Nitrate Mass Balance Study for the Proposed Escondido Estates, a 20-Lot Subdivision of APN 234-231-01 Located at 1125 Idaho Avenue in Escondido, CA 92027

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NOVEMBER 2019

UPDATED DECEMBER 2020

SDC PDS RCVD 01-05-21
TM5639

Printed on 30% post-consumer recycled material.

Table of Contents

SECTION | **PAGE NO.**

TABLES

FIGURES

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1 Introduction

1.1 Purpose of the Report and Regulatory Setting

The purpose of this report is to assess potential nitrate impacts to groundwater as a result of the proposed residential development on Assessor's Parcel Number (APN) 234-231-01. On residential lots which utilize septic systems (also referred to as onsite wastewater treatment systems, or OWTS), groundwater concentrations of nitrate as nitrogen (as N) can be impacted by the downward migration of nitrate from various sources. Groundwater recharge from septic leachate is one of the primary sources of nitrate. Other potential sources of nitrate include landscape fertilizer and irrigation water (if the irrigation source is well water or recycled water).

Historically, the San Diego Regional Water Quality Control Board (RWQCB) issued waste discharge permits for individual subsurface disposal systems. However, the RWQCB found it difficult to efficiently evaluate the large quantity of waste discharge permit applications for individual septic systems. Therefore, the RWQCB deferred regulation of septic tank disposal systems in the San Diego Region to the County of San Diego Department of Environmental Health (DEH). The RWQCB-approved Local Agency Management Program (LAMP) for OWTS, prepared by the County of San Diego DEH in February 2015, provides regulatory guidance for this project. Based on the requirements provided by the LAMP[1] and at the request of the San Diego County DEH, a nitrate study is required to assess potential impacts of the proposed project on local groundwater quality.

The RWQCB has developed water quality objectives for surface water and groundwater in the San Diego region. The RWQCB basin plan objective for nitrate (as NO_3) in groundwater is 45 mg/L (RWQCB, 1994). The United States Environmental Protection Agency (EPA) established a maximum contaminant level (MCL) for nitrate as N in drinking water at 10 mg/L. The California drinking water MCL for nitrate as N is also 10 mg/L.

This nitrate study presents a mass balance analysis to estimate the potential impact from the proposed project on groundwater resources, specifically nitrate loads from all sources of water infiltrating on the Site. Existing nitrate concentrations in groundwater at the Site are not factored into this analysis. The intent of this analysis is to determine if, as a result of the proposed development, the concentration of nitrate as N in onsite domestic wastewater effluent would exceed a concentration of 10 mg/L. If it is determined that the 10 mg/L threshold is exceeded, the estimated level of nitrate reduction via OWTS treatment (e.g. new OWTS technology, advanced, or supplemental OWTS treatment) will be presented.

1.2 Project Location and Description

The Site is located at 1125 Idaho Avenue in Escondido, California (Figure 1). The Site is located within APN 234-231-01 and is currently an undeveloped lot. The project involves developing the 10.28–acre project area (see Figure 1) into twenty (20) single family residence lots. Figure 2 depicts the proposed configuration and size of the

[1] Per the Average Allowable Densities for Subdivision Lots Table (Table 2, pg. 17) presented in the RWQCB-approved San Diego County DEH LAMP for Onsite Wastewater Treatment Systems, the allowable density for subdivisions is 2.0 acres per single-family dwelling in areas with average annual rainfall of >15 to 20 inches/year. Based on the average annual rainfall in Escondido (over a 103-year rainfall record) of 15.48 inches/year and the proposed subdivision of one 10.28-acre lot into twenty half-acre residential lots, this proposed development project would exceed the LAMP allowable density and therefore require "additional studies (such as this nitrate mass balance evaluation) by a qualified professional demonstrating no adverse impacts to groundwater quality will occur."

residential lots. Individual septic systems are planned for each residential lot. Additionally, the residences will be supplied with potable water served by the City of Escondido.

2 Site Setting

The following information characterizes the topography, hydrologic setting, geology, soils and precipitation at the Site.

