CHAPTER 2
PLAN AREA AND BASIN SETTING

2.1 DESCRIPTION OF THE PLAN AREA

As described in Chapter 1, Introduction, the Groundwater Sustainability Agency (GSA) boundary encompasses the entire Borrego Springs Groundwater Subbasin and the portion of the Ocotillo Wells Groundwater Subbasin within San Diego County.[1] The GSA comprises the County of San Diego (County) and the Borrego Water District (BWD). The California Department of Water Resources (DWR) has designated the Borrego Springs Subbasin (Subbasin) of the Borrego Valley Groundwater Basin (BVGB) to be high priority[2] and critically overdrafted (DWR 2016, 2018). The 2018 Sustainable Groundwater Management Act (SGMA) basin prioritization process automatically assigns basins considered to be in critical overdraft a high priority (DWR 2019). Under the DWR Groundwater Sustainability Plan (GSP) regulations, GSA's "have the responsibility for adopting a Plan that defines the basin setting and establishes criteria that will maintain or achieve sustainable groundwater management" (Title 23 California Code of Regulations (CCR) Section 350.4(e)).

For the purpose of this GSP, the "Plan Area" is defined as the Borrego Springs Subbasin, which has a surface area of approximately 98 square miles or 62,776 acres (Figure 2.1-1). The western and southwestern boundary of the Borrego Springs Subbasin is defined by the contact of poorly to moderately consolidated sediments with the plutonic and metamorphic basement of Pinyon Ridge and the San Ysidro Mountains. The northern and eastern boundaries are defined by the mapped trace of the Coyote Creek fault that trends northwest–southeast. East of the Coyote Creek fault lies Coyote Mountain, the Borrego Badlands, and the Ocotillo-Clark Valley Groundwater Basin. The southeastern boundary of the Plan Area is defined by the location of San Felipe ~~Wash~~Creek, as mapped by the U.S. Geological Survey (USGS) National Hydrography Dataset, which also marks the northern boundary of the Ocotillo Wells Subbasin.

Although the Plan Area is limited to the Borrego Springs Subbasin, information applicable to the Ocotillo Wells Subbasin, as well as the hydrologic characteristics of the watersheds contributing to the Borrego Springs Subbasin, is also provided in this chapter. DWR has characterized the Ocotillo Wells Subbasin as having a "very low" priority, because it meets the uniformly applied standard that any basin whose pumpers are using less than 2,000 acre-feet[3] per year (AFY) of

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[1] The Borrego Springs Groundwater Subbasin and Ocotillo Wells Groundwater Subbasin are referred to as the Borrego Springs Subbasin and the Ocotillo Wells Subbasin in this document.

[2] Basin prioritization classifies the California's 517 basins and subbasins into priorities based on components identified in the California Water Code. The priority process consists of applying datasets and information in a consistent, statewide manner in accordance to the provisions in California Water Code, Section 10933(b). Further information on DWR's basin prioritization process can be found on the following website: https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization.

[3] The volume of water required to cover 1 acre of land (43,560 square feet) to a depth of 1 foot. Equal to 325,851 gallons or 1,233 cubic meters.

groundwater be automatically assigned a very low priority, regardless of the prioritization score received from other metrics (DWR 2019). For reference, however, the Ocotillo Wells Subbasin received low priority rankings for most components of the 2018 SGMA basin reprioritization process because it has very low pumping demand, population density, and groundwater well density, as well as a lack of irrigated agriculture (DWR 2019). The Ocotillo Wells Subbasin is approximately 141 square miles or 90,075 acres. GSAs are not required to prepare a GSP for basins categorized as low or very low priority (California Water Code Section 10727).

The watersheds draining to Borrego Springs Subbasin contribute the majority of recharge to the Plan Area (focused infiltration of runoff) in the form of streamflow exiting the mountains onto the desert alluvial fans that abut the mountain front. The major contributing watersheds to the Subbasin include the Coyote Creek Watershed, which is approximately 179 square miles (114,615 acres); the Upper San Felipe Creek Watershed, which is approximately 194 square miles (124,124 acres); and the Borrego Valley-Borrego Sink Wash Watershed, which is approximately 158 square miles (101,371 acres). A summary of the groundwater subbasins, contributing watersheds and DWR designations is provided in Table 2.1-1.

Table 2.1-1
Summary of the Borrego Valley Groundwater Basin and Watershed Areas

Basin Name	Area			DWR Designations			Previous Groundwater Management Plan	2015 USGS Groundwater Basin Model	GSP Required per SGMA
	Acres	*Square Miles*	*Portion in San Diego County*	*Basin Number*	*Critically Overdrafted*	*Basin Priority*[1]			
Borrego Springs Groundwater Subbasin	62,776	98	100%	7-024.01	Yes	High	Yes[2]	Covered	Yes
Ocotillo Wells Groundwater Subbasin	90,075	141	44%[3]	7-024.02	No	Very Low	No	Partially covered	No
Watersheds Contributing to the Borrego Springs Groundwater Subbasin	277,334	433	80%[4]	*Not applicable, but relevant for recharge to the Borrego Springs Subbasin and the water budget. Consists of the Coyote Creek Watershed, Upper San Felipe Creek Watershed, and Borrego Valley-Borrego Sink Wash Watershed. This area excludes watershed areas overlapped by the Borrego Springs Subbasin*					

Notes: DWR = Department of Water Resources; USGS = U.S. Geological Survey; GSP = Groundwater Sustainability Plan; SGMA = Sustainable Groundwater Management Act.

[1] Based on the 2018 SGMA Basin Prioritization (DWR 2019).

[2] The previous Groundwater Management Plan was Adopted by the Borrego Water District in 2002 per Assembly Bill 3030 (BWD 2002).

[3] The remainder of the Ocotillo Wells Subbasin is within Imperial County.

[4] The remainder of the contributing watershed (Coyote Creek Watershed) is within Riverside County.

2.1.1 Summary of Jurisdictional Areas and Other Features

The Plan Area consists primarily of private land under County jurisdiction, which is surrounded on nearly all sides by land owned by the State of California. The developed land uses in the Plan Area include residential, agricultural, recreational, and commercial (County of San Diego 2011). The public water district serving the Plan Area is the BWD, which provides water and sewer service to the developed portions of Borrego Valley within its service area (Figure 2.1-2). BWD's service area is approximately 31,846 acres in size. Approximately 29,938 acres of BWD's service area is within the Plan Area, and the remainder, or about 1,908 acres, is outside of the Plan Area. BWD's service area covers approximately 48% of the Plan Area. With the exception of Air Ranch, a farm to the north of the BWD boundary, certain visitor facilities on Anza-Borrego Desert State Park (ABDSP) land, and a few other minor developed uses, the developed portions of the Plan Area are entirely within BWD's service area boundary. As shown on Figure 2.1-2, there are several small water systems apart from BWD that also provide water service within the Plan Area, including Anza-Borrego Desert State Park at Palm Canyon and Horse Camp, Borrego Air Ranch Water Company, and Smoke Tree Ranch. Figure 2.1-2 also shows public water districts and small water systems within Ocotillo Wells Subbasin for reference.

Approximately 67% of the Plan Area consists of private land under County jurisdiction, and 27% of the Plan Area consists of a portion of the ~~Anza-Borrego Desert State Park (~~ABDSP~~)~~, based on mapping by the California Protected Areas Database (CPAD 2017).[4] ABDSP, which is owned and managed by the California Department of Parks and Recreation, intersects the edges of the Plan Area on all sides except a small part of the northeastern border, and occupies the mountain regions above Borrego Valley (Figure 2.1-3). Approximately 5% of the land within the Plan Area is owned by the Anza-Borrego Foundation, which acquires land for conservation in and around the park, supports research in the region, and is a reserve partner in public service programs. Approximately 1% of the Plan Area is owned by the County for parks and preserves, and the BWD for operations in conjunction with BWD's pre-existing water demand reduction program. Table 2.1-2 summarizes the land ownership and jurisdiction in the Plan Area.

To evaluate current and historical land uses within the Plan Area and the Ocotillo Wells Subbasin in San Diego County, each subbasin was intersected with land use layers from the San Diego Geographic Information Source[5], which has land use mapping specific to years 1990, 1995, 2000, 2004, 2008, and 2015. The percentage of various land use categories are presented in Table 2.1-3

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[4] The California Protected Areas Database contains GIS data about lands that are owned in fee and protected for open space purposes by over 1,000 public agencies or non-profit organizations, and is produced and managed by GreenInfo Network (http://www.calands.org/data).

[5] The San Diego Geographic Information Source is a Joint Powers Authority of the City of San Diego and the County of San Diego responsible for maintaining a regional GIS landbase and data warehouse.

for the Plan Area. The land uses in the Plan Area are shown on Figure 2.1-4. The ABDSP is included as “Open Space/Undeveloped Land” in the land use mapping presented in Table 2.1-3.

Table 2.1-2
Summary of Land Ownership in the Plan Area

Ownership Type	Agency	Description	Acres / % of Total
Private	Private	Urban/developed land, rural residential, agriculture, and open space under San Diego County jurisdiction	42,022 / 67%
State	California Department of Parks and Recreation	Anza-Borrego Desert State Park	17,072 / 27%
Non-Profit	Anza-Borrego Foundation	The foundation purchases land from willing sellers for addition to Anza-Borrego Desert State Park	3,190 / 5%
County	San Diego, County of	Old Springs Road Open Space Preserve, Borrego Springs Park Site Dedication	335 / <1%
Special District	Borrego Water District	District operations and historical water demand reduction program	158 / <1%
		Grand Total	**62,776**

Source: CPAD 2017.

Within the Plan Area, the majority of the land is undeveloped open space (Table 2.1-3). The primary developed land uses in the Plan Area are agriculture, residential, transportation infrastructure, and recreational (including golf course). Less than 1% of the Plan Area consists of institutional and commercial/industrial uses. Since 1990, the coverage of agricultural, residential, and recreational uses has increased. Agriculture is the most water-intensive land use in the Plan Area. ~~Since~~ From 1995 to 2015, ~~between 3,400 and~~as much as 4,000 acres within the Plan Area were estimated to have been used for irrigated agriculture (SANGIS 2017; County of San Diego 2011; BWD 2009a) (Table 2.1-3). ~~Gradual i~~Implementation of the BWD Water Credits Program has resulted in some reductions in the extent of lands used for agriculture in recent years. As further discussed under Section 2.1.2, property owners have fallowed approximately 600 acres of agriculture in exchange for water credits that can be sold to offset future increases in municipal water demand (BWD 2015). Note that the “agriculture” category in San Diego Geographic Information Source and shown in Table 2.1-3 does not distinguish between active, irrigated, and/or fallowed agricultural land and therefore does not assign these 600 acres to a different land use category. Currently, the total area of irrigated agriculture is approximately 2,624 acres based on updated mapping at the parcel level done by the GSA in 2018. The parcel level mapping performed by the GSA is more detailed than the San Diego Geographic Information Source mapping presented in Table 2.1-3, and is therefore not directly comparable but should be considered the most accurate estimate for current conditions. The parcel level mapping includes only areas of the parcel actively irrigated and does not include areas of the parcel not irrigated such as farm roads, equipment storage areas and buildings.

Table 2.1-3
Plan Area Land Uses by Year in Acres and Percent

Land Use Category	1990		1995		2000		2004		2008		2015		1990–2015 Change	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Plan Area														
Open Space/Undeveloped Land	57,133	91.0%	55,649	88.7%	55,685	88.7%	55,054	87.7%	54,632	87.0%	54,500	86.8%	-2,632	-4.6%
Agriculture	2,343	3.7%	3,651	5.8%	3,582	5.7%	3,599	5.7%	3,472	5.5%	3,474	5.5%	1,131	48.3%
Residential	1,149	1.8%	1,288	2.1%	1,376	2.2%	1,809	2.9%	2,318	3.7%	2,369	3.8%	1,220	106.1%
Roadway/Parking Lot/Airstrip	1,048	1.7%	1,048	1.7%	1,064	1.7%	1,057	1.7%	1,064	1.7%	1,047	1.7%	-1	-0.1%
Park/Recreation/Golf Course	568	0.9%	573	0.9%	604	1.0%	723	1.2%	745	1.2%	838	1.3%	270	47.6%
Government/Other Public Institutions	300	0.5%	332	0.5%	192	0.3%	334	0.5%	335	0.5%	340	0.5%	40	13.2%
Commercial/Industrial	229	0.4%	229	0.4%	268	0.4%	195	0.3%	204	0.3%	202	0.3%	-27	1.1%

Source: SANGIS 2017.

Each jurisdictional area is described in greater detail below.

State of California

The total size of the ABDSP is about 615,000 acres. About 17,072 acres, or 27% of the Plan Area, is occupied by the ABDSP. Outside the Plan Area, the ~~Anza-Borrego Desert State Park~~ABDSP occupies 23,383 acres within the portion of the Ocotillo Wells Subbasin within San Diego County. ABDSP draws hundreds of thousands of visitors per year, the vast majority of whom arrive between November and April, with up to 35% visiting in March with significant increases in visitors occurring during the wildflower season. Most visitors are day-users, with about one in four camping overnight. Most (75%) visit the Park's northern sections. Half of visitor traffic is concentrated in the ABDSP Visitor Center/Borrego Palm Canyon area (CDPR 2015). The ABDSP Visitor Center and Palm Canyon Campground, group sites, and trailheads are located in the western part of the Plan Area, and the Vern Whitaker Horse Camp, Desert Garden, and portions of the Wildflower fields are located in the northern end of the Plan Area. The desert springs, palm groves, and the routes/trails within the hilly and mountainous areas of the park are outside the Plan Area. A 2012 economic study developed for the Anza-Borrego Foundation estimates the revenue to the region generated by visitation to the park during an average year is approximately $40 million annually (BBC 2012).

ABDSP partners with the Steele/Burnand and Anza-Borrego Desert Research Center and the Anza Borrego Foundation to advance research opportunities, and provide educational and interpretive programs. The Anza Borrego Foundation currently holds 3,190 acres (or 5% of the Plan Area) in fee for the purpose of adding to ABDSP lands for conservation in and around the Park, educating the public about the Park's resources, and supporting research relevant to the region (ABF 2017). The Steele/Burnand Anza-Borrego Desert Research Center, housed in the former Desert Club building at the western end of Palm Canyon Drive, hosts field research by biologists, astronomers, anthropologists and others, and is operated through the University of California, Irvine (UCI 2018). The center encourages research within ABDSP and its environs to foster management of the park's natural and cultural resources informed by ~~high-quality~~ science.

County of San Diego

Approximately 42,022 acres, or 67% of the Plan Area, consists of private land under County jurisdiction. Outside the Plan Area, there are approximately 15,408 acres of private land within the portion of the Ocotillo Wells Subbasin within San Diego County. The developed portions of the Plan Area consist of residential, agricultural, recreational, and commercial uses, with the majority of agricultural lands located in the northern portion of the Plan Area, where citrus crops and nursery stock, such as date palms, are grown for export out of the Subbasin (County of San Diego 2011).

The permanent population of the Plan Area is concentrated in the County-designated Borrego Springs Community Plan Area (CPA; Figure 2.1-4). About 13,283 acres of the Borrego Springs CPA extends outside the Plan Area; however, all of the currently developed portions of the CPA are within the Plan

Area. The CPA within the Plan Area covers about 49,972 acres of the Plan Area, or about 79%. Aside from California State Park wells within ABDSP, the water wells serving the Plan Area are under County and BWD jurisdiction. Based on County well permits and DWR well logs (including identification of database overlaps), BWD well data, field reconnaissance, and aerial imagery, it is estimated that there are approximately 121 active wells within the Plan Area, including municipal wells, irrigation wells, and private/domestic wells (Figure 2.1-5). Of these 121 wells, 53 are considered to be de minimis[6] users, the majority of which (49) are domestic wells. Of the non-de minimis users, 42 are in agricultural use, 8 are in municipal use by BWD, 13 are in recreational use, and the remainder are small water systems, non-recreational irrigation, and California State Park uses. The average well density within the Plan Area for all active and inactive wells is 2.6 wells per square mile (250 wells per 98 square miles). Figure 2.1-5 shows an estimate of the well density for each square mile township and range section in the Plan Area. The estimated average well density shown on Figure 2.1-5 is based on available well log records and may include wells that are inactive or abandoned.

Population within the Plan Area is reported by several sources. A substantial number of residents choose to reside in the Plan Area during the winter, spring, and fall only, when temperatures are more temperate. The seasonal change in population complicates the population counts. According to the Borrego Springs Community Plan prepared in 2011, the full-time population within the CPA was approximately 2,700, with another 2,000 or more seasonal or "snow bird" residents (County of San Diego 2011). According to the BWD Integrated Regional Water Management (IRWM) Plan prepared in 2009, the population is reported to range from less than 3,000 in summer months to over 8,000 in the height of the winter season (BWD 2009b). The 2010 Decennial Census reported a population of 3,429 and an average household size of 2.18 persons/household (U.S Census Bureau 2018; Table 2.1-4). The 2010 census counted 2,611 housing units, of which only 1,571 were found to be occupied for year-round residence, with the remainder occupied for seasonal use, not rented, or otherwise vacant (U.S. Census Bureau 2018).

It should be noted that the census count for 2010 appears to be high when compared to the population reported by the Borrego Springs Community Plan and the IRWM Plan. In addition, the 2011–2015 American Community Survey 5-Year Estimate for population within the Borrego Springs Census Designated Place (CDP) is 2,518 in 2015 (U.S Census Bureau 2018). For the purpose of projecting future growth, the 2015 estimate by the American Community Survey was used as the current population of the CDP.

Table 2.1-4 projects future population growth using a linear extrapolation of decennial census data from 1990 and the 2015 American Community Survey 5-Year Estimate. Because the 2010 census count appears to have captured at least some portion of non-permanent population, future growth population projections would be too high if based on the 2010 census count. Furthermore, the

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[6] SGMA defines a de minimis extractor as "a person who extracts, for domestic purposes, two acre-feet or less (of groundwater) per year."

apparent growth in population in 2010 is not borne out by recently observed trends (for example, the American Community Survey estimate for 2015), and the same rate of population increase is unlikely to occur when considering current and future constraints on growth. These constraints include physical constraints such as the high Plan Area coverage within the FEMA 100-year floodplain, and economic and public service constraints, which besides groundwater availability limitations, also include the lack of economic sectors that provide year-round employment and limited medical services (particularly important for the older demographic of the Plan Area).

Table 2.1-4
Historical and Projected Permanent Population

Year	Population[a]
1990	2,244
2000	2,541
2010	3,429 [b]
2015	2,518
2020[c]	2,582
2030[c]	2,714
2040[c]	2,852
2050[c]	2,998
Estimated Annual Growth Rate[d]	**0.5%**

Source: U.S. Census 2010, 2018.
Notes:

[a] Borrego Springs is a Census Designated Place. The population estimates in this table are the permanent population. Seasonal population is a large factor in Borrego Springs since the winter population may exceed 8,000 according to Borrego Water District (BWD's) Integrated Regional Water Management Plan.

[b] The 2010 census count is considered an anomalous count and is not used in the annual growth rate estimate for the reasons discussed in the preceding paragraph.

[c] Population Future = Population Current x $(1 + 0.005)^n$. Where Population Current = 2015 Population (2,518), annual growth rate = 0.005 and n = 25 years between periods.

[d] Annual growth rate = ((Present Value – Past Value)/Past Value)) x100 = Growth Rate/Years (N) = Annual Growth Rate, N = 25; The population in 1990 was used for the past value and the population in 2015 was used for the present value.

Borrego Springs Severely Disadvantaged Community

The Borrego Springs CDP is considered a ~~severely disadvantaged community, which means that households average~~Severely Disadvantaged Community (SDAC)[7] and located within an Economically Distressed Area (EDA). As defined in California Health and Safety Code, Section 116760.20, SDACs are Census geographies having less than 60% of the ~~state's~~statewide annual median household income~~;~~. ~~t~~The median household income for the Borrego Springs CDP is $36,583 per year (U.S Census Bureau 2018). As defined by California Water Code Section 79702(k), an EDA is a municipality with a population of 20,000 persons or less, a rural county, or a reasonably isolated and divisible segment of a larger municipality with a population of 20,000 persons or less, with a median household income that is less than 85% of the statewide median

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[7] Map-based DAC information developed by the DWR can be reviewed at https://gis.water.ca.gov/app/dacs/,

household income, and with one or more of the following conditions: (1) financial hardship, (2) unemployment rate at least 2% or higher than statewide average, and/or (3) low population density. The boundary of the SDAC is shown on Figure 2.1-2.

The Borrego Water District conducted a survey of municipal water user households to gather information about the community related to future water use reduction strategies. A total of 367 Borrego Municipal User surveys were collected out of 2,200 total distributed surveys. This translates to a 16.7% response rate. A total of 44 surveys were completed online via Survey Monkey, while 323 paper surveys were mailed in or collected by BWD and local promotoras. Some of the key characteristics of the SDAC community gathered as part of community characteristics survey are as follows (ENSI 2019):

- **Population, Employment, Economy, and Tourism have Large Seasonal Fluctuations**: Borrego Springs population is seasonal, with the population peaking during the high season being from October to May, during which time it is estimated that part-time residents inflate the population from a 2,518 (2015 population) up to almost two-fold. The average seasonal tenure for households reported in the Borrego Municipal User Survey was 9.8 months per year, with about 30% of households reporting they are part-time residents (less than 9 months per year). There are approximately 2,615 total housing units in Borrego Springs, with over 1,000 units estimated to be for seasonal, recreational, or occasional use.

  The majority of business activity in Borrego Springs occurs from October to May, although the village is still active during the summer months. Tourism supports lodging, food service, and retail establishments. Wintertime attractions aside from the ABDSP include golfing and related country club activities. The area experiences extreme heat during the summer months, so the primary economic activity, tourism, is largely limited to the cooler months of the year. Much of the Borrego Springs economy is supported by "outside money" such as revenue derived from tourism, retirement income, and various forms of direct government assistance.
- **Aging Population**: The median age of residents in Borrego Springs is 53.8 years, with almost 60% of the population aged 55 years or older and 31% of the population aged 65 or older. The Census estimates 45.2% of households receive Social Security income at an average of $18,201 per year, and 30.3% of households have retirement income at an average of $19,371 per year.
- **Education and Healthcare Services**: A total of 84% of students in the Borrego Springs Unified School District (BSUSD) are Hispanic/Latino and 44% of students are English Language Learners (ELL). The BSUSD includes a public elementary, middle, and high school, and oversight of three charter schools that have campuses in Borrego Springs. A total of 92% of BSUSD students are considered "socioeconomically disadvantaged," meaning neither of the student's parents have a high school diploma, or the student is

eligible for the National School Lunch Program. Borrego Springs is located within a Medically Underserved Area in San Diego County, as defined by the federal Health Resources and Services Administration. A Medically Underserved Area is an area with too few primary care providers, high poverty rates, a higher older adult population, and/or a high infant mortality rate. There is only one medical clinic that provides comprehensive healthcare for residents in the Borrego Valley, and it does not provide emergency services.

Other than agriculture, recreation, and tourism, there is no major industry or source of high-quality employment within the Plan Area likely due to its remote location. Nearly all of the SDAC community receives water service from BWD.

2.1.2 Water Resources Monitoring and Management Programs

Already existing water resources monitoring and management programs within the Plan Area are described as follows, beginning with statewide programs and ending with local programs. Since there are no surface water resources or imported water sources within the Plan Area, the programs described are exclusively related to groundwater monitoring and management. Furthermore, there are no urban water management plans or agricultural water management plans applicable to the Plan Area, because the thresholds required for the preparation of such plans under the Water Conservation Act of 2009, also known as Senate Bill (SB) X7-7 (California Water Code, Section 10610 et seq.), are not exceeded. BWD does not qualify as an urban water supplier, as defined in California Water Code, Section 10617, because it does not serve more than 3,000 customers or supply more than 3,000 AFY. BWD serves potable water through 2,059 water meters and related infrastructure and provided approximately 1,645 AFY of water in 2016, with a 10-year average (between 2005 and 2015) of 2,502 AFY. Furthermore, BWD is not an agricultural water supplier[8] and thus is not required to prepare an agricultural water management plan.

California Statewide Groundwater Elevation Monitoring Program

In response to SB ~~x~~X7-6, passed by the legislature in 2009, DWR developed the California Statewide Groundwater Elevation Monitoring (CASGEM) Program to encourage collaboration between local monitoring parties and DWR and to collect statewide groundwater elevations for the purpose of tracking seasonal and long-term groundwater elevation trends in groundwater basins statewide. DWR works cooperatively with local agencies, referred to as CASGEM "Monitoring Entities," to collect and maintain groundwater elevation data in a manner that is readily and widely available to the public through the CASGEM online reporting system.

The BWD and the County are the Monitoring Entities for the purpose of tracking groundwater elevation trends within the BVGB. Both parties have been reporting groundwater levels to the

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[8] An "Agricultural water supplier" is defined as a water supplier, either publicly or privately owned, providing water to 10,000 or more irrigated acres, excluding the acreage that receives recycled water (California Water Code, Section 10608.12(a)).

CASGEM online reporting system at least semi-annually since 2011. Within the Borrego Springs Subbasin, the County has been submitting groundwater elevation data for two wells (Dr. Nel and MW-5B), and the BWD has been submitting groundwater elevation for eight wells (RH~~ID1~~-1, ID4-1, ID4-2, ID4-6, MW-1, MW-3, MW-4, and Paddock).

Data collected as part of the CASGEM program have been integrated into the BVGB data management system, the Borrego Valley Hydrologic Model (BVHM), and the monitoring and reporting program developed as part of this GSP. The groundwater elevation data collected through the CASGEM program are also made available to the public through DWR's "Groundwater Information Center (GIC) Interactive Map" application.[9]

Assembly Bill 3030: Borrego Water District Groundwater Management Plan

BWD adopted a Groundwater Management Plan (GMP) in 2001. However, the GMP will no longer be in effect once the GSP is adopted (California Water Code, Section 10750.1(a)).

Under the existing GMP, BWD is the designated Assembly Bill (AB) 3030 groundwater management agency and, per California Water Code, Section 10754, has had the authority of a groundwater replenishment district for the BVGB (BWD 2002). Under the groundwater replenishment district law (California Water Code, Section 60220 et seq.), BWD has the authority, among other powers, to buy and sell water, exchange water, distribute water in exchange for ceasing or reducing groundwater extraction, recharge the basin, and build necessary works to achieve groundwater replenishment. Additionally, BWD has the authority to levy a replenishment assessment, but only if replenishment water is available. The intent of AB 3030 was for water districts to obtain the voluntary agreement of large water users regarding how much groundwater they would extract and how much they would rely upon purchasing imported water. BWD has used AB 3030 to do groundwater planning even though it is an isolated basin that has no access or right to any imported surface water from either the Colorado River or state water derived from the Sacramento-San Joaquin Delta.

Prior to implementation of this GSP, the BVGB remains an unmanaged basin, as the statutory provisions of the AB 3030 did not provide adequate authority for establishing a managed basin in the absence of imported water. Additionally, AB 3030 did not provide a cost-effective means to collect water extraction fees. For these reasons, BWD has previously attempted to address groundwater overdraft in the Plan Area through voluntary measures (BWD 2002, 2010). These measures have been paid for primarily by BWD's ratepayers through new development, although the water used by BWD ratepayers between 2010 and 2015 accounted for only approximately 10%–12% of annual withdrawals from the Borrego Springs Subbasin. Since 2002, despite the efforts of the Borrego Valley stakeholders

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[9] http://www.water.ca.gov/groundwater/MAP_APP/index.cfm.

to address and manage the area's groundwater resources, the BWD has lacked the authority and funding mechanisms to eliminate the overdraft within the Plan Area.

Integrated Regional Water Resources Management Plan

The Anza-Borrego Desert IRWM Region (Region), was formally approved through the California DWR's Region Acceptance Process in 2009. In 2006, the BWD began working to secure a position within an IRWM Region in the San Diego or Colorado River Funding Areas. However, these attempts were unsuccessful due to jurisdictional boundary considerations. In 2009, BWD partnered with the County and Resource Conservation District of Greater San Diego County to form the Anza-Borrego Desert IRWM Region, to better reflect the geologic and hydrologic conditions of the Borrego Valley area. The original Region Acceptance Process submittal for the Borrego Valley area was limited to the Borrego Valley Watershed within San Diego County but was later expanded to include the portion of San Diego County that lies in the Colorado River Hydrologic Basin, the entire Borrego Valley Watershed that extends into Riverside County, and the area of San Diego County east of the Tecate Divide. The expanded Region includes the entire Anza-Borrego Desert State Park, four public water purveyors, and six separate tribal lands. The IRWM Plan prepared in 2009 presented an update on the water management and conservation measures being implemented or contemplated by stakeholders in the BVGB, including an evaluation of alternatives and costs for augmenting water resources by importing non-local supplies from sources outside the BVGB (BWD 2009b). The report accompanied applications to receive state grant funding through Proposition 50 (and subsequently Proposition 84) for a proposed water importation pipeline. Ultimately, BWD did not receive funding for the projects contemplated in the IRWM Plan.

The BWD is engaged in a Conservation Management Program as part of its continued efforts to preserve groundwater resources (BWD 2009b). The program is designed to reduce water use and mitigate impacts of new water uses in the community. The program includes a tiered rate schedule for residential, commercial, and irrigation water usage. Conservation incentive policies include an education program, promotion of low flush toilets, low water use washing machines, turf removal, and irrigation efficiency auditing (BWD 2009b).

Porter–Cologne Water Quality Control Act and Clean Water Act Permitting

The Porter–Cologne Water Quality Control Act (codified in California Water Code, Section 13000 et seq.) is the primary state water quality control law for California; whereas, the federal Clean Water Act applies to all waters of the United States, the Porter–Cologne Act applies to waters of the state[10], which includes isolated wetlands and groundwater in addition to federal waters. It is implemented by the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control

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[10] "Waters of the state" are defined in the Porter–Cologne Act as "any surface water or groundwater, including saline waters, within the boundaries of the state" (California Water Code, Section 13050(e)).

Boards (RWQCBs). In addition to other regulatory responsibilities, the RWQCBs have the authority to conduct, order, and oversee investigation and cleanup where discharges or threatened discharges of waste to waters of the state could cause pollution or nuisance, including impacts to public health and the environment. The BVGB is within the Colorado River Basin (RWQCB Region 7) and within the Anza Borrego Hydrologic Unit per the RWQCB Basin Plan. These statutes are relevant to the GSP in that they regulate the quality of point-source discharges (e.g., wastewater treatment plant effluent, industrial discharges, and on-site wastewater treatment systems (OWTSs) and non-point source discharges (e.g., stormwater runoff) to the underlying aquifer.

The *Water Quality Control Plan for the Colorado River Basin* (Basin Plan) designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters addressed through the Basin Plan (California Water Code, Sections 13240–13247). The Porter–Cologne Act provides the RWQCBs with authority to include within their basin plan water discharge prohibitions applicable to particular conditions, areas, or types of waste. The Basin Plan is continually being updated to include amendments related to implementation of total maximum daily loads, revisions of programs and policies within the Colorado River Basin RWQCB region, and changes to beneficial use designations and associated water quality objectives. The beneficial uses for groundwater for the Anza Borrego Hydrologic Unit are MUN,[11] IND,[12] and AGR[13]. According to the SWRCB "Sources of Drinking Water" policy, as adopted by the SWRCB on May 19, 1988 (Resolution No. 88-63), groundwater is considered to be suitable, or potentially suitable, for municipal or domestic water, except where:

- Total dissolved solids (TDS) exceed 3,000 milligrams per liter (mg/L) (5,000 microSiemens, electrical conductivity), and it is not reasonably expected by the RWQCB to supply a public water system;
- There is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use using either BMPs or best economically achievable treatment practices; or
- The water source does not provide sufficient water to supply a single well capable of producing an average, sustained yield of 200 gallons per day (gpd).

The Basin Plan recognizes that some hydrologic units contain multiple aquifers that may each support different beneficial uses.

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[11] Municipal and Domestic Supply: Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

[12] Industrial Service Supply: Uses of water for industrial activities that do not depend primarily on water quality, including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

[13] Agriculture Supply: Uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

The Basin Plan also designates beneficial uses for surface waters. The designated beneficial uses for San Felipe Creek are agriculture; fresh water replenishment; groundwater recharge; water contact and non-water contact recreation; warm freshwater habitat; wildlife habitat; and preservation of rare, threatened, or endangered species. The Borrego Sink Wash, receiving flows from ephemeral streams, is listed in the Basin Plan as having intermittent beneficial uses of fresh water replenishment, groundwater recharge, non-water contact recreation, and wildlife habitat. The Porter–Cologne Act requires a "Report of Waste Discharge" for any discharge of waste (liquid, solid, or otherwise) to land or surface waters that may impair a beneficial use of surface or groundwater of the state. California Water Code Section 13260 subdivision (a) requires that any person discharging waste or proposing to discharge waste—other than to a community sewer system—that could affect the quality of the waters of the state, file a Report of Waste Discharge with the applicable RWQCB. For discharges directly to surface water (waters of the United States), a National Pollutant Discharge Elimination System (NPDES) permit is required, which is issued under both state and federal law; for other types of discharges, such as waste discharges to land (e.g., spoils disposal and storage), erosion from soil disturbance, or discharges to waters of the state (such as groundwater and isolated wetlands), Waste Discharge Requirements (WDRs) are required and are issued exclusively under state law. WDRs typically require many of the same best management practices (BMPs) and pollution control technologies as required by ~~National Pollutant Discharge Elimination System~~NPDES-derived permits.

The ~~National Pollutant Discharge Elimination System~~NPDES and WDR programs regulate construction, municipal, and industrial stormwater and non-stormwater discharges under the requirements of the Clean Water Act and the Porter–Cologne Act, respectively. The construction and industrial stormwater programs are administered by the SWRCB; whereas, individual WDRs, low-threat waivers, and other basin-specific programs are administered by the Colorado River Basin RWQCB. Programs and policies that have particular relevance to the BVGB include the following:

- **Stormwater General Permits (construction and industrial general permits)**: The SWRCB and Colorado River Basin RWQCB administer a number of general permits that are intended to regulate activities that collectively represent similar threats to water quality across the state and thus can appropriately be held to similar water quality standards and pollution prevention BMPs. Construction projects over 1 acre in size are regulated under the Statewide Construction General Permit and are required to develop and implement a Stormwater Pollution Prevention Plan. Similarly, industrial sites are also required to develop a Stormwater Pollution Prevention Plan that identifies and implements BMPs necessary to address all actual and potential pollutants of concern. The entities within the BVGB currently subject to an industrial Stormwater Pollution Prevention Plan include Borrego Landfill Inc., the Borrego Valley Airport, and the ~~Borrego Springs Unified School District~~BSUSD (for its bus maintenance yard) (SWRCB 2018).

- **Irrigated Lands Regulatory Program**: Water discharges from agricultural operations include irrigation runoff, flows from tile drains, irrigation return flows, and stormwater runoff. These discharges can affect water quality by transporting pollutants, including pesticides, sediment, nutrients, salts (including selenium and boron), pathogens, and heavy metals, from cultivated fields into surface waters and/or groundwater. To prevent agricultural discharges from impairing the waters that receive these discharges, the Irrigated Lands Regulatory Program (ILRP) regulates discharges from irrigated agricultural lands. This is done by issuing WDRs or conditional waivers of WDRs to growers. These orders contain conditions requiring water quality monitoring of receiving waters and corrective actions when impairments are found. Through a series of events related to the passage of SB 390 (Alpert), the ILRP originated in 2003. Initially, the ILRP was developed for the Central Valley RWQCB. As the Central Valley RWQCB ILRP progressed, a groundwater quality element was added to the filing requirement for agricultural lands that had previously been subjected to only surface water discharge concerns. To date, the different RWQCBs are in different stages of implementing the ILRP. The Colorado River RWQCB has a conditional waiver program for farms in the Imperial Valley but does not have a similar program for the Borrego Valley.
- **OWTS Requirements**: Requirements for the siting, design, operation, maintenance, and management of OWTSs are specified in the SWRCB's "Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems (~~OTWS~~ OWTS Policy)." The OWTS policy sets forth a tiered implementation program with requirements based upon levels (tiers) of potential threat to water quality. The OWTS policy includes a conditional waiver for on-site systems that comply with the policy. The County Department of Environmental Health (DEH) enforces these statewide requirements through Chapter 3, Division 8, of Title 6 of the San Diego County Code and the Local Agency Management for OWTS. The DEH Local Agency Management Program for OWTS prepared by the County in February 2015 applies to both the San Diego and Colorado River Basin RWQCBs. Provided that no public sanitary sewer system is available, the ordinance allows for installation of OWTS if the requirements and standards of the ordinance are complied with, and a permit issued by the DEH is obtained. Standards and requirements include, but are not limited to, soil percolation tests to determine soil suitability; the selection of a treatment system appropriate for the site conditions; groundwater separation requirements; contractor licensing requirements; and specific layout/setback requirements from lakes, streams, ponds, slopes, and other utilities and structures. The County DEH also provides permitting services for graywater systems.
- **Individual WDRs**: Individual WDRs are required for point source discharges to land not otherwise covered under a general permit program or conditional waiver. The purpose of individual WDRs are to define discharge prohibitions, effluent limitations, and other water

quality criteria necessary to ensure discharges do not result in exceedances of Basin Plan objectives for receiving waters, including groundwater. Examples of individual WDRs in the Plan Area include those for the Rams Hill Wastewater Treatment Facility (~~WWTP~~WWTF) owned and operated by BWD (Colorado River Basin RWQCB Order No. R7-2007-0053) and the Borrego Springs Landfill (Order No. R7-2014-0051).

Implementation of the GSP would not affect the applicability or implementation of the regulatory programs discussed above, and continued implementation of Porter–Cologne Water Quality Control Act and Clean Water Act permitting would advance the GSP's sustainability goals. The County requires that new development and redevelopment projects proposed within the Subbasin comply with NPDES permits, WDRs, and OWTS requirements as part of its permitting and approval process. These programs will continue to provide benefits to water quality by requiring both point and non-point discharges to comply with Basin Plan water quality objectives and to be protective of Basin Plan beneficial uses throughout SGMA's planning and implementation horizon. In addition, the application of stormwater permits means specific performance standards for capture and infiltration of stormwater runoff would be implemented where applicable, providing opportunities for enhanced recharge of the Subbasin.

Demand Offset Mitigation Water Credits Policy

The current Demand Offset Mitigation Water Credits Policy (WCP) was initiated in 2004 as a means for the BWD and later the County to encourage the voluntary immediate cessation and/or reduction of measurable water use in the Subbasin. The objectives of the WCP include: (a) to reduce the demand on the upper groundwater aquifer that underlies the Borrego Valley; (b) to provide a mechanism by which new water demands are mitigated in compliance with the California Environmental Quality Act (CEQA); and (c) to create economic incentives for property owners engaged in high water demand activities to cease or reduce their groundwater demands consistent with the objectives of the BWD GMP as adopted by the BWD in 2001, and as subsequently amended and updated (BWD 2015). The WCP is designed to encourage the conversion of local farmland and high water use areas (i.e., golf courses) to land uses with less water demand. A Memorandum of Agreement between the County and the BWD identifies criteria that must be met to receive water credit for fallowed lands (BWD and County of San Diego 2013).

The BWD began issuing credits in 2008 that did not necessarily meet County approval standards but abided by the BWD's WCP and aimed to further encourage reduced groundwater demand within the Subbasin. A water credit is an entitlement created under the WCP that recognizes the fallowing of actively irrigated land in the Plan Area. Water credits can be used to offset the future groundwater use of proposed development. One water credit is defined as 1 AFY of groundwater use. The number of water credits issued is calculated by multiplying the total area of irrigated land by a groundwater consumptive use factor based on crop type. Water credits for future groundwater use are made available by the BWD and can be obtained from private landowners with existing water credits issued by the BWD. Although the County can decide if water credit applications meet County requirements, BWD has authority and has issued credits without County input.

To date, fallowed sites are placed in one of two categories: (1) groundwater restrictive easements on lands that were fallowed as direct mitigation measures for development in which no water credits were assigned and (2) fallowing and/or groundwater reduction measure sites that were allotted water credits by the BWD without being related to any particular development. Four groundwater restrictive easements have thus far been issued for direct mitigation, and 12 groundwater restrictive easements for water credits. To date, these fallowed lands consist of approximately 600 acres of irrigated land and 1,886.5 originally issued credits~~[14]~~. Of this total, the County has approved approximately 178 acres and 727 credits. As of December 2018, 46.5 AFY have been retired, and there are 1,840 AFY remaining water credits. ~~The County is also currently conducting compliance and enforcement evaluations related to the credits issued by the BWD program.~~ At a later date, existing water credits associated with the WCP may be converted to a Baseline Pumping Allocation using the groundwater consumptive use factors developed by the GSA, as further discussed in Section 4.4, Pumping Reduction Program.

Groundwater Mitigation Program

By resolution, the BWD implemented a groundwater mitigation program that works in conjunction with the County's *Department of Planning & Land Use Policy Regarding Cumulative Impact Analyses for Borrego Valley Groundwater Use* (adopted in 2004) in the Borrego Valley (County of San Diego 2007). The County policy, originally adopted in 2004, and most recently revised in 2007, requires all proposed development projects subject to discretionary land use review by the County[15] to also be reviewed for potential adverse impacts on the Borrego Springs Subbasin. The County requires these projects to demonstrate that the proposed water demands are offset by an equal water demand reduction or additional water supply (County of San Diego 2007). In 2016, the BWD implemented a more stringent policy in anticipation of SGMA, in which all new development in Borrego Springs supplied by the BWD must retire existing water demands on a 4:1 basis (BWD Resolution No. 2016-01-01).

In 2019, the Governor's Office of Planning and Research released an update to the CEQA Guidelines that included a new requirement to analyze discretionary projects for their compliance with adopted GSPs. Specifically, the new applicable significance criteria include the following:

~~[14] These credits are representative of approximately 1,600 acre feet per year (rounded).~~

[15] This means discretionary land development applications for a project which proposes to use groundwater, including but not limited to, (a) general plan and specific plan adoptions and amendments, (b) tentative and revised tentative maps and parcel maps, (c) zoning and use regulation amendments, (d) major use permits or modifications, (e) certificates of compliance, and (f) lot line adjustments.

