Due to the rugged and valley terrain of the watershed, some areas are steep with many rock outcroppings and other areas are relatively flat with existing vegetation, including oak trees. The ground cover varies between rock, vegetation, or a loose, silty, sand.

The Tule Creek watercourse length through it's watershed is 10.45 miles and elevations of the watershed range from approximately 5640 feet to 3515 feet. Accurate topo data was provided for the project area. The County SANGIS 40 foot contour mapping and a site visit were used to determine the watershed boundaries outside of the project area. The total watershed area is approximately 24.25 square miles.

Refer to Appendix B and C for the existing hydrology exhibits for Tule Creek (Figure 2) and the Project Site (Figures 3A-3E).

### 3.3.1 Land Use

The majority of the tributary watershed and the Project is currently undeveloped and is covered by sparse to moderate growth of native chaparral, shrubs, low-lying grasses, and scattered trees. The area of the watershed where the Project is proposed to be constructed appears to be previous range land. Unpaved roads provide access through the Project, including roads recently constructed to support construction of the Sunrise Powerlink project. During the site reconnaissance, Sunrise Powerlink transmission towers were observed crossing the project site east of McCain Valley Road. Additionally, the central portion of the Project (APNs 611-100-01 and 611-100-02) is currently being used as a construction storage and staging area. Other improvements include several residential structures and minor agricultural developments in the western portion of the project area.

### 3.3.2 Flow Patterns

The flow patterns existing in this watershed are from the west, north and south ridges towards the central valley and down towards the southeast.

### 3.3.3 100-YR Flood Inundation

There are no recorded 100-YR floodplain limits within the proposed Project or the upstream watershed per FEMA or the County of San Diego. However, this project will determine the 100-year inundation limits in order to determine the flow width, depth and velocity that the project will have to be designed for, as well as if there are any adverse effects on the upstream and downstream properties of the Project.

### 3.3.4 Rainfall/Soils

Rainfall and soils data are taken from the SDCHM. The Manual gives the following data:

***NRCS Hydrologic Method***

1. 100-year 6-hour rainfall = 3.75 inches.

   100-year 24-hour rainfall = 6.5 inches.

According to the SDCHM, the $P_6$ (6 hour rainfall in inches) needs to be within 45% and 65% of the 100-yr 24-hour rain event ($P_{24}$). The current $P_6$ for the 100-yr storm falls within the specified range.

(3.75 in ÷ 6.5 in) × 100 = 58%

See Appendix B for the 100-yr 6-hrand 24-hr Isopluvial Charts.

2. Precipitation Zone Number (PZN) = 3.50

   See Appendix B, Figure C-1.

3. Runoff Curve Numbers (CN). The soil types are A, B, C, & D as shown in Appendix B, Soil Hydrologic Groups Map.

   a. Desert Shrub (Fair) CN, Soil Type A = 55 (Appendix B, Table 4-2)

   b. Desert Shrub (Fair) CN, Soil Type B = 72 (Appendix B, Table 4-2)

   c. Desert Shrub (Fair) CN, Soil Type C = 81 (Appendix B, Table 4-2)

   d. Desert Shrub (Fair) CN, Soil Type D = 86 (Appendix B, Table 4-2)

   Since the watershed area has three to four different types of soils, an average CN is calculated. The PZN adjustment factor is based on the initial PZN of 3.5 and so the adjustment factor is 2.5 for the 100-yr storm, as shown in Table 4-6 in Chapter of the SDCHM. Table 4-10 in Chapter 4 of the SDCHM is then used to apply the adjustment to each average CN for each sub-area.

   The above referenced charts, figures, and calculations are in Appendix B.

***Rational Method***

1. 100-year 6-hour rainfall = 3.75 inches.

   100-year 24-hour rainfall = 6.5 inches.

   According to the SDCHM, the $P_6$ (6 hour rainfall in inches) needs to be within 45% and 65% of the 100-yr 24-hour rain event ($P_{24}$). The current $P_6$ for the 100-yr storm falls within the specified range.

(3.75 in ÷ 6.5 in) × 100 = 58%

See Appendix B for the 100-yr 6-hrand 24-hr Isopluvial Charts.

2. Runoff Coefficients: The soil types are A, B, C, & D as shown in Appendix B, Soil Hydrologic Groups Map and the following runoff coefficients are for Undisturbed Natural Terrain in Table 3-1 of SDCHM.

    a. Soil Type A: C=0.20

    b. Soil Type B: C=0.25

    c. Soil Type C: C=0.30

    d. Soil Type D: C=0.35

    Since each sub-area of the watershed area has three to four different types of soils, an average C is calculated for each sub-area.

3. The maximum overland flow length is determined to be 100 from Table 3-2 of the SDCHM for each drainage area.

4. The land cover is assumed to be pasture/range land for the drainage areas within the proposed project site.

    The above referenced charts, figures, and calculations are in Appendix C.

## 3.4 Pre-Project Hydrology

### 3.4.1 Basin Parameters

For this analysis of the pre-project runoff rate of Tule Creek, the 24.25 acre watershed is analyzed as one watershed. Appropriate watershed characteristics were developed for each sub-area using the NRCS hydrologic methodologies discussed in the SDCHM. These pre-project characteristics are shown in Appendix B.

For the analysis of the pre-project runoff within the Project, the watercourses that crisscross the site are analyzed separately as their own tributary areas. Appropriate watershed characteristics are developed for each sub-area using the rational

methodologies discussed in the SDCHM. These pre-project characteristics are shown in Appendix C.

### 3.4.2 Results – Tule Creek

The pre-project peak flows for the Tule Creek, as determined by the watershed inputs to AES 2008 FLOODSCx, are:

**Table 1: Pre-Project Peak Flow Rates for the Tule Creek Watershed**

| Drainage Area Node | Type of Flow | Area (ac) | Pre-Project $Q_{100}$ (cfs) |
|---|---|---|---|
| **101** | **Total Routed Flow** | **15,522** | **14,033** |

See Appendix D for the AES 2008 FLOODSCx Output.

### 3.4.3 Results – Project Site

The pre-project peak flows for the drainage areas tributary to the Project, as determined by the sub-area inputs to AES 2008 RATSCx, are:

**Table 2: Pre-Project Peak Flow Rates for the Project Site Sub-Areas**

| Drainage Area Node | Type of Flow | Area (ac) | Pre-Project $Q_{100}$ (cfs) |
|---|---|---|---|
| **204** | Total Flow | 418 | 444 |
| **302** | Total Flow | 45 | 59 |
| **402** | Total Flow | 20 | 29 |
| **502** | Total Flow | 13 | 18 |
| **603** | Total Flow | 102 | 97 |
| **705** | Total Flow | 734 | 683 |
| **802** | Total Flow | 78 | 71 |
| **902** | Total Flow | 65 | 70 |
| **1004** | Total Flow | 579 | 407 |
| **1103** | Total Flow | 151 | 123 |

| Drainage Area Node | Type of Flow | Area (ac) | Pre-Project $Q_{100}$ (cfs) |
|---|---|---|---|
| **1202** | Total Flow | 104 | 115 |
| **1303** | Total Flow | 46 | 44 |
| **1403** | Total Flow | 83 | 74 |
| **1502** | Total Flow | 78 | 73 |
| **1602** | Total Flow | 18 | 21 |
| **1702** | Total Flow | 20 | 23 |
| **1803** | Total Flow | 91 | 71 |
| **1903** | Total Flow | 136 | 122 |
| **2004** | Total Flow | 503 | 374 |
| **2102** | Total Flow | 10 | 11 |

See Appendix E for the AES 2008 RATSCx Output.