2.1 Topographic and Hydrologic Setting

The Site is located in the Bear Subarea (HSA; 905.24) which encompasses approximately 1,716 acres. The Bear Hydrologic Subarea is contained in the Hodges Hydrologic Area (HA; 905.20), all within the San Dieguito Hydrologic Unit (HU; 907.00) that drains to the Pacific Ocean (Figure 3). Site topography gently slopes from east to west with elevations ranging from approximately 750 feet above mean sea level (amsl) on the eastern edge of the property to approximately 690 feet amsl along the western boundary of the property. Surface water runoff would flow into the nearby drainages to the west of the site.

2.2 Site Geology and Soils

The Site is located in the Peninsular Range geomorphic province, which is a series of northwest-oriented mountain ranges extending from the Transverse Ranges near Los Angeles south through the Baja California peninsula. According to the Geologic Map of the Escondido 7.5-minute quadrangle, the underlying geology of the Site consists mostly of granitic rock characterized as undifferentiated types of granodiorite with minor tonalite of Cretaceous age, with a small portion of the site being underlain by Holocene colluvial and stream deposits (Tan and Kennedy, 1999). Based on maps prepared by the U.S. Department of Agriculture (USDA) Soil Conservation Service (USDA, 1973), 8.99 acres of the central and eastern portions of the Site are underlain by the Ramona sandy loam. The Fallbrook-Vista sandy loam is present on 1.15 acres of the western portion of the Site. Soil types and their properties within the Project area are presented in Table 1 and depicted in Figure 4.

Table 1. Soil Types and Select Soil Properties

Soil Type	Soil Unit	Mean Soil Moisture Holding Capacity (inches)	Recharge Rate (acre-feet/acre per year)	Hydrologic Soil Group	Area (acres)
Ramona sandy loam	RaB	9.5	0.042	C	8.99
Fallbrook-Vista sandy loam	FvE	4.5	0.071	C	1.15

Source: Moisture Holding Capacities and Hydrologic Soil Group values obtained from Table 3-4, SD County 2010. Recharge rates obtained from SD County (Heaton and Giesick, 2002) Report.

2.3 Climate

According to the 30-Year (1974-2004) Average Precipitation Figure 2-2 in Appendix D of the County of San Diego DPLU General Plan Update (San Diego County, 2010; Figure 5), the Site is located within the 15 to 18-inch mean annual precipitation area. The average annual precipitation at the Escondido weather station in downtown Escondido is 15.8 inches (Heaton and Giesick, 2002).

Long-term monthly average reference evapotranspiration (ETo) data was obtained from the California Irrigation Management System (CIMIS), which is a network of 145 automated weather stations that collect climate data throughout California (DWR, 2012). Using this data, California has been divided into 18 ETo zones, each with distinct monthly long term average ETo rates. The Site is located within CIMIS ETo zone 9. Average monthly ETo data for CIMIS zone 9 is presented in Table 2 below. The mean annual total is 55.14 inches (DWR, 2012).

Table 2. Monthly ETo (inches)

CIMIS Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
9	2.1	2.8	4.0	5.1	5.9	6.6	7.4	6.8	5.7	4.0	2.7	1.8	55.14

3 Nitrate Mass Balance

A mass balance analysis was conducted to estimate the concentration of nitrate as N in water infiltrating on the Site resulting from septic recharge, natural groundwater recharge (precipitation), and landscape irrigation recharge associated with the proposed development. This approach follows the method described in a technical report prepared for the San Diego RWQCB by San Diego State professor Dr. David Huntley in September 1987 (Huntley, 1987). The paragraphs below discuss the mass balance in further detail and the data used in this analysis.