- Would the program or project substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin?
- Would the program or project conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?

Therefore, to the extent general plans allow growth that could have an impact on groundwater supply, such projects would be evaluated for their consistency with adopted GSPs and for whether they adversely impact the sustainable management of the Subbasin. Under CEQA, potentially significant impacts identified must be avoided or substantially minimized unless significant impacts are unavoidable, in which case the lead agency must adopt a statement of overriding considerations.

County of San Diego Groundwater Ordinance

The County adopted the San Diego County Groundwater Ordinance in 1991; it was last amended in 2013 (San Diego County Code Title 6, Division 7, Chapter 7, Secs. 67.701 through 67.750). The ordinance establishes legal standards for the protection, preservation, and maintenance of groundwater resources. One of the purposes of the ordinance is to ensure that development is not approved in groundwater-dependent areas of the County unless a project applicant can demonstrate that there are adequate supplies available to serve both existing and proposed uses (County of San Diego 2013). The ordinance includes provisions specific to the Borrego Valley Exemption Area, in which a project[16] that will extract or use at least 1 AFY is required to include one or more groundwater use reduction measures listed in in the ordinance to meet the performance standard of "no net increase" in the amount of water extracted from the basin. The ordinance incorporates the aforementioned groundwater mitigation and water credits program so that land use approvals do not occur within the BVGB without complying with the performance standard of "no net increase" in water demand. Updates to the Groundwater Ordinance are anticipated to ensure consistency with GSP sustainability goals.

Permitting of New Well, Replacement Well, and/or Well Destruction/Abandonment

The San Diego County DEH, Land and Water Quality Division, regulates the design, construction, modification, and destruction of water wells throughout San Diego County to protect San Diego County's groundwater resources (County of San Diego 2016). San Diego County Code, Sections 67.401 through 67.424, provide the regulatory authority to DEH to require and issue water well permits. In addition, Section 67.421 adopts standards from DWR Bulletin 74-81 and 74-90 (i.e., California Well Standards) for the construction, repair, reconstruction or destruction of wells (DWR

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[16] A project is defined in the ordinance as any of the following: General Plan and Specific Plan Adoptions and Amendments, new or revised Tentative Parcel Maps and Tentative Maps, Zoning Reclassifications, new or modified Major Use Permits, Certificates of Compliance filed pursuant to San Diego County Code, Section 81.616.1 or 81.616.2, or in some cases Lot Line Adjustments filed pursuant to San Diego County Code, Section 81.901 et seq.

1981, 1991). California's Water Well Standards include requirements to avoid sources of contamination or cross-contamination, proper sealing of the upper annular space (i.e., first 50 feet), disinfection of the well following construction work, use of appropriate casing material, and other requirements. The County requires wells to meet certain setback criteria (e.g., septic system setback) and specific construction and sealing requirements. In addition, well drilling activities are required to reduce pollution to the maximum extent practicable using BMPs such as installing a sediment basin to contain run-off, using geotextile fabric to contain sediments and drilling mud, or eliminating the use of drilling foam (County of San Diego 2016).

The DEH monitors and enforces these standards by requiring drilling contractors with a valid C-57 license to submit permit applications for the construction, modification, reconstruction (i.e., deepening), or destruction of any well within its jurisdiction. The processing and issuance of a water well permit is currently considered a ministerial action, meaning permits are issued to drillers meeting California Water Well Standards and County sealing requirements, and notwithstanding errors in the application. Certain circumstances, however, such as when installing a well could cause the spread of contaminants to uncontaminated water zones, may prevent DEH from issuing a well permit.

The passage of SB 252 added Article 5, Wells in Critically Overdrafted Groundwater Basins, to chapter 10 of the California Water Code requiring collection of specific information for water wells proposed in critically overdrafted groundwater basins. To facilitate the collection of the required information, DEH has revised the Well Permit Application and created a Supplemental Well Application. The Supplemental Well Application is included in the Well Permit Application and must be submitted for wells proposed in the Borrego Springs Subbasin. Wells drilled by the BWD to provide water solely for the residents are exempt from this requirement. The provisions of SB 252 are effective until January 30, 2020. Consistent with SGMA, SB 252 was passed to support groundwater management by local agencies.

2.1.3 Land Use Considerations

County of San Diego General Plan

The County's General Plan outlines the County's vision for growth, community services, infrastructure, quality of life, and environmental resources. The Land Use Element is a framework that provides maps, goals, and policies that guide planners, the general public, property owners, developers, and decision makers as to how lands are to be conserved and developed in unincorporated San Diego County.

A major component to guiding the physical planning of San Diego County is the "Community Development Model." The Community Development Model is implemented by three regional categories—Village, Semi-Rural, and Rural Lands—that broadly reflect the different character and land use development goals of San Diego County's developed areas, its lower-density residential and agricultural areas, and its very low–density or undeveloped rural lands. The Community Development Model directs the highest intensities and greatest mix of uses to Village areas, while directing lower-intensity uses, such as estate-style residential lots and agricultural operations, to Semi-Rural areas. The Semi-Rural category may effectively serve as an edge to the Village, as well as a transition to the lowest-density category, Rural Lands, which represent large, remote areas where only limited development may occur. The General Plan Land Use Element includes a Community Services and Infrastructure section, which addresses the availability of public infrastructure such as roads, drainage facilities, sewer and water lines, and treatment plants, as appreciable growth cannot occur without such services being available or in place.

The General Plan land use categories within the Plan Area are shown on Figure 2.1-6. It should be noted that General Plan land use categories mapped within the Plan Area may not necessarily mirror the actual land uses on the ground, which are described in Section 2.1.1 and Table 2.1-4. For example, a large portion of the Plan Area mapped as rural or semi-rural residential (RL or SR) currently has an open space/undeveloped land use. In addition, there is no General Plan land use distinction between rural residential and agricultural uses, as the agricultural areas in the northern part of the basin have the RL and SR general plan land use designations. Overall, the most intensive General Plan land use categories are village residential, commercial, and industrial, and these are concentrated in a small portion of the Plan Area generally along the east-west Palm Canyon Drive and the north-south portion of Borrego Springs Road. Rural land designations dominate the Plan Area, with the portion of the Plan Area belonging to ABDSP shown as "public agency lands."

The development and implementation of the GSP is relevant to several General Plan elements, including the Land Use Element, Conservation and Open Space Element, and the Housing Element. The Land Use Element includes a requirement to document and annually review floodways and floodplains (LU-6.12) and to encourage sustainable use of groundwater and properly manage groundwater recharge areas (LU-8). The Conservation Element identifies and describes the natural resources of the County and includes policies and action programs to conserve those resources. The Conservation and Open Space Element identifies policies necessary to achieve (a) long-term viability of the County's water quality and supply through a balanced and regionally integrated water management approach (Goal COS-4), and (b) protection and maintenance of local reservoirs, watersheds, aquifer-recharge areas, and natural drainage systems to maintain high-quality water resources (Goal COS-5). The Housing Element describes the County's plan to provide decent and affordable housing, including appropriately designated land, opportunities for developing a variety of housing types, and policies and programs designed to assist in the development of housing for all income levels and special needs.

The Regional Housing Needs Assessment for San Diego County for 2013–2020 period projects an additional 22,412 residential units, 80% of which are to be accommodated within the San Diego County Water Authority boundary, where water and other public services are more readily available

(County of San Diego 2011).[17] The eastern extent of the San Diego County Water Authority in North County is the Ramona Municipal Water District located about 30 miles west of the Plan Area. Recognizing the constraints on growth presented by the lack of readily available water sources and other public services, the last General Plan Update (adopted in 2011) substantially reduced the degree to which backcountry communities such as Borrego Springs were expected to meet the future housing demand. The General Plan Update reduced the maximum allowable additional residential units in Borrego Valley from 19,466 units to about 8,689 units (County of San Diego 2011).

Under the County's current zoning, there are 3,454 vacant and undeveloped parcels that could be converted to residential development and 526 vacant and undeveloped lots that potentially could be converted to commercial, industrial, office space, rural commercial, open space, public agency, or public/semi-public facilities (SANGIS 2017; County of San Diego 2011). This GSP uses the legal lot status estimate of 85% from the *Evaluation of Groundwater Conditions in Borrego Valley* to develop a more realistic number of buildable lots (County of San Diego 2010). The County developed this estimate considering that:

> "Having a legally created lot which meets Zoning requirements still may not be buildable due to a number of factors such as floodplain issues, having legal access to roadways, having access to sewer or water, etc. Building permits are granted on a case-by-case basis by the County, and it is not possible to accurately estimate the number of legally buildable parcels in Borrego Valley. However, the significant inventory of existing unbuilt lots could possibly provide up to an additional 3,000+ future residential units without any additional subdivision (County of San Diego 2010)."

Zoning ordinance designations for the Plan Area are shown on Figure 2.1-7. It should be noted that only 19 building permits for residential units have been issued in Borrego Springs since 2011 (County of San Diego 2018). As of 2018, there are approximately 2,615 existing residential units within Borrego Springs (County of San Diego 2018).

The 2011 County of San Diego General Plan Update Programmatic Environmental Impact Report (EIR) included a groundwater study that evaluated the impacts that maximum buildout under the 2011 General Plan would have on groundwater. The Programmatic EIR concluded that the buildout of the General Plan Update would have a potentially significant impact to the Borrego Valley aquifer in Borrego Springs. The General Plan Update groundwater study indicated that the General Plan Update allows for an additional 8,689 residential units, plus an additional 3,000+ residential units without subdivision, for a total of 11,689 additional units. Assuming 0.5 acre-feet/year water demand per residential unit, this would equate to 5,844.5 acre-feet/year for the 11,689 units. Future general plan and community plan updates should consider the sustainability

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[17] The Regional Housing Needs Assessment is a state-supervised process by which the San Diego Association of Governments allocates to its local jurisdictions their share of an eleven-year projected housing need at various affordability levels

goals of this GSP. Updated buildout estimates should be considered in conjunction with the sustainability goals, projects, and management actions outlined in this GSP.

Table 2.1-5 provides the residential buildout potential of the existing General Plan.

Table 2.1-5
General Plan Residential Buildout in Borrego Springs Subbasin

General Plan Residential Capacity	Number of Units
Existing Residential Units	2,615
Vacant Buildable Lots (Without Further Subdivision)	3,000+
Additional General Plan Capacity (Requires Future Subdivision)	8,689
Total	**14,304**

The County uses General Plan elements, goals, and policies to guide its discretionary permit decision making, and the policies relevant to the Borrego Springs Subbasin are included in Table 2.1-6.

Borrego Springs Community Plan

The CPA applicable to the Borrego Springs Subbasin is the Borrego Springs Community Plan (County of San Diego 2011). ~~Community plans are part of the General Plan. These~~ A community plan~~plans~~ focuses on a particular region or community within the overall General Plan area. They are meant to refine the policies of the General Plan as they apply to a smaller geographic region and provide a forum for addressing unique local issues. As required by state law, community plans must be internally consistent with General Plan goals and policies of which they are a part. They cannot undermine the policies of the General Plan. Community plans are subject to adoption, review, and amendment by the County Board of Supervisors in the same manner as the General Plan. Table 2.1-~~5~~ 6 presents a summary of general plan and community plan elements, goals, and policies in the Plan Area.

When the County prepares its next General Plan (including community plan) update for Borrego Springs, this GSP will be a key consideration with respect to related goals and policies. The implementation of this GSP and the County's General Plan update process are separate but related processes. Review of the policies in Table 2.1-6 indicate that the current policies are generally consistent with the sustainability goals of this GSP. The existing General Plan designations and policies allow for growth (e.g., community plan goal LU-2.4) and promote agricultural conservation (e.g., General Plan goals LU-7 and COS-6) in a manner that may be inconsistent with the sustainability criteria, pumping reduction program, and the agricultural land fallowing program described in Chapters 3 and 4 of this GSP. However, there are no urban water management plans or agricultural water management plans applicable to the Plan Area that contain assumptions or projections of water supply/demand that would be in conflict with implementation of this GSP (e.g., too generous given the GSP's sustainability goals). Existing County land use regulations, including the Demand Offset Mitigation WCP, the Groundwater Mitigation Program, the Groundwater Ordinance, and the CEQA process, significantly constrain growth by requiring that new land uses result in no net increase in water demand. This, along with economic factors and other public service constraints, is the reason such limited growth has occurred in the Subbasin (e.g., issuance of only 19 building permits for residential units since 2011).

~~The~~ At the next County~~, in conjunction with adoption and implementation of the GSP, will ensure~~ General Plan update, land use policies ~~are~~ will be brought in line with the sustainability goals of this GSP. This will be done by considering the sustainability goals and the projects and management actions of the GSP in the updated ~~General Plan and~~ community plan~~,~~ and through revisions to the County's groundwater ordinance. Furthermore, all future general plan and community plan updates will undergo an analysis of environmental impacts under the CEQA, which now includes a new requirement to analyze programs and projects for their compliance with adopted GSPs. The implementation of existing land use plans would not affect the ability of the GSA to achieve sustainable groundwater management over the planning and implementation horizon.

The Borrego Springs Community Sponsor Group is a seven-member group of representatives that assists the County Planning Director, the Zoning Administrator, the Planning Commission, and the Board of Supervisors in the preparation, amendment, and implementation of community and subregional plans. The principal function of a sponsor group is to be an information link between the community and the County on matters dealing with planning and the use of land in its community. The group provides a public forum for the discussion of planning issues that are important to the community. All meetings are open to the public, held in a publicly accessible place, and the agenda is published in advance according to Brown Act provisions.

Table 2.1-6
Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Element	Policy	Description	GSP Consistency
County of San Diego General Plan			
Land Use Element	Goal LU-5: Climate Change and Land Use		
	LU-5.2	Incorporate into new development sustainable planning and design.	Yes
	LU-5.3	Ensure the preservation of existing open space and rural areas (e.g., forested areas, agricultural lands, wildlife habitat and corridors, wetlands, watersheds, and groundwater recharge areas) when permitting development under the Rural and Semi Rural Land Use Designations.	Yes
	Goal LU-6: Development—Environmental Balance		
	LU-6.1	Require the protection of intact or sensitive natural resources in support of the long-term sustainability of the natural environment.	Yes

Table 2.1-6
Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Element	Policy	Description	GSP Consistency
	LU-6.3	Support conservation-oriented project design.	Yes
	Goal LU-7: Agricultural Conservation		
	LU-7.1	Protect agricultural lands with lower-density land use designations that support continued agricultural operations.	Supporting continued agricultural operations in Borrego Valley at current groundwater extraction rates may be inconsistent with the goal of reducing groundwater demand.
	LU-7.2	Allow for reductions in lot size for compatible development when tracts of existing historically agricultural land are preserved in conservation easements for continued agricultural use.	Yes, although pumping limits in GSP will restrict continued expansion of agricultural lands.
	Goal LU-8: Aquifers and Groundwater Conservation		
	LU-8.2	Require development to identify adequate groundwater resources in groundwater dependent areas. In areas dependent on currently identified groundwater overdrafted basins, prohibit new development from exacerbating overdraft conditions. Encourage programs to alleviate overdraft conditions in Borrego Valley.	Yes
	LU-8.3	Discourage development that would significantly draw down the groundwater table to the detriment of groundwater-dependent habitat.	Yes
	LU-8.4	Support the Borrego Valley Water District with their program to slow the overdrafting and extend the life of the aquifer supporting the residents of the Borrego Valley.	Yes
	Goal LU-13: Adequate Water Quality, Supply, and Protection		
	LU-13.1	Coordinate water infrastructure planning with land use planning to maintain an acceptable availability of a high quality sustainable water supply. Ensure that new development includes both indoor and outdoor water conservation measures to reduce demand.	Yes
	LU-13.2	Require new development to identify adequate water resources, in accordance with state law, to support the development prior to approval.	Yes
	Goal COS-4: Water Management		

Table 2.1-6
Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Element	Policy	Description	GSP Consistency
Conservation and Open Space Element	COS-4.1	Require development to reduce the waste of potable water through use of efficient technologies and conservation efforts that minimize the County's dependence on imported water and conserve groundwater resources.	Yes
	COS-4.2	Require efficient irrigation systems and in new development encourage the use of native plant species and non-invasive drought tolerant/low water use plants in landscaping.	Yes
	COS-4.3	Maximize stormwater filtration and/or infiltration in areas that are not subject to high groundwater by maximizing the natural drainage patterns and the retention of natural vegetation and other pervious surfaces.	Yes
	COS-4.4	Require land uses with a high potential to contaminate groundwater to take appropriate measures to protect water supply sources.	Yes
	COS-4.5	Promote the use of recycled water and gray water systems where feasible.	Yes
	Goal COS-5: Protection and Maintenance of Water Resources		
	COS-5.2	Require development to minimize the use of directly connected impervious surfaces and to retain stormwater run-off caused from the development footprint at or near the site of generation.	Yes
	COS-5.5	Require development projects to avoid impacts to the water quality in local reservoirs, groundwater resources, and recharge areas, watersheds, and other local water sources.	Yes
	Goal COS-6: Sustainable Agricultural Industry		
	COS-6.1	Support the economic competitiveness of agriculture and encourage the diversification of potential sources of farm income, including value added products, agricultural tourism, roadside stands, organic farming, and farmers markets.	Yes, although pumping limits in GSP will restrict continued expansion of agricultural lands.
	COS-6.2	Protect existing agricultural operations from encroachment of incompatible land uses.	Land use designations may need to change to meet groundwater sustainability goals
	COS-6.4	Support the acquisition or voluntary dedication of agriculture conservation easements and programs that preserve agricultural lands.	Yes. Note: The GSP is not inconsistent with this policy although the preservation of agricultural lands in Borrego Valley would not help to fulfill the long-term goals of the GSP. It should also be noted that the land fallowing program

Table 2.1-6
Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

Element	Policy	Description	GSP Consistency
			of the GSP may result in open space conservation easements or other uses to replace the fallowed agricultural lands
	COS-6.5	Encourage best management practices in agriculture and animal operations to protect watersheds, reduce GHG emissions, conserve energy and water, and utilize alternative energy sources, including wind and solar power.	Yes
	Goal COS-14: Sustainable Land Development		
	COS-14.3	Require design of residential subdivisions and nonresidential development through "green" and sustainable land development practices to conserve energy, water, open space, and natural resources.	Yes
	COS-14.4	Require technologies and projects that contribute to the conservation of resources in a sustainable manner, that are compatible with community character, and that increase the self-sufficiency of individual communities, residents, and businesses.	Yes
	Goal COS-19: Sustainable Water Supply		
	COS-19.1	Require land development, building design, landscaping, and operational practices that minimize water consumption.	Yes
	COS-19.2	Require the use of recycled water in development wherever feasible. Restrict the use of recycled water when it increases salt loading in reservoirs.	Yes
Borrego Springs Community Plan			
Community Growth Policy	Goal LU-2.4: The conversion of existing agricultural uses to other, less consumptive uses by 2020 consistent with a Plan population of 8,000.		
	LU-2.4.1	Establish a special study area to work with the BSCSG and Borrego Water District to devise a plan to: a.) convert a majority of agricultural uses existing at the time of the adoption of this Plan (generally, those lands north of Henderson Canyon Road) to other less water consumptive uses and/or b.) secure a permanent alternative supply of water, together sufficient to meet forecast requirements.	Though water credit program and fallowing are being pursued, imports from adjacent basins have been determined to be economically infeasible. See Section 2.1.6 for details.
	Goal LU-2.5: Restoration and revegetation of existing fallowed (abandoned) farmlands and their conversion to open space uses to enhance community character, health and safety, and tourism appeal.		
	LU-2.5.1	Prioritize the preservation and restoration of existing fallowed and abandoned farmlands with their conversion to open space lands held in trust by the County or other suitable governmental or non-governmental organization.	Yes
	LU-2.5.2	Encourage the use of existing fallowed farmlands for the installation of solar farms for energy production.	Yes

Table 2.1-6
Summary of General Plan and Community Plan Land Use Policies Relevant to Groundwater Sustainability in the Plan Area

<table>
<tr><th>Element</th><th>Policy</th><th>Description</th><th>GSP Consistency</th></tr>
<tr><td rowspan="5">Infrastructure and Utilities</td><td colspan="3">Goal CM-10.1: A capacity in the Borrego aquifer that supports continued domestic and recreational demand in Borrego Springs and development of options to augment the water supply to create a sustainable/renewable supply for the community.</td></tr>
<tr><td>CM 10.1.1</td><td>Analyze the capacity of the existing groundwater aquifer and develop programs to create sustainable supplies of water for the projected build-out of the community.</td><td>Yes</td></tr>
<tr><td>CM 10.1.2</td><td>Create incentives for golf courses to decrease turf areas and convert those areas to desert landscape with less water use.</td><td>Yes</td></tr>
<tr><td>CM 10.1.3</td><td>Prohibit the approval of any new agricultural, golf or other water intensive activities in any area overlying or tributary to the Borrego aquifer.</td><td>Yes. Water Credits may provide mechanism to allow approval.</td></tr>
<tr><td>CM 10.1.4</td><td>Request, upon achieving a sustainable supply of water for the domestic water use in the community planning area, the adjudication of the aquifer to insure that future use does not continue to overdraft the aquifer except in times of drought, thus protecting the elements of the local environment dependent on the aquifer in its diminished capacity.</td><td>GSP projects and management actions, including baseline pumping allocation, are being pursued as means to regulate the aquifer through court validation process rather than adjudication.</td></tr>
<tr><td rowspan="6">Conservation and Open Space</td><td colspan="3">Goal COS 1.1: Incremental reductions of agricultural production in the Borrego Valley over the next 20 years while protecting the rights of farmers and the continued environmental health of the Borrego community.</td></tr>
<tr><td>COS 1.1.1</td><td>Encourage a reduction in the production of citrus crops and palm trees to manageable levels or their replacement with low to very low water consumptive crops</td><td>Yes</td></tr>
<tr><td colspan="3">Goal COS 1.4: A sustainable supply of water, ending the current overdrawing of the Borrego Springs sole-source aquifer.</td></tr>
<tr><td>COS 1.4.1</td><td>Encourage and develop methods for Community Plan Area groundwater system human withdrawals to be less than or equal to replenishment amounts on an average ongoing basis.</td><td>Yes</td></tr>
<tr><td>COS 1.4.2</td><td>Prohibit the construction of any new golf courses in the Community Plan Area, unless an alternate water source, such as recycled water is made available.</td><td>Yes. Water Credits and GSP baseline pumping allocation will need to be adhered to.</td></tr>
<tr><td>COS 1.4.3</td><td>Encourage xeriscape landscaping in residential and business developments.</td><td>Yes. A County of San Diego landscape restrictive ordinance applies to Borrego Springs.</td></tr>
</table>

Source: County of San Diego 2011.
Notes: GHG = greenhouse gas; BSCSG = Borrego Springs Community Sponsor Group; GSP = Groundwater Sustainability Plan; County = County of San Diego.

2.1.4 Beneficial Uses and Users

As discussed in Section 2.1.2, designated beneficial uses for groundwater in the Plan Area include municipal and domestic supply (MUN), industrial service supply (IND) and agriculture supply (AGR) based on the Basin Plan. The Basin Plan definition of recreational beneficial uses applies only to surface waters where ingestion of the water is reasonably possible (e.g., contact and non-contact water recreation), and thus is not applicable to groundwater as an underground resource. However, as an important recreational use in the Plan Area, groundwater used to irrigate golf courses and/or to supply ornamental ponds is considered in this GSP separately from the municipal and domestic supply designations. Thus, the "beneficial uses" evaluated in this GSP are not strictly synonymous with those analyzed in the Basin Plan. Three primary sectors extract the majority of groundwater in the Subbasin: (1) agriculture use; (2) municipal use, consisting of BWD; and (3) recreational use, which consists of six golf courses—Borrego Springs Resort, Club Circle, De Anza Country Club, Rams Hill Country Club, Road Runner Golf and Country Club, and The Springs at Borrego RV Resort and Golf Course.

~~Additional~~ Other groundwater users include two active small water systems and two non-potable irrigators. The two small water systems are the ABDSP and the Borrego Air Ranch Water Co. The two non-potable irrigators are the ~~Borrego Springs Unified School District~~BSUSD (Elementary School) and La Casa Del Zorro Resort and Spa. Industrial service supply includes use for two utility scale solar facilities, a redi-mix plant, a County service yard and the Republic Services Borrego Landfill. Private groundwater users who extract less than 2 AFY are considered de minimis users under SGMA.

There are an estimated 52 active de minimis users within the Subbasin. Domestic well users are generally considered to be de minimis users~~, provided however, that a few~~ unless those properties ~~that would otherwise qualify as de minimis~~ contain irrigated areas in excess of about 0.5 acres, ~~thus taking them out~~which would result in more than 2 AFY of ~~the definition of de minimis pumper in SGMA~~ water use. Table 2.1-7 lists beneficial uses and users of groundwater in the Subbasin, including general location and estimated water use.

Table 2.1-7
Beneficial Uses and Users of Groundwater in the Plan Area

Beneficial Users	RWQCB Basin Plan Beneficial Use	Areas of the Subbasin	Estimated Water Use	
			Baseline Pumping Allocation (AFY)	*2018 Estimate (AFY)*
~~Pumpers~~Non-De Minimis Users				
Agriculture Sector	AGR	NMA, CMA	15,74~~29~~8	14,~~767~~ 788 [a]
Municipal Sector	MUN	NMA, CMA, SMA	2,731~~122~~	1,600
Recreation Sector	N/A [~~c~~b]	NMA, CMA, SMA	4,050	3,245 [~~d~~c]

Table 2.1-7
Beneficial Uses and Users of Groundwater in the Plan Area

Beneficial Users	RWQCB Basin Plan Beneficial Use	Areas of the Subbasin	Estimated Water Use	
			Baseline Pumping Allocation (AFY)	*2018 Estimate (AFY)*
Other Users [d] ~~Water Credits~~	MUN~~AGR~~	NMA, CMA, SMA	71~~1,840[e]~~	58~~0~~
		TOTAL	**22,600**	**19,691**
		De Minimis Users		
~~Domestic Users (Non-de minimis)~~	~~MUN~~	~~NMA, CMA, SMA~~	~~62~~	~~58~~
Small Domestic, ~~De minimis users~~Industrial and/or Utility Uses [e]	MUN and IND~~[b]~~	NMA, CMA, SMA	N/A	34
		~~**TOTAL**~~	~~**21,963[f]**~~	~~**19,704**~~

Notes: RWQCB = Regional Water Quality Control Board; AFY = acre-feet per year; AGR = Agriculture Supply; NMA = North Management Area; CMA = Central Management Area; MUN = Municipal and Domestic Supply; SMA = South Management Area; N/A = not applicable; IND = Industrial Service Supply.

a. The 2018 estimate includes fallowing of 153 acres of citrus on the Burnand parcels at an estimated water use factor of 6.29 feet per year (153 acres X 6.29 feet/year = 961 AFY, so 2018 Estimate is 15,~~728~~ 749 AFY – 961 AFY = 14,~~767~~ 788 AFY). The water use factor is determined from local station specific evapotranspiration, documented plant factors, and irrigation efficiency.

~~b. Industrial water use is based on the two utility scale solar facilities, the redi-mix plant, and the County service yard. These users were not given a baseline pumping allocation because they are anticipated to extract less than 2 acre-feet per year.~~

~~c.~~b. The recreational beneficial uses under the Basin Plan definition applies only to surface waters where ingestion of the water is reasonably possible (e.g., contact and non-contact water recreation), and thus is not applied to groundwater as an underground resource. In addition, there is no RWQCB Basin Plan beneficial use specific to groundwater dependent ecosystems.

~~d.~~

c. The 2018 estimate was determined by removing the irrigation formerly applied at the Borrego Springs Resort, using a factor of 6.45 feet/acre.

d. Consists of active small water systems (ABDSP and Air Ranch) and non-potable irrigators (school and resort).

e. Consists of domestic well users not connected to BWD service, two utility scale solar facilities, the redi-mix plant, and the County service yard. These users were not given a baseline pumping allocation because they are anticipated to extract less than two acre-feet per year.~~Water credits issued for fallowed agriculture are based on the original face value. Water credits do not represent a current water use until they have been purchased by entities seeking in-lieu mitigation for the water use of their development projects. The total water credits issued by the BWD is 1,886.5 AFY. To date 45.5 AFY have been retired and there are 1,840 AFY remaining water credits.~~

~~f. The total Baseline Pumping Allocation currently excludes water credits which may be converted to Baseline Pumping Allocation during GSP implementation.~~

2.1.5 Notice and Communication

In 2017, the GSA prepared a Stakeholder Engagement Plan to provide individual stakeholders, stakeholder organizations, and other interested parties an opportunity to be involved in the development and evaluation of this GSP. To this end, the Stakeholder Engagement Plan, included as Appendix C of this GSP, describes the steps the GSA has taken, and will continue to take, to achieve broad, enduring and productive public involvement during the development and implementation phases of this GSP. The Stakeholder Engagement Plan includes a list of identified stakeholders as of 2017 and describes the methods and avenues in which the GSA has continued to identify additional stakeholders, continued to solicit public involvement and feedback, and considered and/or incorporated stakeholder comments and concerns into the development and future implementation of this GSP. In addition to the Stakeholder Engagement Plan, Appendix C also includes a list of public meetings that have been held to date as a means to document the level of public outreach that has occurred thus far.

One of the primary ways the GSA considers the beneficial uses and users of groundwater, pursuant to California Water Code, Sections 10723.2 and 10723.4, is through the establishment and regular meetings of an Advisory Committee (AC) to aid in developing and implementing this GSP. The AC is composed of nine members:

- Four members nominated by the Borrego Water Coalition and filling the following representative roles: one agricultural member, one recreation member, one independent pumper, one at large member
- One member nominated by the Borrego Springs Community Sponsor Group
- One member nominated by the Borrego Valley Stewardship Council
- One member, who is not an employee or elected official, nominated by the BWD Board of Directors to represent ratepayers/property owners
- One member, who is not an employee or elected official, nominated by the County to represent the Farm Bureau
- One member nominated by the California State Parks, Colorado Desert Region to represent the Anza-Borrego Desert State Park

The Borrego Water Coalition represents a broad cross-section of groundwater pumpers and users of the Subbasin who together represent approximately 80% of annual withdrawals from the Subbasin. The Borrego Springs Community Sponsor Group is the officially appointed representative body charged with addressing land use issues to the County. The Borrego Valley Stewardship Council represents community groups associated with the Anza-Borrego Desert State Park and geotourism economic development initiative. The BWD represents over 2,000 ratepayers/property owners in Borrego Springs. Through the Agricultural Alliance for Water and Resource Education, the San Diego County Farm Bureau represents farming interests in Borrego Springs who, at present, collectively use approximately 70% of annual withdrawals from the Borrego Basin. The California State Parks represent the approximately 600,000-acre ~~Anza-Borrego Desert State Park~~ABDSP that surrounds Borrego Springs. Table 2.1-8 describes and lists the various stakeholders with interest in the development and implementation of the GSP.

Throughout Plan development, the AC provided input to the Core Team[18] in the formation of the planning and policy recommendations included in the GSP. The AC was tasked with reviewing technical materials and providing comment, data, and relevant local information related to GSP

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[18] The Core Team is comprised of County and District staff tasked with coordinating the activities of the GSP AC.

development; assisting in communicating concepts and requirements to the stakeholder constituents that they represent; providing comments on materials and reports prepared; and assisting the Core Team to anticipate short- and long-term future events that may impact groundwater sustainability, and trends and conditions that will impact groundwater management. The Core Team regularly met between AC meetings to consider input from the AC and other stakeholders.

The first meeting of the SGMA AC occurred March 6, 2017. Meetings have occurred on a nearly monthly basis through the entirety of GSP development (see list of meetings in Appendix C). AC meetings were facilitated by the Sacramento State Consensus and Collaboration Program funded primarily through a DWR grant. In accordance with California Water Code, Section 10727.8(a), interested parties were encouraged to participate in the AC meetings by attending meetings in Borrego Valley and/or signing up to receive information about AC meetings and GSP development at the County's webpage. AC meeting notices were posted at the Borrego Post Office as well as outside of the meeting venue a minimum 72 hours in advance of the meeting, provided to the Borrego Sun, and posted to the BWD website at http://www.bvgsp.org. The County website publishes all AC meeting agendas, materials, and minutes. All AC meetings were webcast and/or accessible via teleconference line; public comment periods were held during each AC meeting; and correspondence sent to the Core Team and/or AC was published in each AC meeting agenda packet.

In addition to facilitating regular AC meetings, the GSA disseminates information and resources about SGMA and GSP development, as well as opportunities for public participation through email, newsletters/columns, water bill inserts, and the County's SGMA website designed to update the public. ~~Recurring~~ Periodic updates in the Borrego Sun newspaper ~~and County Planning & Development Services newsletter, eBlast,~~ are provided to advise, educate, and inform the public on SGMA implementation in Borrego Valley. A variety of information about SGMA and groundwater conditions in BVGB—including maps, timelines, frequently asked questions, groundwater information, and schedules/agenda of upcoming meetings and milestones—have been produced by the County and the BWD. This information is accessible on the County's SGMA Borrego webpage located at: http://www.sandiegocounty.gov/pds/SGMA.html. County staff update the website regularly and invite users to request information or be added to the interested persons list. Additionally, the BWD maintains a repository of groundwater, economic, and GSP-related technical studies on its website at: http://www.bvgsp.org/sustainability-plan.html.

Table 2.1-8
Stakeholder Categories in the Plan Area

Category of Interest	Examples of Stakeholder Groups	Engagement Purpose
General Public	General Public Borrego Springs Community Sponsor Group	Inform to improve public awareness of sustainable groundwater management

Table 2.1-8
Stakeholder Categories in the Plan Area

Category of Interest	Examples of Stakeholder Groups	Engagement Purpose
Land Use	County of San Diego (Land Use and Environment Group) Community of Borrego Springs Borrego Springs Community Sponsor Group	Consult and involve to ensure land use policies are supporting GSP and vice-versa
Private users	Domestic users	Inform and involve to avoid negative impact to these users
Urban/ Agriculture users/ Golf Courses	Borrego Water District Borrego Water Coalition Agricultural Alliance for Water and Resource Education Small Water Systems Golf Courses and Recreational Facilities	Collaborate to ensure sustainable management of groundwater
Environmental and Ecosystem	California Department of Fish and Wildlife California Department of Parks and Recreation (Anza-Borrego Desert State Park) Anza-Borrego Foundation	Inform and involve to sustain a vital ecosystem
Economic Development	The Borrego Springs Chamber of Commerce and Visitors' Bureau State Assembly Member Randy Voepel State Senator Joel Anderson County District 5 Supervisor Jim Desmond	Inform and involve to support a stable economy
Human right to water	Domestic water users Disadvantaged and Severely Disadvantaged Communities	Inform and involve to provide a safe and secure groundwater supplies to DACs
Integrated Water Management	Regional water management groups (IRWM regions)	Inform, involve, and collaborate to improve regional sustainability

Notes: DAC = disadvantaged community; IRWM = Integrated Regional Water Management.

In addition to the regular AC meeting process, AC members participated in an Ad Hoc Committee ~~of the AC was formed~~ to work with BWD and Le Sar Development Consultants on additional outreach and engagement activities focused on educating the Borrego ~~community~~ SDAC about the GSP, and for soliciting feedback related to water quality and availability, environmental and economic impacts, and GSP implementation and adaptive management strategies. With an emphasis of outreach to the severely disadvantaged portion of the community, the engagement team developed culturally appropriate educational materials (English and Spanish) and a variety of strategies for information dissemination, education, needs assessment, and ongoing feedback. Activities included a series of community meetings, surveys (residential and business), and distribution of educational materials and meeting announcements through door-to-door outreach and digital platforms. Stakeholders were also encouraged to attend SGMA AC and BWD ratepayer meetings.

Through these efforts, the GSA gathered valuable information about community concerns, which primarily related to rising water rates, economic impacts (e.g., job loss), land use changes, water use allocations, water quality, and long-term environmental impacts. ~~These~~ This ~~issues were~~information was then incorporated into the development of this GSP~~,~~ and ~~lead to increased consideration~~considered in the evaluation of groundwater dependent ecosystems (GDEs), development of projects and management actions, seeking additional funding opportunities to minimize impacts on ratepayers, and land use implications. For example, the GSA has sent letters to pumpers informing them of their specific baseline pumping allocation, along with information about opportunities to engage in the process.

In addition, the BWD commissioned an SDAC Impact/Vulnerability Assessment to understand the implications that SGMA implementation will have on the SDAC population of Borrego Springs (ENSI 2009). The SDAC is not a homogeneous group and is comprised of low-income sub-populations. Of note are two sub-populations: (1) households with school age children and (2) retirees. The report describes specific vulnerabilities, including challenges associated with potential loss of seasonal jobs in the agricultural and recreational sectors, funding and access to public schools, and water rate impacts to the lowest income portion of the community. Concerns specific to the SDAC include water affordability (BWD rate impacts), loss of jobs/local economy, impacts to infrastructure, and/or quality of life. The report remarks that the 20-year SGMA compliance period does provide time for the community to adapt, and the community's tourism industry is not highly dependent on water (in contrast to agriculture), which could be further developed to help offset agricultural job losses. The BWD's tiered rate structure (maintenance of low water rates for baseline water use) and seeking state funding to support the SDAC are potential strategies to consider the needs of the SDAC during GSP implementation.

BWD continues to actively work to assess water use and to evaluate how to best structure water costs for the SDAC. SGMA- and SDAC-related grants and other publicly funded support is expected to continue to be available and pursued by BWD to assist in subsidizing future water costs. Borrego Springs is a key part of the utilization experience for the ABDSP.

The outreach effort was guided by the GSP Stakeholder Communication and Guidance Document, the Borrego Valley Groundwater Basin Stakeholder Engagement Plan (Appendix C), and the AC. Many of the activities discussed above were funded through a Proposition One Grant from DWR.

2.1.6 Additional GSP Components

The elements included as "additional GSP components" in DWR's annotated outline released in December 2016 (Title 23 CCR Section 354.8(g)) are presented in Appendix A.

- Control of sea water intrusion. Sea water intrusion is not applicable to the Plan Area because it is not a coastal groundwater basin.
- Wellhead protection. A summary of well development and destruction policies, including wellhead protection is provided in Section 2.1.2, New and/or Replacement Well Permitting. This topic also implicates the potential issue of inducing the migration of groundwater with undesirable quality within the hydraulic capture zone of groundwater wells. Groundwater quality issues within the subbasin are addressed in Section 2.2.2.4, as well as the water quality specific portions of Chapters 3 and 4.
- Migration of contaminated groundwater. Migration of contaminated groundwater from point sources (e.g., industrial and service commercial uses such as gas stations) has limited applicability to the Plan Area, because there are few release of contamination cases in the basin (as reported by regulatory agencies), and the depth of the static groundwater table is well below the areas of concern. The status and severity of open and historic cleanup cases managed by either Department of Toxics Substances Control, RWQCB, or the County are briefly discussed in Section 2.2.2.4. Contaminants of concerns from non-point sources, such as agricultural uses, consist of elevated nitrate concentrations in the upper aquifer of the North Management Area (NMA), discussed in Section 2.2.4.1.
- Well abandonment and well destruction program. San Diego County Code Section 67.421 adopts standards from DWR Bulletin 74-90 for destruction of wells. Section 67.430 through 67.431 provide for investigation and abatement if an abandoned or other well is causing a nuisance by polluting or contaminating groundwater, or constitutes a safety hazard. Well owners and/or well drilling contractors are required to follow DWR well standards, as described in Section 2.1.2, New and/or Replacement Well Permitting, when abandoning or destroying a well, and update the County to list the permit status as inactive or abandoned.
- Replenishment of groundwater extractions. There is currently no program to actively replenish the aquifer. Projects and management actions are described in Chapter 4, though aquifer storage and recovery are not being considered as an option at this time. As discussed in Section 2.2.3.7, a study by the U.S. Bureau of Reclamation (USBR 2015) determined that using imported water to recharge the basin was economically infeasible. The GSA will continue to be supportive of small distributed projects such as rain water harvesting, reuse and/or surface water capture, and recharge projects, for example, in conjunction with proposed development and/or redevelopment, and consistent with Porter–Cologne Water Quality Control Act and Clean Water Act Permitting (see Section 2.1.3).
- Conjunctive use and underground storage. There is currently no conjunctive use and/or underground storage program within the Plan Area. Because the Subbasin lacks surface water, conjunctive use (i.e., coordinated use of surface water and groundwater) is not possible. Projects and management actions are described in Chapter 4.

- Well construction policies. Well construction policies are described in Section 2.1.2.
- Groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects. Section 2.2.2.4 provides background regarding contamination release cases listed in the SWRCB's "Geotracker" database. There are no active groundwater cleanup sites in the Plan Area. Recharge is discussed in Section 2.2.3. Recharge includes stream recharge, irrigation return flows, septic recharge and subsurface inflow. There are no major diversions to storage in the Plan Area other than for irrigation ponds such as those located at the golf courses. Conservation has historically been used by all sectors to reduce water demand and is discussed in Section 4.3, including proposed water conservation projects and management actions. Water recycling has been evaluated by the BWD and determined to be economically infeasible at this time (Dudek 2018). Use of greywater systems may be evaluated as part of the Water Conservation Project and Management Action. Conveyance is discussed in Section 4.7.5 and limited to intra-basin transfers to mitigate existing and future reductions in groundwater storage and groundwater quality impairment by establishing conveyance of water between different management areas in the Subbasin. Extraction projects include drilling of replacement municipal wells to mitigate for loss of production.
- Efficient water management practices. Project and management action no. 2 (Water Conservation), addresses efficient water management and is described in Section 4.3.
- Relationships with state and federal regulatory agencies. This is addressed in Sections 2.1.2 of this chapter.
- Land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity. This is addressed in Sections 2.1.2 and 2.1.3. Notably, the County is both the local land use agency and a member of the GSA; thus, coordination has been inherent in the GSP development process.
- Impacts on GDEs: See Sections 2.2.2.6 and 2.2.2.7.