## 3.5 Post-Project Watershed Characteristics

The Project does very little to change the characteristics of the existing watershed and the drainage areas tributary to the Project. Minor amounts of impervious areas will be added during construction, such as transformer pads, driveways, sub-station pads, foundation posts for the solar panels, and drainage crossings. The exposed ground will be replanted with native plants or compacted to serve as access roads.

The Project will be graded but will retain the same slope characteristics as the existing ground, as well as the same pre-project runoff patterns. The grading will also take into account the existing Tule Creek and tributaries that crisscross the proposed project site.

The largest change within the Project will be the addition of the CPV trackers. The effect of the trackers on the drainage characteristics of the project site will be minimal, even though the actual panel of the tracker is impervious. The panel is divided into two smaller panels by a horizontal break along the middle of the panel. This allows the precipitation falling on the top part if the panel to run off at the middle and the precipitation falling on the lower half of the panel to run off at the bottom. Erosion of the ground below will be minimal since only 2 tablespoons of water per second will flow off of 1 foot of length of the solar panel during a 2-year storm. However, the ground below the panel will be vegetated in order to eliminate erosion of the soil, except for the area that is utilized as an access road. The access roads will be

compacted in order to minimize the erosion from the tracker runoff. Please refer to Appendix H for the runoff calculations and diagram of the CPV tracker.

Refer to Appendix B proposed hydrology exhibit for Tule Creek (Figure 2), since it is the same as the Existing Hydrology exhibit, and the Proposed Hydrology exhibit for the Project Site (Figures 4A-4E) is located in Appendix G.

## 3.6 Post-Project Hydrology

### 3.6.1 Basin Parameters

For the analysis of the post-project runoff rate of Tule Creek, the 24.25 acre watershed is analyzed the same as under the pre-project conditions. The only difference in the input characteristics for the drainage areas is the increase in the percent impervious for the watershed by 3 acres (.02%) to the impervious areas within the Project. Since the slight change in impervious did not change the overall C vale for the watershed, the pre-project and post-project analysis is the same. The post-project characteristics for the watershed are shown in Appendix F.

The analysis of the post-project runoff within the Project is the same as under the pre-project conditions. All of the drainage areas see a slight increase in impervious area after construction, but not enough to change the overall C value for the drainage area. The post-project characteristics are shown in Appendix G.

### 3.6.2 Results – Tule Creek

The post-project peak flows for Tule Creek, as determined by the sub-area inputs to AES 2008 FLOODSCx, are unchanged from the pre-project peak flows:

**Table 3: Post-Project Peak Flow Rates for Tule Creek Watershed**

| Drainage Area Node | Type of Flow | Area (ac) | Post-Project $Q_{100}$ (cfs) |
|---|---|---|---|
| 101 | Total Routed Flow | 15,522 | 14,033 |

### 3.6.3 Results –Project Site

The post-project peak flows for the drainage areas tributary to the Project, as determined by the sub-area inputs to AES 2011 RATSCx, are unchanged from the pre-project peak :

**Table 4: Post-Project Peak Flow Rates for Project Sub-Areas**

| Drainage Area Node | Type of Flow | Area (ac) | Post-Project $Q_{100}$ (cfs) |
|---|---|---|---|
| **204** | Total Flow | 418 | 444 |
| **302** | Total Flow | 45 | 59 |
| **402** | Total Flow | 20 | 29 |
| **502** | Total Flow | 13 | 18 |
| **603** | Total Flow | 102 | 97 |
| **705** | Total Flow | 734 | 683 |
| **802** | Total Flow | 78 | 71 |
| **902** | Total Flow | 65 | 70 |
| **1004** | Total Flow | 579 | 407 |
| **1103** | Total Flow | 151 | 123 |
| **1202** | Total Flow | 104 | 115 |
| **1303** | Total Flow | 46 | 44 |
| **1403** | Total Flow | 83 | 74 |
| **1502** | Total Flow | 78 | 73 |
| **1602** | Total Flow | 18 | 21 |
| **1702** | Total Flow | 20 | 23 |
| **1803** | Total Flow | 91 | 71 |
| **1903** | Total Flow | 136 | 122 |
| **2004** | Total Flow | 503 | 374 |
| **2102** | Total Flow | 10 | 11 |

## 3.7 Pre- and Post-Project Peak Flow Summary

### 3.7.1 Tule Creek

**Table 5: Summary Table for Pre- and Post- Project Peak Flow Rates for Tule Creek**

| Drainage Area Node | Type of Flow | H | L | Area | Q100 (cfs) | | Velocity (fps) | |
|---|---|---|---|---|---|---|---|---|
| | | (ft) | (ft) | acres | Pre-Project | Post-Project | Pre-Project | Post-Project |
| 101 | Total Routed Flow | 2,125 | 55,176 | 15,522 | 14,033 | 14,033 | 8.45 | 8.57 |

### 3.7.2 Project Site

**Table 6: Summary Table for Pre- and Post- Project Peak Flow Rates for Project Site**

| Drainage Area Node | H | L | C Pre-Project | C Post - Project | Tc | I | Area | Q100 (cfs) | | Velocity (fps) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (ft) | (ft) | | | (min.) | (in/hr) | acres | Pre-Project | Post-Project | Pre - Project | Post-Project |
| **204** | 437 | 10,381 | 0.31 | 0.31 | 25.83 | 3.426 | 418 | 444 | 444 | 9.30 | 9.30 |
| **302** | 187 | 4,318 | 0.34 | 0.34 | 21.63 | 3.841 | 45 | 59 | 59 | 6.10 | 6.10 |
| **402** | 113 | 2,210 | 0.31 | 0.31 | 16.25 | 4.62 | 20 | 29 | 29 | 5.31 | 5.31 |
| **502** | 109 | 1,253 | 0.27 | 0.27 | 12.93 | 5.353 | 13 | 18 | 18 | 4.58 | 4.58 |
| **603** | 190 | 7,158 | 0.28 | 0.28 | 25.96 | 3.415 | 102 | 97 | 97 | 8.97 | 8.97 |
| **705** | 738 | 14,622 | 0.25 | 0.25 | 34.80 | 2.827 | 734 | 683 | 683 | 9.36 | 9.36 |
| **802** | 247 | 4,572 | 0.24 | 0.24 | 21.8 | 3.823 | 78 | 71 | 71 | 5.85 | 5.85 |
| **902** | 176 | 2,948 | 0.24 | 0.24 | 16.93 | 4.499 | 65 | 70 | 70 | 6.03 | 6.03 |
| **1004** | 562 | 11,157 | 0.24 | 0.24 | 32.89 | 2.932 | 579 | 407 | 407 | 9.57 | 9.57 |
| **1103** | 230 | 6,501 | 0.25 | 0.25 | 27.88 | 3.261 | 151 | 123 | 123 | 5.82 | 5.82 |
| **1202** | 242 | 3,737 | 0.25 | 0.25 | 17.46 | 4.411 | 104 | 115 | 115 | 7.12 | 7.12 |
| **1303** | 253 | 4,075 | 0.25 | 0.25 | 21.87 | 3.814 | 46 | 44 | 44 | 5.32 | 5.32 |
| **1403** | 277 | 4,562 | 0.25 | 0.25 | 24.65 | 3.531 | 83 | 74 | 74 | 4.70 | 4.70 |
| **1502** | 181 | 4,551 | 0.25 | 0.25 | 22.90 | 3.702 | 78 | 73 | 73 | 5.32 | 5.32 |
| **1602** | 103 | 1,680 | 0.25 | 0.25 | 15.11 | 4.842 | 18 | 21 | 21 | 4.28 | 4.28 |
| **1702** | 104 | 1,868 | 0.25 | 0.25 | 15.83 | 4.699 | 20 | 23 | 23 | 4.28 | 4.28 |