Nitrate Mass Balance Equation:

$$C_r = \frac{Q_s * C_s + Q_I * C_I + Q_p * C_p}{Q_r}$$

Where

C_r = resulting concentration of nitrate from on-site recharge water

Q_r = rate of on-site recharge ($Q_r = Q_s + Q_I + Q_p$)

C_s = concentration of nitrate in septic leachate

Q_s = rate of recharge from septic leachate

C_I = concentration of nitrate in landscape irrigation recharge

Q_I = rate of landscape irrigation recharge

C_p = concentration of nitrate in precipitation

Q_p = rate of recharge from on-site precipitation

Three scenarios were evaluated to consider the potential variability in rate of groundwater recharge and potential future residential development of the proposed project. Precipitation recharge was calculated using the estimated recharge rates by soil type as calculated for the Escondido area by Heaton and Giesick (2002), who performed a limited hydrological study intended to evaluate future build-out scenarios of residential development utilizing septic systems within the Citrus Avenue watershed, located immediately east of the Escondido Estates project site. Precipitation recharge to groundwater was estimated to be 0.46 acre-feet per year based on the soil types presented in Table 1. Potential residential development scenarios were assessed via three scenarios as follows: (1) Twenty 3-bedroom houses with 4 full-time residents, (2) Twenty 4-bedroom houses with 5 full-time residents and (3) Twenty 5-bedroom houses with 6 full-time residents. Landscape irrigation was assumed to be 312 gallons per day, based on reports of residential irrigation use in the vicinity of the proposed project (Heaton and Giesick, 2002). Groundwater recharge from landscape irrigation was estimated to be 10% of irrigation application (Heaton and Giesick, 2002).

3.1 Septic Leachate

The Department of Water Resources (DWR) estimates a per capita daily indoor residential water use of 55 gallons per day (gpd) (DWR, 2011). Additionally, the mean daily per capita indoor water use from a U.S. Environmental Protection Agency study conducted in the San Diego area is equal to 58.3 gallons per person per day (USEPA, 2002). It is assumed that all indoor residential water use is discharged as septic effluent. Therefore, an estimated septic recharge rate (Q_s), per resident, of 55 gpd was used for this analysis.

The three residential development scenarios considered in this study are intended to evaluate potential development scenarios with varying levels of nitrate impact. The lower nitrate impact scenario assumes the construction of twenty 3-bedroom houses with 4 full-time residents. Per capita indoor water use is assumed to be 55 gpd, for a total water use of 220 gpd per residence (4,400 gpd total water use). The intermediate nitrate impact scenario assumes the construction of twenty 4-bedroom houses with 5 full-time residents. Per capita indoor water use is assumed to be 55 gpd, for a total water use of 275 gpd per residence (5,500 gpd total water use). The higher nitrate impact scenario assumes the construction of twenty 5-bedroom houses with 6 full-time residents. Per capita indoor water use is assumed to be 55 gpd, for a total water use of 330 gpd per residence (6,600 gpd total water use). These usage rates are similar to the Huntley (1987) estimated a rate of septic leachate recharge of 0.27 acre-feet/year, or 241 gpd, per residence. The assumption of the number of full time occupants in each residence is a conservative approach.

Based on the results of Huntley's 1987 study in which septic leachate samples were collected from below San Diego County leach fields, nitrate concentrations in septic leachate were in the range of 30 mg/L to 40 mg/L. A concentration of nitrate in septic leachate (C_s) of 35 mg/L was used for this study. This study assumes that there is no evaporative loss from the septic system.

3.2 Precipitation

Precipitation recharge for this study was estimated based on data from a limited hydrological study completed for the area by the County of San Diego DEH (Heaton and Giesick, 2002). The hydrological study calculated the average annual precipitation in the vicinity of the project to be 15.48 inches per year based on a 103-year rainfall record (1897-2002) from the Escondido rainfall station located in downtown Escondido. The hydrological study then used a soil moisture balance approach to estimate the recharge rate (in acre-feet/acre per year) for soil types located in the Citrus Avenue watershed, which is adjacent to the project site (Heaton and Giesick, 2002). Recharge rates and areas for each soil type on the Escondido Estates project site are presented in Table 1. Using the recharge rates and the area of each soil type, the average annual precipitation recharge for the site (Q_p) was calculated to be 0.46 acre-feet/year.

The concentration of nitrate in precipitation (C_p) was assumed to be 0 mg/L for this study.