2.2 BASIN SETTING

Hydrogeologic studies of the Borrego Valley date back to the early 1900s, though the importance of the Plan Area's groundwater resources increased starting in the mid-1940s when more wells were drilled to support the growing agricultural and municipal water demand. Since the mid-1950s, various studies have been completed to assess the Subbasin's groundwater supply and quality and to evaluate the adequacy of water supplies. These studies included summaries of drillers' logs, compilations of geologic data, and hydrogeologic investigations to support planned development. In the early 1980s, the USGS and DWR completed a multiphase study to evaluate hydrogeologic characteristics, recharge rates, future water demand, and possible alternate water supplies in the Borrego Valley, including the application of a numerical model to simulate basin-wide changes in aquifer groundwater levels and storage (USGS 1982, 1988; DWR 1983a, 1983b, 1984). The U.S Bureau of Reclamation studied the adequacy of water supply and later evaluated the options for importing water into the basin when it became clear that there was an overdraft problem in the Subbasin (USBR 1972, 2003, 2015). Since then, the Plan Area has been the subject of two Masters' theses by Netto (2001) and Henderson (2001); and a comprehensive update to the earlier 1980's work that incorporates updated numerical modeling methods, geophysical and remote-sensing techniques, and groundwater quantity and quality observations for the years between 1945 and 2010 (USGS 2015).

This section describes the basin setting of the Plan Area based on the existing studies as well as an update of the existing USGS numerical model to incorporate the 2010–2011 to 2015–2016 water years.[19] The General Plan Update Groundwater Study, prepared by the County of San Diego (2010), states:

> Borrego Springs Subbasin is completely groundwater dependent, has a well-documented groundwater overdraft condition where year after year groundwater extraction exceeds the amount of groundwater that is recharged back into the aquifer. Groundwater extraction exceeds 20,000 AFY whereas average groundwater recharge is estimated at approximately 5,000 AFY. The aquifer holds a large amount of groundwater in storage, estimated to be approximately 1.6-million acre-feet of usable groundwater. Groundwater levels have been declining for decades as a result of the overdraft condition and groundwater production at current rates is not sustainable.

Under existing conditions, the overall magnitude of the overdraft problem within the Plan Area remains similar to that described in 2010, although updated estimates of extraction and recharge are provided in Section 2.2.3.

This section is organized as follows: Section 2.2.1 describes the hydrogeologic conceptual model (HCM) of the Plan Area; Section 2.2.2 summarizes the current and historical groundwater conditions in terms of groundwater elevations, storage, water quality, and the other issues identified in SGMA; Section 2.2.3 establishes the water budget of the Plan Area based on the updated groundwater model; and Section 2.2.4 describes the boundaries, basis and purpose of the three groundwater management areas established for the Plan Area.

2.2.1 Hydrogeologic Conceptual Model

The HCM provides the framework for the development of water budgets, analytical and numerical models, and monitoring networks. Additionally, the HCM serves as a tool for stakeholder outreach

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[19] A water year is a continuous 12-month period selected to present data relative to hydrologic or meteorological phenomena during which a complete annual hydrologic cycle normally occurs. The water year used by the U.S. Geological Survey runs from October 1 through September 30, and is designated by the year in which it ends.

and communication, and assists with the identification of data gaps. A HCM ~~differs from a mathematical (analytical or numerical) model in that it does not compute specific quantities of water flowing through or moving into or out of a basin, but rather~~ provides a general understanding of the physical setting, characteristics, and processes that govern groundwater occurrence and movement within the basin. Figure 2.2-1 presents the parameters of the HCM developed for the Plan Area, which conceptually depicts basin boundaries, stratigraphy, groundwater table, land use, and the components of inflow and outflow from the Borrego Springs Subbasin. The ~~thickness of~~ arrows depict schematically the ~~magnitude of the~~ inflows and outflows averaged over a 10-year period between 2005 and 2015 for various components of the water budget. Groundwater pumping for agricultural and recreational uses (i.e., golf courses) together and individually exceed the magnitude of pumping for municipal/domestic uses. Inflows/outflows for the period 2005–2015 are quantified based on the results of the BVHM that indicates outflows are about 20,000 AFY; whereas, inflows are about 5,000 AFY (Figure 2.2-1).

The following subsections detail the physical setting of the basin.

2.2.1.1 Climate

The primary sources of current and historical climate data come from the National Oceanic and Atmospheric Administration, the Western Regional Climate Center, the California Irrigation Management Information System (CIMIS), and the San Diego County Flood Control District. The primary web access portal for historical climate information is the National Oceanic and Atmospheric Administration National Centers for Environmental Information (formerly known as the National Climatic Data Center). In addition, weather stations were installed in 2015 by the University of California, Irvine as part of its Anza-Borrego Desert Research Center. Table 2.2-1 lists the weather stations available in the vicinity of the Plan Area.

Table 2.2-1
Weather Stations in the Vicinity of the Plan Area

Station Name (Agency No./ID)	Latitude	Longitude	Status	Period of Record
National Oceanic and Atmospheric Administration National Centers for Environmental Information and Western Regional Climate Center				
Borrego Desert Park, CA US (40983)	33.2559	-116.4036	Active	1942–present
Borrego Springs 2.4 WSW, CA US (CASD0014)	33.2225	-116.3904	Inactive	2009–2016
Borrego Springs 3 NN, CA US (46386)	33.28333	-116.35	Inactive	1944–1967
Borrego Springs 7.1 SE, CA US (CASD0130)	33.1934	-116.2786	Active	2016–present
Ocotillo Wells 2 W, CA US (40986)	33.1552	-116.1688	Active	2003–present
Ocotillo Wells, CA US (46383)	33.15	-116.13333	Inactive	1932–1975
California Irrigation Management Information System				
Borrego Springs/Station 207	33.26844722	-116.36505	Active	2008–~~2015~~present

Table 2.2-1
Weather Stations in the Vicinity of the Plan Area

Station Name (Agency No./ID)	Latitude	Longitude	Status	Period of Record
University of California, Irvine, Steele/Burnand Anza-Borrego Desert Research Center				
Viking Ranch 6 (VR)	33.328633	-116.356917	Active	2016–present
Clark Dry Lake 7 (CL)	33.296579	-116.280926	Active	2016–present
Elementary 2 (ELEM)	33.254722	-116.346389	Active	2016–present
Dry Canyon Weather Station 5 (MONT)	33.2194	-116.419583	Active	2016–present
Wilcox Well 3 (BWD-W)	33.211001	-116.365133	Active	2016–present
University of California, Irvine, Steele/Burnand Anza-Borrego Desert Research Center	33.240123	-116.388973	Active	2016–present
Culp Valley 4 (BAKER)	33.203721	-116.4772	Active	2016–present
San Diego County Flood Control District				
Borrego Palm (BRPC1 / 62)	33.2686111	-116.4113889	Active	1983–present
Coyote Creek (CCYC1 / 61)	33.3655556	-116.4161111	Active	1984–present
Borrego CRS (BGOC1 / 63)	33.2211111	-116.3369444	Active	1983–present
Ocotillo Wells RS (OCWC1 / 3886)	33.1536111	-116.1769444	Active	1988–present

Precipitation

Within the Plan Area, the County's 30-year isopluvial[20] map (1971–2001) shows that the average annual precipitation ranges from up to 8 inches/year along the northwest edge of the valley, to less than 4 inches per year to the southeast (Figure 2.2-2; SDCFCD 2004). Average yearly precipitation is greater outside the plan area in the mountains to the west, north, and northeast of the Borrego Valley (Figure 2.2-2).

Precipitation patterns in the Plan Area are influenced by two distinct sources. The first source is Pacific frontal systems that bring regional rain bands to Southern California, typically between October and April. The second source is isolated and scattered thunderstorms that occur when moisture from the Gulf of California advects from south to north through the Plan Area. This phenomenon, commonly referred to as the "monsoon" season, is strongest in the summer months, but is not a regular or consistent occurrence. Occasionally, the decaying remnants of former tropical storms or hurricanes can pass through the area and in some years these further enhance the precipitation totals during the monsoon season. As a consequence of these disparate influences, the precipitation record is highly variable both seasonally and annually (Figure 2.2-3 and Figure 2.2-4). This makes defining the parameters of "wet" or "dry" years difficult (e.g., one thunderstorm may drop half of the yearly total in an otherwise dry season). For the purpose of the precipitation record, years with above average precipitation are considered "wet," and years with below average precipitation are considered "dry."

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[20] A line on a map connecting places registering the same amount of precipitation or rainfall

The weather station in the Plan Area with the longest and most complete precipitation record is the Borrego Desert Park Station, which spans the period from water year 1942 to 2017 (Figure 2.2-3). Based on this record, the mean annual precipitation at Borrego Desert Park Station is 5.55 inches (shown as dashed line on Figure 2.2-3). The cumulative departure from mean precipitation shows a wet period for the basin between 1972 and 1986, with 1983 being the wettest year on record (Figure 2.2-3). The total precipitation in the 1983 water year was 21.82 inches. In contrast, the period from 1946 to 1972 was dominated by years of below average rainfall. In addition to year ~~on~~ to year precipitation being highly variable, precipitation by month also has a wide spread. Figure 2.2-4 shows average monthly precipitation at the Borrego Park Station (1947–2017) along with a measure of one standard deviation which provides a statistical estimate of precipitation variability. The record of precipitation by month also shows the influence of the monsoon season, with an uptick in the average precipitation for June, July, and August.

Temperature

The climate of the Borrego Valley is arid with hot summers and cool winters. Based on the Borrego Desert Park Station, the average annual high (daytime) temperature is 87.6°F, ranging from a low of 68.9°F in December to a high of 107.4°F in July. The average annual low (nighttime) temperature is 58.3°F, ranging from a low of 43.3°F in December, to a high of 75.8°F in July. The historical minimum and maximum monthly mean temperature, and average temperature record for the Plan Area is shown on Figure 2.2-5.

Evapotranspiration

Reference evapotranspiration (ETo) in the Plan Area has been calculated from the data collected at CIMIS Station 207 on a daily basis ~~between~~ since 2008 ~~and 2017~~ (Figure 2.2-6; Table 2.2-2). The average ETo measured at CIMIS Station 207 between 2008 and 2017 is 72.21 inches per year or 6.02 feet per year (Table 2.2-2). In contrast, the average annual precipitation in the Plan Area is 5.6 inches per year. The ETo values calculated from the CIMIS data reflect the amount of water that could be transpired by grass or alfalfa if supplied by irrigation, but do not represent the actual transpiration from any specific crop or native vegetation. To calculate the ET rate for a specific crop or native vegetation, the ETo is multiplied by a crop coefficient that adjusts the water consumption for each crop relative to the water consumption for alfalfa.

Table 2.2-2
Monthly and Yearly Reference Evapotranspiration (ETo) Totals for California Irrigation Management Information System Station No. 207 from 2008 to 2017 (Inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2008[a]	0.46	3.43	6.16	7.60	9.30	10.02	9.07	6.76	6.77	5.13	3.36	2.27	70.33
2009	2.68	5.16	5.69	7.07	8.76	8.28	8.87	8.71	7.21	5.00	3.08	1.96	72.47

Table 2.2-2
Monthly and Yearly Reference Evapotranspiration (ETo) Totals for California Irrigation Management Information System Station No. 207 from 2008 to 2017 (Inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2010	2.41	3.21	8.81	9.84	8.58	9.22	9.51	9.11	7.44	4.36	2.88	1.98	77.35
2011	2.68	3.35	5.55	7.12	8.77	8.23	7.98	8.47	6.43	4.92	2.72	2.11	68.33
2012	2.85	3.56	5.33	6.77	7.66	9.47	8.77	8.04	7.09	5.04	3.20	2.23	70.01
2013	2.54	3.57	5.75	7.56	8.64	9.02	8.01	7.57	6.46	5.05	3.00	2.27	69.44
2014	2.67	3.66	5.94	7.23	8.66	9.13	8.83	8.00	6.97	4.55	3.14	1.58	70.36
2015	2.17	3.54	5.82	7.22	7.96	8.51	8.76	8.74	6.54	5.15	3.37	2.40	70.18
2016	2.42	4.15	6.35	7.44	8.97	9.79	10.17	8.91	6.51	5.17	3.37	1.99	75.24
2017	2.33	3.28	6.27	8.18	9.14	10.20	9.70	9.43	6.99	5.38	3.16	2.47	76.53
9-Year Average	**2.53**	**3.72**	**6.17**	**7.60**	**8.57**	**9.09**	**8.96**	**8.55**	**6.85**	**4.96**	**3.10**	**2.11**	**72.21**

Source: CIMIS 2018.

Notes:

[a] 2008 is excluded from the average as the record for that year is not complete.

According to the State of California Reference Evapotranspiration Map developed by CIMIS, the Plan Area is located within Evapotranspiration Zone 18, with an annual average ETo of 71.6 inches or 5.97 feet (CIMIS 1999). This regional average annual ETo estimate is comparable to the ETo measured at CIMIS Station 207 (Table 2.2-2).

2.2.1.2 Geology and Geologic Structure

The Borrego Springs Subbasin lies along the boundary of two major geomorphic provinces. To the west of the Subbasin is the Peninsular Ranges Geomorphic Province, which extends from the Pacific Ocean in the west, to the Colorado Desert in the east (CGS 2002). The Peninsular Ranges are dominated by granitic rock intruding older metamorphic rocks that makeup the San Ysidro Mountains, Pinyon Ridge, Yaqui Ridge and other local mountaintops that surround the Subbasin. The Peninsular Ranges trend northwest-southeast, subparallel to major branches of the San Andreas fault, including the San Jacinto fault and Elsinore fault (Figure 2.2-7).

The San Andreas fault is located approximately 30 miles east and the Elsinore fault is located approximately 22 miles west of the Subbasin. Individual segments of the San Jacinto fault zone are located in the vicinity of the Subbasin, including the Coyote Creek fault that forms the eastern boundary of the Subbasin. The Borrego Valley is often described as an embayment of the Salton Trough because the physiographic features of the Colorado Desert Geomorphic Province are also expressed in the Subbasin. This is indicated by the presence of the West Salton detachment fault that is part of a large block of basement rock that broke away from the mountains as a result of crustal stretching between active branches of the San Andreas fault.

The juxtaposition of these two Geomorphic Provinces result in dramatic vistas within the Plan Area. The elevation of the Borrego Springs Subbasin ranges between approximately 450 feet above mean sea level (amsl) east of the Borrego Sink to over 2,000 feet amsl at the northern tip of the subbasin (Figure 2.2-7). As shown on Figure 2.2-8, the Borrego Springs Subbasin, which underlies the Borrego Valley, is bounded to the north and west by the contact between Quaternary-age[21] sedimentary deposits (i.e., alluvium) and Cretaceous- to Mesozoic-age[22] plutonic and metamorphic basement rocks. The eastern boundary of the Borrego Springs Subbasin is defined by the trace of the Coyote Creek fault. The Borrego Badlands and the Ocotillo-Clark Valley Groundwater Basin lie to the east of the Coyote Creek fault (Figure 2.1-~~1~~8; DWR Basin No. 7-025). The southern boundary of the Subbasin is marked by the course of San Felipe Creek. It should be noted that this section focuses on geologic structures, geologic history, and traditional geologic nomenclatures (i.e., formations); whereas Section 2.2.1.3 generalizes the geology of the water bearing formations, described as follows, into three aquifers based on a textural model developed by the USGS (2015). Therefore, the stratigraphic boundaries of geologic units below do not necessarily co-occur with the three aquifer boundaries described in Section 2.2.1.3.

Geologic History

The geologic history of the Subbasin is complex but can be generally divided into three primary phases of activity. The first begins 450 million years ago when the region's oldest rocks were deposited in a near-shore marine environment along a passive continental plate margin. As stated on the Anza-Borrego Desert Natural History Association website,

> With deep burial and cementation, these ancient sediment layers hardened into marine sedimentary rocks, including sandstone, mudstone, and limestone. Later, these marine sedimentary rocks would be squeezed and baked by intruding magma (molten rock in Earth's interior) and transformed by pressure and heat into metamorphic rock. Limestone transformed into marble, sandstone into quartzite, and mudstone into layered schist and banded gneiss--all metamorphic rocks exposed in Anza-Borrego's prominent mountain ranges, including Coyote Mountain as well as the Santa Rosa, Vallecito, and San Ysidro Mountains (Barrie 2018).

The intruding magma marks the second major phase of geologic activity, when the Eastern Peninsular Ranges Batholith[23] formed in place along a continental volcanic arc about 100 million years ago as a result of subduction. The batholith includes varieties of plutonic rocks, including granite, that comprise the basement rocks of the Subbasin and those mapped in the San Ysidro

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[21] The most recent Period of the Cenozoic Era. Encompasses the time interval of 1.6 million years ago through today.

[22] The Cretaceous period spans from 65 to 144 million years ago, the Mesozoic era spans from 65 to 245 million years ago.

[23] Very large mass of intrusive (plutonic) igneous rock that forms when magma solidifies at depth. A batholith must have greater than 100 square kilometers (40 square miles) of exposed area.

Mountains (Figure 2.2-8). Finally, about 30 million years ago, a complex plate boundary formed as a result of both transform and divergent plate tectonic motions that are responsible for development of the Salton Trough as well as the Elsinore, San Jacinto, and San Andreas fault zones. An overview of the Plate Tectonic History of the Anza-Borrego region by Don Barrie is available on the Anza-Borrego Desert Natural History Association's website: http://www.abdnha.org/anza-borrego-desert-geology.htm

Geologic Units

The granitic and metasedimentary basement complex is the oldest geologic unit underlying the Borrego Valley, and the contact between the low permeability basement complex and the overlying basin fill defines the bottom boundary of the Subbasin (Dibblee 2008, USGS 2015). The rocks of the basement complex crop out in the San Ysidro Mountains, Coyote Mountain, and Borrego Mountain, but are over 3,000 feet below land surface in the center of the Borrego Valley (Dibblee 2008, USGS 2015). Overlying the basement complex is a sequence of older marine and younger continental basin fill deposits. The marine deposits, which range in age from possibly Miocene to possibly Pleistocene, make up the Imperial Formation; whereas, the Pliocene and Pleistocene-age continental deposits make up the Palm Spring and Borrego Formations, as well as the Ocotillo Conglomerate (Dibblee 2008, USGS 1982). The youngest deposit in the Subbasin is the Quaternary alluvium (Figure 2.2-8). The Quaternary alluvium covers the majority of the Borrego Valley floor (Figure 2.2-8). Outcrops of unnamed terrestrial sediments are found in the northern portion of the Borrego Valley, within the boundaries of the Subbasin. Outcrops of the Palm Spring Formation are found in the southern area of the Subbasin, associated with the Desert Lodge anticline and a series of synclines and anticlines to the north of San Felipe Creek (Figure 2.2-8).

Imperial Formation

The deepest water bearing rocks in the Subbasin are the marine deposits of the Imperial Formation (USGS 2015). These deposits are composed of late Miocene to early Pliocene gray to yellow gray claystone. The claystone is weakly to moderately consolidated, and has been tilted and folded by motion along the San Andreas and San Jacinto faults (USGS 2015). Age dating of the Imperial Formation is based on fossil oyster shells, other mollusks, and corals. Overall, the fossil record is insufficient to define specific time-stratigraphic units within the Imperial Formation (USGS 2015). The Imperial Formation grades upward into the overlying Palm Spring Formation (Netto 2001). The Imperial Formation is likely not widespread in the Borrego Springs Subbasin, as it has only been identified in two well borings.

Palm Spring Formation

Deposited by the ancestral Colorado River, the Palm Spring Formation consists of thousands of feet of Pliocene- to Pleistocene-age fluvial and deltaic sand, silt, and clay deposits (USGS 2015).

Similar to the underlying Imperial Formation, the Palm Spring Formation is weakly to moderately consolidated, and has been tilted and folded by motion along the San Andreas and San Jacinto faults (USGS 2015). In the vicinity of Borrego Valley, the deposits of the Palm Spring Formation are typically interbedded light gray arkosic sandstone and red claystone (Netto 2001). In areas of the Borrego Valley where the Imperial Formation is absent, the Palm Spring Formation directly overlies the basement complex (Netto 2001).

Borrego Formation

The Pliocene- to Pleistocene-age Borrego Formation, which is primarily composed of light-gray lacustrine claystone and siltstone, was deposited in a perennial lake that became tectonically isolated from the Gulf of California (Dorsey 2005; USGS 1982). The Borrego Formation, based on its origin, may locally contain evaporites (e.g., gypsum). Sandstone beds are rare in the Borrego Formation but, where present, are composed of both Colorado River and locally derived material (Dorsey 2005).

Ocotillo Conglomerate

Locally overlying the Borrego Formation in the Borrego and Ocotillo Badlands is the Ocotillo conglomerate (Dorsey 2005). The Pliocene- to Pleistocene-age Ocotillo conglomerate comprises gray alluvial fan and ephemeral stream deposits (Dorsey 2005; USGS 1982). This formation outcrops on the surface at the southwestern margin of the basin.

Quaternary Alluvium

Quaternary alluvium deposits are exposed over most of the Borrego Valley floor (USGS 2015; Figure 2.2-8). These deposits include lacustrine silts and clays that are present at or near the surface of the Borrego Sink, as well as coarse to fine sands derived primarily from Coyote Creek but also the numerous ephemeral stream channels that enter the Subbasin. The Quaternary Alluvium is further described in Section 2.2.1.3.

Soil Units

Overlying the geologic units described above are surface soils mapped by the U.S. Department of Agriculture. Soil types present within the Plan Area are mapped and described in U.S. Department of Agriculture Web Soil Survey of the Anza-Borrego Area, California (CA804), and San Diego County Area, California (CA638) (USDA 2018). The predominant soil units in the Plan Area (i.e., greater than 10% coverage) include the following, from greatest to least coverage:

- Carrizo very gravelly sand, 0%–9% slopes (CeC)
- Rositas fine sand, 0%–2% slopes (RoA)

- Sloping gullied land
- Indio silt loam, saline, 0%–2% slopes (IoA)
- Mecca fine sandy loam, 0%–2% slopes, eroded (MpA2)
- Rositas loamy coarse sand, 0%–2% slopes (RsA)

Figure 2.2-9 presents the soil units mapped within the Plan Area in terms of their predominant texture. Coarser soils occur around the valley edges and along the major stream corridors, whereas the finest soils occur in the valley center and within the Borrego Sink. According to the U.S. Department of Agriculture (USDA 2018), the Carrizo very gravelly sand has a “very high” saturated hydraulic conductivity[24] (Ksat) in the Plan Area (the weighted average of representative values for all soil horizons is 141 micrometers per second (µm/sec)). This soil unit develops over coarse alluvial fan units close to the mountain front, and along Coyote Creek and San Felipe Creek. The Rositas soil units, which underlie the developed community and the agricultural areas of the valley, have a high Ksat (the weighted average of representative values for all soil horizons is 92 µm/sec). The Mecca soil units also have a high Ksat, but are less permeable than the Rositas soils (the weighted average of representative values for all soil horizons is 28 µm/sec). The Indio soil units, which underlie undeveloped open space areas north of the Borrego Sink, have a “moderately high” Ksat (the weighted average of representative values for all soil horizons is 9 µm/sec). The only soil in the Plan Area with a moderately low Ksat is the playa unit, which underlies the Borrego sink (the weighted average of representative values for all soil horizons is 0.215 µm/sec). Areas mapped as sloping gullied land do not have a Ksat value assigned (USDA 2018).

Geologic Structures

Coyote Creek Fault

The right-lateral Coyote Creek fault, which is one of seven segments of the larger San Jacinto fault zone, defines the eastern boundary of the Subbasin (USGS 2015; Figure 2.2-8). The Coyote Creek segment is approximately 80 kilometers long and has an approximate slip rate of 2–6 millimeters per year (SCEDC 2018). The Coyote Creek fault is mapped by the USGS (2006) as having a well constrained location, and as being “latest Quaternary” in age, meaning its last rupture occurred less than 15,000 years ago. Historical (less than 150 years ago) motion along the San Jacinto fault zone has opened cracks as large as 2 feet wide along the Coyote Creek fault (USGS 2015). These cracks were later observed to infill with low permeability surface sediments (USGS 2015). Groundwater level

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[24] Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. It is based on soil characteristics observed in the field, particularly structure, porosity, and texture. Ksat are grouped according to standard Ksat class limits. The classes are: Very low (0.00 to 0.01 µm/sec), Low (0.01 to 0.1 µm/sec), moderately low (0.1 to 1.0 µm/sec), Moderately high (1 to 10 µm/sec), High (10 to 100 µm/sec), and Very high (100 to 705 µm/sec).

contours are generally perpendicular to the fault, suggesting that groundwater flow parallels the fault in most places (USGS 2015). It should be noted that because groundwater level data coverage on either side of the fault is poor, groundwater contours are subject to a high degree of interpretation.

Changes in groundwater elevations of 40–50 feet across the fault indicate that the Coyote Creek fault acts as a partial barrier to groundwater flow between the Borrego Springs Subbasin to the west and the Clark Lake Valley to the east (USGS 1982). An electrical resistivity study conducted by San Diego State University students in March 1983 under the direction of Professor David Huntley, along with groundwater level measurements reported by the USGS (1982), were reviewed to evaluate groundwater conditions in the early 1980s on either side of the fault, and to provide a screening assessment of potential flux across the fault using a groundwater flow equation. Given the hydraulic conductivity of the fault zone is not known precisely, a range of flux into the Borrego Springs Subbasin from the Ocotillo-Clark Valley Basin was estimated to be anywhere between 32 and 3,200 AFY (Wiedlin, pers. comm. 2018). Thus, there is a potential that the groundwater flux across the Coyote Creek fault and into the Borrego Springs Subbasin could be significant (Wiedlin, pers. comm. 2018).

Given this assessment is based on limited data, and is inconsistent with the assumption in the BVHM of a no flow boundary across the site, it represents a data gap. The flux into the Borrego Springs Subbasin from the Ocotillo-Clark Valley Basin could be verified by incorporating existing water wells on either side of the fault into the groundwater monitoring networks, evaluating the salinity of groundwater on the northeast side of the fault, and conducting a groundwater model sensitivity analysis (Wiedlin, pers. comm. 2018). The GSA does not consider this a critical data gap because historical groundwater levels and trends suggest the flux would be into the Subbasin rather than out of the Subbasin (i.e., a potential missing input to the water budget), and because the Coyote Creek Fault is distant from the active pumping centers within the Subbasin. This data gap does not affect the GSP's establishment of sustainable management criteria in Chapter 3, or the effectiveness of projects and management actions described in Chapter 4. If inflow from the Ocotillo-Clark Valley Basin is indeed significant, it ~~would~~ could contribute to progress towards the GSP's interim milestones and measurable objectives, and/or contribute operational flexibility within the Subbasin.

Borrego Syncline

The Borrego syncline, which developed during the early stages of faulting in the San Jacinto fault zone, forms the deep portion of the Subbasin (Lutz et al. 2006; Kirby et al. 2007; Steely et al. 2009; Janecke et al. 2010; USGS 1982; cross section A-A' on Figure 2.2-10). The deepest part of the Subbasin, where bedrock is buried beneath sediments, is in the vicinity of the Borrego Valley Airport (cross section A-A' on Figure 2.2-10; USGS 1993). The basement rock underlying this area is estimated to be at a depth of 3,800 feet (USGS 2015).

Yaqui Ridge/ San Felipe Anticline

The Yaqui Ridge/San Felipe anticline and San Felipe fault create a basement high in the vicinity south and east of the San Felipe Creek (cross section A-A’ on Figure 2.2-10). These structures are also related to deformation in the San Jacinto fault zone (Steely et al. 2009). The basement bedrock underlying the basin sediments drops away southeast of Ocotillo Wells following the southern limb of the San Felipe anticline into the Lower Borrego Valley. These structures effectively offset sediments north of San Felipe Creek from those to the south, forming the boundary between the Borrego Springs Subbasin and the Ocotillo Wells Subbasin (cross section A-A’ on Figure 2.2-10). The upper and middle aquifers, described as follows in Section 2.2.1.3, essentially pinch out in the vicinity of the San Felipe anticline, where the lower aquifer drapes down over the basement high. This structure creates a barrier to groundwater flow, which is evidenced by groundwater levels in the Borrego Springs Subbasin that are several hundred feet higher than those in the Ocotillo Wells Subbasin (which are at or near sea level).

2.2.1.3 Principal Aquifers and Aquitards

The USGS (2015) has subdivided the groundwater system within the Borrego Springs Subbasin into upper, middle, and lower aquifers. The differentiation between the three aquifers is based on a textural analysis of driller’s lithologic logs and geophysical logs. Differences in overall texture were determined by analyzing the fraction of coarse material like sand and gravel with depth for available logs. Historically, different nomenclatures have been applied to the Quaternary and late Tertiary geologic units (USGS 1982; Henderson 2001). Despite the differences in nomenclature, however, all the lithologic descriptions indicate that the basin fill sediments of the Borrego Valley consist of unconsolidated to poorly consolidated mixtures of gravel, sand, silt, and clay. As a result, the establishment of a purely textural definition for the three aquifers relies on a basin wide analysis of subsurface data rather than previously assigned geologic unit names.

As there are no regionally extensive aquitards (e.g., a thick clay layer), the upper aquifer behaves in a predominantly unconfined manner, and the lower and middle aquifer exhibit leaky confined or semi-confined characteristics based on limited aquifer testing (Netto 2001; Dudek 2014, 2015a, 2015b). The lower aquifer is the most fine-grained unit, containing higher amounts of silt and clay. The Imperial Formation was identified in two borings located in the southern part of the Subbasin, though it is not likely a wide-spread formation within the Subbasin. USGS (2015) notes that,

> hydraulic conductivities generally decrease with depth and with increasing distances from the original source of the sediments in adjacent mountain ranges and stream channels, which is consistent with the fining-down and fining-toward-the-basin-center sequences observed in the aquifer sediments and texture model.

The USGS prepared a cross-section running from Borrego Springs in the northwest to the southeast that illustrates the basement low in the Borrego syncline and the basement high of the San Felipe anticline (cross section A-A’ on Figure 2.2-10) (USGS 1982). This cross-section also illustrates that neither saturated portions of the high permeability sediments of the upper aquifer nor saturated sediments of the middle aquifer extend to the area south of the San Felipe anticline. Only the lower permeability sediments of the lower aquifer drape over the San Felipe anticline, and these older sediments are higly folded. This explains why the overdraft resulting from pumping of the upper and middle aquifers has been confined to the Borrego Springs area and has not propagated southeast of the San Felipe Creek area.

The three aquifers are shown on Figure 2.2-10 and are summarized from USGS (2015) as follows:

- **The upper aquifer** consists of coarse sediments (i.e., unconsolidated gravel, sand silt and clay of Holocene to Pleistocene age), primarily sourced from the Coyote Creek Watershed. It represents the unconfined aquifer, which historically has been the main source of water in the valley with well yields as high as 2,000 gallons per minute. The upper aquifer has been extensively dewatered by municipal, agricultural, and recreational pumping. The maximum thickness of the upper aquifer is estimated to be 643 feet where Coyote Creek enters the Subbasin, thinning to less than 50 feet near the Borrego Sink. The upper aquifer becomes mostly unsaturated south of the Desert Lodge anticline near Rams Hill.
- **The middle aquifer** consists of Pleistocene-age continental deposits of gravel to silt with moderate amounts of consolidation and cementation, and is thought to originate from lower energy sediment sources prior to the initiation of slip along the Coyote Creek fault. The maximum thickness of the middle aquifer is estimated to be 908 feet in the northwestern part of the Subbasin, and like the upper aquifer, thins to less than 50 feet toward the southeastern part of the Subbasin. USGS (1988) indicates that the middle aquifer yields moderate quantities of water to wells, but is considered a nonviable source of water south of San Felipe Creek in the Ocotillo Wells Subbasin because of its diminished thickness.
- **The lower aquifer** consists of partly consolidated continental and lacustrine sediments of the lower Palm Spring and Imperial Formations. The maximum thickness of the lower aquifer is estimated to be 3,831 feet in the eastern part of the basin near the Borrego Airport. The lower aquifer yields smaller quantities of water to wells than the upper and middle aquifers.

USGS (2015) summarized information on the hydrogeologic properties of each aquifer, and aquifer tests have been conducted on multiple wells in the basin (~~ID1~~RH-1, RH~~ID1~~-2, ID1-8~~.~~, RH-3, RH-4, RH-5, RH-6, Bauer 1, and Borrego Springs Water Co. Well 5); the range of aquifer values are shown in Table 2.2-3. The highest hydraulic conductivities were defined in the central portion of the valley where sand deposits of Quaternary age were characterized and older fan deposits at the base of the San Ysidro and Vallecito Mountains. Lower hydraulic conductivities were identified in areas characterized with younger fan deposits and consolidated continental deposits (Appendix D). The Borrego Sink was characterized with a uniform hydraulic conductivity of 6 feet per day in all three aquifer units (USGS 2015). The lower hydraulic conductivity in the middle and lower aquifers relative to the upper aquifer are based on a lower energy depositional environment to the Borrego Valley prior to activity along the Coyote Creek fault that opened the northern portion of the valley to sediment deposition from Coyote Creek (Appendix D). USGS (2015) reported that the specific storage defined for each aquifer unit under confined conditions ranged from 5.1×10^{-7} in the upper aquifer to 1.6×10^{-6} in the middle aquifer.

Table 2.2-3
Aquifer Hydraulic Conductivity and Storage Properties

Aquifer	Mean / Maximum Thickness (feet)[1]	Horizontal Hydraulic Conductivity (feet/day)[2]	Average Specific Yield (percent)
Upper	258 / 643	0.3–184	15 (Range: 2–28)
Middle	267 / 908	0.02–10	17.5 (Range: 15–21)
Lower	1,015 / 3,831		3 (Range: 0.7–5.6)

Source: USGS 2015; Dudek 2014, 2015a, 2015b, 2017.
Notes:

[1] Based on the sediment texture analysis developed for use in the Borrego Valley Hydrologic Model (BVHM) (USGS 2015).

[2] The range of hydraulic conductivities for the middle and lower aquifers are based on aquifer testing in wells screened across both zones, primarily in the South Management Area. The range for the upper aquifer is based on based on the distribution of coarse-grain sediments defined by the textural map created from lithologic and geophysical logs in the BVHM. The Borrego Sink was characterized by U.S. Geological Survey (USGS 2015) with a uniform hydraulic conductivity of 6 feet/day in all three aquifer units.

2.2.1.4 Recharge and Water Deliveries

There are no water deliveries to the Plan Area from external sources, and surface water imports are not available for managed recharge. In addition, there are currently no managed stormwater recharge facilities in the Plan Area. Thus, recharge is limited to natural infiltration of stormwater, and to a lesser degree, return flows of applied irrigation water and septic recharge.

The Coyote Creek Watershed, which drains the Santa Rosa Mountains to the north of the Borrego Springs Subbasin, provides most of the recharge to the Subbasin through infiltration of streamflow into the shallow alluvial sediments. Mountain front recharge that occurs at the interface between surrounding bedrock and unconsolidated sediments is the primary source of recharge along the smaller tributaries that enter the Subbasin, largely comprising the Borrego Valley-Borrego Sink Wash Watershed. These include Borrego Palm Creek, and washes exiting the San Ysidro Mountains, Pinyon Ridge, Yaqui Ridge, Coyote Mountains, and the Borrego Badlands. These areas of recharge are shown on Figure 2.2-11. USGS (2015) reported that "over the 66-year study period, on average, the natural recharge that reaches to the saturated groundwater system is approximately 5,700 acre-ft/yr. Natural recharge fluctuates in the arid climate from less than 1,000 to more than 25,000 acre-ft/yr."

The other, though less voluminous, source of recharge are return flows from agricultural irrigation. USGS (2015) estimated recharge from irrigation return flows to be between 10%–30% agricultural and recreational pumping based on the results of the BVHM. This is consistent with the estimate of irrigation return flow by Netto (2001), who used a chloride mass balance technique at a citrus grove located northwest of the intersection of Di Giorgio Road and Henderson Canyon Road to estimate a return flow of 22%. Netto (2001) used a similar approach to estimate a return flow for golf course irrigation of 14%. As agricultural efficiency increases, this fraction decreases. It can take years to decades for irrigation return flows to pass through the unsaturated zone to the underlying groundwater table, and much of the water that initially infiltrates into the soil is likely lost to evapotranspiration within the root zone, or (past the root zone) remains in storage within the unsaturated zone. However, elevated nitrate concentrations in the northern part of the Plan Area does provide evidence that agricultural return flows from years' past may be reaching the underlying aquifer (see Section 2.2.2.4).

Septic tank treatment and disposal systems also constitute a source of recharge to the basin, but is considered negligible when compared to natural recharge (USGS 2015). Most of the homes in the area utilize septic-tank treatment and disposal systems. The BWD estimates that about 80% of the domestic water deliveries are to homes with septic-tank systems (Dudek 2018). Potential recharge from this water use is difficult to quantify, but is believed to be small. The infiltration from septic tanks was simulated by the USGS (2015) at an application rate of 0.056 AFY per home at land surface into the unsaturated zone. This estimate was based on estimates per home water use of 100 gpd, and a 50% loss rate owing to evaporation and transpiration that was cited in the BWD IRWM Plan (USGS 2015). Septic tank treatment and disposal systems are known to be potential contributors to groundwater quality degradation, particularly when used in high concentrations and built to poor or outdated standards.

Recharge sources are quantified ~~as follows~~ in Section 2.2.3.

2.2.2 Current and Historical Groundwater Conditions

The primary sources of existing data for wells and groundwater include the various entities that have been collecting groundwater level and water quality data within the Plan Area since the early 1950s, primarily the BWD, County, DWR, SWRCB, and the USGS. As part of development of this GSP, the GSA is implementing a data management system (DMS) used to display and track groundwater well locations and monitoring data for groundwater levels, water quality, and production. The groundwater monitoring network established for the Plan Area by the GSA is intended to support tracking progress toward sustainability goals established in this GSP and to continue to report the data to the CASGEM Program and DWR's Water Data Library.

The location and type of monitoring for wells in the Plan Area are shown on Figure 2.2-12 and listed in Table 2.2-4. Water wells included in the groundwater monitoring network were incorporated from previous monitoring networks established by the BWD and consultants, County, DWR, and USGS. In addition to monitored wells in the Plan Area, there are four wells monitored within the Ocotillo Wells Subbasin, which are: "Dr. Nell" Well, "State" Well, SVRA Well, and Split Mountain Road Well. The Borrego Springs Subbasin monitoring network currently consists of 50 groundwater wells owned by BWD, the County, ABDSP, and private parties; some are strictly observation wells (no pumping), while others are used for municipal, recreation (e.g., golf courses and ABDSP), and rural residential purposes. The groundwater level-monitoring network ~~currently consists of 50 wells, including~~ includes 23 dedicated monitoring wells and 27 extraction wells. Of the 50 wells in the network, 46 are monitored for groundwater levels, 30 are monitored for water quality, and 19 are monitored for production. Groundwater levels are measured manually in the majority of the wells in the monitoring network, although the BWD and the Rams Hill Golf Course collectively have 17 wells equipped with pressure transducers that collect groundwater level data at frequencies as high as every 15 minutes. These wells are listed in Table 2.2-5.

The groundwater monitoring network is expected to evolve over time. The GSA expects to add additional wells as suitability issues are resolved, and as access permissions are granted from private well owners. The monitoring network currently lacks representation from certain recreational pumpers and agricultural pumpers in the NMA (see Section 2.2.4 for a description of management area). The GSA has prepared a Groundwater Extraction Facility Registration Form for each private well owner to complete in order to expand the inventory of private wells in the Borrego Springs Subbasin. Table 2.2-4 includes the wells' State Well ID, which is a unique well identifier designated by the DWR.[25]

Table 2.2-4
Groundwater Monitoring Network

Common Well Name [a]	State Well Identification (SWID)	Latitude	Longitude	Use	Groundwater Monitoring Networks		
					Elevation	*Quality*	*Production*
North Management Area							
Horse Camp	009S006E31E003S	33.349264	-116.400345	Other	X	X	—
Private Well	010S006E09N001S	33.314535	-116.366688	Residential	X	X	—
ID4-4	010S006E29K002S	33.277136	-116.374327	Public Supply	X	X	X
ID4-18	010S006E18J001S	33.306751	-116.384715	Public Supply	X	X	X

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[25] Wells monitored by the DWR and cooperating agencies are identified according to the State Well Numbering system. The numbering system is based on the public land grid, and includes the township, range, and section in which the well is located. Each section is further subdivided into sixteen 40-acre tracts, which are assigned a letter designation of A, B, C, D, E, F, G, H, J, K, L, M, N, P, Q, or R. Within each 40-acre tract, wells are numbered sequentially. The final letter of the State Well Number refers to the base line and meridian of the public land grid in which the well lies. "M" refers to the Mount Diablo base line and meridian; "S" refers to the San Bernardino base line and meridian; "H" refers to the Humboldt base line and meridian (DWR 2017).