| Drainage Area Node | H | L | C Pre-Project | C Post - Project | Tc | I | Area | Q100 (cfs) | | Velocity (fps) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (ft) | (ft) | | | (min.) | (in/hr) | acres | Pre-Project | Post-Project | Pre - Project | Post-Project |
| **1803** | 336 | 7,060 | 0.25 | 0.25 | 29.99 | 3.112 | 91 | 71 | 71 | 5.41 | 5.41 |
| **1903** | 333 | 6,076 | 0.25 | 0.25 | 24 | 3.593 | 136 | 122 | 122 | 6.42 | 6.42 |
| **2004** | 508 | 10,747 | 0.25 | 0.25 | 32.19 | 2.972 | 503 | 374 | 374 | 9.18 | 9.18 |
| **2102** | 105 | 1,827 | 0.25 | 0.25 | 16.4 | 4.592 | 10 | 11 | 11 | 3.86 | 3.86 |

# SECTION 4.0 FLOOD HAZARD

## 4.1 Tule Creek Inundation Limits

Tule Creek drains a 24.25 square mile watershed and conveys 14,033 cfs during a 100-year storm event. Due to the large nature of the flow, the flow width, depth and velocity need to be known for design purposes, as well as analysis of the effect of the project on the upstream and downstream properties. The same flow rate has been established for the pre-project and post-project conditions, so the only difference between the pre- and post-project conditions is the proposed grading and tracker poles. The tracker poles were assumed to be 2 feet in diameter, but far enough apart to not collect debris.

The difference in the width, depth and velocity of flow between the pre- and post-project conditions is very minimal, even through the Project area. Please refer to Figures 5A & B in Appendix I for the pre- and post-project inundation limits and water surface elevations. Please refer to Appendix J for the pre-project HEC-RAS model run and Appendix K for the post-project HEC-RAS model run.

## 4.2 Post-Project Effects

The effects of the Project on the upstream and downstream properties are negligible when compared. The average post-project difference in water surface elevation and velocity upstream of the Project is -0.14 feet and 0.22 fps respectively and downstream is 0.03 feet and 0.09 fps. These differences are considered negligible since the input developed for HEC-RAS was developed from the surveyed topo with an error of +/- 0.25 feet and a Civil 3D generated surface. There also are no structures within the inundation limits on the adjacent properties that could potentially be affected by a change in water surface elevation or flow velocity.

Please refer to Appendix J for a complete comparison of each cross section upstream and downstream of the Project.

## 4.3 Potential Scour

Due to the preliminary nature of the project design, only a preliminary scour analysis was completed. Approximate calculations using the CSU and Froehlich Equations were prepared and they indicated a scour potential of 3 to 5 feet. However, because several critical design parameters including the final tracker pole diameter, D50 and D95 have not been established, these calculations are very preliminary and have not been included as part of this report. Once the final design of the trackers and has been determined and a complete geological

reconnaissance of the surface and underlying soils has been completed, final scour calculations will be included in the final design drainage study.

## 4.4 Project Site Mitigation

Due to the width, depth and velocity of the 100-year storm flow within Tule Creek, the trackers within the inundation limits will be designed to handle the inundation and scour. The following methods will be employed to protect the trackers and their associated infrastructure:

- Increase clearance between final grade and electrical boxes, including MAU, TCU, ADU and disconnect.
- All interconnects leading to inverter shall be waterproof.
- No inverters to be installed within the Tule Creek's 100-year inundation limits.
- Electrical box shall be waterproof.
- Overall height of tracker shall be raised to allow for electrical boxes to clear water surface by at least 1 foot.

With all of the above mitigation measures the trackers proposed within the 100-year inundation limits for Tule Creek will be able to handle the flow, velocity and scour potential.

# SECTION 5.0 DRAINAGE DESIGN

## 5.1 Pre-Project Drainage Design

Currently there are no drainage facilities within the proposed Project area except for natural watercourses, which will remain.

## 5.2 Post-Project Drainage Design

The Project is divided into approximately four different areas where the trackers are clustered. Tule Creek runs through the middle of the northwest area with trackers on both sides. At this location, the flow from the 100-yr storm could easily flow within and around the trackers. The tracker foundations need to be evaluated in order to ensure that they will be able to withstand the flow and the tracker panels shall be placed 1foot above the 100 year flow elevation in order to not impede the flow.

All the other areas have smaller watercourses that cross the layout of the trackers. Each watercourse will remain in order to continue to carry the flow even after construction of the Project. Each existing drainage course will be re-graded to work within the Project and will meet each existing watercourse on the upstream and downstream ends. If an access road crosses an existing watercourse, the road will be paved and constructed contiguous with the flow line of the channel in order to not impede the flow of the channel and protect the road from erosion during a storm. Please see Table 7 below for information on each road crossing and Appendix G for the calculations.

**Table 7: Summary of Existing Watercourse & Proposed Road Crossings**

| Watercourse No. | Dip Crossing Down Stream Node. | Design Flow Rate | Depth | Flooded Width | Crossing Length |
|---|---|---|---|---|---|
| | | (cfs) | (ft) | (ft) | ft |
| **200** | **204** | 444 | 1.37 | 47.4 | 20 |
| | **204** | 444 | 1.37 | 47.4 | 20 |
| **600** | **602** | 96 | 0.61 | 32.2 | 20 |
| | **602** | 96 | 0.61 | 32.2 | 20 |
| **900** | **902** | 70 | 0.51 | 30.2 | 20 |
| **1300** | **1303** | 44 | 0.39 | 27.80 | 20 |
| | **1303** | 44 | 0.39 | 27.80 | 20 |

| Watercourse No. | Dip Crossing Down Stream Node. | Design Flow Rate | Depth | Flooded Width | Crossing Length |
|---|---|---|---|---|---|
| | | (cfs) | (ft) | (ft) | ft |
| **1400** | **1402** | 15 | 0.21 | 24.20 | 20 |
| | **1402** | 15 | 0.21 | 24.20 | 20 |
| | **1402** | 15 | 0.21 | 24.20 | 20 |
| **1500** | **1502** | 73 | 0.51 | 30.20 | 20 |
| | **1502** | 73 | 0.51 | 30.20 | 20 |
| | **1502** | 73 | 0.51 | 30.20 | 20 |
| **1800** | **1803** | 71 | 0.51 | 30.20 | 20 |
| | **1803** | 71 | 0.51 | 30.20 | 20 |
| | **1803** | 71 | 0.51 | 30.20 | 20 |
| | **1803** | 71 | 0.51 | 30.20 | 20 |
| | **1803** | 71 | 0.51 | 30.20 | 20 |
| **1900** | **1902** | 122 | 0.69 | 33.8 | 20 |
| | **1902** | 122 | 0.69 | 33.80 | 20 |
| **2000** | **2004** | 374 | 1.25 | 45.00 | 20 |
| | **2004** | 374 | 1.25 | 45.00 | 20 |
| | **2004** | 374 | 1.25 | 45.00 | 20 |
| | **2004** | 374 | 1.25 | 45.00 | 20 |