3.3 Landscape Irrigation Recharge

Landscape irrigation recharge for this study was estimated based on data from a limited hydrological study completed for the area by the County of San Diego DEH (Heaton and Giesick, 2002). The limited hydrological study estimated landscape irrigation use at approximately 312 gpd per residence, with approximately 10% of the applied water recharging groundwater. As a result, the assumed recharge from landscape irrigation for the project is approximately 0.70 acre-feet per year.

The landscape irrigation water for this project will be water served by City of Escondido. Based on the City of Escondido's Consumer Confidence Report for 2018, there are no detectable concentrations of nitrate as N (C_l) in the supplied water (City of Escondido, 2019). It is assumed that no fertilizer will be applied to the residential landscaping. Therefore, the concentration of nitrate as N in the irrigation recharge is estimated to be 0 mg/L.

4 Results and Recommendations

Three development scenarios were evaluated to consider the potential variability in rate of groundwater recharge and potential future residential development. The same nitrate mass balance equation shown in Section 3.0 will be used to evaluate each of the three scenarios. The variables Q_s (rate of recharge from septic leachate) will depend on the scenario being evaluated. The scenarios and associated variables are described below.

Scenario 1 – Twenty 3-Bedroom Residences

Scenario 1 assumes the site is developed with twenty 3-bedroom residences with 4 full-time residents. A table of mass balance inputs and the resulting nitrate concentration is presented below.

Table 3. Twenty 3-Bedroom Residences

Parameter	Value	Units
Q_r = Resulting discharge of groundwater recharge (Qr = Qs + Ql + Qp)	5,434	gpd
Q_s = Rate of groundwater recharge from septic leachate[1]	4,400	gpd
C_s = Concentration of nitrate in septic leachate	35	mg/L
Q_l = Rate of landscape irrigation recharge	624	gpd
C_l = Concentration of nitrate in landscape irrigation recharge	0	mg/L
Q_p = Average Annual Rate of Recharge from on-site precipitation	410	gpd
C_p = Concentration of nitrate in precipitation	0	mg/L
C_r = Resulting concentration of nitrate as N from on-site groundwater recharge	**28**	**mg/L**

[1] = 220 gpd x 20 residences
mg/L = milligrams per liter
gpd = gallons per day

Based on the resulting on-site recharge of water with a concentration of 28 mg/L to the system, this proposed development scenario will exceed the water quality standard of 10 mg/l. In order to determine the maximum concentration of nitrate as N in the septic leachate (C_s) which would result in a C_r value of 10 mg/L or lower, the mass balance equation is rearranged below to solve for C_{smax}. The variable C_r is set at the nitrate water quality standard of 10 mg/L.

$$C_{s_{max}} = \frac{Q_r * C_r - Q_I * C_I - Q_p * C_p}{Q_s}$$

$$C_{s_{max}} = \frac{(4{,}400\ \text{gpd} * 10\ \text{mg/L}) - (624\ \text{gpd} * 0\ \text{mg/L}) - (410\ \text{gpd} * 0\ \text{mg/L})}{5{,}434\ \text{gpd}}$$

$$C_{s_{max}} = 12.3\ {}^{\text{mg}}/_{\text{L}}\ \text{nitrate as N}$$

The minimum percent reduction to be achieved by an onsite wastewater treatment system is expressed by the following equation:

$$\%\ \text{reduction} = \frac{(C_s - C_{s_{max}}) * 100}{C_s}$$

$$\% \text{ reduction} = \frac{(35 \,{}^{\text{mg}}/_{\text{L}} - 12.3 \,{}^{\text{mg}}/_{\text{L}}) * 100}{35 \,{}^{\text{mg}}/_{\text{L}}}$$

$$\% \text{ reduction} = 65\%$$

Scenario 2 – Twenty 4-Bedroom Residences

Scenario 2 assumes the development of twenty 4-bedroom residences with 5 full-time residents. A table of mass balance inputs and the resulting nitrate concentration is presented below.