Table 2.2-4
Groundwater Monitoring Network

Common Well Name [a]	State Well Identification (SWID)	Latitude	Longitude	Use	Groundwater Monitoring Networks		
					Elevation	*Quality*	*Production*
ID4-3	010S006E18R001S	33.298040	-116.384339	Public Supply	X	—	—
MW-1	010S006E21A002S	33.300634	-116.349471	Observation	X	X	—
Evans	010S006E21E01S	33.29429300	-116.36194000	Observation	X	—	—
Central Management Area							
County Yard (SD DOT)	011S006E15G001S	33.220966	-116.337613	Industrial	X	X	X
BSR Well 6	011S006E09B002S	33.23906	-116.35567	Irrigation - Recreation	—	X	X
BSR Well 3	011S006E04P001S	33.24559	-116.35875	Irrigation - Recreation	—	—	X
Hanna (Flowers)	010S006E14G001S	33.306115	-116.323982	Observation	X	—	—
Gabrych No. 2	011S006E01C001S	33.257255	-116.304700	Observation	X	—	—
ID4-1	010S006E32R001S	33.257486	-116.371035	Observation	X	—	—
ID4-5	010S006E33Q001S	33.257428	-116.355899	Observation	X	—	—
Airport 2	010S006E35N001S	33.257385	-116.326102	Observation	X	—	—
MW-4	010S006E35Q001S	33.257561	-116.313108	Observation	X	X	—
ID4-2	011S006E07K003S	33.231602	-116.388737	Observation	X	—	—
Palleson	010S006E33J001S	33.26156287	-116.34875075	Observation	X	—	—
Abandon Motel-1	011S006E10N001S	33.23.359532	-116.34704679	Observation	X	—	—
Abandon Motel-2	011S006E10N004S	33.23048074	-116.34689137	Observation	X	—	—
State Park No. 3	010S005E25R002S	33.27038000	-116.40354600	Other	X	X	X
Anzio/Yaqui Pass	011S006E22E001S	33.206040	-116.347150	Observation	X	—	—
Paddock	011S006E22B001S	33.211593	-116.334036	Observation	X	—	—
Cameron 2	011S006E04F001S	33.249652	-116.357102	Observation	X	—	—
ID5-5	011S006E09E001S	33.237067	-116.364304	Public Supply	—	X	X
ID1-10	011S006E22D001S	33.211790	-116.346813	Public Supply	X	X	X
ID1-16	011S006E16N001S	33.216557	-116.362440	Public Supply	X	X	X
Wilcox	011S006E20A001S	33.210910	-116.364826	Public Supply	X	X	X

Table 2.2-4
Groundwater Monitoring Network

Common Well Name [a]	State Well Identification (SWID)	Latitude	Longitude	Use	Groundwater Monitoring Networks		
					Elevation	*Quality*	*Production*
ID1-12	011S006E16A002S	33.226030	-116.348317	Public Supply	X	X	X
ID4-10	011S006E18L001S	33.218319	-116.392226	Public Supply	X	—	—
ID4-11	010S006E32D001S	33.267499	-116.383357	Public Supply	—	X	X
White Well	010S006E29A001S	33.280900	-116.367011	Residential	X	—	—
South Management Area							
RH-5	011S006E26B001S	33.195428	-116.319088	Irrigation - Recreation	X	X	X
RH-6	011S006E26H001S	33.194778	-116.314273	Irrigation - Recreation	X	X	X
RH~~ID1~~-2	011S006E25C001S	33.195655	-116.304156	Irrigation - Recreation	X	X	X
RH-4	011S006E24Q002S	33.199973	-116.303654	Irrigation - Recreation	X	X	X
~~ID1~~RH~~1~~-1	011S006E25A001S	33.198121	-116.295854	Irrigation - Recreation	X	X	X
RH-3	011006E25C002S	33.197950	-116.307563	Irrigation - Recreation	X	X	X
WWTP	011S006E23H001S	33.207400	-116.315199	Observation	X	X	—
MW-5A	011S007E07R001S	33.226557	-116.279352	Observation	X	X	—
MW-5B	011S007E07R002S	33.226557	-116.279352	Observation	X	X	—
Bakko	011S006E22A001S	33.210901	-116.330845	Observation	X	—	—
Army Well	011S006E34A001S	33.184156	-116.332830	Observation	X	X	—
Hayden (32Q1)	011S007E32Q001S	33.173998	-116.264318	Observation	X	—	—
Bing Crosby Well	011S007E20P001S	33.199489	-116.267939	Observation	X	—	—
MW-3	011S006E23J002S	33.203481	-116.314252	Observation	X	X	—
ID1-8	011S006E23J001S	33.203160	-116.314343	Public Supply	X	X	X
Air Ranch Well 4	011S007E30L001S	33.190830	-116.286730	Public Supply	X	X	—
JC Well	011S006E24Q001S	33.201936	-116.303268	Residential	X	X	—
La Casa	011S006E23E001S	33.208044	-116.328359	Unknown	X	X	—

Notes: X = Monitored; — = Not Monitored; SD DOT = San Diego County Department of Transportation; BSR = Borrego Springs Resort.

[a] Common names beginning in "ID" are Borrego Water District (BWD) wells, common names beginning in "RH" area Ram's Hill Country Club Wells, and common names consisting of pronouns refer to the well owner or small water system.

Table 2.2-5
Wells Equipped with Pressure Transducers

Well ID	Period of Record	Frequency of Data Collection (minutes)	Well Owner
Currently Monitored Wells			
RH~~ID1~~-1	April 2014 to Present	15	Rams Hill Golf Course
RH~~ID1~~-2	April 2014 to Present	15	Rams Hill Golf Course
ID1-8	March 2014 to Present	15	Borrego Water District
RH-3	August 2014 to Present	15	Rams Hill Golf Course
ID1-12	March 2018 to Present	30	Borrego Water District
ID1-16	March 2018 to Present	30	Borrego Water District
ID4-4	March 2018 to Present	30	Borrego Water District
ID4-18	March 2018 to Present	30	Borrego Water District
RH-4	January 2015 to Present	15	Rams Hill Golf Course
RH-5	June 2015 to Present	15	Rams Hill Golf Course
RH-6	November 2015 to Present	15	Rams Hill Golf Course
~~Jack Crosby (~~JC Well~~)~~	September 2014 to Present	15	Rams Hill Golf Course
MW-1	April 2016 to Present	120	Borrego Water District
MW-3	April 2014 to Present	15	Borrego Water District
MW-5A (Lower)	May 2016 to Present	15	Borrego Water District
MW-5B (Upper)	June 2016 to Present	15	Borrego Water District
WWTP	March 2014 to Present	15	Borrego Water District
Previously Monitored Wells			
Air Ranch Well No 4	May 2016 to February 2017	15	Borrego Air Ranch

The following subsections address current and historical conditions related to each of the undesirable results identified under SGMA, including groundwater elevations (Section 2.2.2.1), changes in groundwater storage (Section 2.2.2.2), groundwater quality (Section 2.2.2.4), subsidence (Section 2.2.2.5), and groundwater-surface water interactions and groundwater-dependent ecosystems (Sections 2.2.2.6 and 2.2.2.7) in the Borrego Springs Subbasin.

2.2.2.1 Groundwater Elevation Data

Current Groundwater Levels

Current groundwater levels in the Borrego Springs Subbasin were measured in Spring and Fall 2018, and are shown on Figure 2.2-13A and Figure 2.2-13B, respectively. Measured groundwater elevations in Spring 2018 ranged from a high of 644.76 feet amsl in the northern part of the subbasin (DWR Well No. 009S006E31E003S (Horse Camp Well)) to a low of 377.58 feet amsl north of the intersection of Henderson Canyon Road on Di Giorgio Rd (DWR Well No. 010S006E09N001S), which marks the central area of the primary agriculture area in the valley.

Measured groundwater elevations in Fall 2018 were similar to those measured in the spring, showing a similar spatial pattern of static groundwater level elevations. On average, groundwater elevation measurements in Spring 2018 were 12.59 feet lower than Fall 2018, with a maximum rise of 2.48 feet amsl (DWR Well No. 011S006E22E001S (Anzio/Yaqui Pass)), and a maximum fall of 10.51 feet amsl (DWR Well No. 011S006E23J002S (MW-3)). In certain wells and at certain times of the year, particularly the irrigation season, near-by pumping can influence groundwater level elevation in monitored wells.

The predominant direction of groundwater flow within the Subbasin is away from mountain front regions, and away from San Felipe Creek, toward the center of the valley near Palm Canyon Drive about 2 miles north of Borrego Sink. The steepest groundwater gradient measured in Spring 2018 occurred across the cultivated areas of the northern part of the basin. In this area (between the ABDSP Horse Camp Well and DWR Well No. 010S006E09N001S), the groundwater gradient in Spring 2018 was 0.016. The groundwater gradients in the central and eastern parts of the Plan Area were relatively flat.

Two pumping-related depressions were exhibited in the data collected, one centered on the agricultural areas north of Henderson Canyon Road, and possibly another centered around a cluster of wells north of the Ram’s Hill Country Club. Groundwater levels in terms of depth from the surface tend to shallow towards the Borrego Sink and tend to deepen around the northern, western and southern margins of the Subbasin, as shown on Figure 2.2-10.

Historical Groundwater Levels

Historical groundwater levels in the Borrego Springs Subbasin are shown on Figure 2.2-13C for 2010 and Figure 2.2-13D for 1945. In 2010, groundwater contours indicate that groundwater elevations ranged from a high of over 500 feet amsl in the southern part of the Subbasin near San Felipe Creek to a low of about 340 feet amsl about 3 miles east of the Borrego Sink (Figure 2.2-13C). The 2010 contours show two pumping depressions. One appears as an elongated zone centered north of Henderson Canyon Road extending south toward Christmas Circle within the 400-foot groundwater contour. The other is centered just north of the intersection of Borrego Springs Road and Anzio Drive, extending further west towards the mouths of Culp Canyon and Dry Canyon, also within the 400-foot groundwater contour.

In 1945, prior to development in the Plan Area, the direction of groundwater flow was predominantly from the northwest to the southeast (Figure 2.2-13D). Groundwater elevations ranged from more than 600 feet amsl near Coyote Creek in the northwestern part of Borrego Valley to about 460 feet amsl in the southeastern part. The lowest groundwater-level elevations occurred east of the Borrego Sink, an area of natural drainage in the middle of the valley that is currently dry most of the time. According to the USGS (2015), the Borrego Sink was historically the site of about 450 acres of honey mesquite (*Prosopis glandulosa*) and other native phreatophytes, indicating that shallow groundwater and occasional accumulations of surface water was sufficient to support a GDE. Old Borrego Spring~~s~~, located about~~ 2 ~~ 1 mile~~s~~ ~~west ~~east of the Borrego Sink, was flowing in 1945, but ran dry as agricultural uses began in the following decade. In 1945, the groundwater flowed parallel to Coyote Creek in an easterly to southeasterly direction.

Groundwater Level Trends

Since the early 1950s, groundwater extraction has exceeded recharge, and the direction of flow has been altered in all areas of the valley to the current period. The human influence on groundwater levels within the Plan Area is most pronounced in the northern part of the basin, generally decreasing in intensity towards the southeast. One exception to this general trend is that municipal and recreational well clusters, generally located east and south of the Borrego Sink do show more intense pumping than the areas north of the Borrego Sink within the central part of the Subbasin.

As shown on Figure 2.2-13E, groundwater levels between 1953 and 2018 declined by as much as 133 feet in the northern part of the Plan Area (Northern Management Area (NMA)), equivalent to an average rate of 2.05 feet per year. The rate of groundwater level decline in the northern area was greatest prior to 1965, which is around the time that irrigation of grape crops in the Plan Area ceased. During grape cultivation, groundwater levels were dropping by as much as 3.4 feet per year (USGS 2015). Groundwater levels briefly stabilized and slightly rebounded from the mid-1960s until the early 1970s, at which point groundwater levels began dropping again, albeit at a lower rate than in the 1950s and early 1960s. Starting in the late 1970s, cultivation of citrus crops began in earnest, and groundwater levels in the northern part of the Plan Area have been dropping at a relatively constant rate since that time. Figure 2.2-13E includes key wells with a long-running record, however, hydrographs for every well in the GSA's current monitoring network is included in Appendix D.

Also shown on Figure 2.2-13E is a second, smaller area of groundwater-level depression in the west-central part of the basin (Central Management Area (CMA)), which is associated with pumping for municipal and recreational purposes. The magnitude of the groundwater level decline is smaller, dropping by about 88 feet between 1953 and 2018, or an average rate of 1.35 feet per year. In the southeastern part of the valley (South Management Area (SMA)), where less groundwater has been pumped, the groundwater-level has remained about the same in the historical record, remaining at an elevation of about 500 amsl (approximately 10 feet) at DWR well Nos. 011S007E20P001S and 011S007E32Q001S. An exception to this observed trend in the SMA is the resumption of pumping for the Rams Hill golf course starting in 2014, and shown in the groundwater level record for DWR well No. 011S006E23J002S on Figure 2.2-13E.

To visualize the recent rate of groundwater decline across the Subbasin, Figure 2.2-13F shows the difference between the 2010 and Fall 2018 groundwater elevation contours. Furthermore, Chapter 3

Figures 3.2-1, 3.2-2, and 3.2-3 depict the remaining saturated thickness of each aquifer in the upper, middle and lower aquifers, respectively. The upper aquifer currently hosts the most accessible (i.e., shallowest) and highest-yielding wells within the Subbasin as a whole. As shown on Figure 3.2-1, the groundwater table has dropped below the base of the upper aquifer in some parts of the Subbasin, particularly within the southwestern half of the CMA, which overlies the more developed portion of Borrego Springs that is served by the BWD with wells located in the CMA (Figure 3.2-1). Up to 175 feet of the upper aquifer remains saturated in the east central part of the CMA, and roughly 50 feet, on average, of the upper aquifer remains saturated within portions of the SMA and CMA. The middle aquifer maintains much of its saturated thickness over much of the Subbasin, except where the aquifer unit pinches out in the southwest part of the Subbasin (Figure 3.2-2). The lower aquifer is the thickest aquifer underlying the Plan Area (Figure 3.2-3).

Data Gaps

Review of existing groundwater elevation data within the Plan Area suggests that although three distinct aquifers are delineated in varying thickness across the Subbasin, the effect of well screen lengths and intervals is potentially negligible with respect to measured depths to groundwater (i.e., potentiometric surface). An example includes MW-5A/5B with dual nested wells screened across the upper/middle aquifers and middle/lower aquifers. Variation of groundwater depths between these wells averages less than 0.01 foot. Therefore, although the Subbasin may not include data for groundwater monitoring wells screened solely in each of the three aquifer units for each of the three management areas, these data gaps are not considered significant with regard to groundwater levels. As such, for the purposes of the GSP, the need for wells screened solely in each vertical aquifer unit independently does not appear to be necessary to achieve adequate spatial representation of groundwater elevations in the Subbasin. Spatial (vertical) distribution suggests that the existing well infrastructure may be adequate to determine the minimum threshold for chronic groundwater lowering.

Lateral distribution suggests that existing wells are adequate to meet SGMA requirements; however, elevation data from some critical monitoring points have yet to be received from sources such as the DWR. The adequacy of the lateral distribution of monitoring wells in the NMA, CMA, and SMA is described as follows.

- *North Management Area*: The well distribution in the NMA appears adequate to meet SGMA requirements; however, groundwater elevation data from agricultural pumpers are limited. The compiled data currently includes existing well data from four wells in the NMA, but historical data from additional wells would be beneficial to establish the minimum threshold. Developing a better understanding of groundwater elevations and quality in the future is a goal for this portion of the Borrego Springs Subbasin.

- *Central Management Area*: The well distribution in the CMA appears adequate to meet SGMA requirements, and because this area has been well studied historically, sufficient groundwater elevation data has been obtained to establish the minimum threshold.
- *South Management Area*: The well distribution in the SMA appears adequate to meet SGMA requirements. This area includes wells that are routinely monitored by the BWD, in addition to several wells that are routinely monitored under the CASGEM program.

Significant data gaps have been identified associated with access to the DWR and private well information in the Plan Area, which are primarily agricultural wells. Specifically, this includes an area north of the Borrego Sink, which results in the 2018 groundwater level contours that may obscure finer details on groundwater flow direction and gradient in the area. This area consists of undeveloped open space and a lack of production wells. In addition, additional groundwater level data on either side of the Coyote Creek fault would aid in verifying the degree to which the fault acts as a partial barrier to groundwater flow (Wiedlin, pers. comm. 2018). As previously discussed, the GSA has been working to close these data gaps by identifying additional monitoring locations. The GSA has developed the Borrego Springs Subbasin Monitoring Plan (described in Chapter 3, Section 3.5), to be updated periodically, to address these data gaps and to monitor groundwater levels and water quality against the sustainability indicators defined and outlined in Chapter 3 of this GSP.

2.2.2.2 Estimate of Groundwater in Storage

The storage capacity based on stable groundwater levels before groundwater development began in the basin is estimated to have been about 5,500,000 AF (USGS 1982). Based upon subsequent study by Dr. David Huntley, the majority of readily available water to existing well users in the Borrego Valley exists in the upper and middle aquifer. The amount of groundwater within these two aquifers was estimated to be approximately 2,131,000 AF in 1945 and 1,900,500 AF in 1980 (Huntley 1993). The remaining water located within the lower aquifer is more difficult and costly to extract due to its low specific yield (estimated to be approximately 3%), its depth, and low specific capacity (estimated to be 5 gallons per minute/foot of drawdown or less) (County of San Diego 2010). As discussed in the following Section 2.2.3.3, it is estimated that 520,000 AF of water has been removed from storage over the period of model simulation, which begins in the pre-development period. The BVHM estimates that total storage loss from water year 1980 through water year 2016 is 334,293 AF. Therefore as of 2016, the volume of groundwater in storage within the upper and middle aquifers of the Subbasin is approximately 1,566,207 AF. It should be noted that the extent of the BVGB analyzed by the USGS (1982) was about 12% larger than the Plan Area, due to differences in the southeastern boundary of the study area along San Felipe Creek.

2.2.2.3 Seawater Intrusion

As an inland basin, the Borrego Springs Subbasin has no hydraulic connection to the Pacific Ocean. The Subbasin is more than 50 miles from the Pacific Ocean, more than 130 miles from the Gulf of California, and 15 miles from the Salton Sea, which is an inwardly draining sink. Additionally, the Salton Sea is geologically separated from the Subbasin by the Coyote Creek fault and Coyote Mountains. Therefore, sufficient data appears to demonstrate that seawater intrusion is not an applicable sustainability indicator[26] in the Plan Area.

2.2.2.4 Groundwater Quality

The most extensive water quality monitoring data within the Borrego Springs Subbasin comes from reporting by public water supply systems to the SWRCB Division of Drinking Water for the purpose of ensuring adequate drinking water quality. For example, the BWD routinely monitors approximately 12 wells to test ~~pumped~~ groundwater for general minerals, aggregate properties, solids, metals, and nutrients at least every 3 years. In addition to historical water quality data available within the Subbasin, Table 2.2-4 shows the wells included in the GSA monitoring network for groundwater quality. Constituents to be monitored have been selected based on the results of prior monitoring activities in the Subbasin conducted primarily by DWR, USGS, and BWD. These monitoring activities along with USGS publications (USGS 2014, 2015) have summarized groundwater quality conditions in sufficient detail to identify arsenic, nitrate, sulfate, fluoride, TDS, and radionuclides as the Subbasin's main constituents of concern (COCs).

To provide some context for the groundwater quality results, concentrations of constituents measured in the untreated groundwater are compared with regulatory and non-regulatory health-based benchmarks established by the U.S. Environmental Protection Agency and SWRCB Division of Drinking Water. The primary metric for identifying undesirable results[27] related to groundwater quality within the Subbasin are exceedances of State of California Maximum Contaminant Limits (MCLs)[28] (Title 17 CCR and Title 22 CCR). It should be noted that these regulatory benchmarks apply to water that is delivered to the consumer, not to untreated groundwater. Exceedances of MCLs within raw groundwater indicate potential threats to human health in untreated groundwater and the potential need for additional treatment steps to make groundwater suitable for potable use. All BWD wells currently have water quality adequate for

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[26] "Sustainability indicator" refers to any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results (California Water Code Section 10721(x)). Sustainability indicators as they relate to the Plan Area are discussed in Chapter 3.

[27] Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators defined by SGMA are caused by groundwater conditions occurring in one of the Subbasin's three management areas, or throughout the Subbasin. Undesirable results as they relate to the Plan Area are discussed in Chapter 3.

[28] MCLs are standards that are set by the U.S. Environmental Protection Agency and SWRCB for drinking water quality. An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems under the Safe Drinking Water Act (Federal and State).

non-potable use (i.e., Title 22 CCR) without treatment. Monitoring wells identified in Table 2.2-4 are also used for comparison to potable water quality standards (i.e., Title 17 CCR) and/or those identified as having irrigation/recreation use. Though the current water quality of non-potable wells does not limit beneficial use for irrigation, the monitoring network in place will monitor and track trends for water quality constituents throughout the Subbasin.

There are both anthropogenic and natural sources of the COCs in the Borrego Springs Subbasin. Anthropogenic sources that may contribute to degradation of the current water quality in the Subbasin include agricultural use of pesticides and fertilizers, salt accumulation resulting from agricultural irrigation practices, and household septic system return flows. Natural sources of COCs in the Subbasin include the rocks and minerals that comprise the aquifer matrix material. These naturally occurring COCs contain evaporite minerals, which can dissolve and increase TDS concentration in the aquifer; silicate minerals, which can contribute arsenic to the groundwater; and sulfate minerals, which can contribute sulfate to the groundwater. All are found in differing amounts in the upper, middle, and lower aquifers. Differences in the mineralogical composition of the aquifers can result in groundwater quality differences between the aquifers. Current and historical data was reviewed for COC concentrations exceeding applicable MCLs, and the Mann-Kendall test was applied in wells with sufficient data[29] to assess temporal trends in groundwater quality. The GSA, through development and implementation of this GSP, will further the goal of continuing to deepen the understanding of groundwater elevations and quality in the Subbasin.

Nitrate

Sources of nitrate in groundwater are ~~typically associated with specific land use but they can also occur naturally. Nitrate is~~ commonly associated with fertilizers and septic tanks; however, ~~it~~ nitrate can also be naturally occurring. Fertilizers and septic tanks are common anthropogenic sources of nitrate detected in groundwater. Potential natural sources of nitrate in groundwater may result from leaching of soil nitrate, which occurs by atmospheric deposition, and dissolution of evaporative minerals, igneous rocks, and deep geothermal fluids. In desert groundwater basins, the largest source of naturally occurring nitrates in groundwater occurs from incomplete utilization of nitrate by sparse vegetation. This nitrate accumulates in the unsaturated zone and may become mobile when surficial recharge percolates through the unsaturated zone (Walvoord et al. 2003). In arid environments, nitrate stored in the unsaturated zone may become mobilized by artificial recharge from irrigation return flow, septic effluent, and infiltration basins. Because the Borrego Springs Subbasin lacks appreciable evaporitic deposits (other than near the area of the Borrego Sink), anthropogenic sources (irrigation and wastewater return flows) are likely the main contributors of

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[29] A minimum of four data points are required to calculate trend. Insufficient data indicates wells where no trend was established because either four data points were not available, or because the data reported was less than laboratory reporting limits.

nitrates to groundwater. The California drinking water MCL is 10 mg/L for nitrate as (N) and can be expressed as 45 mg/L for nitrate (NO_3).

Figure 2.2-14A presents wellheads sampled for nitrate concentrations by aquifer, in terms of whether samples analyzed exceeded MCLs. Although there are no exceedances shown on Figure 2.2-14A, historical exceedances of nitrate concentration have occurred in five wells in the vicinity of Henderson Canyon Road in the northern part of the valley, adjacent to areas of agricultural use (USGS 2015). Nitrate concentrations in these wells ranged from above the MCL of 10 mg/L to ~~67~~ 155 mg/L. The existing groundwater network also indicates elevated nitrate at the State well ID 010S006E09N001S in the NMA and at the BWD's WWTP monitoring well.

Historical nitrate trends in the Subbasin show decreasing, increasing and neutral trends, depending on the well sampled. Wells exhibiting an increasing trend include BWD Wells ID4-11 and ID4-18 in the NMA, Well ID1-10 in the CMA, and Well ID1-8 in the SMA~~.~~, though the concentration of nitrate in these wells remain substantially below one-half of the MCL. The Fall 2018 monitoring data indicates the nitrate concentration of Wells ID4-11, ID4-18, ID1-10, and ID1-8 are 0.82 mg/L, 0.67 mg/L, 1.2 mg/L, and 1.8 mg/L, respectively. All other wells that are currently monitored have a neutral or declining trend, or have insufficient historical data to establish a trend. Spatial concentration patterns of nitrate indicate the agricultural fields, golf courses, and the percolation ponds at the Rams Hill WWTP may represent anthropogenic sources of nitrate in groundwater. In the past, the BWD improvement district 4 (ID4) wells 1 and 4, Borrego Springs Water Company Well No. 1 (located at the BWD office), the Roadrunner Mobile Home Park and Santiago Estates wells had to be taken out of potable service due to elevated nitrate. The latter two developments were connected to municipal wells operated by the BWD as an alternative source of supply. Well ID4-4 was re-drilled and screened deeper at the same location and successfully accessed good water quality not impacted by nitrates. The Di Giorgio wells 11, 14 and 15 located north of Henderson Road have historical detections of nitrate and TDS above drinking water standards (BWD 2002).

Total Dissolved Solids

TDS is a measure of all dissolved solids in water including organic and suspended particles. Sources of TDS in groundwater include interaction of groundwater with the minerals that comprise the aquifer matrix material. Over time, TDS will increase as more minerals in contact with groundwater dissolve. In desert basins, evaporative enrichment near dry lake beds (playas) is known to naturally increase TDS in groundwater. This process also occurs in plants, both in agriculture and natural systems. Anthropogenic sources include synthetic fertilizers, manure, wastewater treatment facilities, and septic effluent. Repeated irrigation is also a known cause of elevated TDS, as minerals concentrate in the soil column with repeated evaporation. These increased concentrations can then be mobilized into the underlying groundwater table. The California drinking water secondary MCL for TDS is recommended at 500 mg/L with upper and short-term limits of 1,000 mg/L and 1,500 mg/L, respectively. TDS have been historically detected above the secondary MCL in some wells in the Subbasin. There is no primary MCL established for TDS.

Figure 2.2-14B presents wellheads sampled for TDS concentrations by aquifer, in terms of whether samples analyzed exceeded MCLs. The majority of wells sampled have TDS concentrations less than half the secondary MCL, of 500 mg/L. However, RH~~ID1~~-1 and MW-5A/B have TDS concentrations that exceed the secondary MCL. TDS concentrations in the Subbasin have historically ranged from less than 500 mg/L to 2,330 mg/L, and elevated TDS has occurred in wells that also have elevated nitrate concentrations (USGS 2015). The TDS concentrations are generally highest in the shallow aquifer and in the northern part of the Borrego Valley (USGS 2015). Historical TDS trends in the Subbasin show both decreasing, increasing and neutral trends, depending on the well sampled. Wells exhibiting an increasing trend include an irrigation well, ~~BWD~~ RH~~ID1~~-1, and BWD Well ID1-8 in the SMA. All other wells that are monitored have no trend, or have insufficient historical data to determine a trend.

Drilling of a dual screened monitoring well by DWR in the southern portion of Borrego Valley (northeast of Borrego Sink) shows poor water quality in shallow groundwater deteriorating with depth (DWR 2007). Groundwater samples collected from a dual screen monitoring well drilled by DWR (MW-5A and MW-5B) in the southern portion of the Borrego Valley (northeast of Borrego Sink) were analyzed for TDS and sulfate. The concentration of TDS in water collected from the upper completion (45 to 155 feet below ground surface) was 1,300 mg/L while the concentration of water collected from the lower completion (200–345 feet below ground surface) was 2,300 mg/L (DWR 2007). The measured concentrations of TDS and sulfate in these samples (MW-5A and MW-5B) are too high for drinking water supply without additional treatment. Elevated TDS appears to be associated with poorer water quality near the Borrego Sink, likely due to concentration of dissolved solids as a result of evaporation of water in the Borrego Sink and later leaching of naturally occurring evaporites (sediments formed by the evaporation of water). Furthermore, the differing TDS values provides supporting evidence that salinity increases with depth, and that treatment requirements may increase as users draw a higher percentage of water from the lower aquifer.

Sulfate

Natural sulfate sources include atmospheric deposition, sulfate mineral dissolution, and sulfide mineral oxidation of sulfur. Gypsum is an important source of natural sulfate near localized economically important deposits such as in the Ocotillo Wells Subbasin near Fish Creek Mountains in Imperial County. Fertilizers can also be a source of sulfate in groundwater but typically do not result in exceedance of drinking water standards. The California drinking water secondary MCL for sulfate is recommended at 250 mg/L, with upper and short-term limits of 500 mg/L and 600 mg/L, respectively.

Figure 2.2-14C presents wellheads sampled for sulfate by aquifer, in terms of whether samples analyzed exceeded MCLs. Although none of the samples analyzed as part of the USGS study had concentration of sulfate that exceeded the California secondary MCL for sulfate (USGS 2015), wells MW-4, MW-5A, MW-5B, and ~~ID1~~RH1-1 have had sulfate detected above the secondary MCL with concentrations of 330 mg/L, 1,300 mg/L, 2,300 mg/L, and 650 mg/L, respectively. Historical sulfate trends in the Subbasin show both decreasing, increasing and neutral trends, depending on the well sampled. Wells exhibiting an increasing trend include BWD Wells RH~~ID1-~~1 and ID1-8 in the SMA. All other wells that are monitored have no trend, or have insufficient historical data to determine a trend. Based on the available data, it appears that elevated sulfate concentrations go hand in hand with elevated TDS concentrations around the Borrego Sink in the SMA as previously explained for dissolved solids.

Arsenic

Arsenic is naturally occurring, and concentrations of arsenic in Southern California groundwater basins commonly exceed California's drinking water MCL of 10 micrograms per liter (µg/L) (Anning et al. 2012; Welch et al. 2000). In semi-arid and arid groundwater basins, groundwater recharge is limited due to low precipitation and the residence time of the groundwater in the basin is high. The long residence time of the groundwater in the basin allows for more interaction between the groundwater and the minerals that comprise the aquifer matrix material. With time, arsenic desorbs from sediments and enters the groundwater. This process is more efficient in groundwater with higher pH. The groundwater in the Subbasin has a pH of 7.5 to 9.0, a range that is conducive for this transfer of arsenic from the sediment to the water. Arsenic concentrations have been demonstrated to increase as groundwater levels decrease for wells located in the SMA, and have been historically detected above laboratory reporting limits in some wells in the Borrego Springs Subbasin.

Figure 2.2-14D presents wellheads sampled for arsenic by aquifer, in terms of whether samples analyzed exceeded MCLs. Arsenic concentrations have been detected above laboratory reporting limits at several wells in the Borrego Springs Subbasin since the 1980s.[30] Arsenic has been detected in non-potable wells up to 22 µg/L in Rams Hill Golf Course well RH-4 (Dudek 2015a). Arsenic concentrations for wells located in the NMA were less than half the MCL (<5 µg/L) for wells screened in the upper, middle, and lower aquifers. Arsenic concentrations ~~from 2016~~ for wells located in the CMA were less than half the MCL (<5 µg/L) for wells predominantly screened in the middle aquifer and less than the MCL (<10 µg/L) for wells predominantly screened in the

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[30] Prior to the 1980s, laboratory detection limits for arsenic where often established at 10 µg/L or 50 µg/L and results were reported as below the laboratory detection limit.

lower aquifer. Arsenic concentrations ~~from 2016~~ for wells located in the SMA ranged from less than half the MCL (<5 µg/L) to greater than the MCL (>10 µg/L). The screen intervals of wells in the SMA predominantly intercept the lower aquifer though most wells are partially screened in the middle aquifer as well.

Historical arsenic trends in the Subbasin show decreasing, increasing and neutral trends, depending on the well sampled. The only well exhibiting an increasing trend is ~~BWD~~ Well ~~ID1~~RH-2, which is an irrigation well in the SMA. All other wells that are monitored have no trend, or have insufficient historical data to determine a trend. Trends for most wells that have concentrations below the MCL were not determined due to results being below the laboratory reporting limits.

Fluoride

Fluoride is a naturally occurring element in groundwater resulting from the dissolution of fluoride-bearing minerals from the aquifer sediments and surrounding bedrock. Brown staining or mottling of teeth and resistance to tooth decay as a result of drinking water with high concentrations of fluoride has been known since the 1930s. While drinking fluoridated water at low concentrations (i.e., 0.7 parts per million) is beneficial to prevent tooth decay, excessive exposure to fluoride can result in dental and skeletal fluorosis. The California drinking water MCL for fluoride is 2 mg/L, and fluoride has historically been detected in some wells above this level in the Subbasin.

The USGS identified three wells with fluoride concentrations that exceed the California drinking water primary MCL of 2 µg/L. Fluoride concentrations in these wells ranged from 2.69 to 4.87 mg/L (USGS 2015). The Cocopah Well tested above the California drinking water standard at concentration of 2.2 mg/L (USGS 2015). Otherwise, fluoride concentrations within the Subbasin are typically below one-half the MCL. For wells with adequate data to analyze trends one well shows an increasing trend (Wilcox Well); for Wells RH~~ID1~~-1, RH~~ID1~~-2, and ID1-8, no trend is indicated.

Radionuclides

Radionuclides occur naturally in the mineralogy of sediment particles and become dissolved in groundwater as groundwater flows through the porous sediment matrix that contains trace levels of radioactive isotopes. Gross alpha and beta measurements are screening tools for quantification of radioactivity in groundwater, which is measured as activity units of picocuries per liter (pCi/L). The California drinking water primary MCL for gross alpha is 15 pCi/L based on a four-quarter average. Other radionuclides with California drinking water primary MCLs include radium-226 + radium-228 (5 pCi/L), strontium-90 (8 pCi/L), tritium (20,000 pCi/L) and uranium (20 pCi/L).

Limited radionuclide data is available for the Subbasin; however, gross alpha concentrations will be tracked to document and evaluate progress toward sustainability throughout development and implementation of the GSP. Gross alpha and gross beta results available for BWD indicate concentrations detected are below primary MCLs. Gross Alpha for Well ID4-11 was measured in Fall 2017 as being 5.24 pCi/L ± 1.68. Gross Alpha for Well ID1-16 was measured in Fall 2017 as being 0.751 pCi/L ± 0.872. Gross Alpha for Wilcox Well was measured in Fall 2017 as being 0.489 pCi/L ± 0.739. Gross Alpha for ID1-10 was measured in Fall 2017 as being 0.614 pCi/L ± 1.39. Gross Alpha for ID1-8 was measured in Fall 2017 as being 4.12 pCi/L ± 2.13.

Constituents of Concern Point Sources (Release Cases or Oil/Gas Wells)

Petroleum hydrocarbons and other contaminants can be released to the groundwater system as a result of leaking underground fuel tanks, disposal facilities, or poor management of activities on industrial sites and/or service commercial uses. The SWRCB's "Geotracker" database and the Department of Toxics Substances Control "Envirostor" database were reviewed to identify current and historical cleanup cases within the Subbasin. These case locations are shown on Figure 2.2-15. The potential media of concern for all the cases shown on Figure 2.2-15 is soil rather than groundwater, and all but two of the cases are identified as closed status, which indicates that the contamination issue has been verified to either be remediated or contained (i.e., prevented from migrating greater distances or to other media). The open cases include the Borrego Sites/Carrizo Impact Site (DOD100031200) and the Borrego Springs Landfill Class III Solid Waste Disposal Site (L10003017008). The Borrego Springs Landfill is in the Geotracker database as a solid waste facility subject to a WDR, and there is no contaminant release case associated with it. The landfill conducts semi-annual monitoring to ensure compliance with the terms of the WDR, developed to protect basin plan objectives for surface and groundwater (see Section 2.1.2).

The Borrego Sites/Carrizo Impact Site is a former military site used between 1942 and 1959 to train combat troops for desert warfare, to train mechanized artillery service units and staff, anti-aircraft training, and practice bombing training. Although the site is indicated on Figure 2.2-15 as a point location, it actually encompasses approximately 400 square miles (256,000 acres) of desert terrain and dry lakes, mostly outside of the Plan Area (in the Clark Valley and Ocotillo Wells area). The historic areas of activities within the Plan Area is Camp Ensign, a 1,918-acre site overlapping and south of the Borrego Springs Resort and Circle Club Resort. This site was used between 1942 to 1944 as a headquarters and bivouac/cantonment area in support of various training activities (ACOE 2011). The main issues of concern come from munitions debris and a historic dump site within the soil matrix. Soil sample sites were selected for testing of explosives, pH, and select metals (aluminum, antimony, copper, lead, and zinc) based on historical review of site activities. The site inspection report summarizing the testing results and risk assessment indicates the COC concentrations in soil do not present unacceptable human health or ecological risks and no further DOD was recommended (ACOE 2011). Since these activities occurred in the soil and no unacceptable concentrations of explosives or munitions-related metals were found, this site is not considered a current or potential future groundwater quality risk for the Borrego Springs Subbasin.

The SGMA GSP regulations also require identification of oil and gas wells within the groundwater basin. Such wells could be a concern if different aquifer units are cross contaminated. Information about oil and gas wells from the California Department of Oil, Gas, and Geothermal Resources was reviewed to identify whether the Subbasin has oil and/or gas resources. As shown on Figure 2.2-16, the closest oil and gas wells are located outside the Subbasin in and north of Ocotillo Wells. Note that there are no active oil extraction wells in the map extent; the well shown as active on Figure 2.2-16 refers solely to the permit status as recorded in the California Department of Oil, Gas, and Geothermal Resources database.

Summary

In general, water quality has historically been good within BWD's wells with TDS at concentrations of less than 500 mg/L. The high proportion of sulfate in the surface water of Coyote Creek appears to dominate the character of groundwater in the northern and eastern parts of the basin (DWR 2014). The more bicarbonate waters of Borrego Palm Canyon and Big Spring influence the groundwater along the western and southern parts of the basin. Historical issues with elevated nitrate concentrations have been noted as evidenced by wells either taken out of production or drilled deeper including BWD Wells ID4-1 and ID4-4, and the Roadrunner Mobile Home Park well. ID4-4 was abandoned and drilled deeper at the same location to avoid nitrates in the upper aquifer. High salinity, poor-quality connate water is thought to occur in deeper formational materials in select areas of the aquifer as well as shallow groundwater in the vicinity of the Borrego Sink in the southern portion of the Plan Area.

Based on historical and contemporary water quality sampling, the trend of historical data, current concentration and background water quality concentrations for the identified COCs are listed by management area in Table 2.2-6.

Table 2.2-6
Management Area Background Water Quality

Constituent	Trend of Historical Data[a]	Current Concentration (2018)[b]	Background Concentration[c]
North Management Area			
Arsenic	No Trend	1.5 µg/L and 2.2 µg/L	0.0 µg/L (Range: 0.0–3.0 µg/L)
Fluoride	No Trend	0.66 mg/L (Range: 0.16–0.87 mg/L)	0.63 mg/L (Range: 0.11–1.3 mg/L)
Nitrate (as N)	Increasing	0.52 mg/L (Range: 0.1–15 mg/L)	0.63 mg/L (Range: 0–15 mg/L)
Sulfate	Decreasing	285 mg/L (Range: 110–440 mg/L)	147 mg/L (Range: 99–440 mg/L)
TDS	No Trend	675 mg/L (Range: 330–1,100 mg/L)	562 mg/L (Range: 295–1,100 mg/L)
Central Management Area			
Arsenic	No trend	2.1 µg/L (Range: 1.2–3.8 µg/L)	2.2 µg/L (Range: 0.0–12.2ug/L)
Fluoride	No Trend	0.46 mg/L (Range: 0.23–0.81 mg/L)	0.50 mg/L (Range: 0.00–1.40 mg/L)
Nitrate (as N)	No Trend	0.37 mg/L (Range: 0.1–1.3 mg/L)	0.97 mg/L (Range: 0.00–8.40 mg/L)

Table 2.2-6
Management Area Background Water Quality

Constituent	Trend of Historical Data[a]	Current Concentration (2018)[b]	Background Concentration[c]
Sulfate	Decreasing	98 mg/L (Range: 19–300 mg/L)	89 mg/L (Range: 14–330 mg/L)
TDS	No trend	335 mg/L (Range: 230–610 mg/L)	325 mg/L (Range: 200–699 mg/L)
South Management Area			
Arsenic	No Trend	4.1 µg/L (Range: 1.6–15 µg/L)	4.8 µg/L (Range: 0.0–22.0 µg/L)
Fluoride	No Trend	0.51 mg/L (Range: 0.18–2.1 mg/L)	0.61 mg/L (Range: 0.00–2.10 mg/L)
Nitrate (as N)	No Trend	1.0 mg/L (Range: 0.1–20.0 mg/L)	1.2 mg/L (Range: 0.0–29.0 mg/L)
Sulfate	Increasing	105 mg/L (Range: 24–700 mg/L)	86 mg/L (Range: 14–1,200 mg/L)
TDS	Increasing	640 mg/L (Range: 310–1,600 mg/L)	520 mg/L (Range: 230–1,600 mg/L)

Notes: µg/L = micrograms per liter; mg/L= milligrams per liter; N = nitrogen; TDS = total dissolved solids.

[a] Mann-Kendall analysis was used to determine trend in individual wells at the selected significance level of 0.05. For trend in management area, the trend in the majority of wells in the management area is reported.

[b] Median concentration and range from all samples collected within a management area in 2018.

[c] Median concentration and range from all samples collected within a management area on record in the data management system.

As indicated in the preceding discussion, water quality impacts may occur as decreased groundwater levels could induce flow of poor quality water (i.e., unsuitable for municipal uses) found in select deeper formational materials of the aquifer. This may eventually necessitate additional expensive treatment of groundwater to make the water suitable as a drinking water supply. Further, the preceding discussion indicated that water quality issues appear to be most extensive in the SMA. Well ID1-8 displays an increasing concentration trend from 1972 to present for nitrate, TDS, and sulfate; however, the current concentration is below the MCL for each constituent. It should be noted that well ID1-8 is down gradient from the Rams Hill golf course, which is a probable anthropogenic source of nitrates in the SMA in addition to the percolation ponds at the wastewater treatment plant. Rams Hill W~~w~~ells RH-5 and RH-6, ~~which are~~ located on the old golf course, indicate ~~elevated~~ nitrate as N concentrations at 3.8 mg/L and 3.2 mg/L, which are elevated compared to background concentrations (Dudek 2015b). Rams Hill ~~will~~ currently monitors groundwater quality annually from its wells~~ as part of the Long-Term Cooperation Agreement with the BWD~~.

Data Gaps

The lateral distribution of the wells in the monitoring network that measure groundwater quality is limited, and does not extend to the outer portions of each management area. However, there is sufficient distribution to make reasonable interpretations of trends in groundwater elevations and groundwater quality in each of the three management areas. Vertical coverage of the BWD well network is similarly limited, as most of the wells are cross-screened in more than one aquifer. Deficiencies of this particular program as it relates to SGMA include limited vertical and horizontal spatial coverage and temporal deficiencies, since historical analytical data was only collected at approximately 3-year intervals for BWD wells. Of the more than 120 wells located in the Subbasin, approximately 12 were routinely monitored and sampled over multiple years prior to development of the GSA monitoring network. Based on the inconsistent analytical suites between wells and monitoring periods, this variability represents a significant data gap.