Within the Project, the proposed design for the site drainage is to provide earthen swales along the service roads in between the trackers. These swales will capture the runoff from the trackers and site and will only convey low flows. The larger flows will over top the channels and flow down the service roads, following the topography of the Project. The swales will be constructed with fiber roll check dams in place to capture the sediment that erodes off the site. Gravel bag check dams will be placed prior to the swales entering the existing drainage course, Tule Creek, in order to capture sediment. At the tie-in of the proposed earthen swales and the existing drainage course, Tule Creek, outlet protection will be provided to prevent scour and erosion.

Please refer to Appendix G for the Project Site Proposed Hydrology exhibit which shows the proposed site design and drainage facilities.

# SECTION 6.0 SUMMARY

This study concludes that the construction of the Project does not adversely affect or substantially alter the existing watershed, Tule Creek, the tributaries crossing the project site and the properties upstream and downstream of the Project.

Due to the nature of the Project, the addition of impervious area is very minimal and will not increase the amount of runoff. The grading of the site will mimic the existing terrain and the drainage patterns will remain unchanged, also helping to keep the pre-project peak flow rates. Since there is no increase in flow, the project is not subject to hydromodification or stormwater requirements. There is no hydromodification or water quality flow connection to the Salton Sea since these small flow rates would infiltrate and evaporate into the ground before leaving the valley and reaching the Salton Sea.

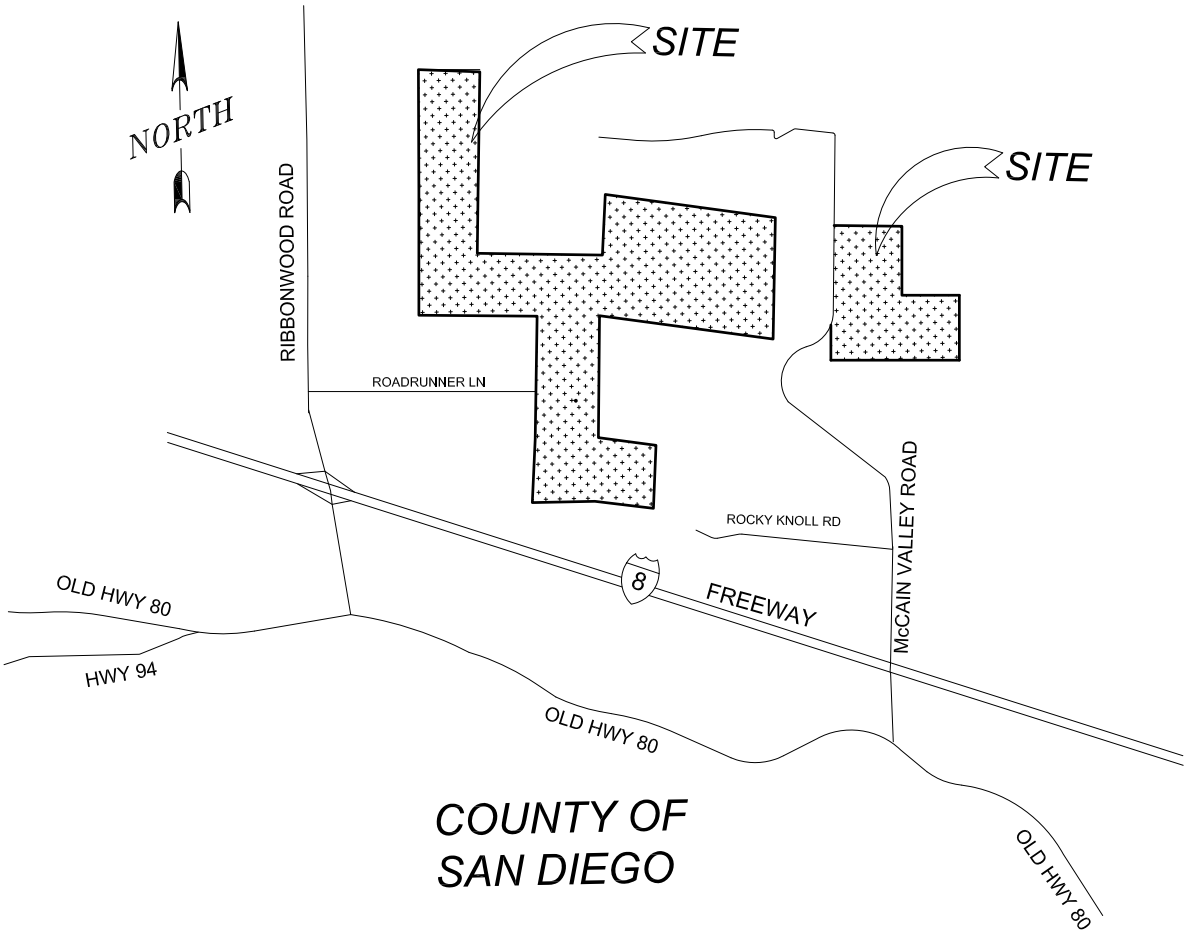
Most of the proposed site will be planted with native vegetation; however there will be earthen roads that may be susceptible to erosion. Check dams will be provided in the proposed drainage channels along side of the access roads in order to capture any sediment that is eroded off of the earthen roads. There will not be any additional sediment transported to Tule Creek due to the Project since it will be collected on site.

Currently the only drainage conveyance that exists with the Project is Tule Creek and the tributary watercourses. The tributary watercourses will remain within the Project in order to maintain the existing drainage patterns and flow capacity. There are no existing drainage facilities that will be adversely affected by the project and the post-project flows will be able to be conveyed within the watercourses crossing the Project. The change in water surface elevation and velocity on the upstream and downstream properties is negligible in the post-project condition.

Trackers will be placed within the 100-year storm inundation limits; however mitigation measures will be taken to ensure that the trackers and associated infrastructure will be able to handle the inundation and potential scour.