Table 4. Twenty 4-Bedroom Residences

Parameter	Value	Units
Q_r = Resulting discharge of groundwater recharge (Qr = Qs + Ql + Qp)	6,534	gpd
Q_s = Rate of groundwater recharge from septic leachate[1]	5,500	gpd
C_s = Concentration of nitrate in septic leachate	35	mg/L
Q_l = Rate of landscape irrigation recharge	624	gpd
C_l = Concentration of nitrate in landscape irrigation recharge	0	mg/L
Q_p = Average Annual Rate of Recharge from on-site precipitation	410	gpd
C_p = Concentration of nitrate in precipitation	0	mg/L
C_r = Resulting concentration of nitrate as N from on-site groundwater recharge	**29**	**mg/L**

[1] = 275 gpd x 20 residences
mg/L = milligrams per liter
gpd = gallons per day

Based on the resulting on-site recharge of water with a concentration of 29 mg/L to the system, this proposed development scenario will exceed the water quality standard of 10 mg/l. In order to determine the maximum concentration of nitrate as N in the septic leachate (C_s) which would result in a C_r value of 10 mg/L or lower, the mass balance equation is rearranged below to solve for C_{smax}. The variable C_r is set at the nitrate water quality standard of 10 mg/L.

$$C_{s_{max}} = \frac{Q_r * C_r - Q_I * C_I - Q_p * C_p}{Q_s}$$

$$C_{s_{max}} = \frac{(5{,}500 \text{ gpd} * 10 \text{ mg/L}) - (624 \text{ gpd} * 0 \text{ mg/L}) - (410 \text{ gpd} * 0 \text{ mg/L})}{6{,}534 \text{ gpd}}$$

$$C_{s_{max}} = 11.9 \ {}^{mg}/_{L} \text{ nitrate as N}$$

The minimum percent reduction to be achieved by an onsite wastewater treatment system is expressed by the following equation:

$$\% \text{ reduction} = \frac{(C_s - C_{s_{max}}) * 100}{C_s}$$

$$\% \text{ reduction} = \frac{(35 \ {}^{mg}/_{L} - 11.9 \ {}^{mg}/_{L}) * 100}{35 \ {}^{mg}/_{L}}$$

$$\% \text{ reduction} = 66\%$$

Scenario 3 – Twenty 5-Bedroom Residences

Scenario 3 assumes the development of twenty 5-bedroom residences with 6 full-time residents. A table of mass balance inputs and the resulting nitrate concentration is presented below.

Table 5. Twenty 5-Bedroom Residences

Parameter	Value	Units
Q_r = Resulting discharge of groundwater recharge (Qr = Qs + Ql + Qp)	7,634	gpd
Q_s = Rate of groundwater recharge from septic leachate[1]	6,600	gpd
C_s = Concentration of nitrate in septic leachate	35	mg/L
Q_l = Rate of landscape irrigation recharge	624	gpd
C_l = Concentration of nitrate in landscape irrigation recharge	0	mg/L
Q_p = Average Annual Rate of Recharge from on-site precipitation	410	gpd
C_p = Concentration of nitrate in precipitation	0	mg/L
C_r = Resulting concentration of nitrate as N from on-site groundwater recharge	**30**	**mg/L**

[1] = 330 gpd x 20 residences

mg/L = milligrams per liter
gpd = gallons per day

Based on the resulting on-site recharge of water with a concentration of 30 mg/L to the system, this proposed development scenario will exceed the water quality standard of 10 mg/l. In order to determine the maximum concentration of nitrate as N in the septic leachate (C_s) which would result in a C_r value of 10 mg/L or lower, the mass balance equation is rearranged below to solve for C_{smax}. The variable C_r is set at the nitrate water quality standard of 10 mg/L.