Additional routine analytical groundwater quality sampling is needed to establish long-term trends. As part of the GSP monitoring program (further described in Chapter 3, Section 3.5), the GSA will be sampling wells semi-annually rather than every 3 years as required by the Division of Drinking Water, at least for wells that indicate detections of COCs above one-half the drinking water MCL or where increasing concentration trend is indicated. In addition to conducting more frequent groundwater quality sampling, the GSA has standardized the analytical sampling suite and methods in accordance with the *Sampling and Analysis Plan and Quality Assurance Project Plan* included as part of Appendix E. The selection of which wells to monitor for groundwater quality represent a combination of factors, including the well's geographic location, the screen interval relative to three principal aquifers, accessibility, anticipated well longevity, and continuity of historical data.

As previously discussed, the GSA has been working to close these data gaps by identifying additional monitoring locations. Pursuant to the DWR's *BMPs for Sustainable Management of Groundwater, Monitoring Networks, and Identification of Data Gaps*, the GSA has developed the Borrego Springs Subbasin Monitoring Plan (described in Chapter 3, Section 3.5), to be updated periodically, in order to address these data gaps and to monitor groundwater levels and water quality against the sustainability indicators outlined in Chapter 3 of this GSP. The Monitoring Plan includes monitoring objectives and recommendations for collecting data that demonstrate short- and long-term trends in groundwater, and progress toward achieving measurable objectives. The Monitoring Plan is also designed to monitor impacts to beneficial uses of groundwater, and to quantify annual changes in water budget components.

2.2.2.5 Land Subsidence

Land subsidence can occur when long-term groundwater extractions result in the lowering of the groundwater table, which in turn increases the effective stress in the overlying aquifer matrix. This can cause the collapse of pore space within the matrix. Land subsidence can be either reversible (elastic), or irreversible (inelastic), depending on the soil characteristics of the aquifer. The USGS (2015) used two methods to evaluate land subsidence within the Plan Area. First, repeat GPS surveys were conducted over time, using 25 geodetic monuments as GPS stations. In addition to geodetic monuments, the USGS collected high-precision GPS elevation data from 79 groundwater wells in December 2008 and March 2009 to augment the evaluation of land subsidence. Second, interferometric synthetic aperture radar (InSAR) satellite data collected between 2003 and 2007 were reviewed. The difference between the two methods is that GPS is generally available over a longer period of time but has less spatial resolution, whereas InSAR has high spatial resolution but is only available for the recent past.

Land surface elevations from 1978 were compared with those collected in 2009 to estimate the degree of land subsidence in the Plan Area (USGS 2015). Analysis of the sources of error in the measured elevations indicated that the resolution of the data collected was approximately plus or minus 0.54 feet. This analysis included potential errors in the measurements associated with the GPS survey instrument, the error in the geoid, and the assumed errors associated with historical data. Land surface elevation changes within the Plan Area between 1978 and 2009 were found to be less than 0.54 feet, and included both increases and decreases (USGS 2015). Based on these observations, measurable land subsidence did not occur in the Plan Area between 1978 and 2009. InSAR was used to analyze data at a greater temporal and spatial scale, but over a shorter time period. Data from the European Space Agency's Earth Remote Sensing 1 and 2 (ERS-1 and ERS-2) and ENVISAT satellites were used to detect changes in land surface elevations. Based on these data, the average maximum annual subsidence rate between 2003 and 2007 was found to be 0.2 inches per year, which is consistent with the subsidence findings using GPS data (USGS 2015). Analysis of the InSAR data revealed a small but consistent and seasonal pattern of elastic subsidence, in which land surface elevations decrease in the summer with increased pumping, and recover about half the decrease by the end of the year. The greatest area of subsidence detected between 2003 and 2007 is concentrated southeast of the agricultural fields in the Plan Area and amounts to 15 millimeters (or 0.59 inches), or 3.75 millimeters per year (or 0.15 inches per year).

Additional subsidence data for the Subbasin between 2015 and 2018 is provided by DWR's provision of vertical ground surface displacement in more than 200 of the high-use and populated groundwater basins across the state.[31] Vertical displacement estimates are derived from InSAR data that are collected by the European Space Agency Sentinel-1A satellite and processed by TRE ALTAMIRA Inc., under contract with the DWR as part of DWR's SGMA technical assistance to provide important SGMA-relevant data to GSAs for GSP development and implementation. Figure 2.2-17 provides total vertical displacement for the Subbasin between June 2015 and June 2018. The total maximum vertical decrease in land surface (i.e., subsidence) in the Subbasin between 2015 and 2018 was measured to be 0.023 feet, in an area approximately 1.5 miles east of Borrego Springs Resort. This is equivalent to less than 0.1 inches/year, and it should be noted a greater area of the Subbasin had an increase in elevation than a decrease (Figure 2.2-17). Based on this information, the rate of subsidence, which was already minor, appears to be decreasing.

The degree of land subsidence occurring in the Plan Area is minimal, has not substantially interfered with surface land uses in the past, and is not anticipated to substantially interfere with surface land uses in the foreseeable future. The minor amount of subsidence that has occurred

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[31] Full dataset is available at https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#landsub.

when compared to over a hundred feet of groundwater level decline in the northern parts of the Plan Area indicate that the subsurface strata may be less sensitive to land subsidence due to its coarse-grained nature. There is sufficient data to qualify the subsidence criterion as insignificant, and not currently an undesirable result of groundwater overdraft (USGS 2015). Given the low sensitivity of subsurface strata to land subsidence in response to historical groundwater level declines, along with the lack of infrastructure in the Plan Area that may be sensitive to subsidence (i.e., linear infrastructure such as canals and high hazard pipelines), subsidence is also not expected to become an undesirable result over the planning and implementation horizon.

2.2.2.6 Identification of Interconnected Surface Water Systems~~Groundwater–Surface Water connections~~

Streams interact with groundwater in three basic ways; streams gain water from inflow of groundwater through the streambed (gaining stream), they lose water to groundwater by outflow (losing stream), or they do both, gaining in some reaches and losing in other reaches. Streams or stream segments may also not interact at all with groundwater (disconnected stream). As shown on Figure 2.2-~~17~~18, the only springs identified within the Subbasin are Old Borrego Spring and Pup Fish Pond Spring. Old Borrego Spring dried up sometime before 1963, as described below, and the artificial Pup Fish Pond (in addition to the pupfish pond near the Palm Canyon Trailhead in Borrego Palm Canyon Campground) is sustained by ABDSP's public water system, not a spring. ~~while~~ Perennial[32] surface waters (e.g., Coyote Creek and Borrego Palm Creek) ~~daylights~~ have been mapped ~~in localized areas within~~as extending for a short distance into the Subbasin.~~ as natural seeps and springs, the majority of~~ These creeks are sustained by surface runoff and springs/seeps originating from the bedrock portions of their contributing watersheds~~ springs and perennial[33] creeks occur~~ outside the Plan Area (Appendix D4)~~ within the ABDSP~~. ~~These surface water sources are topographically higher than the groundwater elevation of the underlying basin, in many cases hundreds of feet higher. Therefore, ongoing drawdown of groundwater elevations in the Subbasin does not appear to correlate to a depletion of interconnected surface water.~~

The environment that contributes to perennial flows in the region is that of springs and seeps emanating out of the basement rock in narrow stream valleys (outside the Plan Area), where the alluvium is both narrow and shallow, allowing at least some groundwater from the basement rock outside the boundaries of the Borrego Springs Subbasin to surface. The streams within the Plan Area are predominantly disconnected from the underlying groundwater table. This is because, when present, stream flows of moderate magnitude and short duration do not tend to percolate deeply enough to reach

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[32] A perennial stream typically flows continuously in all or part of its streambed during all of the calendar year as a result of groundwater discharge or surface runoff. However, during unusually dry years, a normally perennial stream may cease flowing, becoming intermittent until precipitation falls on the watershed.

~~[33] Perennial streams typically flow continuously in all or part of its streambed during all of the calendar year as a result of groundwater discharge or surface runoff. However, during unusually dry years, a normally perennial stream may cease flowing, becoming intermittent until precipitation falls on the watershed.~~

the underlying aquifer. Instead, water flowing upon and within the saturated alluvium beneath the stream bed is quickly lost to evaporation or transpiration. This is the case for most of the streams and washes in the Plan Area, and is typical of an arid desert environment.

Old Borrego Spring, shown on Figure 2.2-~~17~~18, is no longer flowing. In 1963 (referring to Borrego Spring about ~~one~~ 1 mile west of the Borrego Sink), Lester Reed wrote in *Old Time Cattlemen and Other Pioneers of the Anza-Borrego Area,*

> Since so much recent pumping of water in the Borrego Valley, the old spring no longer flows. This spring was one of the watering places upon which the Indians, and the old-timers could depend, although the water was of poor quality. The first time I visited Old Borrego Spring was just two or three days before Christmas 1913 when my brother Gilbert (Gib), and I were riding though on horseback from Imperial Valley to spend the holidays with our parents at the Mud Spring Ranch about fifteen miles southeast of Hemet. Since early boyhood, I heard old-timers talk about Borrego Springs water; so I thought I would try it. As I have said many times before, I found it to taste but very little better than the treated water we are expected to drink today.

Storm flows may occasionally be adequate in intensity and duration for recharge to be initiated through deep percolation of storm runoff. Figure 2.2-~~18~~ 19 shows the Federal Emergency Management Agency mapping of the 100-year floodplain as an extreme scenario, where most of the valley north of Borrego Sink would be inundated by shallow floodwater (Zone AO), and a narrower portion of the valley along Borrego Palm Creek would have deep, higher velocity flooding (Zone A). The zones shown on Figure 2.2-~~18~~ 19 are more accurately referred to as a flood with a 1% annual chance of occurring. It is peak rain events such as the 2-year or higher flood flows, or a prolonged series of storms, which contribute to the vast majority of recharge to the underlying aquifer, as further discussed in Section 2.2.3. However, not since the beginning of large-scale pumping in the Plan Area has groundwater (i.e., seeps, springs or gaining streams) been observed discharging onto the valley floor. The perennial portions of streams at the fringes of the Subbasin are ~~likely~~ derived from springs, groundwater discharge from the basement rock and residual storm runoff outside the boundaries of the Borrego Springs Subbasin~~, or possibly the presence of perched groundwater~~.

Table 2.2-7 summarizes the watersheds and subwatersheds that overlap the Plan Area, as mapped by the USGS's watershed boundary dataset. The USGS National Hydrography Dataset, as well as mapping provided by ABDSP, were used to identify additional springs and the approximate extent of perennial creeks (commonly referred to as "blue-line" streams) versus those that are intermittent or ephemeral (Figure 2.2-~~17~~18).[34] The perennial creeks in the Plan Area consist of a 1,000-foot section of Borrego Palm Creek as it exits the mountains and enters the Plan Area Boundary, as

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[34] Intermittent streams flow only seasonally or in response to runoff-generating precipitation.

well as an approximately 2,000-foot portion of Coyote Creek in the northern part of the Subbasin. The GSA investigated the blue-line stream mapped for Coyote Creek by the USGS National Hydrography Dataset, to validate whether it indeed represents a perennial stream. Field investigation found that grading of the creek bed near Seley Ranch causes stormwater to pond, resulting in the ~~possible illusion~~ appearance that the reach has perennial flow.

Once they exit the mountains and enter the Borrego Springs Subbasin, ~~Generally,~~ the creeks and washes~~,~~ ~~once they exit the mountains and enter the Borrego Springs Subbasin,~~ become disconnected from the alluvial groundwater table (i.e., ~~100% of~~ their flow is ~~attributable to surface runoff and~~ not affected by fluctuations in the underlying groundwater table). However, for creek segments to be mapped as perennial in such an arid environment means at least some of the flow is likely attributable to groundwater discharge higher up in the watershed, outside the Subbasin's boundaries. SGMA defines interconnected surface water as surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Although there is a groundwater connection to the ephemeral streams entering the Subbasin, that connection occurs in the bedrock aquifer outside the Plan Area. Therefore, groundwater pumping within the Subbasin has not and will not lead to undesirable results associated with depletion of surface water.

Table 2.2-7
U.S. Geological Survey Watersheds and Subwatersheds Overlapping the Plan Area

Watershed (size)	Subwatershed	Subwatershed Size (acres)	Acres in Plan Area (percent of subwatershed)	Primary Hydrologic Features within Plan Area
Coyote Creek (179 square miles)	Upper Coyote Creek	13,521	21 (0.2%)	Coyote Creek, Perrenial Sections; potential GDEs
	Lower Coyote Creek	21,197	10,541 (50%)	Coyote Creek, Primarily Ephemeral; Historical Mesquite Bosque Habitat
Borrego Valley – Borrego Sink Wash (158 square miles)	Borrego Valley	15,858	14,916 (94%)	Unnamed dry washes only; Historical Mesquite Bosque Habitat
	Borrego Sink Wash	36,565	25,657 (70%)	Unnamed dry washes and Borrego Sink (dry); Historical Mesquite Bosque Habitat; Old Borrego Spring
	Dry Canyon	12,082	2,222 (18%)	Unnamed dry washes
	Borrego Palm Canyon	36,875	7,449 (20%)	Borrego Palm Creek, partly perennial; Pup Fish Spring; potential GDEs
Upper San Felipe Creek (194 square miles)	Mine Wash – San Felipe Creek	31,560	1,922 (6%)	San Felipe Creek, ephemeral

Source: USGS 2017.
Notes: GDE = groundwater dependent ecosystem.

2.2.2.7 Identification of Groundwater Dependent Ecosystems

A GDE is a plant and animal community that requires groundwater to meet some or all water needs (TNC 2018). GDEs are defined under the SGMA as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (Title 23 CCR Section 351(m)). Based on groundwater monitoring closest to creek segments that enter the northern and western margins of the Plan Area, there is a separation of hundreds of feet between the creek beds and the Subbasin's groundwater table. Although the perennial streams are partially supported by springs and/or seeps located outside the Subbasin, they become disconnected streams as soon as they exit the mountain front. Groundwater level trends within the Subbasin's alluvial aquifer have no appreciable connection to the water sources supporting ephemeral streams, because the bedrock aquifer is so much higher in elevation and receives recharge from elevations hundreds of feet higher than the Subbasin's aquifer within the mountainous areas outside the Plan Area.

Groundwater is critical to sustaining springs, wetlands, and perennial flow (baseflow) in streams as well as to sustaining vegetation such as phreatophytes that directly tap groundwater. In response to SGMA, the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset was provided by DWR and The Nature Conservancy (TNC) as a reference dataset and starting point for GSA's to review and validate the mapped features and supplement the dataset as necessary with the GSA's understanding of local surface water hydrology, groundwater conditions, and geology within the groundwater basin (TNC 2018). The Natural Communities dataset is comprised of 48 publicly available state and federal agency mapping datasets including but not limited to the following: VegCAMP – The Vegetation Classification and Mapping Program, California Department of Fish and Wildlife; CALVEG – Classification and Assessment with Landsat Of Visible Ecological Groupings, U.S. Department of Agriculture Forest Service; NWI V 2.0 – National Wetlands Inventory (Version 2.0), U.S. Fish and Wildlife Service; FVEG – California Department of Forestry and Fire Protection, Fire and Resources Assessment Program; USGS National Hydrography Dataset; and Mojave Desert Springs and Waterholes (Mojave Desert Spring Survey). After the previously described vegetation, wetland, seeps, and springs data were compiled into the Natural Communities dataset, data were screened to exclude vegetation and wetland types less likely to be associated with groundwater and retain types commonly associated with groundwater (TNC 2018).

The mapped vegetation types in the Plan Area considered to be potential GDEs are wetland and honey mesquite bosque (Figure 2.2-~~19~~20). Because ~~The Nature Conservancy's (~~TNC's~~)~~ method for identifying potential GDEs does not assess or incorporate local groundwater conditions, the GSA has conducted a review, evaluation, and validation of the NCCAG dataset specific to the Subbasin and has evaluated whether there is a significant nexus between the regional groundwater aquifer and the potential GDEs identified in the NCCAG. Appendix D4 contains a detailed evaluation of the mapped GDEs, the local hydrology, geology and groundwater conditions that surround them, and a HCM to illustrate how the NCCAG are sustained.

The potential GDEs have been categorized into three discrete geographic units, described as follows. Additional details are provided in Appendix D4.

GDE Unit 1 (Coyote Creek)

GDE Unit 1 occurs along the perennial section of Coyote Creek at the northern end of the Subbasin as shown in the inset map on Figure 2.2-~~19~~ 20 (TNC 2010; ABDSP 2017). Both NCCAG wetlands and vegetation are mapped in this unit and are narrowly focused within the riparian corridors associated with Coyote Creek. GDE plant type mapped in association with Coyote Creek are desert willow (*Chilopsis linearis ssp. arcuata*), narrowleaf willow (*Salix exigua var. exigua*), honey mesquite, and catclaw acacia (*Senegalia greggii*) (drought deciduous, which lack leaves for most of the year). The nearest water well in the Subbasin to the mapped GDEs is the Horse Camp well owned by the ABDSP. The depth to groundwater at the Horse Camp well is ~~287.69~~285.59 feet below top of casing (666~~4~~.8~~7~~6 feet amsl) as measured in ~~Spring~~ Fall 2018 (Figure 2.2-~~19~~20).

Coyote Creek Watershed encompasses approximately 180 square miles, as shown on Figure 2.2-~~17~~20. The watershed is located almost entirely within the boundary of the Anza-Borrego Desert State Park and streamflow in the Coyote Creek Watershed has been documented by USGS as the number one source of recharge to the Subbasin via streamflow leakage (i.e., infiltration of surface water runoff). Approximately 65% of the surface water inflow to the Borrego Valley comes from Coyote Creek (USGS 1982). There are two streamgages along Coyote Creek located at the northernmost boundary of the Subbasin, one of which stopped recording streamflow in 1983, and the other stopped recording flow in 1993. USGS Station Number 1025580 (Upper–Northern) recorded daily discharge data from 1951–1983; at this station, annual average streamflow was measured to be 1,831 AFY (USGS 2017). USGS Station Number 10255805 (Lower–Southern) recorded daily discharge data from 1983–1993; at this station, annual average streamflow was measured to be 1,774 AFY (USGS 2017). Annual variability over the period measured ranges from 326 acre-feet to 10,715 acre-feet. This large annual variability is a function of large annual variability of precipitation falling on the Coyote Creek Watershed.

To begin to evaluate the GDEs associated with Coyote Creek, the GSA has investigated whether the perennial and ephemeral creek segments are gaining water or losing water to the underlying aquifer system. To complete this analysis, the GSA has begun to map the perennial extent of flow in to the Subbasin on a semi-annual basis (spring and fall). The upper historical streamgage is the GSA's manual monitoring point for Coyote Creek. At this location, the GSA manually measured an instantaneous streamflow of 0.46 cubic feet per second in Spring 2018, which converts to 206.5 gallons per minute. At that time, the former lower historical USGS stream gage station was observed to be dry.

In Spring 2018, the perennial extent of flow in Coyote Creek was documented to occur downstream of the third-crossing and upstream of the second crossing. No flow was observed in Spring 2018 at the lower inactive USGS stream gage, which is one of the permanent locations for manual flow readings. In Fall 2017, streamflow extended almost half-way from the second crossing to the first crossing. The crossings refer to where an unimproved road crosses the creek bed. In Fall 2017, there was a precipitation event in the Coyote Creek Watershed that produced runoff in Coyote Creek; however, no streamflow measurements are available for this event. Flow in the stream was observed to decrease incrementally from the upper inactive USGS stream gage to two locations measured downstream.

Furthermore, as described in Appendix D4, comparison of aerial photography and evaluation of trends in satellite-derived vegetation metrics indicated that there have been no significant changes in the extent of the GDE since 1954 and no significant change in the health of the GDE since 1985. Small fluctuations in vegetation metrics were determined to be moderately correlated to precipitation (Appendix D4).

The evidence gathered~~ thus far~~ indicates that the reach of Coyote Creek that was mapped by DWR and TNC as potential GDE ~~by DWR and TNC~~ is actually a “losing” stream, and that this habitat, where it occurs, is supported by intermittent storm events and/or flows emanating from the upland watersheds and basins, rather than local discharge of groundwater from the Subbasin to the stream reach.

GDE Unit 2 (Palm Canyon)

GDE Unit 2 occurs along the perennial section of Borrego Palm Creek at the western boundary of the Plan Area (Figure 2.2-~~19~~20) (TNC 2010; ABDSP 2017). The nearest water well in the Subbasin to GDE Unit 2 is the Anza-Borrego Desert State Park Well No. 3, owned by the ABDSP. The depth to groundwater at the State Park Well No. 3 ~~Horse Camp well~~ is 347.84 feet below top of casing as measured in Spring 2018 (Figure 2.2-20). Furthermore, as described in Appendix D4, comparison of aerial photography and evaluation of trends in satellite-derived vegetation metrics indicated that there have been no significant changes in the extent of the GDE since 1954 and no significant change in the health of the GDE since 1985. Small fluctuations in vegetation metrics were determined to be moderately correlated to precipitation (Appendix D4). This indicates that GDE Unit 2 is supported by surface water flows originating outside the Subbasin (which can be storm fed and/or spring-fed) and entering the Subbasin through Borrego Palm Creek. Given the depth to groundwater within the Subbasin, there is no substantial nexus between pumping and GDE Unit 2.

GDE Unit 3 (Mesquite Bosque)

According to the USGS (2015), the Borrego Sink, a topographic low where the groundwater table was within 10 feet of land surface, was the site of about 450 acres of honey mesquite bosque and other native phreatophytes[35], indicating that shallow groundwater and occasional accumulations of surface water was historically sufficient to support a GDE (Figure 2.2-~~19~~20). Prior to development, honey mesquite (*Prosopis glandulosa*), salt grass (*Distichlis spicata*), willow (*Salix*), and rushes were reported to be abundant in the valley (Mendenhall 1909 as cited in USGS 2015). Today, the dominant species is honey mesquite.

Honey mesquite are an adaptable species characterized by a dimorphic root system capable of opportunistically utilizing both surface water and groundwater resources. Honey mesquite exhibit mechanisms of drought tolerance, including seasonally changing stomatal sensitivity and osmotic adjustment. Sharifi et al. (1982) stated that "[d]esert phreatophytes are a complex group of species with varied adaptive mechanisms to tolerate or avoid drought and should not be considered simply as a group of species that avoid desert water stress by utilizing deep ground water unavailable to other desert species of drought tolerance and avoidance." Similarly, Ansley et al. (1991) stated, "in regions where accessible groundwater is minimal, honey mesquite often appear to be less than fully phreatophytic. […] These plants have developed an extensive system of lateral roots and respond rapidly to precipitation." Thus, with a sufficiently rapid and large decline in groundwater levels, honey mesquite can transition to a less-than-phreatophytic state, retaining the ability to utilize surface water and/or localized pockets of soil moisture perched above the groundwater table.

As stated in General Plan Update Groundwater Study completed by San Diego County (2010): "The mesquite bosque, a rare and sensitive groundwater-dependent habitat, is believed by many experts to be desiccating in portions of Borrego Valley, even though their taproots can reach down to 150 feet for water." The habitat covered an approximate four-square mile area. However, while mesquite bosque can have extremely deep taproots, the best available information does not support the occurrence of extremely deep taproots in the Subbasin (Appendix D4)~~the USGS (2015) notes that the deepest rooting depth for phreatophytes found in around the Borrego Sink and areas to the north was at 15.3 feet~~. Recent groundwater levels from wells adjacent to the main mapped habitat range from approximately 55 to 134 feet below the ground surface. The USGS (1988) and others estimated that prior to 1946, about 4,300 acre-feet of water was discharged from phreatophytes annually by evapotranspiration.

The honey mesquite bosque, shown as purple on Figure 2.2-~~19~~ 20 north of the Borrego Sink, is considered a pre-2015 impact.~~,~~ ~~because groundwater levels have declined to a level that no longer supports a viable habitat.~~ Groundwater levels have long since declined below a level which can support the estimated rooting depth of the habitat, which is estimated to be approximately 20 feet, based on observation of honey mesquite root depth at Harper's Well, located 20 miles to the southeast ~~is 15.3 feet~~ (~~USGS 2015~~Appendix D4). Natural discharge determined from the BVHM attributable to evapotranspiration was approximately 6,500 AFY prior to development, but has

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[35] Phreatophytes are long-rooted water loving plants that obtain water supply from groundwater or the capillary fringe just above the water table.

been virtually zero in the last several decades (1990–2010) (USGS 2015). The green area on Figure 2.2-~~19~~ 20 depicts the pre-pumping mapped historical extent of phreatophytes in the Subbasin by USGS (USGS 2015). The pink area depicts the mapped pre-January 1, 2015, extent of potential GDEs; (SANGIS 2017) and the orange area depicts the extent of mapped GDEs by the natural communities dataset (DWR 2018).

Pumping in the Subbasin has resulted in a groundwater level decline of about 44.1 feet over the last 65 years in the vicinity of the Borrego Sink. The average rate of decline over this 65-year period is approximately 0.67 feet per year. Because of the long-term imbalance of pumping with available natural recharge, an irreversible impact has occurred to the honey mesquite bosque, which was mostly desiccated prior to January 1, 2015. MW-5 is a multicompletion well that was constructed with BWD and DWR oversight. MW-5B is screened from 45 to 155 feet below ground surface and appears to sufficiently represent the depth of the groundwater table in the vicinity of the Borrego Sink, though it is possible that it represents a semi-confined potentiometric surface rather than the unconfined groundwater table. MW-5A is screed from 200 to 340 feet and has a similar groundwater level to the shallower MW-5B suggesting potentially unconfined conditions in this part of the Subbasin; however, it is uncertain whether a good well seal was obtained during installation of the multicompletion monitoring well. The “Sink” wells shown on Figure 2.2-~~19~~ 20 (i.e., 12G1 and 7N1) have become dry based on measurements recently performed by DWR. The overlap of a groundwater level measurement in 2009 of Sink Well 12G1 with MW-5B, which has a similar groundwater level elevation suggests that well MW-5B is sufficiently representative of depth to the groundwater table in the area of the Borrego Sink.

As indicated earlier, Old Borrego Spring located about 1 mile east of the Borrego Sink historically provided water to cattle prior to 1963. The Borrego Spring was located in the vicinity of the Desert Lodge anticline, which is evidenced by fold axes running perpendicular to the Veggie Line fault, the Coyote Creek fault and the Yaqui Ridge/San Felipe anticline associated with the San Jacinto fault zone (Steely et al. 2009). The faulting and folding effectively compartmentalize the deep sediments of the Borrego Springs Groundwater Subbasin and likely once resulted in ‘daylighting’ of groundwater at the Borrego Sink prior to interception of groundwater flow by pumping.

As described in Appendix D4, evaluation of trends in satellite-derived vegetation metrics indicated that there have been no significant changes in the health of the GDE since 1985. Small fluctuations in vegetation metrics were determined to be moderately correlated to precipitation and not correlated to declining groundwater levels (Appendix D4). The precipitous drop in groundwater levels in the Subbasin following the onset of pumping in the Subbasin has significantly reduced the extent and health of the ecosystem, as it eliminated a readily available source of water for seedlings and immature plants, leaving the regeneration process dependent on brief and highly intermittent surface water flows.

Other Potential GDEs

Other potential GDEs include Hellhole Palms, Tubb Canyon, Glorietta Canyon, and other minor or unnamed stream segments entering the Subbasin. Similar to Coyote Creek and Borrego Palm Canyon, these other potential GDEs are supported by surface water flows originating outside the Subbasin (which can be storm fed and/or spring-fed) as further described in Appendix D4.

2.2.3 Water Budget

The water budget for the basin provides an accounting and assessment of the average annual volume of groundwater and surface water entering and leaving the basin. This section includes information on the historical and current water budget conditions, as well as the change in the volume of groundwater stored. The water budget provides detail sufficient to build local understanding of how historical changes to supply, demand, hydrology, population, land use, and climatic conditions have affected the applicable sustainability indicators in the basin. This information is used to predict how these same variables may affect or guide future management actions. Building a coordinated understanding of the interrelationship between changing water budget components and aquifer response will allow the GSA to effectively identify future management actions and projects most likely to achieve and maintain the sustainability goal for the basin (DWR 2016).

In order to estimate the groundwater budget for Borrego Valley, the GSA has leveraged the public domain numerical groundwater model produced by the USGS in 2015 (USGS 2015), also referred to as the BVHM. The BVHM has a period of simulation of 1945 through 2010. The USGS calibrated the model to groundwater levels that were measured throughout the period of simulation, but no model validation was completed as part of the original modeling process. In order to comply with GSP requirements, the GSA has updated the model to simulate water budget components up through Water Year 2016[36] and conducted a model validation. The 6-year period of measured groundwater level data including 2011 through 2016 was used to validate the model. As part of model validation, simulated groundwater levels were compared to measured groundwater levels including 2011 through 2016, with the resulting errors in groundwater levels being used to assess model uncertainty and support potential model revisions necessary to refine the water budget calculations. It should be noted that the results of the BVHM are subject to change as new data become available.

The model domain is defined by a finite-difference grid of uniform cells, or nodes, with each cell being 2,000-feet by 2,000-feet, or approximately 92 acres in area. The model domain includes 30 rows and 75 columns with 2,250 active cells (Figure 2.2-~~20~~21). The total area simulated in the model is 73,876 acres, which is greater than the Plan Area, extending further southeast into the northwestern portion of the Ocotillo Wells Subbasin. Due to the resolution of the model grid, certain parts of the Borrego Springs Subbasin, namely its northern tip and small fringe areas of the Subbasin's southeastern boundary were not included in the model grid. This spatial discrepancy

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[36] See footnote 17. All references to years in this section are water years.

between the model grid and the Plan Area boundary is expected to have minimal effect on the water budget because the areas in question have minimal if any pumping. However, it should be noted that all references to the Borrego Springs Subbasin within this subsection refer specifically to the model domain rather than the Plan Area. The model was divided vertically into three layers, corresponding to the upper, middle and lower aquifers described in Section 2.2.1.3. A technical report—*Update to the United States Geological Survey Borrego Valley Hydrologic Model for the Borrego Valley Sustainability Agency*—goes into detail on the specific methods of analysis and model inputs and outputs, and is included in Appendix D1 of this GSP.

The following sections break down the water budget into components of inflow and outflow and summarizes the results of the BVHM update. The USGS' Groundwater Model is based on an overall long-term water budget consisting of all inflows and outflows that contribute to developing the sustainable yield. Overall, the average annual water budget can be expressed in terms of three inflow values and three outflow values summarized in ~~The discussion below is summarized in~~ Table 2.2-~~9~~ 8 and discussed further below~~A and Table 2.2-9B~~.

Table 2.2-~~9~~8~~A~~
Summarized Historical Water Budget~~Borrego Valley Hydrologic Model Simulated Water Budget Components, Water Years 1945–2016~~

Water Budget Components (Units in Acre-Feet per Year)~~Component~~	**Original USGS Model (1945–2010)~~Minimum (AF) (Water Year)~~**	**Model Update (1945–2016)~~Maximum (AF) (Water Year)~~**	**Most Recent 20 Years~~71-Year Annual Average (AFY)~~ (1997–2016)**	**Most Recent 10 Years (2007–2016)~~Standard Deviation (AFY)~~**
		Inflows		
Stream Recharge	4,028~~112 (1947)~~	3,905~~22,504 (1978)~~	2,749~~3,905~~	1,865~~4,965~~
~~Irrigation Return Flows~~Unsaturated Zone Recharge [a]	1,486~~572 (1961)~~	1,497~~3,706 (1978)~~	1,635~~1,497~~	1,505~~708~~
~~Subsurface Inflow~~Underflow (Inflow from Adjacent Basins)	1,367~~Constant (Specified) Flow~~	1,367	1,367~~1,367~~	1,367~~2~~
~~Annual Average~~Total Average Annual Inflow	**6,881**	**6,770**	**5,751~~6,770~~**	**4,737~~5,470~~**
		Outflows		
Pumping	10,128~~996 (1945)~~	10,597~~19,911 (2006)~~	16,466~~10,597~~	16,856~~4,744~~
~~Net~~ Evapotranspiration ~~Losses~~[b]	3,032~~364 (2014)~~	2,815~~9,998 (1945)~~	759~~2,815~~	498~~2,372~~
Underflow (Flow out of Southern End)~~Subsurface Outflow~~	522~~Constant (Specified) Flow~~	522	520~~522~~	523~~12~~
Total Average Annual Outflow~~Annual Average Outflow~~	**13,682**	**13,934**	**17,745~~13,934~~**	**17,877~~3,552~~**

Table 2.2-~~9~~8~~A~~
Summarized Historical Water Budget~~Borrego Valley Hydrologic Model Simulated Water Budget Components, Water Years 1945–2016~~

Water Budget Components (Units in Acre-Feet per Year)~~Component~~	Original USGS Model (1945–2010)~~Minimum (AF) (Water Year)~~	Model Update (1945–2016)~~Maximum (AF) (Water Year)~~	Most Recent 20 Years~~71-Year Annual Average (AFY)~~ (1997–2016)	Most Recent 10 Years (2007–2016)~~Standard Deviation (AFY)~~
Average Annual Deficit~~71-Year Average Annual Deficit (7,165)~~				
Change in Storage	**-6,~~783~~801**	**-7,1~~45~~64**	**-11,9~~55~~94**	**-13,~~098~~140**

Source: USGS 2015; Appendix D1.

Notes: USGS = U.S. Geological Survey~~AF = acre-feet; AFY = acre-feet per year~~.

[a] Consists of flow from the unsaturated zone into groundwater. Includes direct precipitation recharge (negligible), leakage from some streams within the model domain, and irrigation return flows (Distributed Recharge).

[b] Consumptive use of water calculated by the Farm Process Package for all land use type; primarily represents evapotranspiration.

~~Table 2.2-9B~~
~~Borrego Valley Hydrologic Model Simulated Water Budget Components, Water Years 2006~~1997~~–2016~~

~~Component~~	~~Minimum (AF) (Water Year)~~	~~Maximum (AF) (Water Year)~~	~~10~~20~~-Year Annual Average (AFY)~~	~~Standard Deviation (AFY)~~
~~Inflows~~				
~~Stream Recharge~~	~~234 (2009)~~	~~6,493 (2011)~~	~~1,928~~	~~1,680~~
~~Unsaturated Zone Recharge[a] Irrigation Return Flows~~	~~1,215 (2008)~~	~~1,919 (2011)~~	~~1,533~~	~~242~~
~~Underflow (Inflow from Adjacent Basins)Subsurface Inflow~~	~~Constant (Specified) Flow~~		~~1,367~~	~~2~~
~~Annual Average Inflow~~			~~4,828~~	~~1,859~~
~~Outflows~~				
~~Pumping~~	~~14,759 (2011)~~	~~19,911 (2006)~~	~~16,945~~	~~1,630~~
~~Net Evaporation Lossestranspiration[b]~~	~~364 (2014)~~	~~946 (2005)~~	~~539~~	~~172~~
~~Underflow (Flow out of Southern End)Subsurface Outflow~~	~~Constant (Specified) Flow~~		~~523~~	~~4~~
~~Annual Average Outflow~~			~~18,007~~	~~1,747~~
~~10-Year Average Annual Deficit~~			**~~(13,179)~~**	

~~**Source:** USGS 2015; Appendix D.~~

~~**Notes:** AF = acre-feet; AFY = acre-feet per year.~~

~~[a] Consists of flow from the unsaturated zone into groundwater. Includes direct precipitation recharge (negligible), leakage from some streams within the model domain, and irrigation return flows (Distributed Recharge).~~

~~[b] Consumptive use of water calculated by the Farm Process Package for all land use type. Primarily represents evapotranspiration.~~

2.2.3.1 Inflow to Groundwater System

Stream Recharge

Stream recharge is the primary source of groundwater recharge. It comes from surface water that flows into the valley from adjacent watersheds and infiltrates within stream channels.

Infiltration from the ephemeral stream and washes entering the Borrego Valley from the adjacent mountains is the major component of recharge in the groundwater budget in the Plan Area. Within the Borrego Springs Subbasin, the natural recharge of underflow and surface water runoff from the adjoining watersheds was estimated from data obtained from the regional-scale USGS Basin Characterization Model (BCM). There are no known existing streamgages within the boundaries of the numerical groundwater model. There are three historical USGS streamgages located outside of the numerical model boundaries but within the boundaries of regional scale BCM, the most complete of which is the streamgage record on Borrego Palm Creek (USGS gage no. 10255810). Flows from streams into the model domain were estimated using the modeled streamflow from the BCM, which were calibrated using the USGS streamgages for the periods when data are available from the streamgages. The BVHM includes 84 stream segments where multiple segments were joined to represent streamflow in Coyote Creek, San Felipe Creek, Borrego Palm Creek, and other minor tributaries. The streams received inflow at 24 entry points that represented runoff from the adjoining upstream watersheds in the San Ysidro and Vallecitos Mountains, the general locations of which are shown on Figure 2.2-~~20~~21.

Typically, there was little to no perennial streamflow into the Borrego Springs Subbasin from 1945~~0~~ to 2016. Only after major wet seasons or large individual rainfall events did runoff to the Subbasin exceed 10,000 AFY or more. Stream recharge only occurred during 7 years in the 1945~~0~~ to 2016 period (on average roughly once per decade). Runoff into the Subbasin from the 24 entry points modeled ranged from less than 10 AFY to 44,000 AFY with an average annual rate of 3,600 AFY. The BVHM includes perennial flow entering Coyote Creek at 0.014 cubic feet per second and an unnamed tributary at 0.002 cubic feet per second from a minor watershed to the southwest of the Subbasin. It should be noted that the BVHM also models runoff produced within the basin (as opposed to the 24 entry points) from direct precipitation in the unsaturated zone recharge component.

Stream recharge ranged from 112 AF in 1947 to 22,500 AF in 1978. The annual average recharge rate from stream leakage between 1945 and 2016 was 3,905~~831~~ AFY with a standard deviation of 4,965~~690~~ AFY.

~~Irrigation Return Flows~~Unsaturated Zone Recharge

Unsaturated zone recharge is water that infiltrates through soils within the valley and is primarily associated with irrigation return flows.– Rainfall within the valley does little to contribute to groundwater recharge. ~~Another component of inflow to the Subbasin, particularly as the valley became more developed, is return flow from applied irrigation within agricultural areas.~~ USGS (2015) estimated recharge from irrigation return flows to be between 10%–30% agricultural and recreational pumping based on the results of the BVHM. This is consistent with the estimate of irrigation return flow by Netto (2001), who used a chloride mass balance technique at a citrus grove located northwest of the intersection of Di Giorgio Road and Henderson Canyon Road to estimate a return flow of 22%. Netto (2001) used a similar approach to estimate a return flow for golf course irrigation of 14%.

The BVHM calculated the amount of water from applied irrigation returning to the aquifer using the Farm Process (FMP) and Unsaturated Zone Package (UZP). The volume of applied water in excess of losses to evapotranspiration, irrigation inefficiencies, and surface runoff was simulated as infiltrating below the root zone and entering the unsaturated zone. An important update from earlier versions of the BVHM is that the Farm Process links to information on unsaturated flow, so that the considerable thickness of unsaturated sediment in the valley can be considered. This allows for a more realistic simulation of the years to decades it can take for irrigation return flow to pass through the unsaturated zone. Earlier versions of MODFLOW simulated an instantaneous contribution of infiltrating water from land surface to the groundwater table.

Because irrigation efficiency has improved over the BVHM model period, the 10%–30% range for irrigation return flows cited by the USGS (2015) has both narrowed and decreased in the more recent past. By comparing model components that simulate return flows in the FMP and the UZF in the last 10 years, the UZF flows are approximately 10% of total pumping, and range from 7% to 13% (ENSI 2018). Combined agricultural and golf course irrigation represent approximately 80% of total pumping so these rates correspond to irrigation-specific return flow rates of approximately 9% to 16% (ENSI 2018).

~~Recharge from applied irrigation return flows~~Unsaturated zone recharge ranged from 572 AF in 1961 to 3,706 AF in 1978. The annual average recharge rate from irrigation return flows between 1945 and 2016 was 1,497~~3~~ AFY with a standard deviation of 683 AFY.

~~Subsurface Inflow~~Underflow

Underflow is groundwater that enters or leaves the valley aquifer system as subsurface flow at the edges of the groundwater model. Underflow entering the Borrego Valley Subbasin from the adjoining upstream watersheds was simulated using the Flow Head Boundary package. Underflow from these watersheds was distributed over 44 cells aligned at the model domain boundaries with the San Ysidro and Vallecitos Mountains. ~~The rate of underflow entering the BVHM for each cell was based on monthly data obtained from the BCM.~~ The USGS defined an average rate of underflow at each cell to the model domain and held these rates constant throughout the simulation.

The total underflow to the model domain was 3.7 acre-feet per day, or 1,367 AFY, and essentially held constant through the simulation period.

Henderson (2001) and Netto (2001) examined groundwater flow through bedrock in the surrounding watershed utilizing the computer program Recharg2, and found that on average between 1945 and the year 2000, bedrock recharge to the BVGB averaged 1,790 AFY (with a range of 0–19,860 AFY). Henderson (2001) found that 6 of the 15 drainage areas were expected to drain to the valley as surface flow rather than bedrock underflow due to the geologic stratigraphy and topography, which for some watersheds meant that the majority of bedrock groundwater was carried as surface flow to stream valleys of the adjoining watersheds. It should be noted that the study area for Henderson and Netto's Masters' theses was larger and encompassed the whole BVGB as opposed to the Borrego Springs Subbasin.

The USGS's BVHM treatment of subsurface inflow as a constant rate of 1,367 AFY is reasonable when compared to the Master's thesis findings (of an average of 1,790 AFY) and when considering their study areas were larger.

Other Inflows

Other inflows considered to be a negligible contribution to the water budget include septic system return flows and Rams Hill WWTF discharges. The USGS (2015) cited a previous study that estimated an average use of 100 gpd per household and assumed that 50% of the water used was lost to evaporation and transpiration. Therefore, the USGS estimated that return flow from septic tank systems in the valley was constant at 0.056 AFY per home, or $5.14e^{-7}$ cubic meters per day. The USGS identified residential and/or developed areas in the valley and estimated a number of septic tank systems associated with those land use types on a per node basis in the numerical model. The number of septic tank systems were periodically defined in the model and used for subsequent monthly stress periods until the next count. The last count of septic tank systems defined in the numerical model was based on development identified in 2009. The USGS (2015) reported that "the infiltration from irrigation of municipal lawns and treated and untreated wastewater was assumed to be negligible."