# Appendix A

## Vicinity Map

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| | | |
|---|---|---|
| RUGGED ACRES | AECOM PROJECT NO. | FIGURE |
| VICINITY MAP | 60212653 | 1 |

# Appendix B

## NRCS Hydrologic Method Inputs

## Existing/Proposed Hydrology Map – Tule Creek

## Soil Hydrologic Groups Map

## Rainfall Isopluvials

## Figure C-1

## Table 4-2

## Table 4-6

## Table 4-10

## CN Calculations

## Watershed Characteristics



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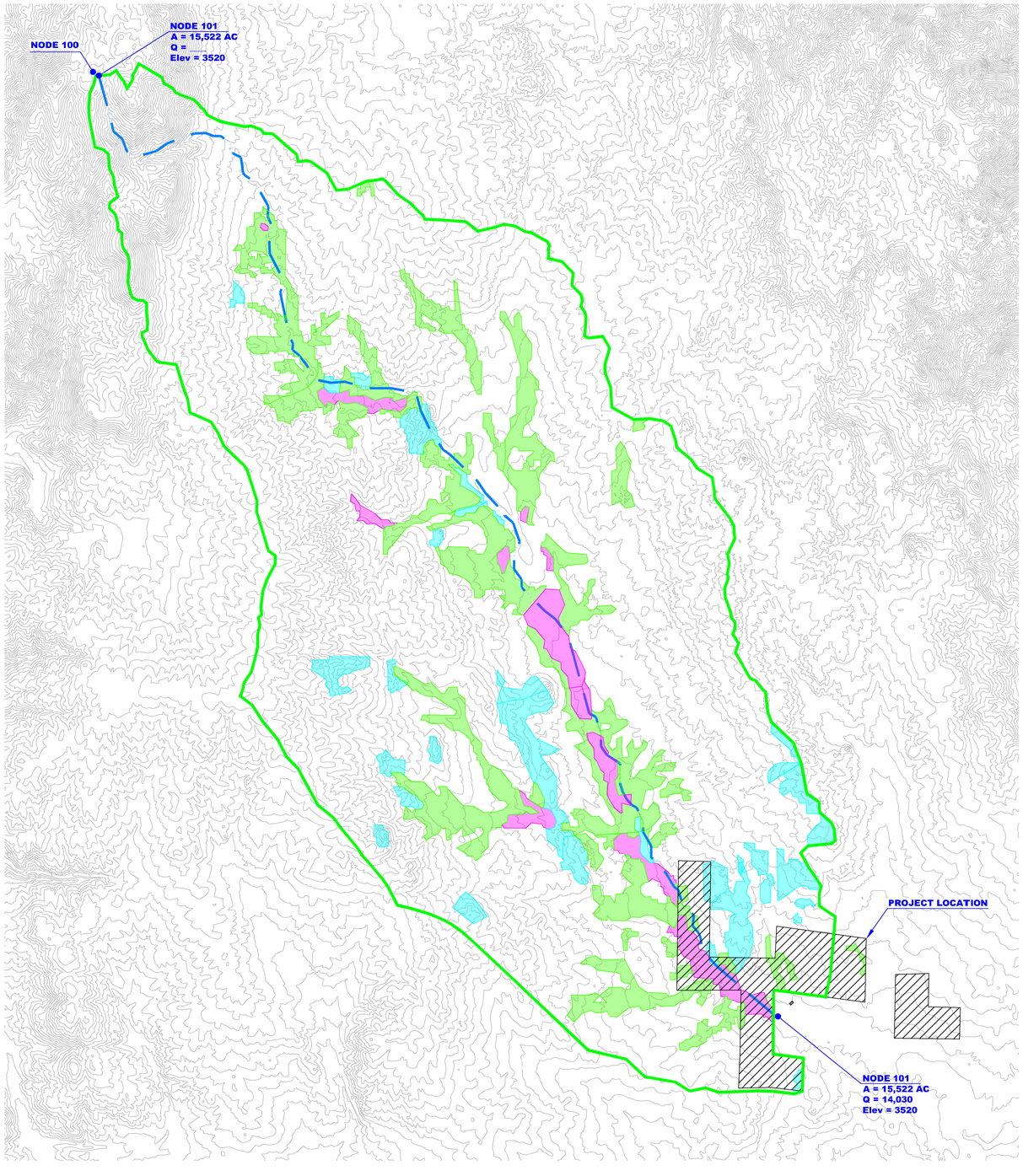


## LEGEND

- EXISTING DRAINAGE BASIN
- EXISTING DRAINAGE COURSE
- SOIL A
- SOIL B, ALL OTHER PROJECT AREAS
- SOIL C
- SOIL D
- PROPOSED PROJECT AREA

2500 1250 0 2500 5000

SCALE IN FEET

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RUGGED ACRES
TULE CREEK DRAINAGE BASIN

EXISTING & PROPOSED HYDROLOGY

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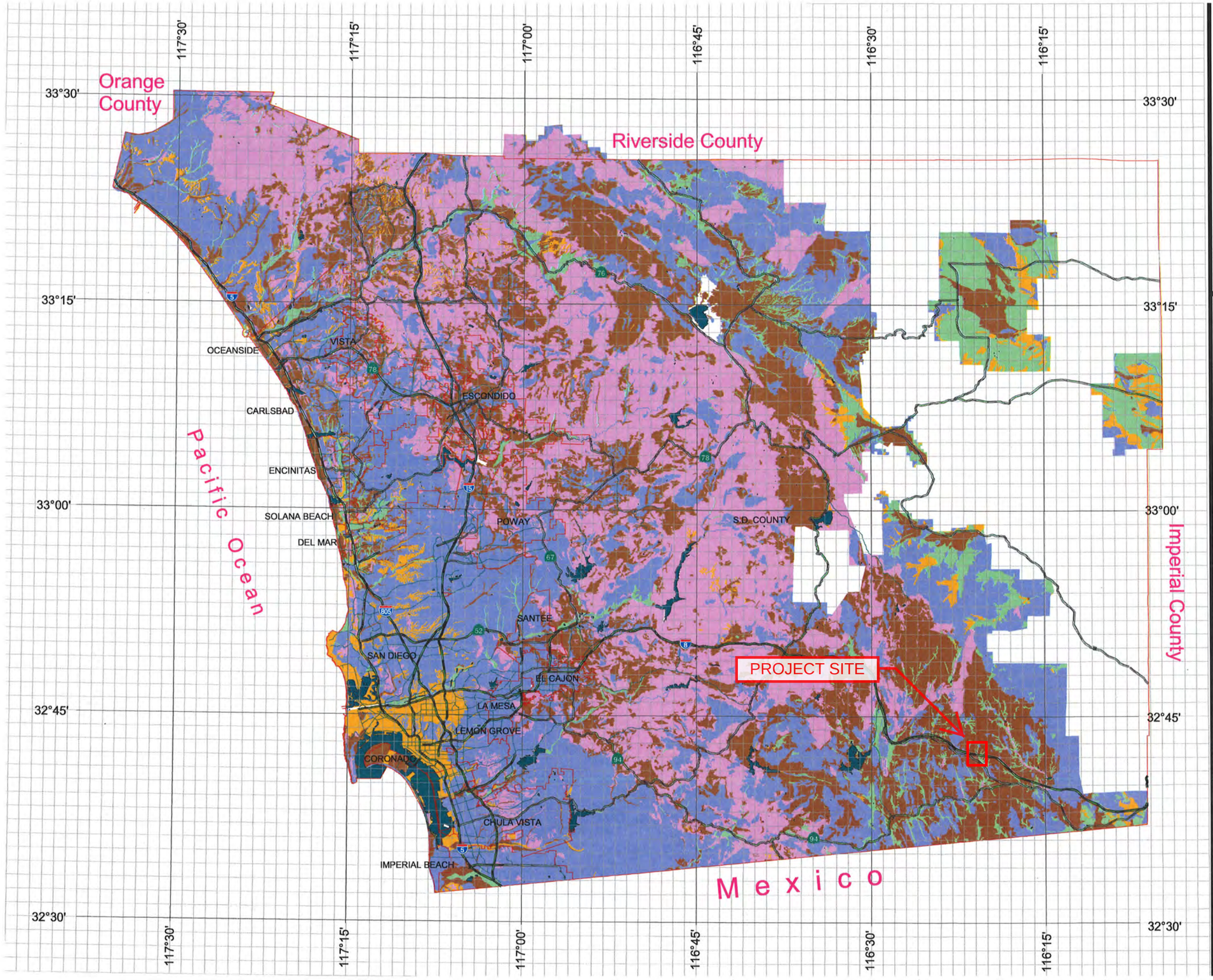
60212653