$$C_{s_{max}} = \frac{Q_r * C_r - Q_I * C_I - Q_p * C_p}{Q_s}$$

$$C_{s_{max}} = \frac{(6{,}600 \text{ gpd} * 10 \text{ mg/L}) - (624 \text{ gpd} * 0 \text{ mg/L}) - (410 \text{ gpd} * 0 \text{ mg/L})}{7{,}634 \text{ gpd}}$$

$$C_{s_{max}} = 11.6 \ {}^{mg}/_{L} \text{ nitrate as N}$$

The minimum percent reduction to be achieved by an onsite wastewater treatment system is expressed by the following equation:

$$\% \text{ reduction} = \frac{(C_s - C_{s_{max}}) * 100}{C_s}$$

$$\% \text{ reduction} = \frac{(35 \ {}^{mg}/_{L} - 11.6 \ {}^{mg}/_{L}) * 100}{35 \ {}^{mg}/_{L}}$$

$$\% \text{ reduction} = 67\%$$

Recommendations

Nitrate as N concentrations in water infiltrating from the approximately 10.3-acre site were estimated to range from 28 mg/L to 30 mg/L as a result of the development scenarios considered above. This exceeds the California nitrate drinking water quality standard and Basin Plan Water Quality Objective of 10 mg/L. Therefore, treatment via individual OWTS with supplemental treatment systems (STS) will be required to reduce nitrate as N concentrations in septic effluent. The anticipated level of treatment is similar under all development scenarios, with reductions ranging from 65-67%. Septic systems capable of reducing nitrate as N concentrations by 67% should be considered for this project.

5 References

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SOURCE: BING Maps

Figure 1
Vicinity Map

1125 Idaho Avenue Escondido Nitrate Study

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Figure 2. Proposed 20-Lot Subdivision Plan

NOTE

1. ALL PROPOSED LANE CONFIGURATION IS SHOWN AS CONCEPTUAL ONLY AND SHALL BE VERIFIED BY TRAFFIC ENGINEER AND COUNTY AND/OR CALTRANS.
2. NO IMPROVEMENTS TO SAN PASQUAL VALLEY ROAD ARE PROPOSED AS PART OF THIS PROJECT. ADEQUATE RIGHT-OF-WAY IS PRESENT.

LOT TABLE

LOT NUMBER	LOT SIZE (SF)	PAD SIZE (SF)	SEPTIC FIELD SIZE (SF)	NUMBER OF ALLOWABLE BEDROOMS
1	16,101	5,771	2,250	4
2	13,860	6,870	2,250	4
3	15,295	7,715	2,250	4
4	15,330	7,185	2,250	4
5	16,637	8,191	2,250	4
6	24,440	9,812	3,000	5
7	22,197	7,589	2,800	5
8	14,513	6,268	2,800	5
9	21,377	8,879	2,730	4
10	12,730	7,308	2,250	4
11	12,834	6,696	2,318	4
12	11,523	4,142	2,257	4
13	12,863	5,964	2,258	4
14	12,945	5,913	2,290	4
15	16,715	7,463	2,934	5
16	15,210	6,340	2,280	4
17	10,587	5,113	2,250	4
18	9,872	4,556	2,280	4
19	9,872	4,591	2,432	4
20	9,602	5,113	2,277	4

SITE INFORMATION

SITE ADDRESS: 1125 IDAHO AVE., ESCONDIDO, CA 92025
APN: 234-23-101-00

SITE GROSS ACREAGE	10.28 AC
SITE NET ACREAGE	9.87 AC
PROPOSED LOTS	18

EARTHWORK VOLUME (RAW)

NOT INCLUDING SHRINKAGE/BULKING, OVEREXCAVATION, ROADWAY UNDERCUTS, OR BASIN, UTILITY, WALL, AND BUILDING SPOILS.