The Rams Hill WWTF may also contribute to recharge of the basin, and though unquantified, the amount is thought to be limited. The BWD operates the facility under a waste discharge permit (Order No. R7-2007-0053) issued by the California RWQCB, Region 7 – Colorado River Basin. The WWTF is a 250,000-gallons-per-day (gpd) extended aeration (oxidation ditch) plant with evaporation/percolation ponds for disposal. The WWTF serves approximately 20% of the community of Borrego Springs, specifically the Rams Hill residential community and the Town Center area, which includes hotels, a motel and small businesses along Palm Canyon Drive. The WWTF currently treats an annual average of flowrate of 74,000 gpd with low season (summer) flows down to approximately 20,000 gpd. Treated effluent from the Rams Hill WWTF is discharged into ~~three~~ evaporation-percolation ponds. Given the desert location and dry, hot conditions a portion of the treated effluent is evaporated and a portion percolates into the aquifer. Groundwater level monitoring at a 15-minute frequency using a pressure transducer installed in the WWTP-1 monitoring well indicates that treated effluent discharged into the percolation ponds does recharge the basin, however the volume has not been quantified. Discharge to the evaporation-percolation ponds is approximately~~.~~ 50 AFY, with recharge ~~roughly 25 AFY, and there is some~~evidenced by mounding that shows water is reaching the groundwater table.

2.2.3.2 Outflows from Groundwater System

Groundwater Pumping

The BVHM simulated municipal pumping using metered data obtained from BWD, and simulated agricultural and recreational pumping using the FMP. Before 1944, groundwater pumping in the basin averaged less than 300 AFY, which was used mostly for domestic purposes (USGS 2015). No pumping was simulated in the BVHM from 1929 to 1943. Population growth in Borrego Valley after World War II led to increasing groundwater production with the majority of water produced for irrigation purposes. Figure 2.2-~~21A~~ 22A and Figure 2.2-~~21B~~ 22B show simulated groundwater pumping by aquifer and by sector (i.e., agricultural municipal and recreational), respectively, for the period from 1945 to 2016. Groundwater production ramped up from essentially 0 AFY in 1943 to over 10,000 AFY in 1955 (Figure 2.2-~~21A~~22A). Annual production declined to less than 7,000 AFY beginning in 1965 but began increasing again in the mid-1970s with a peak production of almost 20,000 AFY in 2006. USGS (2015) reported that, “about 70 percent of the groundwater used each year has been for agriculture, about 20 percent for golf courses and other recreational uses, and about 10 percent for municipal and domestic use (residential, commercial, and the Anza-Borrego Desert State Park)” (Figure 2.2-~~21B~~22B).

Outflow from groundwater pumping within the Subbasin ranged from a low of 996 AF in 1945 to a high of 19,909 AF in 2006. As shown on Figure 2.2-~~21A~~22A, the lower and middle aquifers have become utilized to a higher degree since the early 1990s, likely as a result of problems accessing available water or suitable water quality within the upper aquifer. As shown on Figure 2.2-~~21B~~22B, there has been a trend towards decreased municipal pumping in recent years relative to recreational and agricultural uses.

Evapotranspiration Losses

Evapotranspiration refers to water losses from non-irrigated plants. Monthly potential evapotranspiration (PET) data were obtained from the BCM and included as part of the water-balance calculations in the FMP. Direct evapotranspiration from groundwater was estimated in the FMP by calculating the monthly PET values by monthly crop coefficients assigned to each land-use type (e.g., phreatophytes, citrus, golf courses, native), the rooting depths defined for each land-use type, the depth to groundwater and height of capillary fringe. Phreatophytes, found mostly around the Borrego Sink, ~~had the deepest rooting depth at 15.3 feet. They~~ were responsible for most of the groundwater losses from the basin prior to the mid-1940s. Prior to development, mesquite trees, salt grass, willow and rushes were reported to be abundant in the valley (Mendenhall 1909). The USGS (1988) reported that approximately 4,300 AFY was lost via evapotranspiration from phreatophytes before 1946. The amount of water extracted by pumping from the basin surpassed losses by evapotranspiration by 1954 (USGS 2015). This was attributed to declining groundwater levels in the basin, which reduced the amount of water available for transpiration. Evapotranspiration losses were less than 2,000 AFY by 1990 and less than 1,000 AFY by 2000.

Outflow as a result of evapotranspiration has steadily decreased as the groundwater level decreased below the root zone of native phreatophytes. Evapotranspiration losses within the Subbasin ranged from a low of 364 AF in 2014 to a high of 9,998 AF in 1945. Additionally, evapotranspiration decreased from an average of 3,032 AFY for the period 1945 to 2010 to 498 AFY for the most recent 10-year period (Table 2.2-8). The 498 AFY includes evapotranspiration from both native and non-native vegetation in the Subbasin, most of which is currently comprised of non-native tamarisk that were traditionally used as wind breaks throughout the Subbasin. ~~Currently, evapotranspiration losses estimated by the BVHM is dominated by losses from farms, golf courses, non-native tamarisk, and other land uses. As evaluated in Appendix D, water lost to evapotranspiration, even where in support of NCCAGs, come from percolating or perched groundwater, which means this component of the water budget does not represent water from the regional groundwater table, or water that is accessed by Subbasin pumping. This means that impacts to GDEs is a pre-2015 impact and is not currently an undesirable result applicable to the Subbasin.~~

Subsurface Outflow

A constant-head boundary condition was assigned to three cells marking the southern boundary of the BVHM model domain. This boundary was identified by the USGS based on groundwater level data from other sources that indicated this area was not influenced by groundwater level fluctuations and hydraulic conditions to the north. The average outflow at this boundary throughout the simulation was 1.4 acre-feet per day or ~~511~~ 520 AFY. No water flowed into the model domain at this boundary.

Annual outflow from the Subbasin at the southern boundary of the model domain fluctuated slightly around ~~511~~ 520 AFY between 1945 and 2016.

2.2.3.3 Change in Annual Volume of Groundwater in Storage

Annual and cumulative changes in storage for the BVHM model domain were estimated using the USGS groundwater numerical model, and shown on Figure 2.2-~~22A~~ 23A and Figure 2.2-~~22B~~23B, respectively. The numerical model treats groundwater in storage as a separate reservoir from which water can be added or removed to satisfy the groundwater balance equation. For each period of model calculation, water may be added to storage in one part of the model and removed from storage in another part of the model. Therefore, change in storage values reported for the model represent the net change in storage over the entire model grid.

For the period of model simulation, including the model update (1945–2016), the annual change in storage ranged from a decrease in storage of approximately 18,000 AF in 2006 to an increase in storage of approximately 18,100 AF in 1978 (Figure 2.2-~~22B~~23B). On average, the Subbasin lost approximately 7,300 AFY from storage for the period between 1945 and 2016. When considering the average over the last 10 years only, the average loss increases to 13,137 AFY. Water was removed from storage in 63 of the 71 years simulated, with water generally being added to storage in years in which the frequency, intensity and/or duration of runoff events were sufficient to initiate substantial stream recharge (e.g., water years 1967, 1977, 1979, and 1992). As a result, a cumulative amount of approximately 520,000 acre-feet of water was removed from storage over the period of model simulation (Figure 2.2-~~22B~~23B).

Each year in the period of simulation has been assigned one of three water year types: wet, average or dry. Water year types were assigned by the USGS during model development based on the amount of precipitation in each year relative to the average over the period of model simulation (USGS 2015).

2.2.3.4 Discussion of Model Validation, Uncertainties, and Recommendations for Improvement

The sensitivity analysis conducted by the USGS indicated the greatest uncertainty in the numerical model was in agricultural pumping, streamflow leakage, and storage. The FMP estimates agricultural pumping using precipitation and evapotranspiration data obtained from the BCM, assumptions about soil types and their associated soil moisture characteristics, rooting depths, crop coefficients, overland runoff, and estimated efficiencies of applied irrigation. Additionally, the coarse uniform grid of the model domain may overstate the water demands of certain land-use types, like golf courses, and, consequently, overestimate the amount of groundwater pumped to meet the water demand.

The simulated hydraulic heads compared to observed hydraulic heads indicated a slight bias of the model in underestimating hydraulic heads. This may be the result of the model simulating too much pumping compared to actual usage, or underestimating storage values like specific yield for the upper aquifer, or underestimating the amount of recharge to the BVGB, or a combination of all three. To improve the accuracy of the BVHM in simulating actual conditions and provide greater confidence in predictive simulations, the GSA intends to undertake the following actions to obtain additional data and further study the hydrogeology of the basin:

- At GSP implementation, the GSA will require agricultural and golf course wells to be metered. This will allow collection of actual agricultural pumping data via existing or ~~installing~~ new flow meters at farm wells. The pumping data may be incorporated in the numerical model to calibrate the FMP to more accurately estimate the water demands for the various crops and golf courses being irrigated.

- At GSP implementation, the GSA intends to collect periodic manual streamflow measurements at major drainages that convey most of the surface water runoff to the valley, either from perennial flows or flash flows from major precipitation events. Collection of this information can be used to further verify the accuracy of the BCM used in the BVHM, and ultimately to provide a more accurate estimate of stream leakage.
- As future funding allows, the GSA intends to conduct aquifer tests at wells screened only in the upper aquifer and only in the middle aquifer to obtain site-specific estimates of hydraulic conductivity and specific yield for each aquifer unit. This information may be used to enhance the calibration of the model to these hydraulic properties and our understanding of storage in the BVGB.

It should be noted that the results of the BVHM are subject to change as new data become available and sources of uncertainty are reduced. The GSA will consider these uncertainties in addition to the model uncertainties listed by USGS (2015) and will consider prioritization of the items that could improve the accuracy and reduce uncertainty of the model. Section 3.5.4 provides additional information on steps the GSA will take to fill data gaps.

2.2.3.5 Quantification of Overdraft

The average groundwater extraction calculated by the model for the 1945 though 2016 period of simulation was 10,750 AFY. This is approximately 5,000 AFY more than the natural recharge estimated by the USGS using the model (5,700 AFY; USGS 2015). The average groundwater extraction calculated by the model since 1980 is 14,130 AFY, approximately 8,400 AFY more than the estimated natural recharge. As shown in Figure 2.2-~~22~~23A, since 2007, the amount of groundwater pumped from the Subbasin has been in decline, due to a combination of water conservation efforts by BWD and agricultural irrigators, economic factors, and limited agricultural land fallowing.

Because groundwater is the sole source of water for the Subbasin, the inflows, outflows, and cumulative change in groundwater storage described in Sections 2.2.3.1 through 2.2.3.4, as well as Table~~s~~ 2.2-~~9~~8A ~~and 2.2-9B~~ represent past and current water supply and demand conditions. Future water supply conditions are anticipated to mirror the pumping reduction program~~ being implemented under this GSP~~, meaning that water supply will be incrementally reduced from the estimated current (2018) level of pumping (inclusive of all beneficial uses) of 19,~~656~~ 725 acre-feet to the sustainable yield of 5,700 acre-feet by 2040. ~~This is equivalent to an approximately 71% reduction in current groundwater use.~~

2.2.3.6 Sustainable Yield Estimate

The average annual natural recharge of water reaching the saturated zone, which includes stream leakage and infiltrating water through the unsaturated zone, was 5,700 AFY for the ~~full~~ USGS pre-development model simulation scenario with a period from ~~1929~~ 1945 to 2010 (USGS 2015). The USGS water budget developed using the BVHM for the years 1945 through 2010 and updated by Dudek for the years 2011 through 2016 indicated that the average total inflow, which includes groundwater subsurface inflow (specified flows), stream leakage, and unsaturated zone recharge (UZF recharge), is 6,900 AFY (rounded) for the period 1945 to 2010 and 6,800 AFY (rounded) for the period 1945 to 2016 (Table 2.2-8). The 20-year and 10-year averages for the most recent periods are 5,800 AF (rounded) and 4,700 AFY (rounded), respectively. These recent periods were comprised mostly of a drier climatic period compared to the longer scenarios beginning in 1945 that included both wet and dry periods. Future recharge from the unsaturated zone is likely to be less than historical estimates because of diminishing irrigation return flows due to pumping ramp down over the GSP implementation period and/or the potential effects of climate change on recharge within the Subbasin.

Historical inflows from 1945 to 2016 were compared to recent (past 10 years) groundwater outflows from the BHVM model update to estimate the initial sustainable yield of the Subbasin. Average inflows from the entire run of the model update provide a reasonable estimate of potential basin inflows because they capture a wide variety of climatic conditions. Outflows from the most recent 10 years were considered to be more representative of potential Subbasin outflows than the entire historical model period because the loss of native phreatophytes has decreased outflow from evapotranspiration in the Subbasin. Using these assumptions, the surplus of inflows over outflows in the Subbasin is estimated to be approximately 5,750 AF (rounded; Table 2.2-~~10~~9). These results are in line with the 5,700 AFY estimate of sustainable yield based on the USGS' pre-development scenario, which estimated natural inflows to the boundaries of the Borrego Valley Hydrologic Model (BVHM) for the period 1945 through 2010 (USGS 2015).

~~In addition to natural recharge from stream leakage and infiltrating water (mostly from irrigation return flows), the Subbasin received underflow originating from the adjacent watersheds at an average annual rate of 1,400 AFY. Therefore, the combined average annual natural recharge to the BVGB is approximately 7,100 AFY. Recharge in the basin is bimodal, with the majority of recharge occurring on decadal basis in a few very wet years. Most years have significantly less natural recharge than the average. Given that this bimodal pattern introduces a level of uncertainty regarding the actual amount of recharge that could occur over the next 20 years, the GSA has determined that a target pumping rate of 5,700 AFY by 2040 would be consistent with the GSP's sustainability goal (discussed in Chapter 3).~~

~~Historical inflows from 1945 to 2016 were compared to recent (past 10 years) groundwater outflows from the BHVM model update to estimate the initial sustainable yield of the basin. Average inflows from the entire run of the model update provide a reasonable estimate of potential basin inflows because they capture a wide variety of climatic conditions. Outflows from the most recent 10 years were considered to be more representative of potential basin outflows than the entire historical model period because the loss of native phreatophytes has decreased outflow from evapotranspiration in the basin. Using these assumptions, the surplus of inflows over outflows in the basin is estimated to be approximately 5,750 AF (rounded; Table 2).~~

Table 2.2-9
Estimated Surplus of Inflows Over Outflows

Water Budget Components (Units in Acre-Feet per Year)	Acre-Feet/Year
INFLOWS (Model Update 1945–2016)	
INFLOWS	
Stream Recharge	3,905
Unsaturated Zone Recharge	1,497
Underflow (Inflow from Adjacent Basins)	1,367
Total Inflows	**6,770**
OUTFLOWS BESIDES PUMPING (Most Recent 10 Years, 2007–2016)	
Evapotranspiration	498
Underflow (Flow out of Southern End)	523
Total Outflows	**1,021**
Surplus of Inflows over Outflows	5,749

Source: USGS 2015; Dudek 2018, 2019.

The use of 5,700 AFY as the initial estimate of sustainable yield for the Borrego Springs Subbasin is a reasonable approach recognizing the iterative and adaptive nature of SGMA to identify data gaps, acquire new data, and update the estimate of sustainable yield at each 5-year check-in during GSP implementation.

2.2.3.7 Quantification of Current, Historical, and Projected Water Budget

The highest levels of uncertainty in the model were from agricultural pumping, specific yield, and streamflow entering the valley. Agricultural pumping (and to a lesser extent recreational pumping) was estimated using the FMP package, which calculates a water demand on a cell-by-cell basis for each land-use type. The water demand is based on an estimated water consumption factoring in evapotranspiration, applied water (via irrigation or rainfall), efficiencies of applied irrigation water, soil moisture content, rooting depth, and potential runoff. The following measures could be taken to improve the uncertainty in the model: (1) information on actual pumping for agricultural and recreational uses can be used to improve the accuracy of the FMP in estimating pumping, (2) long-term constant-rate aquifer tests ~~in the upper and middle aquifer units~~ would improve the estimates of specific yield, and (3) the installation of stream gaging stations or manual streamflow measurements in Coyote Creek and other major drainages to the valley would improve the estimates of runoff to the basin.

2.2.3.8 Surface Water Available for Groundwater Recharge or In-Lieu Use

Traditional projects and management actions to physically supplement groundwater supply have been determined to be generally infeasible. Specific examples are summarized as follows:

- *Imported water*: The importation of groundwater from outside the boundary of the ~~Borrego Springs Groundwater~~ Subbasin is not considered feasible at this time. The U.S. Bureau of Reclamation's *Summary Report—Southeast California Regional Basin Study* found that the structural alternatives evaluated did not produce benefits in excess of their costs (USBR 2015). Therefore, the U.S. Bureau of Reclamation found that importing water was not economically viable at the time of the study, in 2012, and did not recommend additional studies at that time. Additionally, BWD evaluated the feasibility of importing groundwater from the Clark Dry Lake, Ocotillo Wells Subbasin and Allegretti Farms (Ocotillo-Clark Valley Groundwater Basin) (Burzell 2006). The BWD evaluation found these projects to be economically infeasible, because the estimated project cost of $6,480,000 (2006 dollars) did not justify the estimated production of 1,900 AF.
- *Wastewater Treatment Plant Upgrades*: In some basins wastewater treatment plants can be upgraded or additional service connections can be added to increase effluent volumes usable for producing recycled water or effluent for groundwater recharge. However, the nature of the Borrego Springs community and distribution of potential service connections is such that the upgrades would not result in an appreciable increase in groundwater recharge due to the insufficient scale of the system. The Final Tertiary Treatment Project Feasibility Study concluded that the production of recycled water within the BWD is not feasible at this time, and the No Project Alternative is recommended (Dudek 2018).
- *Stormwater Capture and Infiltration*: The infrequent occurrence of rainfall in the region results in extended periods of zero-recharge. Additionally, design criteria for capturing and infiltrating desert flood events, as well as removal and disposition of accumulated sediment from large storm events, is costly (USBR 2015). Therefore, while this potential supply-side project requires additional analysis, the costs to construct this as a stand-alone project outweigh the benefits at this time. Stormwater retention will be evaluated on a case-by-case basis in conjunction with future development in the Subbasin.

Feasible and effective projects and management actions needed to achieve sustainability within the GSP's implementation horizon are discussed in GSP Chapter 4.

2.2.4 Management Areas

The depth, elevation and quality of groundwater resources in the Plan Area appears to vary geographically from north to south and with depth in the aquifer based on present and historical data discussed in Section 2.2-1. Three Subbasin management areas (the NMA, CMA, and SMA) are proposed to contextualize baseline conditions, monitor the status of groundwater quality, and measure progress toward achieving sustainability goals pertaining to groundwater quality (Figure 2.2-~~23~~24).

The boundaries of these areas are based on the distribution of the three aquifers underlying the Subbasin, geologic controls on groundwater movement, and differences in overlying land uses and associated groundwater pumping depressions. The two primary features that define the boundaries between Subbasin management areas are the West Salton detachment fault (between the NMA and the CMA) and the Desert Lodge anticline (between the CMA and SMA), shown on Figure 2.2-~~23~~24. The shape and thickness of the aquifers and subsurface geological features such as the Desert Lodge anticline and the West Salton detachment fault appear to influence hydrologic communication between the northern, central, and southern parts of the Subbasin. Due to the variable thickness of the individual aquifers, extraction wells are predominantly cross-screened in the upper, middle, and lower aquifers in the northern part of the Subbasin, cross-screened in the middle and lower aquifers in the central part of the Subbasin, and cross-screened in the middle and lower aquifers in the southern part of the Subbasin. The justification for use of these three areas has been covered in earlier sections, which differentiate aquifer geometry, groundwater levels and groundwater quality laterally across the three management areas (Sections 2.2.1 and 2.2.2, previously outlined).

The use of management areas is optional under SGMA, and in this GSP, the definition of the three management areas are primarily for the purpose of groundwater quality management, since the end uses of groundwater differs substantially across the three management areas. Wells in the NMA serve primarily agricultural use, whereas wells in the CMA ~~primarily~~ serve municipal and recreational use, and wells in the SMA primarily serve recreational use which means there may be different thresholds for undesirable results for potable versus non-potable uses. These are discussed in Chapter 3.

2.2.4.1 North Management Area

In terms of sustainability indicators, this management area is differentiated from the others primarily on the basis of water quality, but also incorporates differences in historical groundwater level declines and changes in predominant land use. The main land use in the NMA is agriculture but also includes domestic uses in the northwestern part of Borrego Springs (Figure 2.2-~~23~~24). Accordingly, it has the greatest overall groundwater level declines when compared to the CMA and SMA.

2.2.4.2 Central Management Area

In terms of sustainability indicators, this management area is differentiated from the others primarily on the basis of water quality, but also incorporates differences in historical groundwater level declines and changes in predominant land use. The main land uses in the CMA are municipal and recreational (golf courses) but also include substantial undeveloped areas to the northeast. Like the NMA, water quality is generally good, and historical groundwater level declines are also high. The main differentiating factor between the NMA and CMA is the predominant beneficial use of groundwater.

2.2.4.3 South Management Area

The geological basis for differentiating the management areas are previously described (Section 2.2.4). In terms of sustainability indicators, this management area is differentiated from the others primarily on the basis of water quality, but also incorporates differences in historical groundwater level declines and changes in predominant land use. Additionally, the Desert Lodge anticline effectively compartmentalizes the SMA from the CMA (USGS 2015). The land use in the SMA is undeveloped open space, with the exception of the Rams Hill Country Club and Air Ranch. Unlike the NMA and CMA, arsenic is a water quality COC in groundwater and wells in this area tap the lower groundwater aquifer.

The minimum thresholds and measurable objectives for indicator wells within each management area, the rationale for selecting those thresholds, and the levels of monitoring and analysis for each management area are described in Chapter 3. The three management areas are shown in Figure 2.2-~~23~~ 24 as well as included on the figure in in Chapter 3.

2.3 REFERENCES CITED

ABDSP (Anza Borrego Desert State Park) 2017. GIS Package of Hydrologic Feature Data. Received 10/17/2017.

ABF (Anza Borrego Foundation). 2018. “Our Work.” Website accessed at http://theabf.org/our-work, on 2/20/2018.

ACOE (U.S. Army Corps of Engineers). 2011. *Final Site Inspection Report, Borrego Springs - Camp Ensign San Diego County, California*. FUDS Project No. J09CA701102. September 22, 2011.

Anning, D.W., A.P. Paul, T.S. McKinney, J.M. Huntington, L.M. Bexfield, and S.A. Thiros. 2012. *Predicted Nitrate and Arsenic Concentrations in Basin-Fill Aquifers of the Southwestern United States.* U.S. Geological Survey Scientific Investigations Report 2012–5065.

Barrie, Don. 2018. “Anza-Borrego Geology.” Anza-Borrego Desert Natural History Association. Website accessed at http://www.abdnha.org/anza-borrego-desert-geology.htm, on 2/20/2018.

BBC (BBC Research & Consulting). 2012. *Potential Impacts of Wind Farm Development Near Anza-Borrego Desert State Park: Reconnaissance Level Evaluation*. Prepared for The Anza-Borrego Foundation, with financial support from the California State Parks Foundation.

Burzell, L.R. 2006. Consideration of drilling production wells on the 240 acre District property near Clark Lake and other areas nearby which are on the northeast side of the Coyote Canyon Fault. Memorandum to BWD Board of Directors. October 12, 2016.

BWD (Borrego Water District). 2002. *Groundwater Management Plan*. Adopted October 18, 2002.

BWD. 2009a. *Borrego Valley Water Resources Investigation*. Submitted for grant funding under the Bureau of Reclamation Basin Study Program. Final. June 26, 2009.

BWD. 2009b. *Integrated Water Resources Management Plan.* Final report. Prepared by William R. Mills. March 2009.

BWD. 2015. *Demand Offset Mitigation Water Credits Policy*. Adopted January 30, 2013, as amended through May 19, 2015.

BWD and County of San Diego. 2013. *Memorandum of Agreement Between the Borrego Water District and the County of San Diego Regarding Water Credits*. February 4, 2013.

CDPR (California Department of Parks and Recreation). 2015. *Anza-Borrego Desert State Park Interpretation Master Plan*. Prepared by The Acorn Group Inc. September 2015.

CGS (California Geological Survey). 2002. *California Geomorphic Provinces*. CGS Note 36, revised December 2002.

CIMIS (California Irrigation Management Information System). 2018. Daily Evapotranspiration Data for CIMIS Station 207 - 2008 through 2018. Compiled 9/4/2018. http://www.cimis.water.ca.gov/cimis/cimiSatEtoZones.jsp.

County of San Diego. 2007. *DPLU Policy Regarding CEQA Cumulative Impact Analyses for Borrego Valley Groundwater Use.* Adopted October 5 2004, revised through January 17, 2007.

County of San Diego. 2010. *Evaluation of Groundwater Conditions in Borrego Valley*. General Plan Update, Appendix A. April 2010.

County of San Diego. 2011. *Borrego Springs Community Plan*. Adopted August 3, 2011. Amended May 15, 2013.

County of San Diego. 2013. *San Diego Groundwater Ordinance – An Excerpt From The San Diego County Code Of Regulatory Ordinances*. San Diego County Code Title 6, Division 7, Chapter 7. Amendments effective 3/01/2013.

County of San Diego. 2016. Sealing Materials for Water Wells, Monitoring Wells, Cathodic Protection Wells, Geothermal Heat Exchange Wells, and other Permitted Wells. Department of Environmental Health Well Sealing Materials Policy. November 13, 2016.

County of San Diego. 2018. Development Tracker Map#3 (Existing Dwelling Units), Map #11 (Dwelling Units – Completed Building Permits [2011 General Plan Forward]). Published October 8, 2018.

CPAD (California Protected Areas Database). 2017. California Protected Areas Data Portal. Accessed 10/5/2017. http://www.calands.org/.

Dibblee, T.W. 2008. Geologic Map of the Borrego & Borrego Mountain 15 Minute Quadrangles, San Diego and Imperial Counties. September 2008.

Dorsey, Rebecca. 2005. Stratigraphy, Tectonics, and Basin Evolution in the Anza-Borrego Desert Region. Geology. Unpublished Paper. Accessed at https://pages.uoregon.edu /rdorsey/Downloads/DorseyChaperNov05.pdf, on 2/20/2018

Dudek. 2014. Aquifer Test Report for Wells ID1-1 and ID1-2. Prepared for Borrego Water District and T2 Borrego LLC. August 2014.

Dudek. 2015a. Draft Rams Hill Golf Course Water Supply Application for Wells RH-4. Prepared for Borrego Water District and T2 Borrego LLC. February 2015.

Dudek. 2015b. Draft Rams Hill Golf Course Water Supply Application for Wells RH-5 and RH-6. Prepared for Borrego Water District and T2 Borrego LLC. October 2015.

Dudek. 2018. Final Tertiary Treatment Conversion Project Study Preapred for Borrego Water District. March 2018.

DWR (California Department of Water Resources). 1981. *Water Well Standards - State of California*. DWR Bulletin 74-81. December 1981

DWR. 1983a. *Preliminary Evaluation of Annual Recharge to the Borrego Valley Ground Water Basin*. Study No. 1335-11-B-1. Prepared by Kenneth Hatai. March 1983.

DWR. 1983b. *A Preliminary Evaluation of Historical and Projected Water Demand for Borrego Valley. Draft*. Study No. 1335-11-C-1. Prepared by Kenneth Hatai. March 1983.

DWR. 1984. *Borrego Valley Water Management Plan*. June 1984.

DWR. 1991. *California Well Standards*. DWR Bulletin 74-90 (Supplement to Bulletin 74-81). June 1991.

DWR. 2007. *An Interpretation of Geologic Materials Encountered in the Boring of Borrego Water District Monitoring Well MW-5*. Technical Information Record SD-07-02. April 2007.

DWR. 2014. *Groundwater Quality Information for Borrego Valley*. PowerPoint slides. May 2014. Presented by Tim Ross.

DWR. 2016. California’s Groundwater, Working Toward Sustainability. Bulletin 118 Interim Update. December 22, 2016.

DWR. 2017. Water Management Planning Tool. Disadvantaged Communities Places Layer.

DWR. 2018. Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset. April 2018.

DWR. 2019. Sustainable Groundwater Management Act 2018 Basin Prioritization Process and Results. January 2019.

ENSI ~~(Environmental Navigation Services Inc.)~~. 2018. RE: Methodology To Examine Future Groundwater Overdraft In Terms Of The Overall Hydrologic Water Balance Considering Recharge Variability And Parameter Uncertainty. Memorandum. Prepared for Borrego Water District. September 12, 2018.

ENSI (Environmental Navigation Services Inc.). 2019. SDAC Impact/Vulnerability Analysis (Task 2 Report). Prepared for the Borrego Water District. April 15, 2019.

Henderson, T.W. 2001. ""Hydrogeology and Numerical Modeling of the Borrego Valley Aquifer System."" Master's thesis; San Diego State University.

Huntley. 1993. Letters from Professor David Huntley, San Diego State University to John Peterson, San Diego County Department of Planning, and to Brian Billbray, San Diego County Board of Supervisors. Dated January 26, 1993.

Janecke, S.U., R.J. Dorsey, D. Forand, A.N. Steely, S.M. Kirby, A.T. Lutz, B.A. Housen, B. Belgarde, V.E. Langenheim, and T.M. Rittenour. 2010. “High Geologic Slip Rates since Early Pleistocene Initiation of the San Jacinto and San Felipe Fault Zones in the San Andreas Fault System, Southern California, USA.” Special Paper 475. Boulder, Colorado: The Geological Society of America.

Kirby S.M., S.U. Janecke, R.J. Dorsey, B.A. Housen, and V.E. Langenheim. 2007. “Pleistocene Brawley and Ocotillo Formations: Evidence for Initial Strike-Slip Deformation along the San Felipe and San Jacinto Fault Zones, Southern California.” *The Journal of Geology*115:43–62.

Lutz, A.T., R.J. Dorsey, B.A. Housen, and S.U. Janecke. 2006. "Stratigraphic Record of Pleistocene Faulting and Basin Evolution in the Borrego Badlands, San Jacinto Fault Zone, Southern California." Geological Society of America Bulletin, November/December 2006: 1377–1397. DOI: 10.1130/B25946.1.

Netto, S.P. 2001. "Water Resources of Borrego Valley, San Diego, California." Master's thesis; San Diego State University.

SDCFCD (San Diego County Flood Control District) 2004. *San Diego County Rainfall 30 - Year Annual Average Period of Record: July, 1971 to June, 2001*. Map. Dated July 14, 2004.

SANGIS. 2017. SanGIS/SANDAG GIS Data Warehouse. Accessed July 20, 2017. http://www.sangis.org/download/index.html.

Steely, A.N., S.U. Janecke, R.J. Dorsey, and G.J. Axen. 2009. "Early Pleistocene Initiation of the San Felipe Fault Zone, SW Salton Trough, during Reorganization of the San Andreas Fault System." Geological Society of American Bulletin (121): 663–687. DOI: 10.1130/B26239.1.

SCEDC (Southern California Earthquale Data Center). 2018. “Significant Earthquakes and Faults.” Webpage. http://scedc.caltech.edu/significant/sanjacinto.html. Accessed March 14, 2018.

SWRCB (State Water Resources Control Board). 2018. Water Boards Storm Water Multiple Application and Report Tracking System (SMARTS). Public User search for Notice of Intents within San Diego County and RWQCB Region 7. Available at https://smarts.waterboards.ca.gov/smarts/faces/PublicDataAccess/PublicNoiSearch.xhtm, Accessed 4/11/18.

TNC (The Nature Conservancy). 2010. Groundwater Dependent Ecosystems in California - GIS Package. June 2010. Site accessed September 7, 2017: http://scienceforconservation.org/downloads/groundwater_dependent_ecosystems_in_california_gis_package.

TNC. 2018. Groundwater Dependent Ecosystems Under the Sustainable Groundwater Management Act. Guidance for Preparing Sustainability Plans. January 2018.

UCI (University of California, at Irvine) 2018. Steele/Burnand Anza-Borrego Desert Research Center. Website. Accessed at http://anzaborrego.ucnrs.org/, on 2/20/2018.

USBR (U.S. Bureau of Reclamation). 1972. *Inland Basins Projects California – Nevada Summary Report: Reconnaissance Investigations*. June 1972.

USBR. 2013. *Proposed Imported Water Pipeline Routes for Borrego Water District Apprasial Analysis.* Technical memorandum. Southeast California Regional Study, Lower Colorado Region. Prepared by Douglas Blatchford. December 2013.

USBR. 2015. *Southeast California Regional Basin Study Summary Report*. September 2015.

U.S. Census Bureau. 2010. 2010 Census Count. https://www.census.gov/data.html.

U.S. Census Bureau. 2018. 2012–2016 American Community Survey 5-Year Estimates. Accessed February 13, 2018 at https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

USDA (U.S. Department of Agriculture). 2018. "Custom Soil Resource Report for Anza-Borrego Area, California (CA804) and San Diego County Area, California (CA638). BVGB GSP." Web Soil Survey. USDA Natural Resources Conservation Service, Soil Survey Staff. Accessed March 23, 2018. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

USGS (U.S. Geological Survey). 1982. *Water Resources of Borrego Valley and Vicinity, California: Phase 1–Definition of Geologic and Hydrologic Characteristics of Basin*. Open-File Report 82-855. Prepared by W.R. Moyle Jr. in cooperation with the County of San Diego.

USGS. 1988. *Water Resources of Borrego Valley and Vicinity, San Diego County, California: Phase 2 – Development of a Ground-Water Flow Model*. Water-Resources Investigations Report 87-4199. Prepared by Hugh T. Mitten, Gregory C. Lines, Charles Berenbrock, and Timothy J. Durbin in cooperation with the County of San Diego and the California Department of Water Resources. Sacramento, California: USGS. 1988.

USGS. 1993. "Isostatic Residual Gravity Map of the Borrego Valley" [map]. 1:100,000. USGS Open File Report 93-246. By Langenhiem, V.E., and R.C. Jachens. U.S. Department of the Interior, U.S. Geological Survey.

USGS. 2006. Quaternary Fault and Fold Database for the United States. Accessed November 12, 2018. http//earthquakes.usgs.gov/hazards/qfaults/.

USGS. 2014. *Status of Groundwater Quality in the Borrego Valley, Central Desert, and Low-Use Basins of the Mojave and Sonoran Deserts Study Unit, 2008–2010: California GAMA Priority Basin Project*. By Mary C. Parsons, Tracy Connell Hancock, Justin T. Kulongoski, and Kenneth Belitz. Groundwater Ambient Monitoring Program. USGS Scientific Investigations Report 2014–5001. 2014.

USGS. 2015. *Hydrogeology, Hydrologic Effects of Development, and Simulation of Groundwater Flow in the Borrego Valley, San Diego County, California*. Scientific Investigations Report 2015–5150. Prepared by Claudia C. Faunt, Christina L. Stamos, Lorraine E. Flint, Michael T. Wright, Matthew K. Burgess, Michelle Sneed, Justin Brandt, Peter Martin, and Alissa L. Coes in cooperation with the Borrego Water District. DOI: 10.3133/sir20155150.

USGS. 2017. The National Map. Watershed Boundary Dataset. Web Map Viewer. Accessed at https://viewer.nationalmap.gov/advanced-viewer/. Accessed December 2017.

Walvoord, M.A., F.M. Phillips, D.A. Stonestrom, R.D. Evans, P.C. Hartsough, B.D. Newman, and R.G. Strieg. 2003. “A Reservoir of Nitrate Beneath Desert Soils.” *Science* 302(5647):1021–1024.

Welch, A.H., D.B. Westhohn, D.R. Helsel, and R.B. Wanty. 2000. “Arsenic in Groundwater of the United States—Occurrence and Geochemistry.” *Groundwater* 38(4):589–604.

Wiedlin, M. 2018. Review of Existing Data on Groundwater Flow Boundary Type across Coyote Creek Fault. Phone conversation between M. Wiedlin (Wiedlin & Associates) and Trey Driscoll (Dudek). June 5, 2018.