FIGURE
2

# County of San Diego Hydrology Manual

*Soil Hydrologic Groups*




## Legend

Soil Groups

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

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N W E S

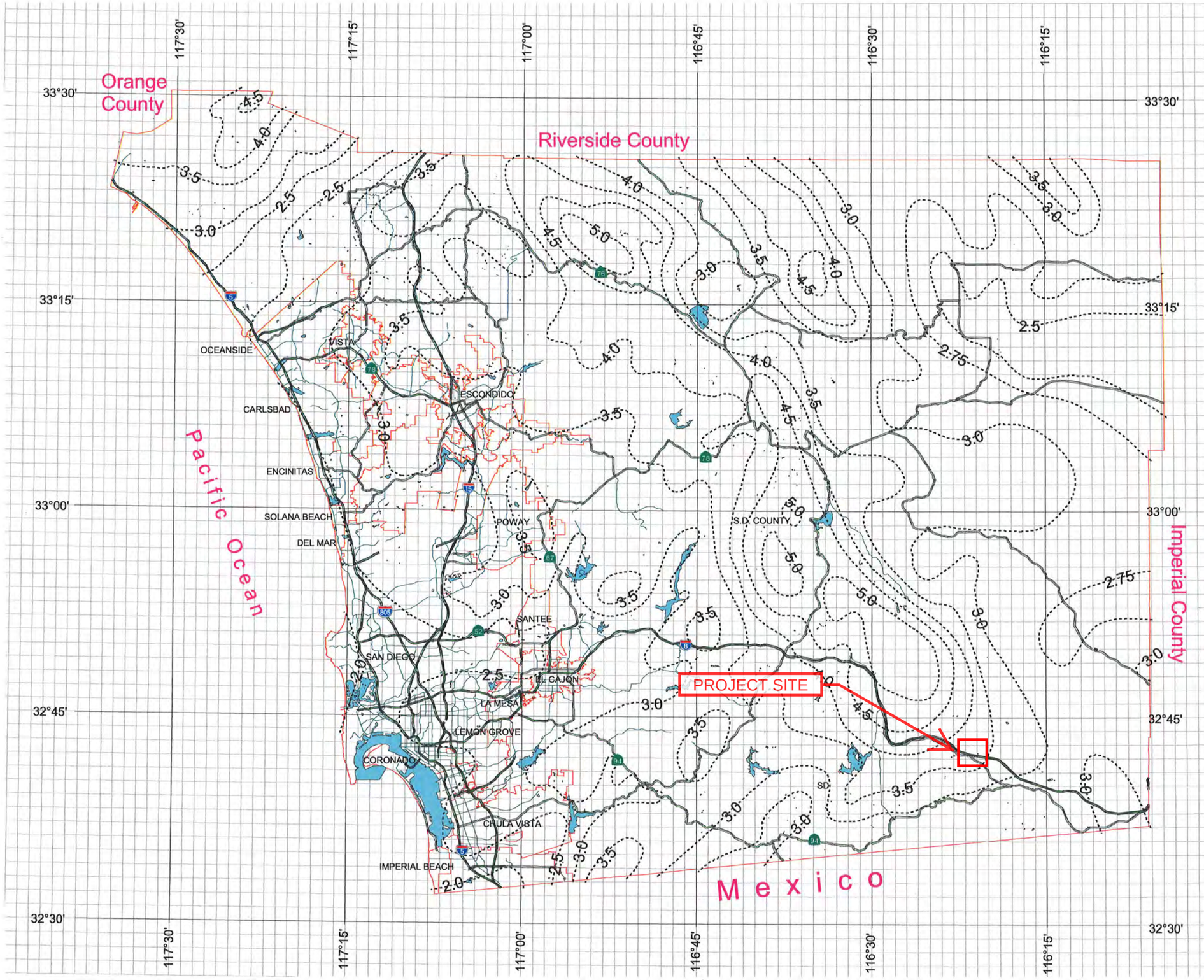
3 0 3 Miles

# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 6 Hours**

Isopluvial (inches)