CUT: 13,500 CYS
FILL: 23,053 CYS

CONCEPTUAL SITE PLAN AND GRADING EXHIBIT
IDAHO 10

X ENGINEERING & CONSULTING, INC.
6 Hutton Centre Drive, Suite 650
Santa Ana, California 92707
949.522.7100 | xengineeringinc.com

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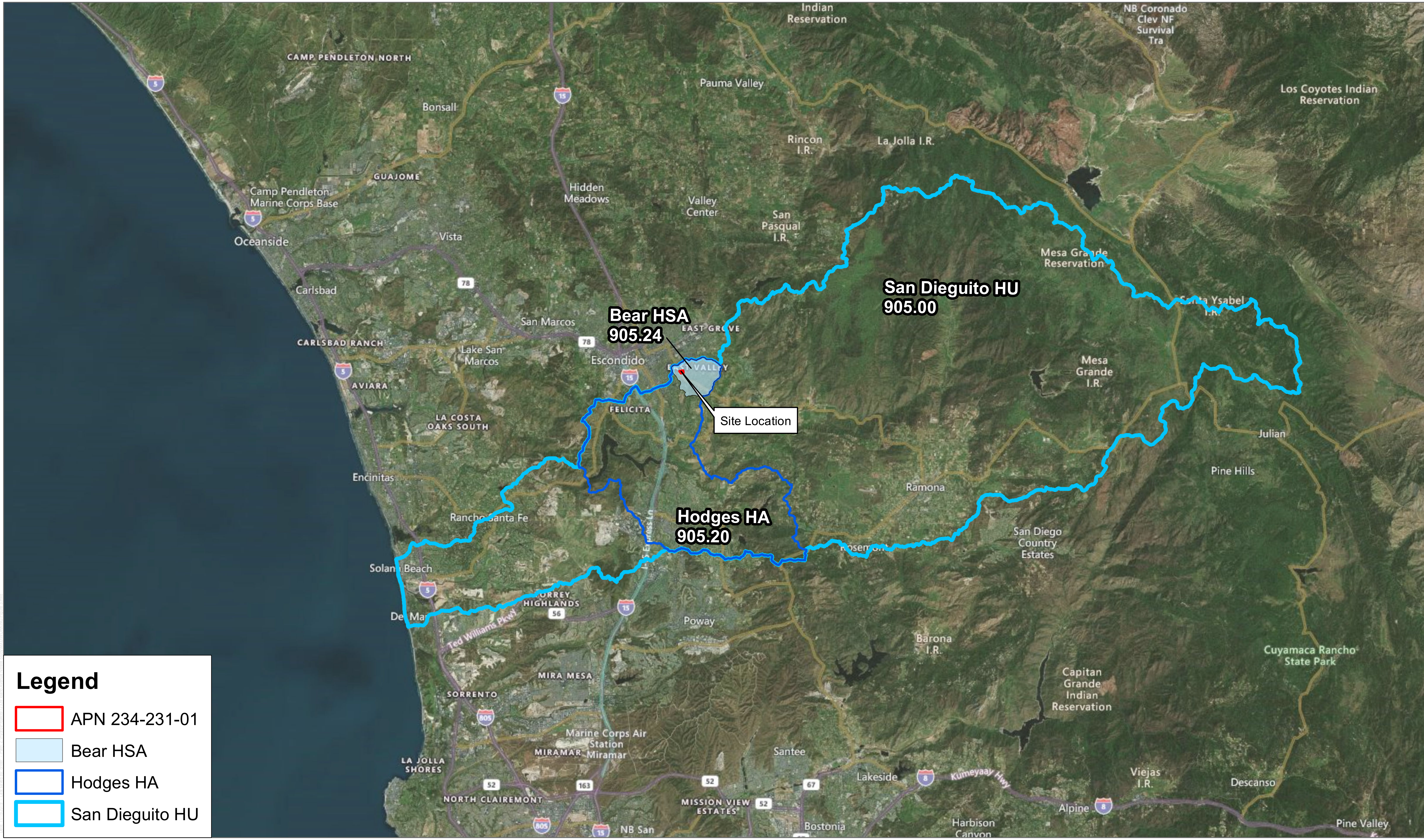