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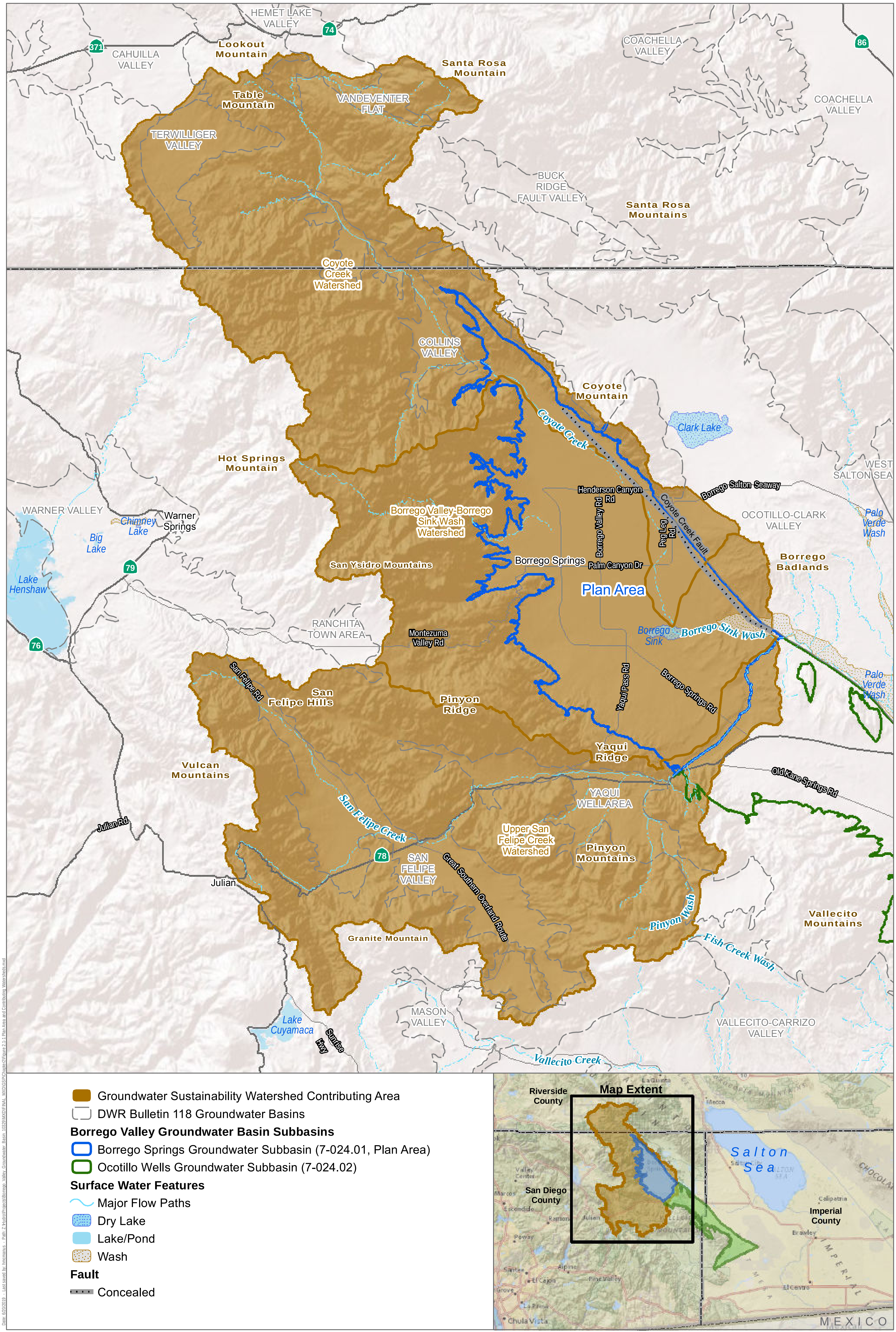

- 🟫 Groundwater Sustainability Watershed Contributing Area
- ⬚ DWR Bulletin 118 Groundwater Basins

Borrego Valley Groundwater Basin Subbasins

- ▢ Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
- ▢ Ocotillo Wells Groundwater Subbasin (7-024.02)

Surface Water Features

- ～ Major Flow Paths
- ▨ Dry Lake
- ■ Lake/Pond
- ▨ Wash

Fault

- ┅ Concealed

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015; SanGIS 2014; USGS NHD 2017

DUDEK

0 1.5 3 Miles

Figure 2.1-1

Plan Area and Contributing Watersheds

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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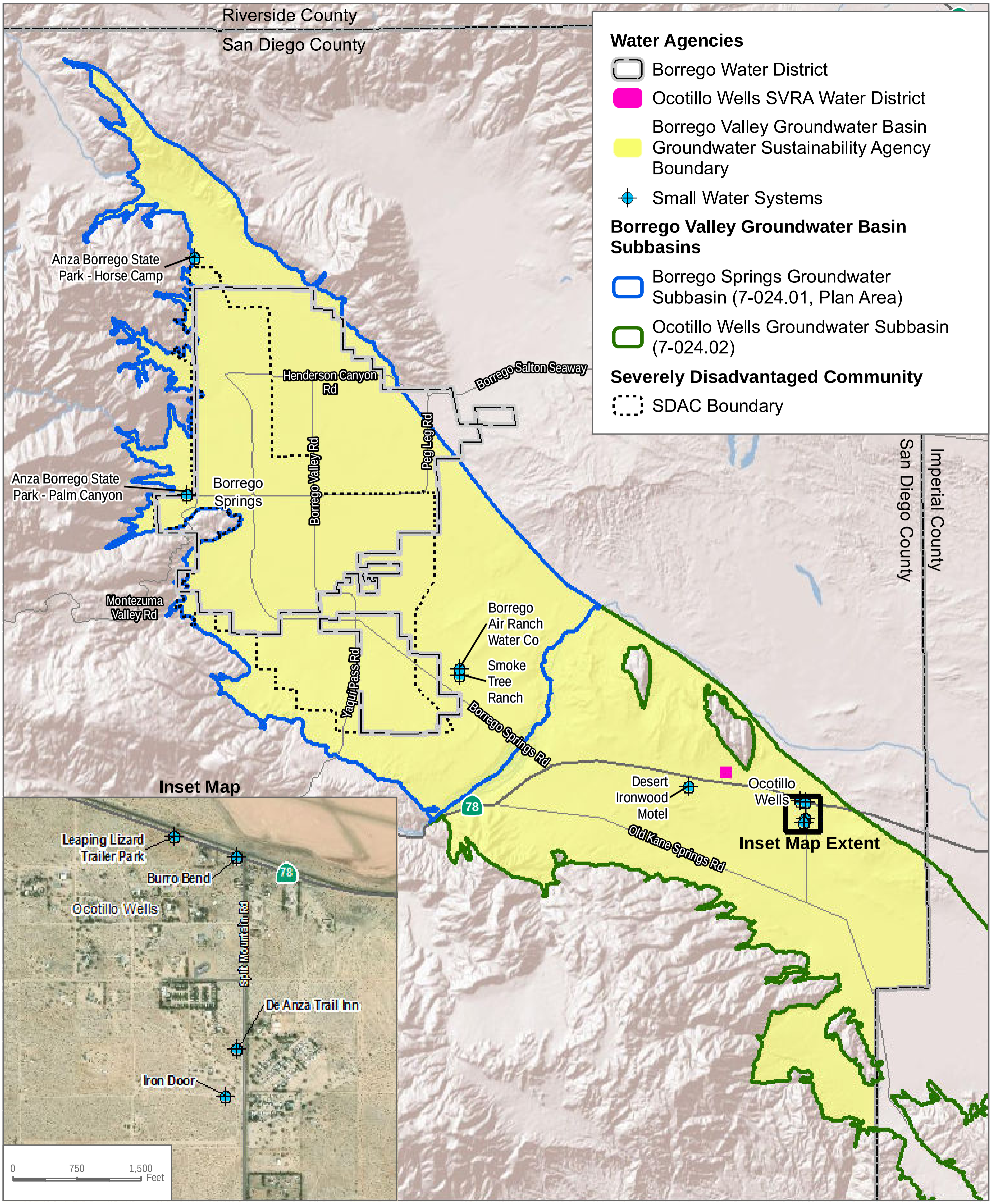

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015; San Diego County

DUDEK

0 1.5 3 Miles

Figure 2.1-2

Water Purveyors within the Groundwater Sustainability Agency Boundary

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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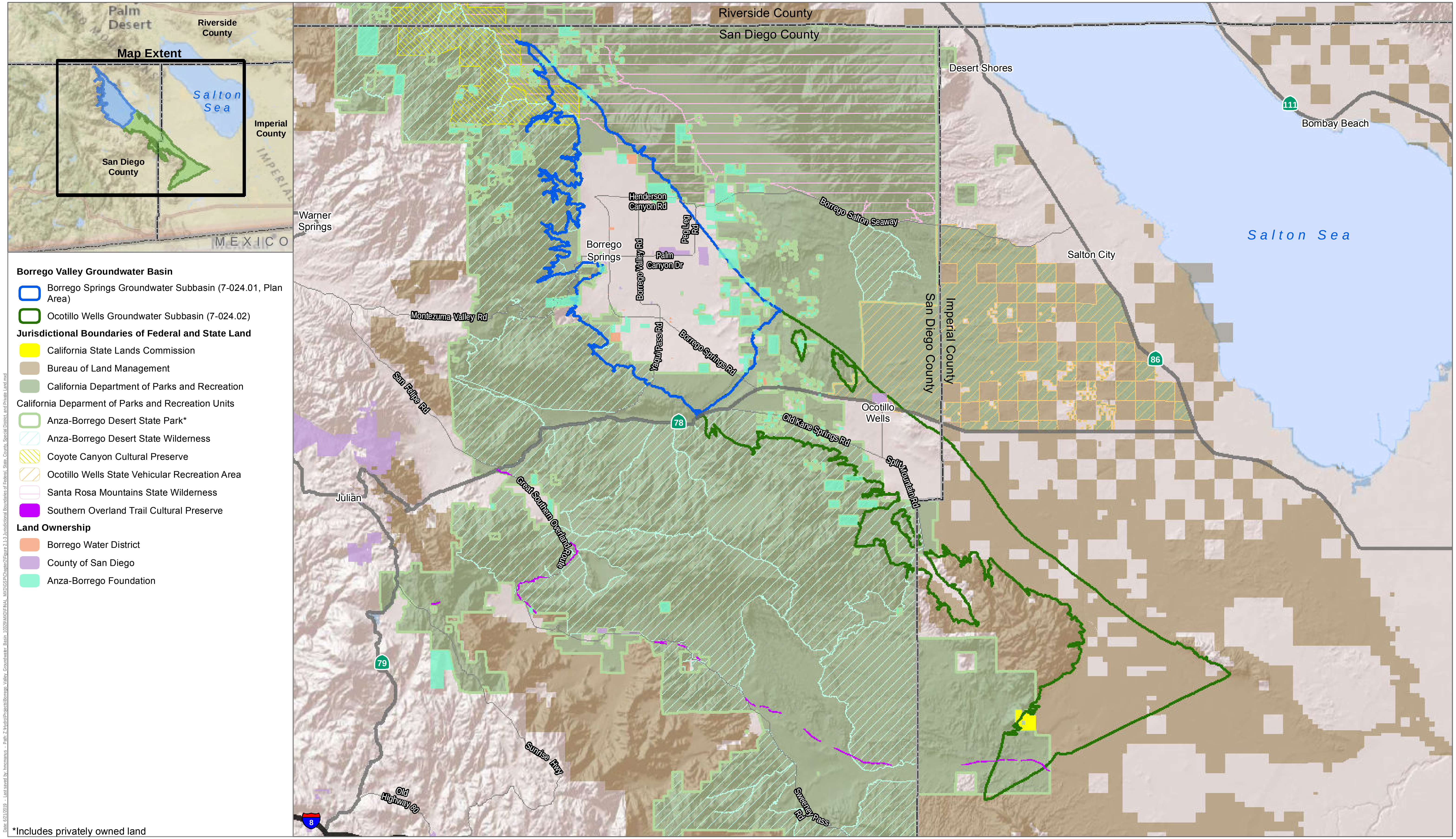

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015; SanGIS 2014; CPAD 2015; CSP 2012; BLM 2014

DUDEK

0 2 4 Miles

Figure 2.1-3

Jurisdictional Boundaries of Federal, State,County, Special District, and Private Land

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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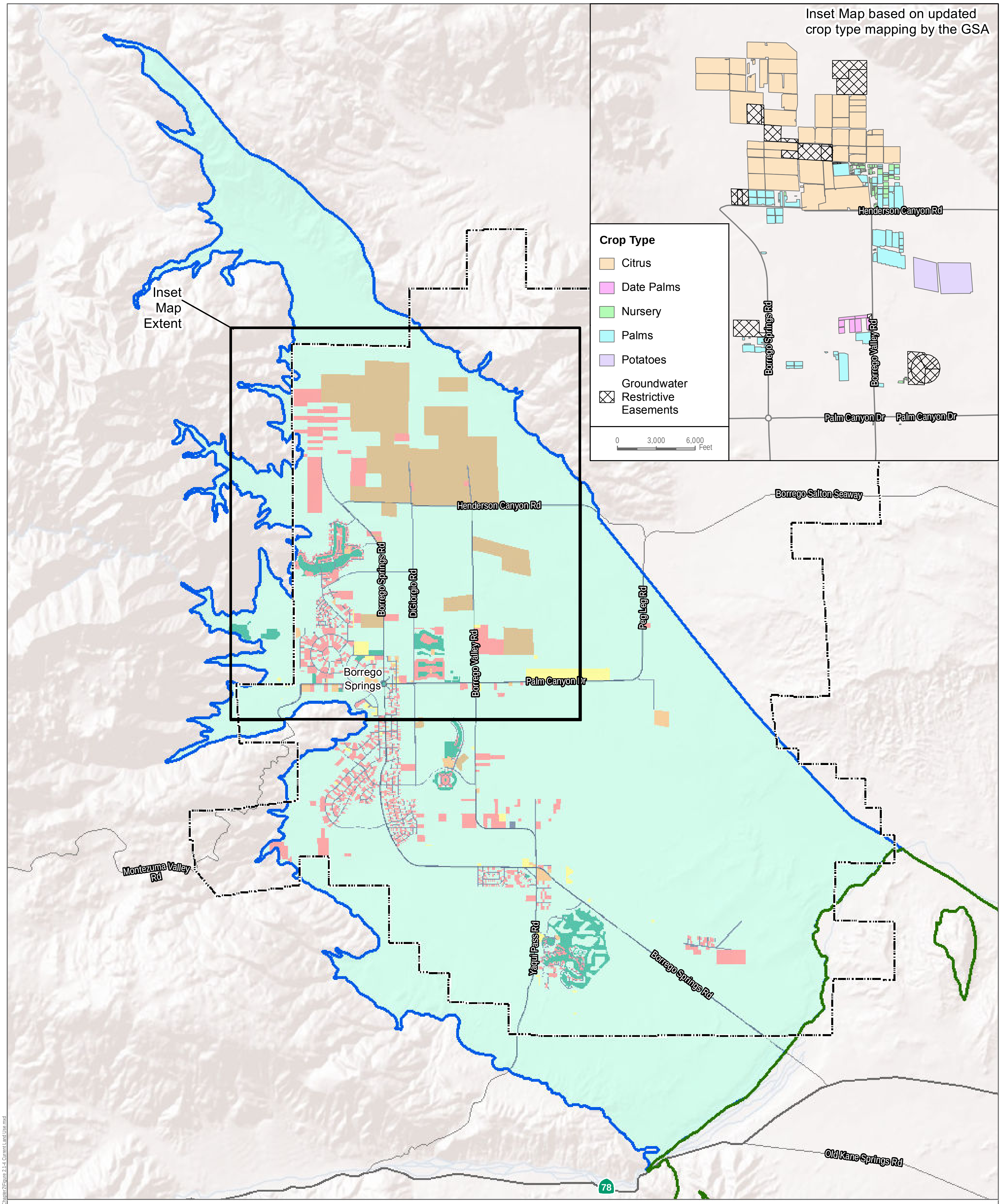

⬚ Borrego Springs Community Plan Area

Borrego Valley Groundwater Basin Subbasins

- ▭ Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
- ▭ Ocotillo Wells Groundwater Subbasin (7-024.02)

Current Land Use

Land Use Groups

- ■ Agriculture
- ■ Commercial/Industrial
- ■ Government/Other Public Institutions
- ■ Open Space/Undeveloped Land
- ■ Park/Recreation/Golf Course
- ■ Residential
- ■ Roadway/Parking Lot/Airstrip

August 2019

DATUM: NAD 1983. DATA SOURCE: SanGIS 2017; Inset Map Source GSA 2018

DUDEK 0 0.75 1.5 Miles

Figure 2.1-4

Current Land Use

Date: 9/7/2018 - Last saved by: hmcmanus - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.1-4 Current Land Use.mxd

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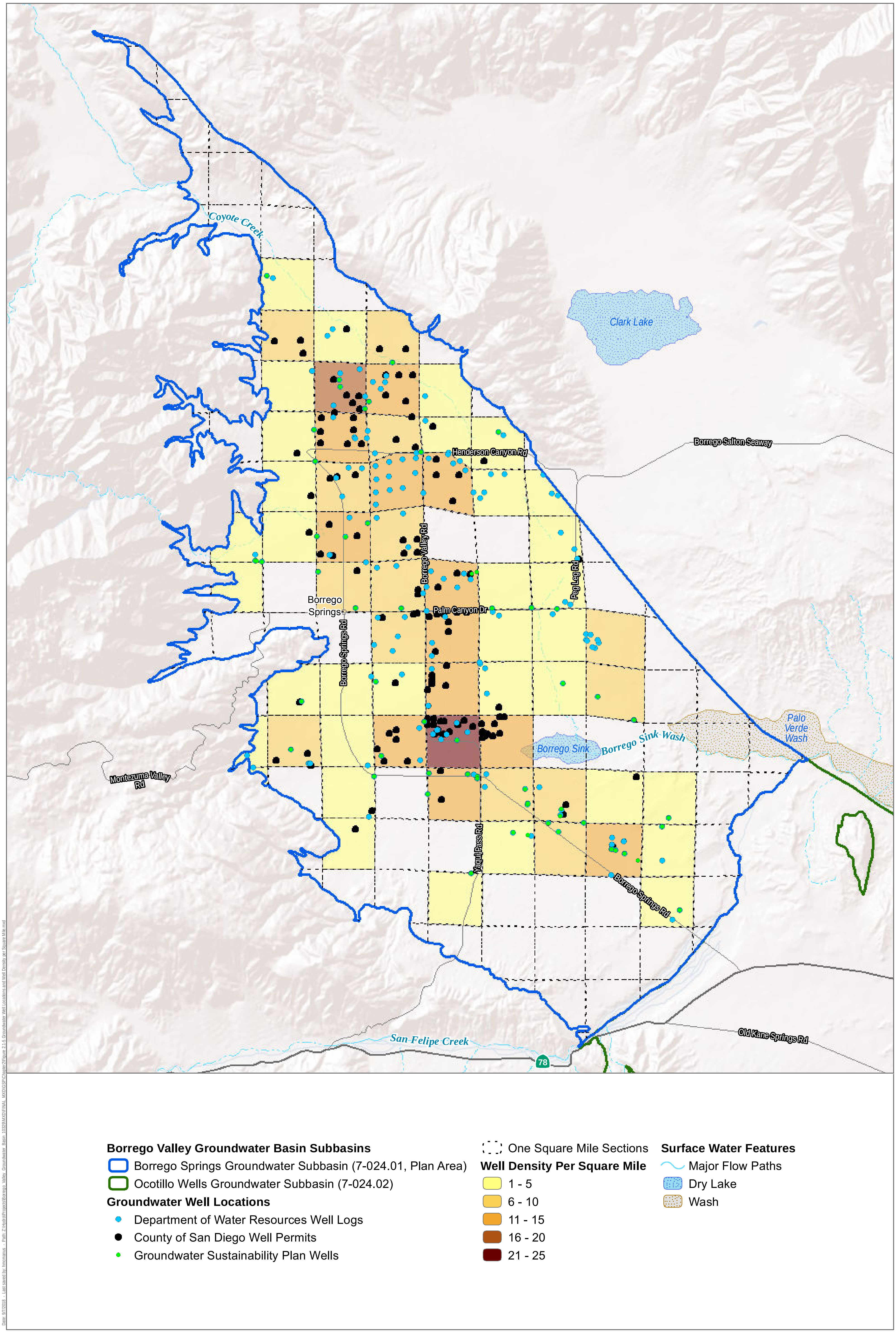

Date: 9/7/2018 - Last saved by: hmcmanus - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.1-5 Groundwater Well Locations and Well Density per Square Mile.mxd

August 2019

DATUM: NAD 1983. DATA SOURCE: SanGIS 2017

DUDEK

0 0.75 1.5 Miles

Figure 2.1-5

Groundwater Well Locations and Well Density per Square Mile

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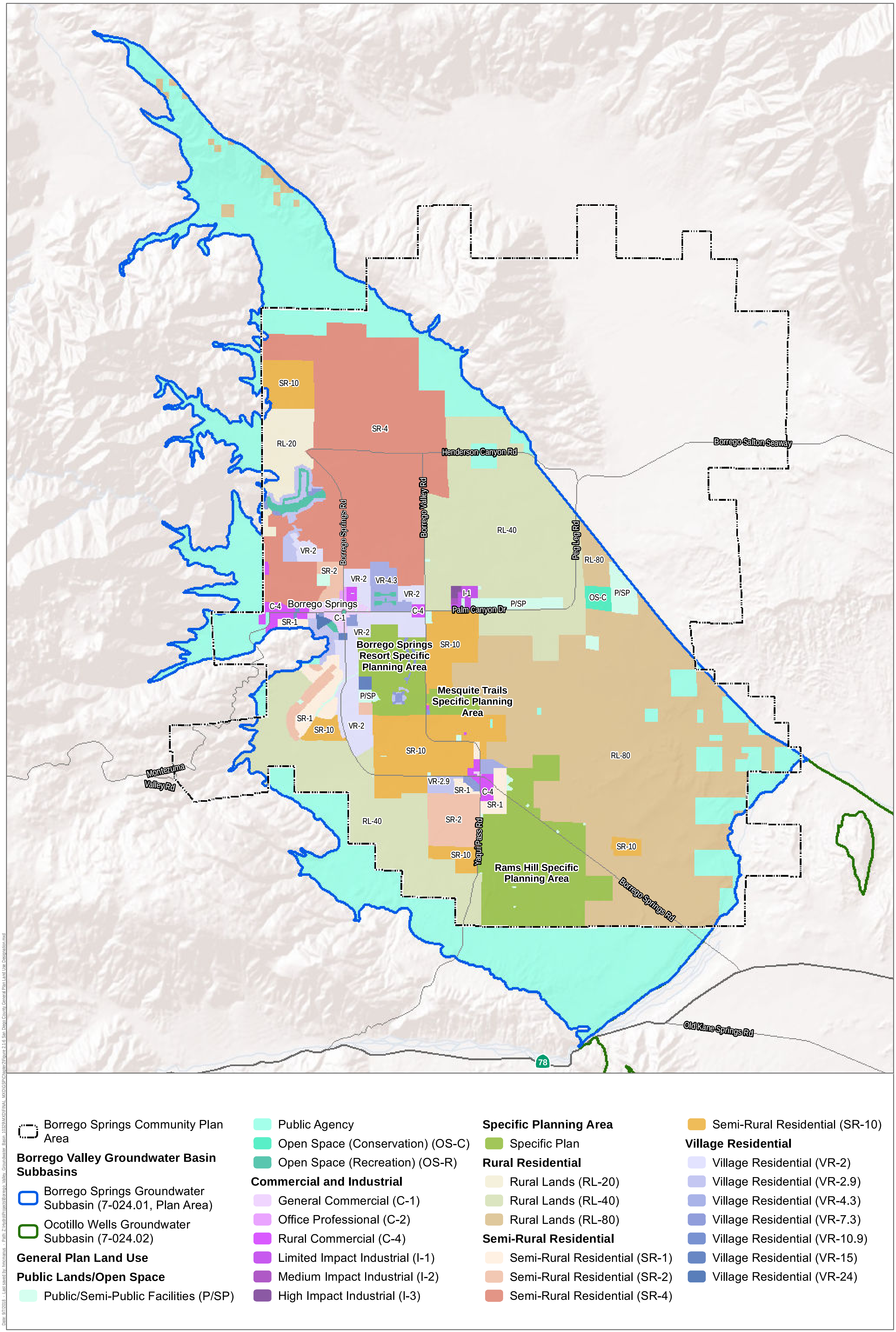

August 2019

DATUM: NAD 1983. DATA SOURCE: SanGIS 2011

DUDEK

Figure 2.1-6

San Diego County General Plan Land Use Designations

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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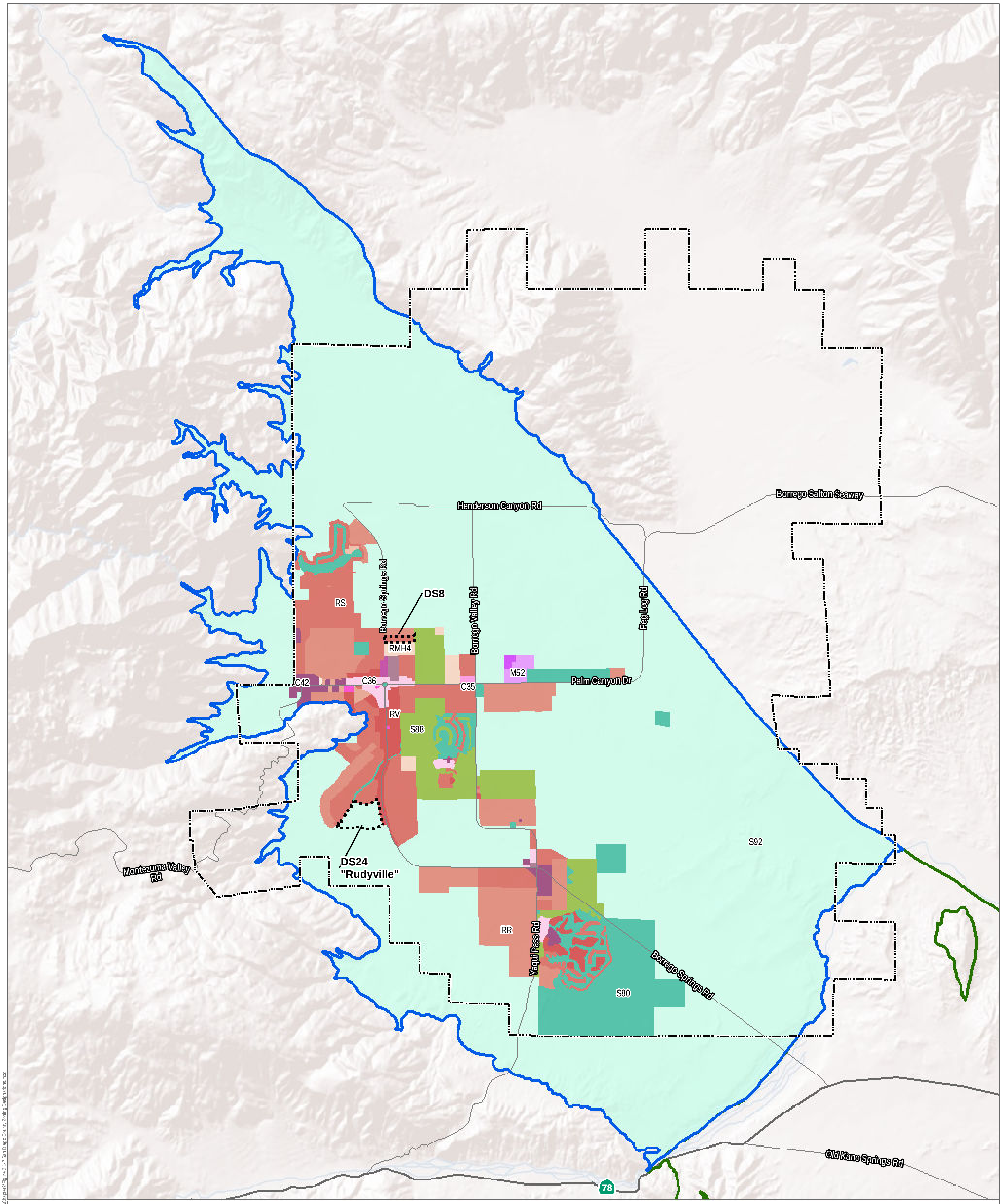

⬚ Borrego Springs Community Plan Area

Borrego Valley Groundwater Basin Subbasins

▭ Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)

▭ Ocotillo Wells Groundwater Subbasin (7-024.02)

Zoning Ordinance

Commercial

- ■ General Commercial (C36)
- ■ General Commercial/Limited Residential (C35)
- ■ General Commercial/Residential (C34)
- ■ Residential-Office (C31)
- ■ Service Commercial (C38)
- ■ Visitor Serving Commercial (C42)

Industrial

- ■ Limited Impact Industrial (M52)
- ■ General Impact Industrial (M54)

Residential

- ■ Mobilehome Residential (RMH)
- ■ Mobilehome Residential 4 dwelling units per acre (RMH4)
- ■ Recreation Oriented Residential (RRO)
- ■ Residential/Commercial (RC)
- ■ Rural Residential (RR)
- ■ Single Family Residential (RS)
- ■ Variable Family Residential (RV)

Special Purpose

- ■ General Rural (S92)
- ■ Open Space (S80)

Specific Planning Area

- ■ Specific Planning Area
- ⬚ Property Specific Request

August 2019

DATUM: NAD 1983. DATA SOURCE: SanGIS 2017

DUDEK

0 0.75 1.5 Miles

Figure 2.1-7

San Diego County Zoning Designations

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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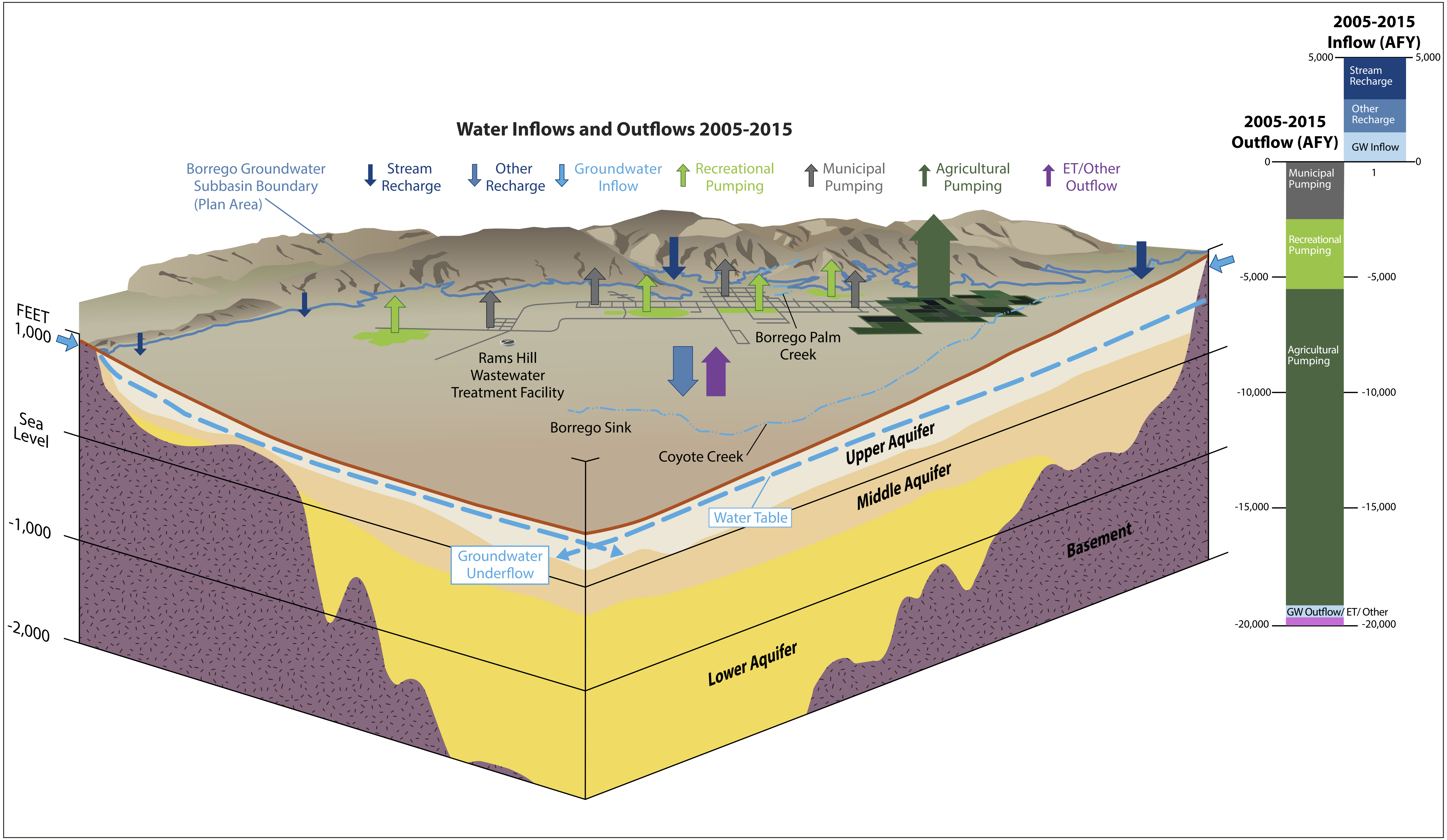

SOURCE: USGS 1982 and USGS 2015

FIGURE 2.2-1

Hydrogeological Conceptual Model of the Plan Area

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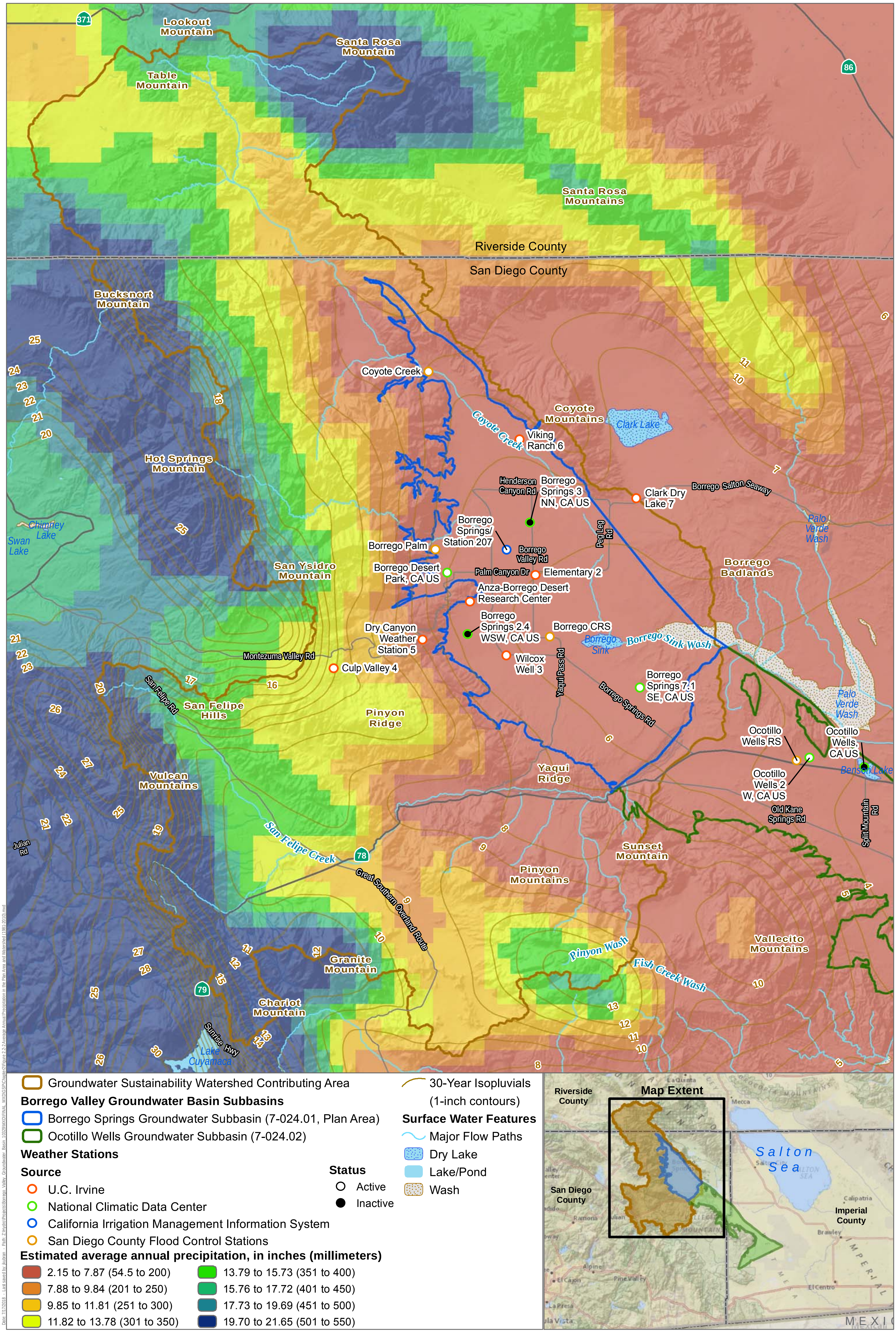

August 2019

DATUM: NAD 1983. DATA SOURCE: PRISM Climate Group 2017

DUDEK

0 1.5 3 Miles

Figure 2.2-2

Average Annual Precipitation in the Plan Area and Watershed (1981-2010)

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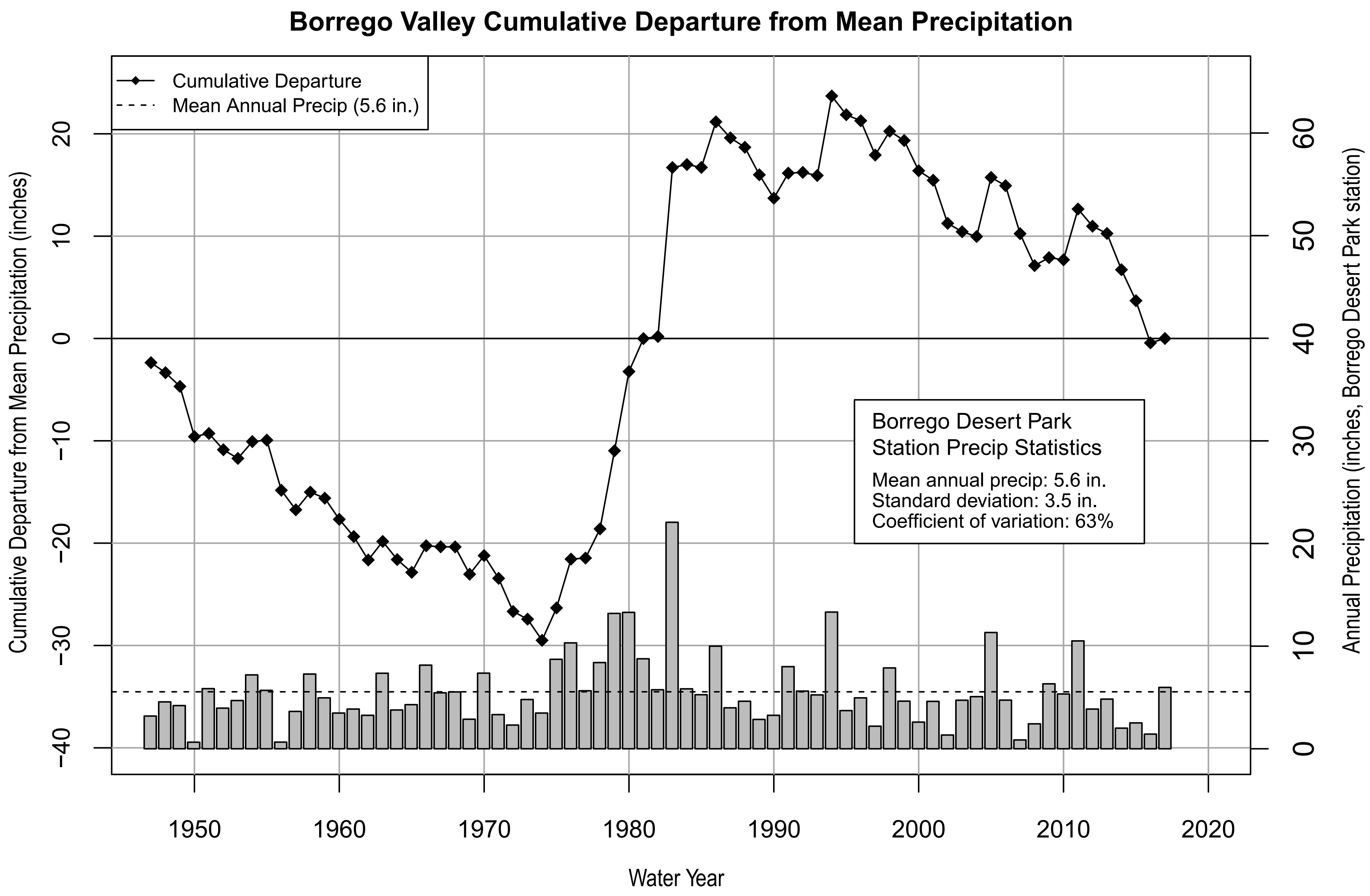

SOURCE: NOAA 2017

FIGURE 2.2-3

Precipitation Record for the Borrego Desert Park Station by Water Year (1947 - 2017)

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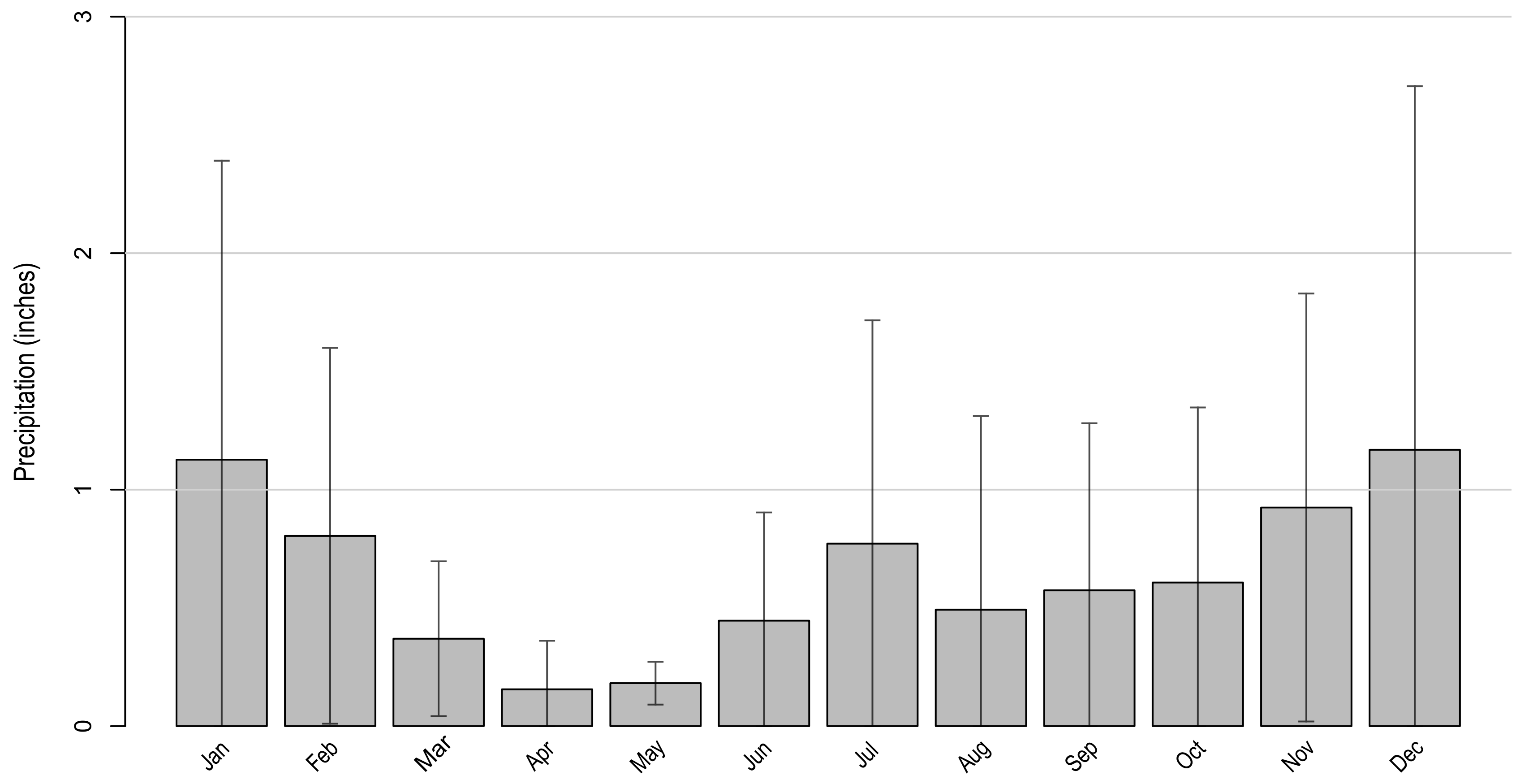
The standard deviation is based on the concept of a bell curve. One standard deviation give an estimate of the range of values around the average that occurs about 67% of the time. This means that 67% of the time, monthly precipitation will vary by one standard deviation from the long-term average.

The standard deviation provides a statistical estimate of precipitation variability. A larger standard deviation indicates a larger variability in precipitation from long-term average.



▨ Average Monthly Precipitation at Borrego Desert Park Station (1947 - 2017)

⌶ Tickmarks show one standard deviation above and below the mean monthly precipitation. Where a bottom tickmark is not shown, the standard deviation is greater than the mean for that month in the period of record.