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N W E S

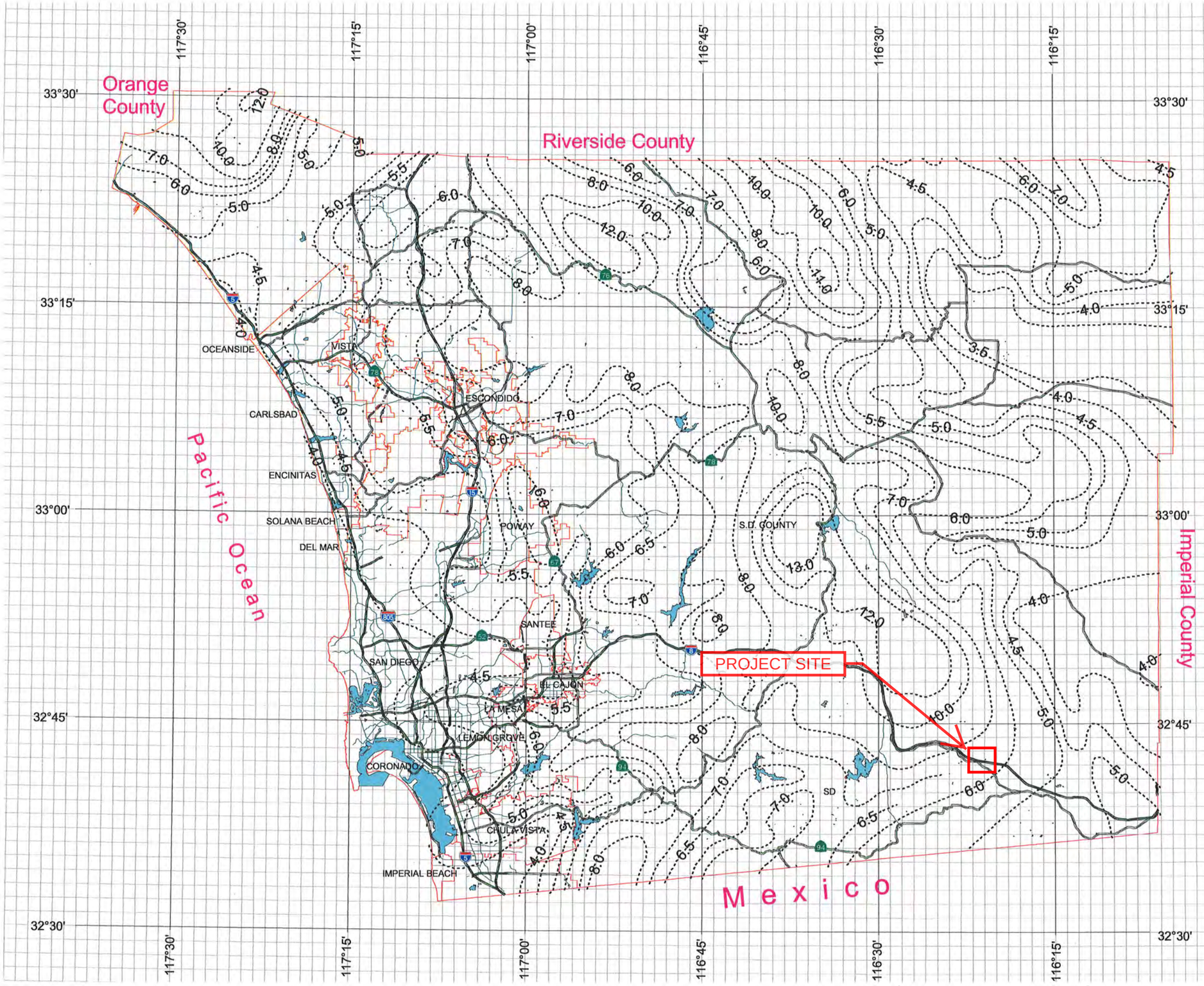
3 0 3 Miles

# County of San Diego Hydrology Manual

*Rainfall Isopluvials*

**100 Year Rainfall Event - 24 Hours**

Isopluvial (inches)

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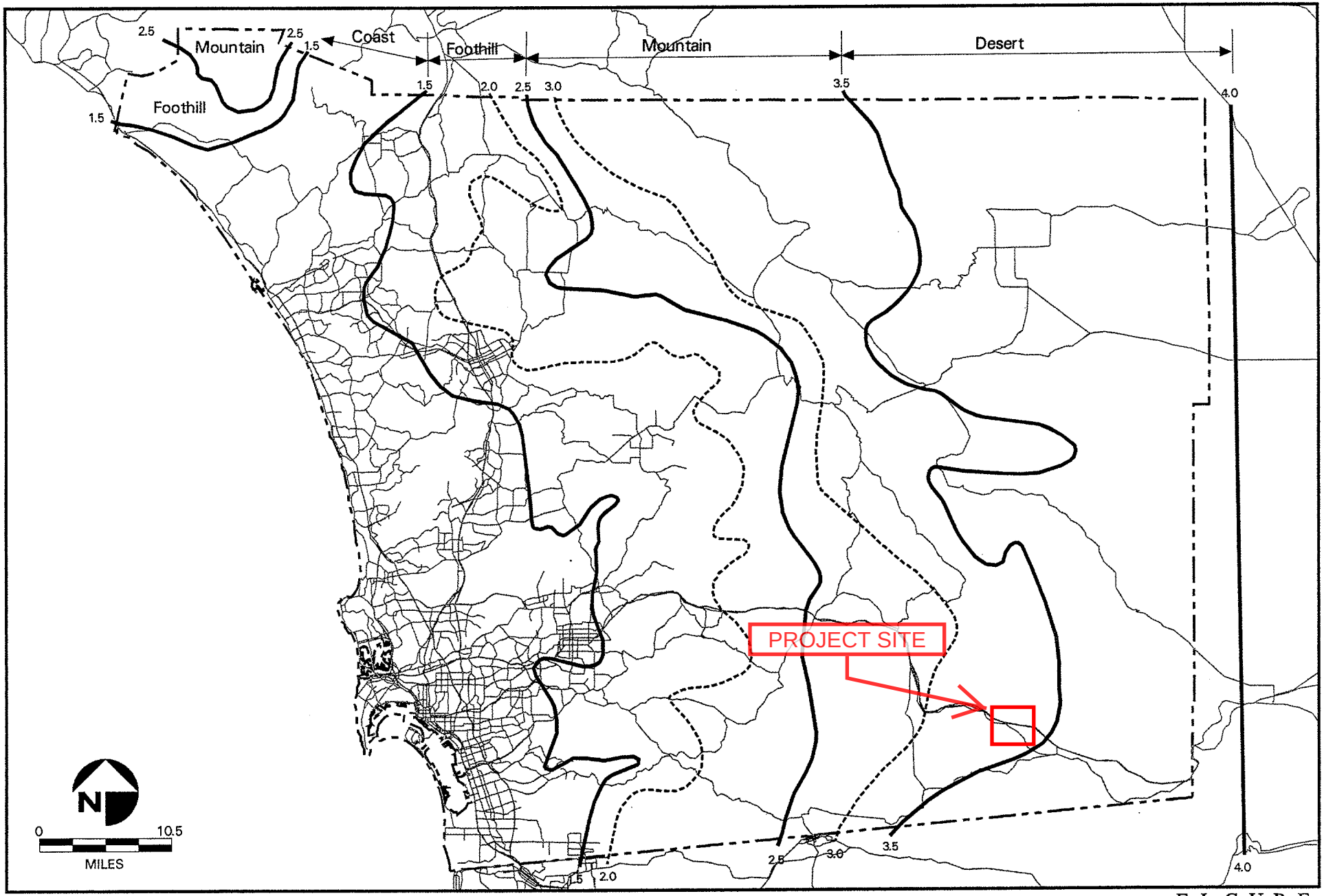
N
W E
S



3 0 3 Miles




**County of San Diego Hydrology Manual**

*Precipitation Zone Numbers (PZN)*

FIGURE

**C-1**

The adjustment for PZN Condition may be made to the composite CN for the watershed. It is not necessary to make the PZN Condition adjustment to each of the CNs for the different combinations of ground cover and soil group within the watershed before calculating the composite CN.

PZN=3.5 FROM FIGURE C-1

**Table 4-6**

**PZN ADJUSTMENT FACTORS FOR FLOW COMPUTATIONS (San Diego County)**

| Storm Frequency | Coast (PZN = 1.0) | Foothills (PZN = 2.0) | Mountains (PZN = 3.0) | Desert (PZN = 4.0) |
|---|---|---|---|---|
| Less than 35-year return period | 1.5 | 2.5 | 2.0 | 1.5 |
| Greater than or equal to 35-year return period | 2.0 | 3.0 | 3.0 | 2.0 |

2.5

Notes: PZN is the precipitation zone number (see Map, Appendix C). The PZN adjustment factor represents the PZN Condition that the CN for the watershed should be adjusted to.