SOURCE: Bing Maps, SanGIS

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0 10,500 21,000 Feet

Figure 3
Local Hodrologic Setting

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SOURCE: Bing Maps, SanGIS

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0 50 100 Feet

Figure 4
Site Soils Map

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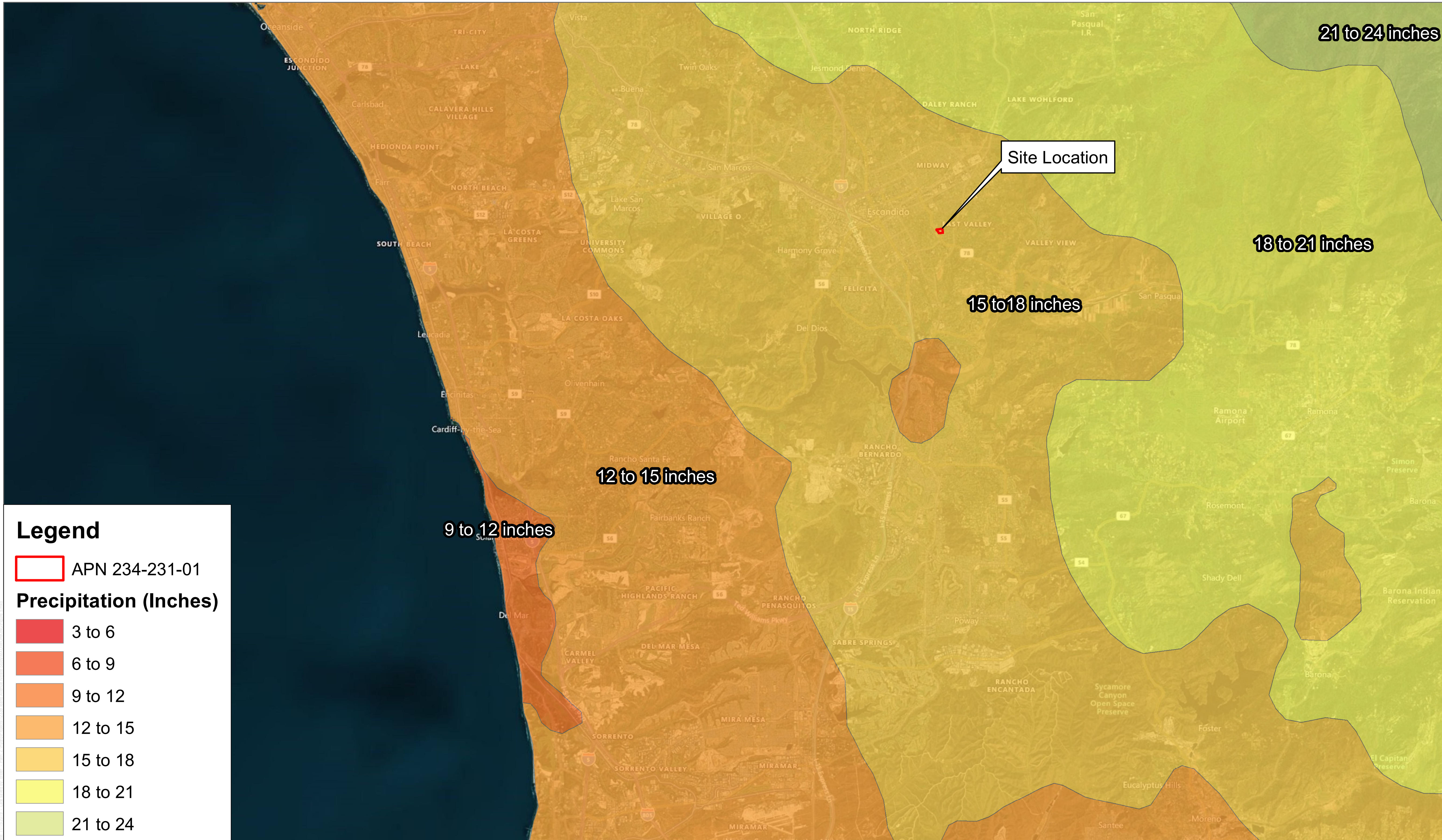

SOURCE: Bing Maps, SanGIS

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0 6,500 13,000 Feet

Figure 5
Area 30-Year Average Precipitation Data (1974-2004)