### 4.1.3 Rainfall-Runoff Relationship

A relationship between accumulated rainfall and accumulated runoff was derived by NRCS from experimental plots for numerous soils and vegetative cover conditions. The following NRCS runoff equation is used to estimate direct runoff from 24-hour or 6-hour storm rainfall. The equation is:

$$Q_a = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad \text{(Eq. 4-1)}$$

where: $Q_a$ = accumulated direct runoff (in)

$P$ = accumulated rainfall (potential maximum runoff) (in)

$I_a$ = initial abstraction including surface storage, interception, evaporation, and infiltration prior to runoff (in)

$S$ = potential maximum soil retention (in)

## Table 4-2 (Continued)
## RUNOFF CURVE NUMBERS[1] FOR PZN CONDITION = 2.0

| Cover Description | Cover Treatment or Practice[2] | Hydrologic Condition[3] | Average Percent Impervious Area[4] | Curve Numbers for Hydrologic Soil Groups: A | B | C | D |
|---|---|---|---|---|---|---|---|
| Turf[8] | | Poor | | 58 | 74 | 83 | 87 |
| | | Fair | | 44 | 65 | 77 | 82 |
| | | Good | | 33 | 58 | 72 | 79 |
| Water surfaces (during floods) | | | | 97 | 98 | 99 | 99 |
| Broadleaf chaparral | | Poor | | 53 | 70 | 80 | 85 |
| | | Fair | | 40 | 63 | 75 | 81 |
| | | Good | | 31 | 57 | 71 | 78 |
| Desert shrub–major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus | | Poor | | 63 | 77 | 85 | 88 |
| | | Fair | | 55 | 72 | 81 | 86 |
| | | Good | | 49 | 68 | 79 | 84 |
| Herbaceous–mixture of grass, weeds, and low-growing brush, with brush the minor element | | Poor | | [9] | 80 | 87 | 93 |
| | | Fair | | [9] | 71 | 81 | 89 |
| | | Good | | [9] | 62 | 74 | 85 |
| Narrowleaf chaparral | | Poor | | 71 | 82 | 88 | 91 |
| | | Fair | | 55 | 72 | 81 | 86 |
| Oak-aspen–mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush | | Poor | | [9] | 66 | 74 | 79 |
| | | Fair | | [9] | 48 | 57 | 63 |
| | | Good | | [9] | 30 | 41 | 48 |
| Open brush | | Poor | | 62 | 76 | 84 | 88 |
| | | Fair | | 46 | 66 | 77 | 83 |
| | | Good | | 41 | 63 | 75 | 81 |

**Table 4-10**

**RUNOFF CURVE NUMBERS FOR PZN CONDITIONS 1.0, 2.0, AND 3.0**

| CN For: | | | CN For: | | |
|---|---|---|---|---|---|
| PZN Condition = 1.0 | PZN Condition = 2.0 | PZN Condition = 3.0 | PZN Condition = 1.0 | PZN Condition = 2.0 | PZN Condition = 3.0 |
| 100 | 100 | 100 | 40 | 60 | 78 |
| 97 | 99 | 100 | 39 | 59 | 77 |
| 94 | 98 | 99 | 38 | 58 | 76 |
| 91 | 97 | 99 | 37 | 57 | 75 |
| 89 | 96 | 99 | 37 | 56 | 75 |
| 87 | 95 | 98 | 34 | 55 | 73 |
| 85 | 94 | 98 | 34 | 54 | 73 |
| 83 | 93 | 98 | 33 | 53 | 72 |
| 81 | 92 | 97 | 32 | 52 | 71 |
| 80 | 91 | 97 | 31 | 51 | 70 |
| 78 | 90 | 96 | 31 | 50 | 70 |
| 76 | 89 | 96 | 30 | 49 | 69 |
| 75 | 88 | 95 | 29 | 48 | 68 |
| 73 | 87 | 95 | 28 | 47 | 67 |
| 72 | 86 | 94 | 27 | 46 | 66 |
| 70 | 85 | 94 | 26 | 45 | 65 |
| 68 | 84 | 93 | 25 | 44 | 64 |
| 67 | 83 | 93 | 25 | 43 | 63 |
| 66 | 82 | 92 | 24 | 42 | 62 |
| 64 | 81 | 92 | 23 | 41 | 61 |
| 63 | 80 | 91 | 22 | 40 | 60 |
| 62 | 79 | 91 | 21 | 39 | 59 |
| 60 | 78 | 90 | 21 | 38 | 58 |
| 59 | 77 | 89 | 20 | 37 | 57 |
| 58 | 76 | 89 | 19 | 36 | 56 |
| 57 | 75 | 88 | 18 | 35 | 55 |
| 55 | 74 | 88 | 18 | 34 | 54 |
| 54 | 73 | 87 | 17 | 33 | 53 |
| 53 | 72 | 86 | 16 | 32 | 52 |
| 52 | 71 | 86 | 16 | 31 | 51 |
| 51 | 70 | 85 | 15 | 30 | 50 |
| 50 | 69 | 84 | | | |
| 48 | 68 | 84 | 12 | 25 | 43 |
| 47 | 67 | 83 | 9 | 20 | 37 |
| 46 | 66 | 82 | 6 | 15 | 30 |
| 45 | 65 | 82 | 4 | 10 | 22 |
| 44 | 64 | 81 | 2 | 5 | 13 |
| 43 | 63 | 80 | 0 | 0 | 0 |
| 42 | 62 | 79 | | | |
| 41 | 61 | 78 | | | |

The CN is taken between the PZN 2.0 and PZN 3.0 since the adjusted PZN is 2.5.

**Pre-Project Soil Type Areas for Tule Creek**

| Sub Basins Area (ft^2) | Soil Type - Area 100 | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 1 | 87631401 | 0 | 17697306 | 24105750 |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| Sub Basin Total Area | | 676102604 | | |
| Total Area (ft^2) | 87631401 | 570773897 | 17697306 | 24105750 |
| Total Area (acres) | 2011.74 | 13103.17 | 406.27 | 553.39 |
| Total Sub Basin Drainage Area (acres) | 15521.18 | | | |
| Percentage of Total | 12.96% | 84.42% | 2.62% | 3.57% |
| CN for Desert Shrub (Fair) | 55 | 72 | 81 | 86 |
| Watershed Weighted CN | 70 | | | |
| Adjusted PZN for Q100 (Table 4-10) | 79 | | | |

| | |
|---|---|
| PZN (Figure C-1) | 3.5 |
| PZN Adjustment Factor (Table 4-6, Page 4-20) | 2.5 |

**PRE-PROJECT AES 2011 FLOODSCx Inputs - Tule Creek**

| | |
|---|---|
| P6 (in) | 3.75 |
| P24 (in) | 6.5 |

| | Drainage Area |
|---|---|
| **Watershed Parameters** | **100** |
| **Area (ft^2)** | 676,154,521.00 |
| **Area (acres)** | 15,522.37 |
| **Area (miles^2)** | 24.25 |
| **Percent Impervious** | 0.0% |
| **Max elev. (ft)** | 5640 |
| **Min elev. (ft)** | 3515 |
| **Difference (ft)** | 2,125.00 |
| **Longest Watercourse (ft)** | 55,176.00 |
| **Longest Watercourse (miles)** | 10.45 |
| **Slope (ft/mile)** | 203.35 |
| **Lc (ft)** | 22,726.00 |
| **Lc (miles)** | 4.30 |
| **Basin n** | 0.04 |

# Appendix C

## Rational Method Inputs

## Existing Hydrology Map – Project Site

## Figure 3-1

## Table 3-1

## Table 3-2

## C Calculations

## Watershed Sub-Area Characteristics



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