FIGURE 2.2-4

Average Monthly Precipitation at Borrego Desert Park Station (1947 - 2017)

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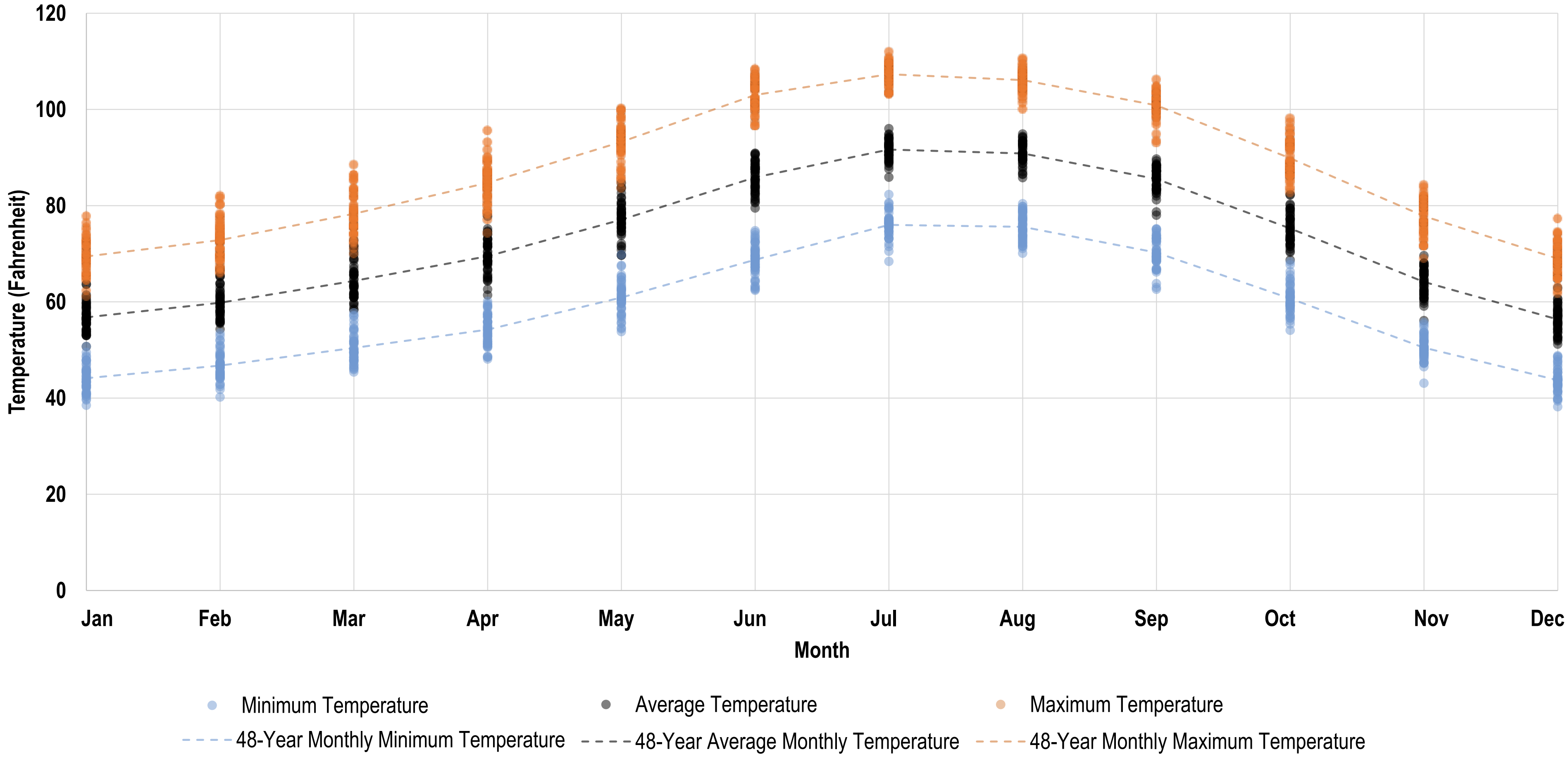

SOURCE: NOAA 2017

DUDEK

FIGURE 2.2-5

Average Minimum and Maximum Air Temperatures at the Borrego Desert Park Station by Month (1968 - 2017)

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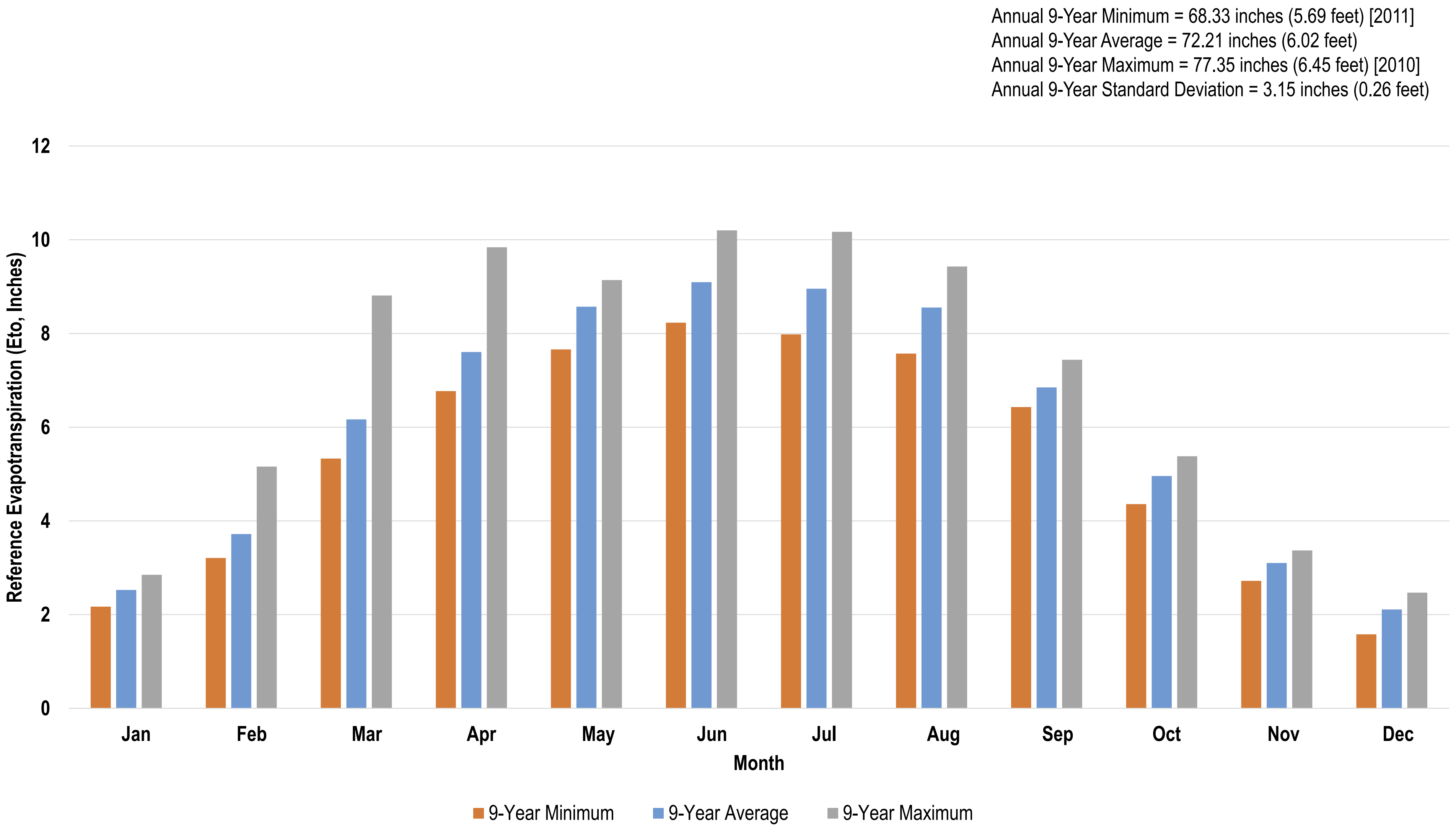

Annual 9-Year Minimum = 68.33 inches (5.69 feet) [2011]
Annual 9-Year Average = 72.21 inches (6.02 feet)
Annual 9-Year Maximum = 77.35 inches (6.45 feet) [2010]
Annual 9-Year Standard Deviation = 3.15 inches (0.26 feet)

Note: Data is from Borrego Springs CIMIS Station # 207 from available record 2008 - 2017. Monthly Eto from 2008 is excluded from the average as the record for that year is not complete.

SOURCE: CIMIS 2018

FIGURE 2.2-6

Average Minimum and Maximum Evapotranspiration at CIMIS Station 207 by Month (2009 - 2017)

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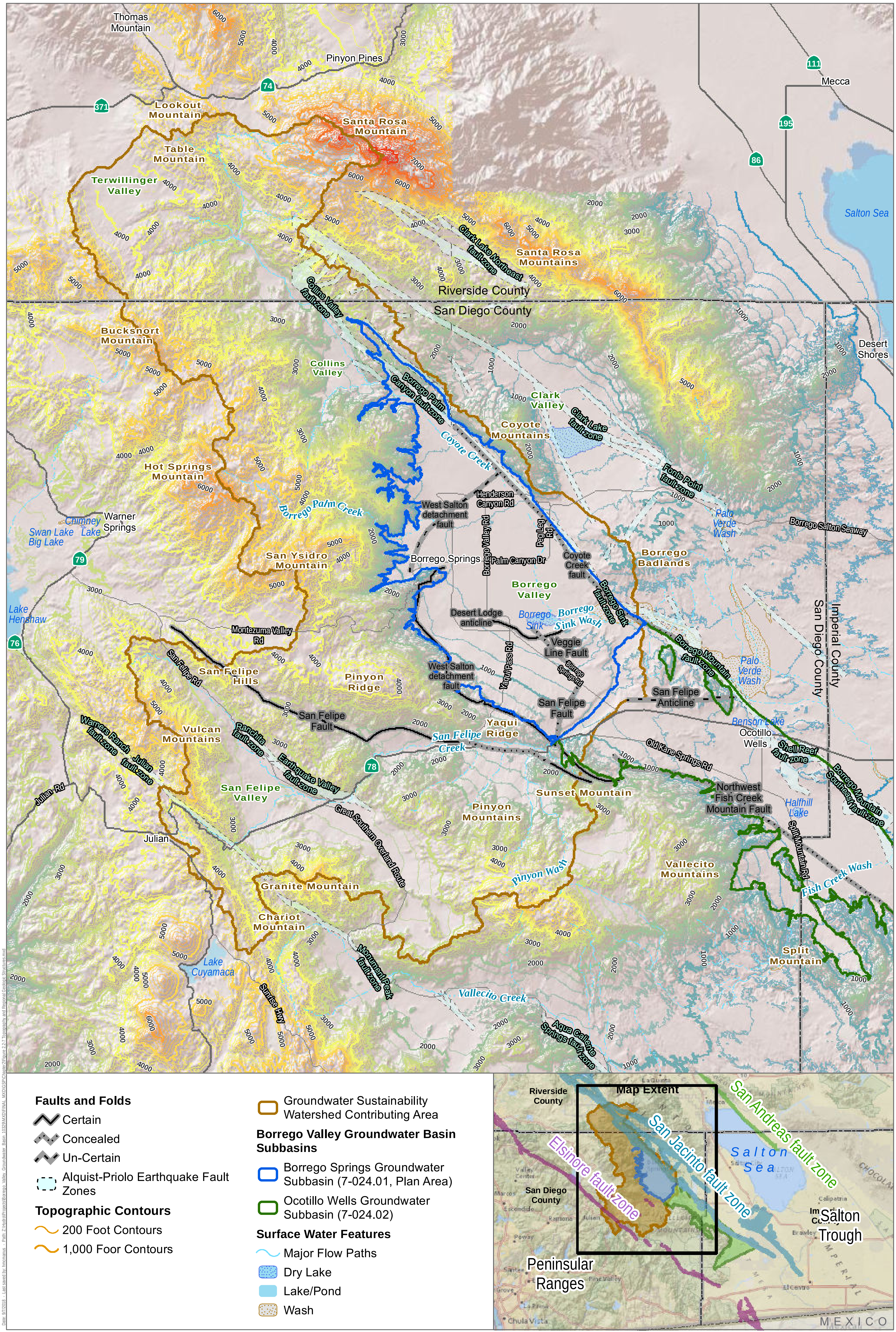

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015; USGS NHD 2017; USGS 2015; Steely et. al 2009; CGS 2012

DUDEK

0 1.75 3.5 Miles

Figure 2.2-7

Topography and Regional Geologic Structures

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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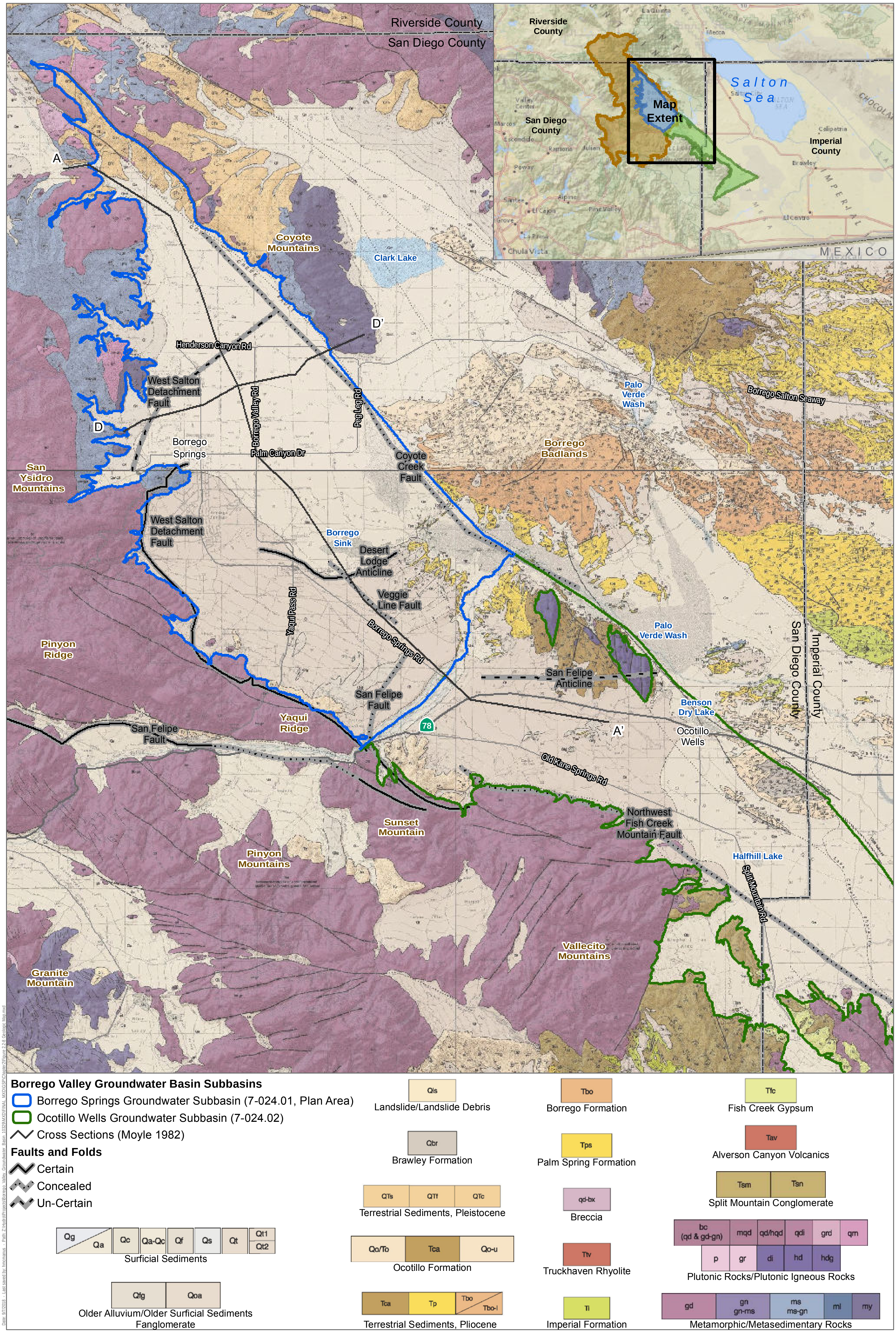

August 2019

DATUM: NAD 1983. DATA SOURCE: Dibblee 2008; USGS 2015; Steely et. al 2009; CGS 2012

DUDEK

0 1 2 Miles

Figure 2.2-8

Geologic Map

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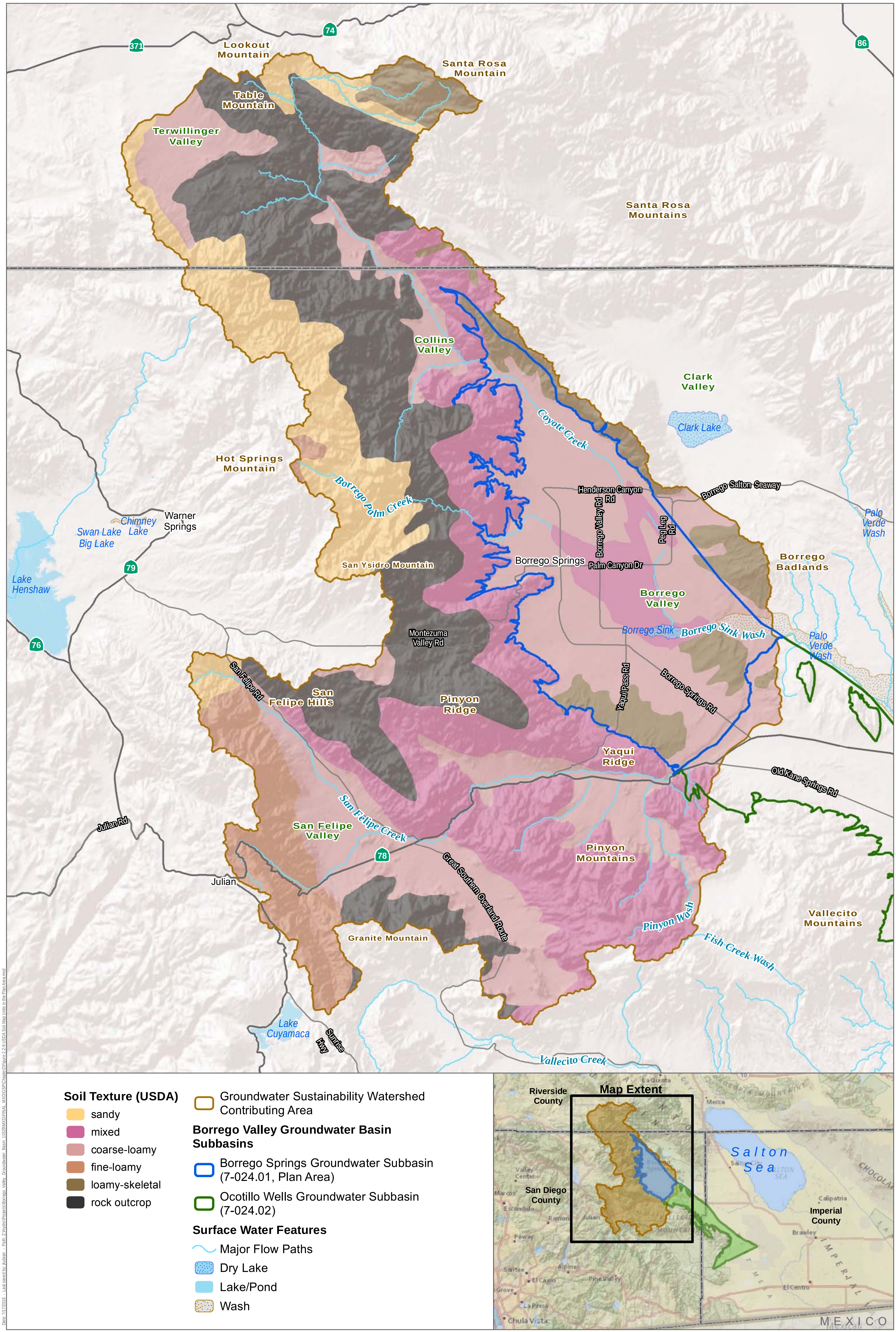

August 2019

DATUM: NAD 1983. DATASOURCE: DWR 2015; SanGIS 2014; USGS NHD 2017; USDASTATSGO 2

DUDEK

0 1.5 3 Miles

Figure 2.2-9

USDA Soil Map Units in the Plan Area

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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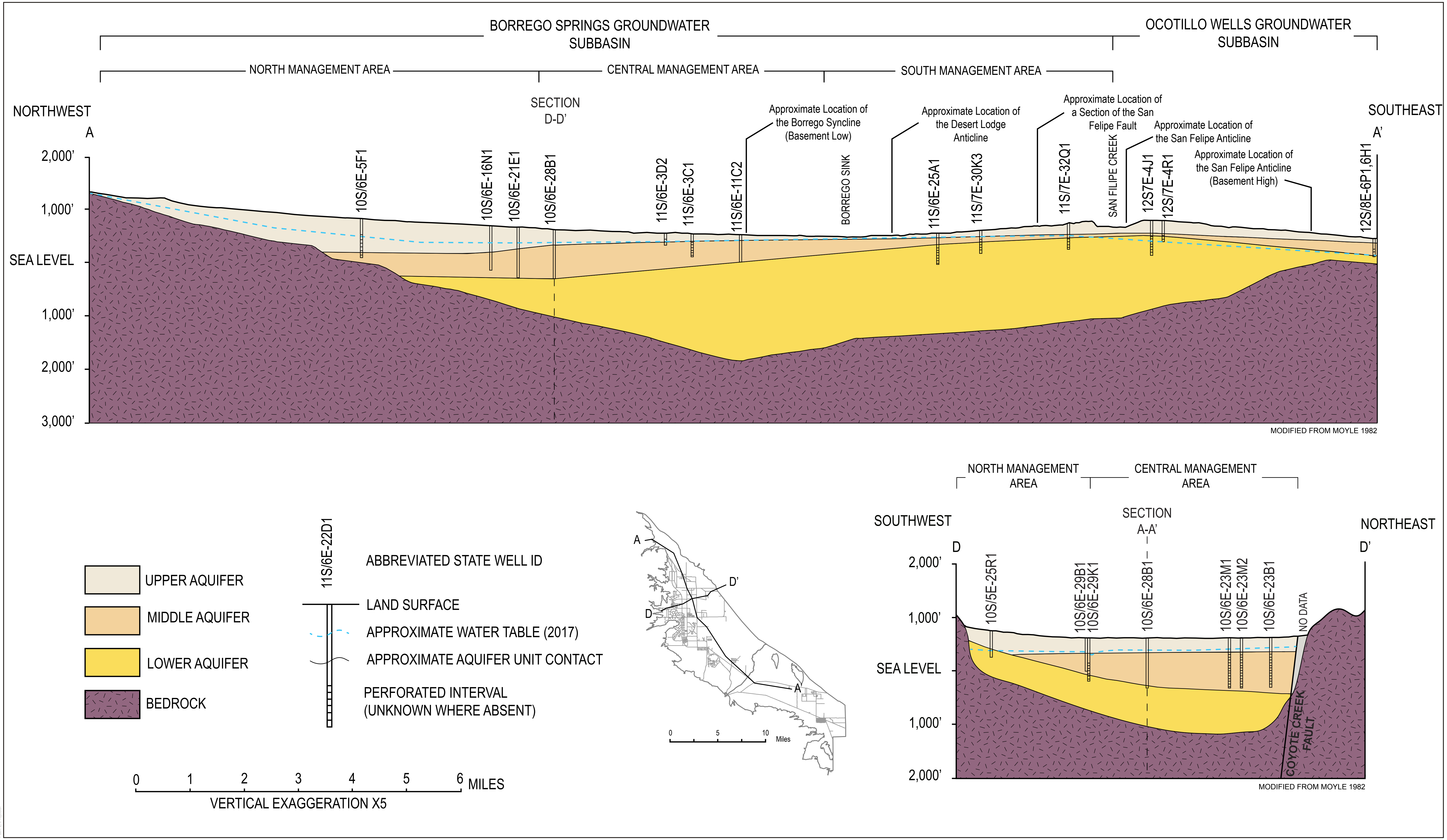

SOURCE: USGS 1982, 2015

DUDEK

FIGURE 2.2-10

Hydrogeologic Cross Sections of the Plan Area

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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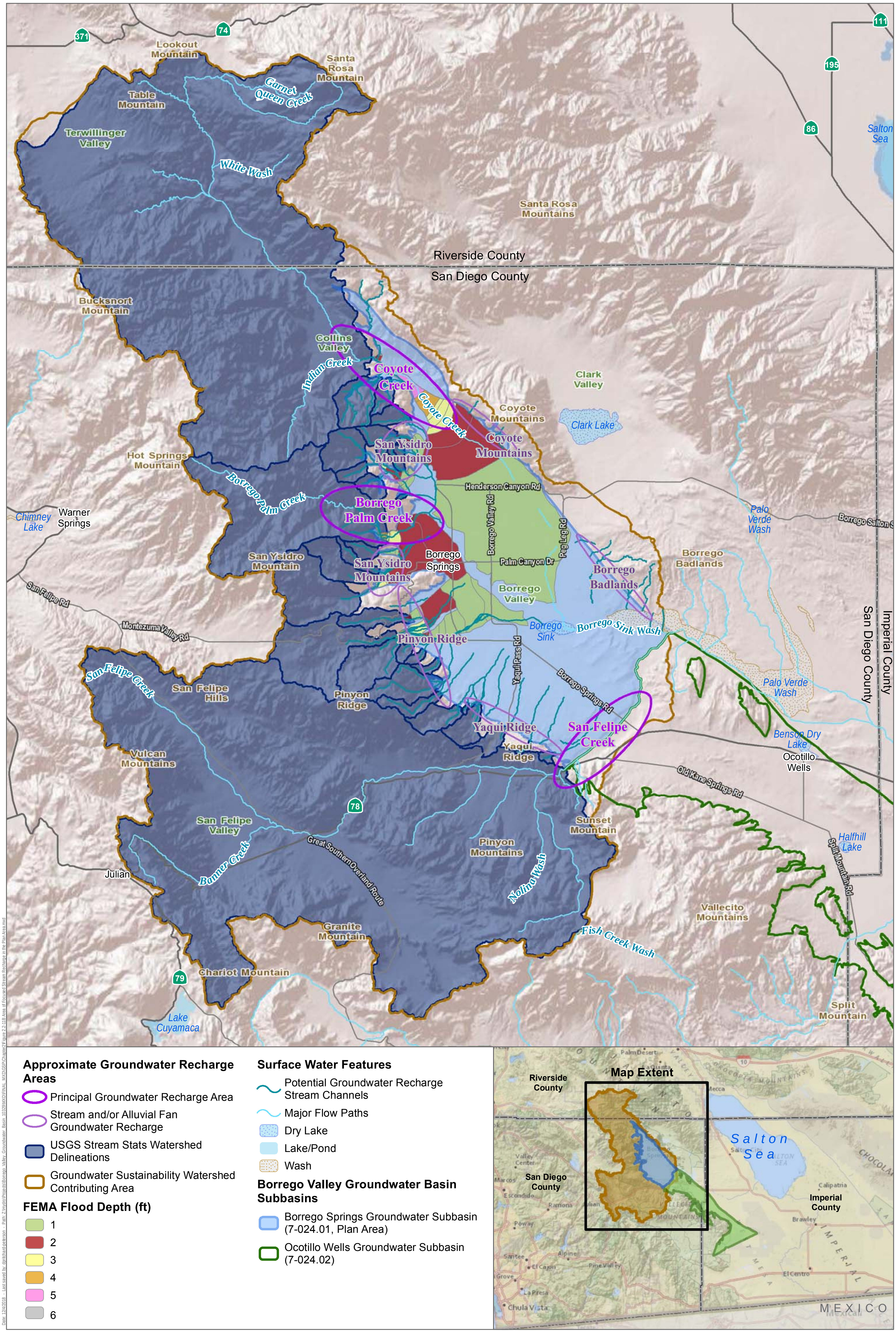

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015; USGS NHD 2017; USGS 2018; FEMA 2017

DUDEK

Figure 2.2-11

Areas of Focused Stream Recharge in the Plan Area

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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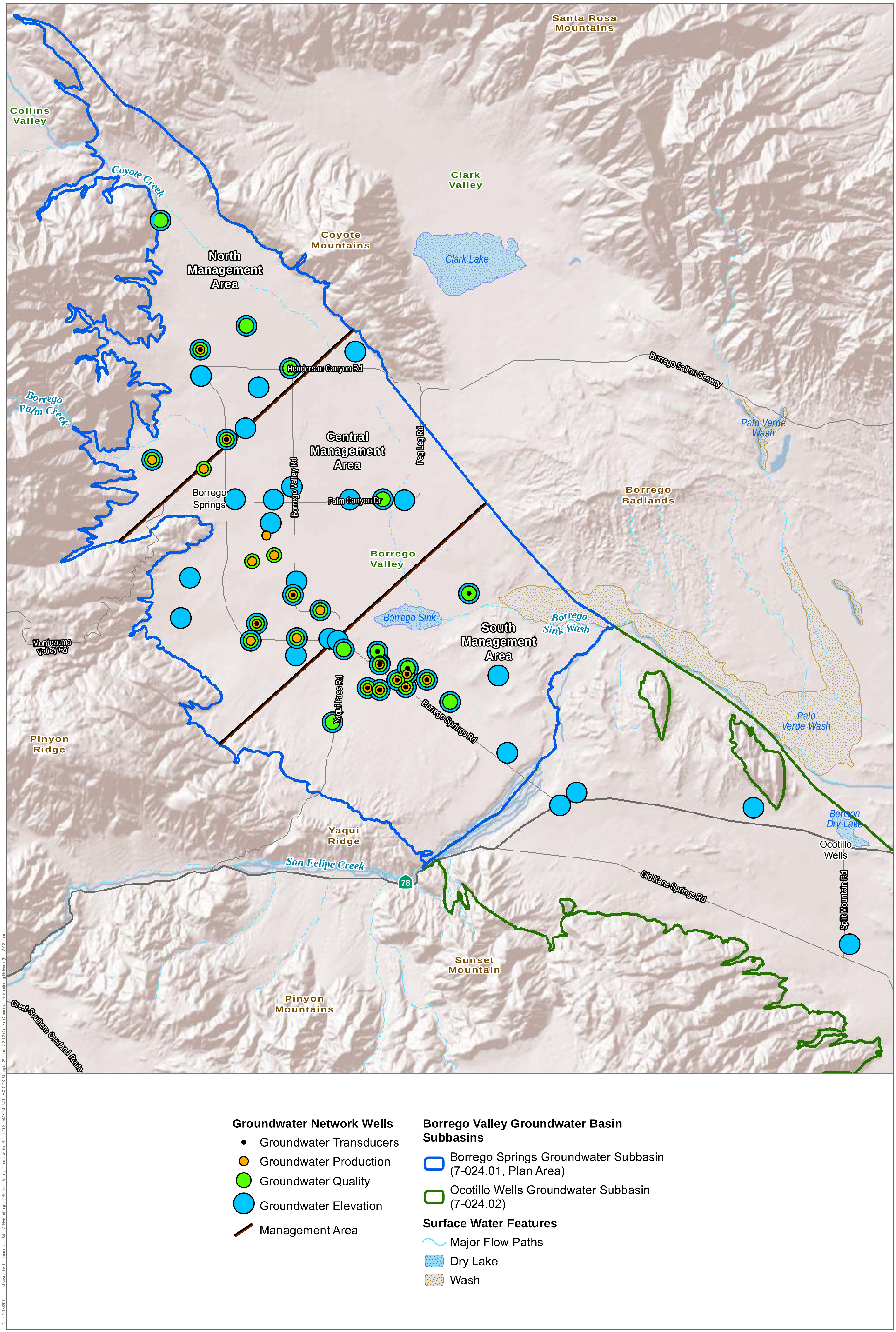

August 2019

DATUM: NAD 1983.

0 0.75 1.5 Miles

Figure 2.2-12

Groundwater Monitoring Network (Fall 2018)

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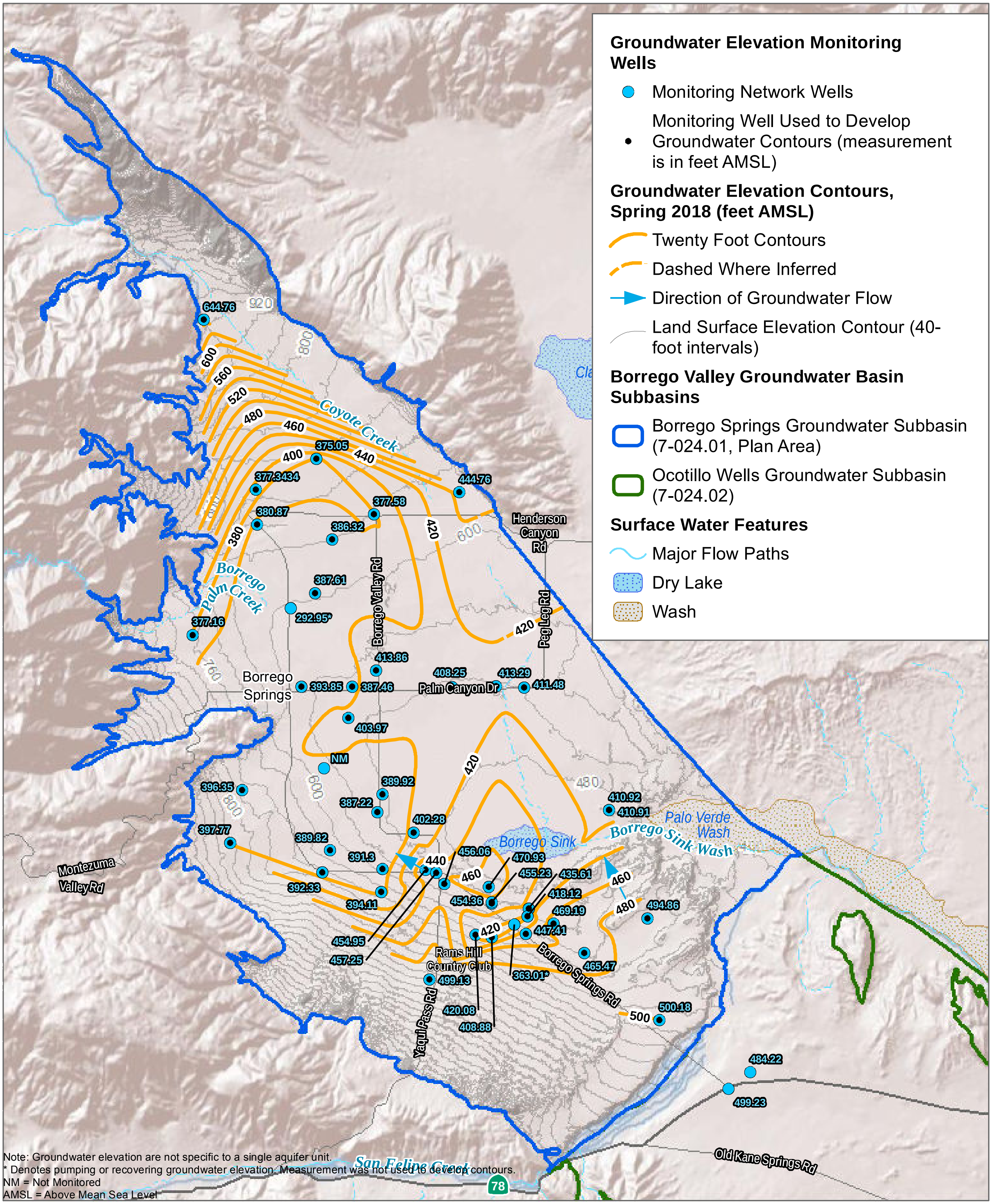

Note: Groundwater elevation are not specific to a single aquifer unit.
* Denotes pumping or recovering groundwater elevation. Measurement was not used to develop contours.
NM = Not Monitored
AMSL = Above Mean Sea Level

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek 2018; SanGIS

DUDEK

0 1 2 Miles

Figure 2.2-13A

Groundwater Levels in the Plan Area (Spring 2018)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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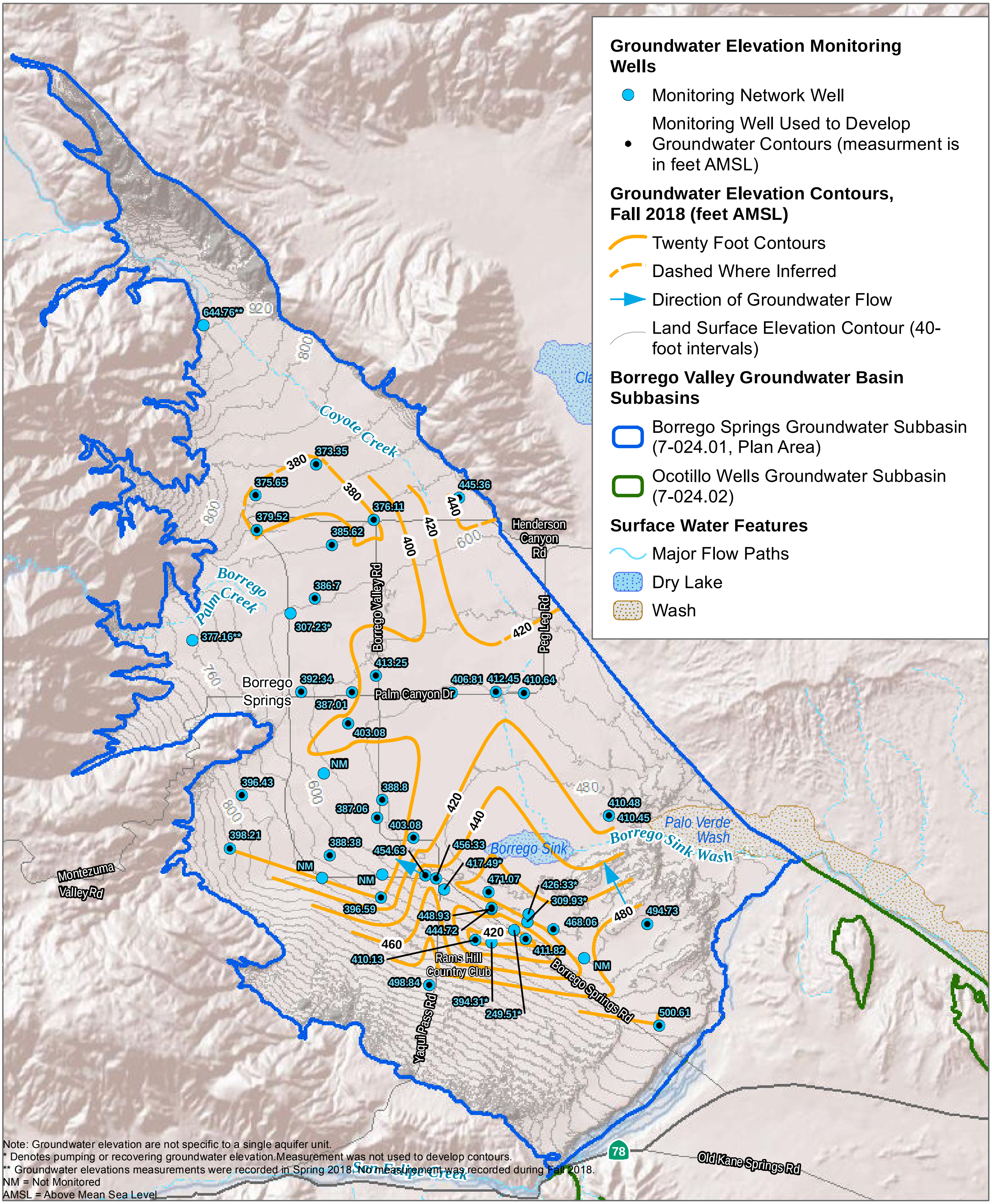

Note: Groundwater elevation are not specific to a single aquifer unit.
* Denotes pumping or recovering groundwater elevation.Measurement was not used to develop contours.
** Groundwater elevations measurements were recorded in Spring 2018. No measurement was recorded during Fall 2018.
NM = Not Monitored
AMSL = Above Mean Sea Level

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek 2018; SanGIS

DUDEK

0 1 2 Miles

Figure 2.2-13B

Groundwater Levels in the Plan Area (Fall 2018)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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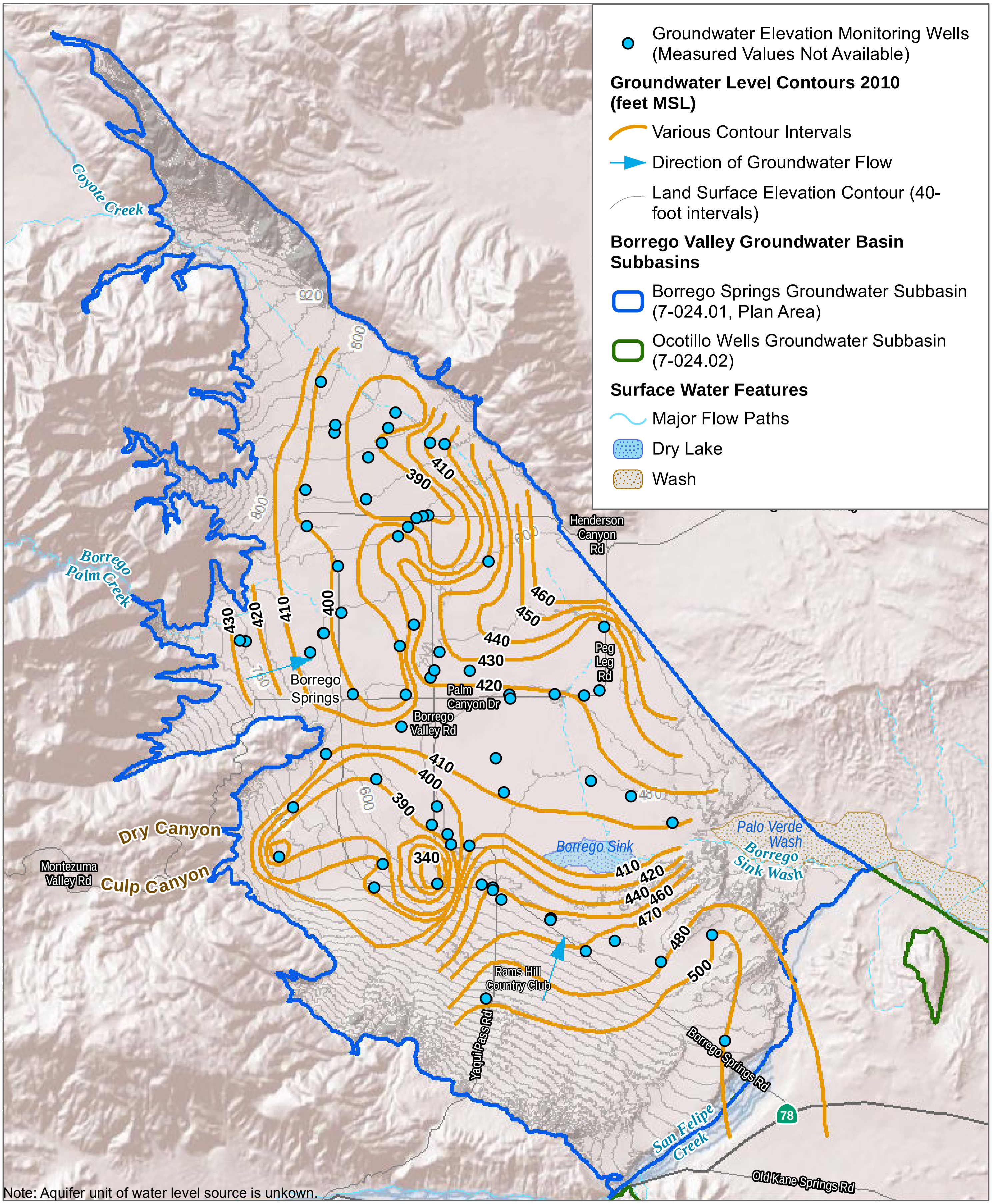

Note: Aquifer unit of water level source is unkown.

August 2019

DATUM: NAD 1983. DATA SOURCE: USGS 2015; SanGIS

DUDEK

0 1 2 Miles

Figure 2.2-13C

Historical Groundwater Levels in the Plan Area (2010)

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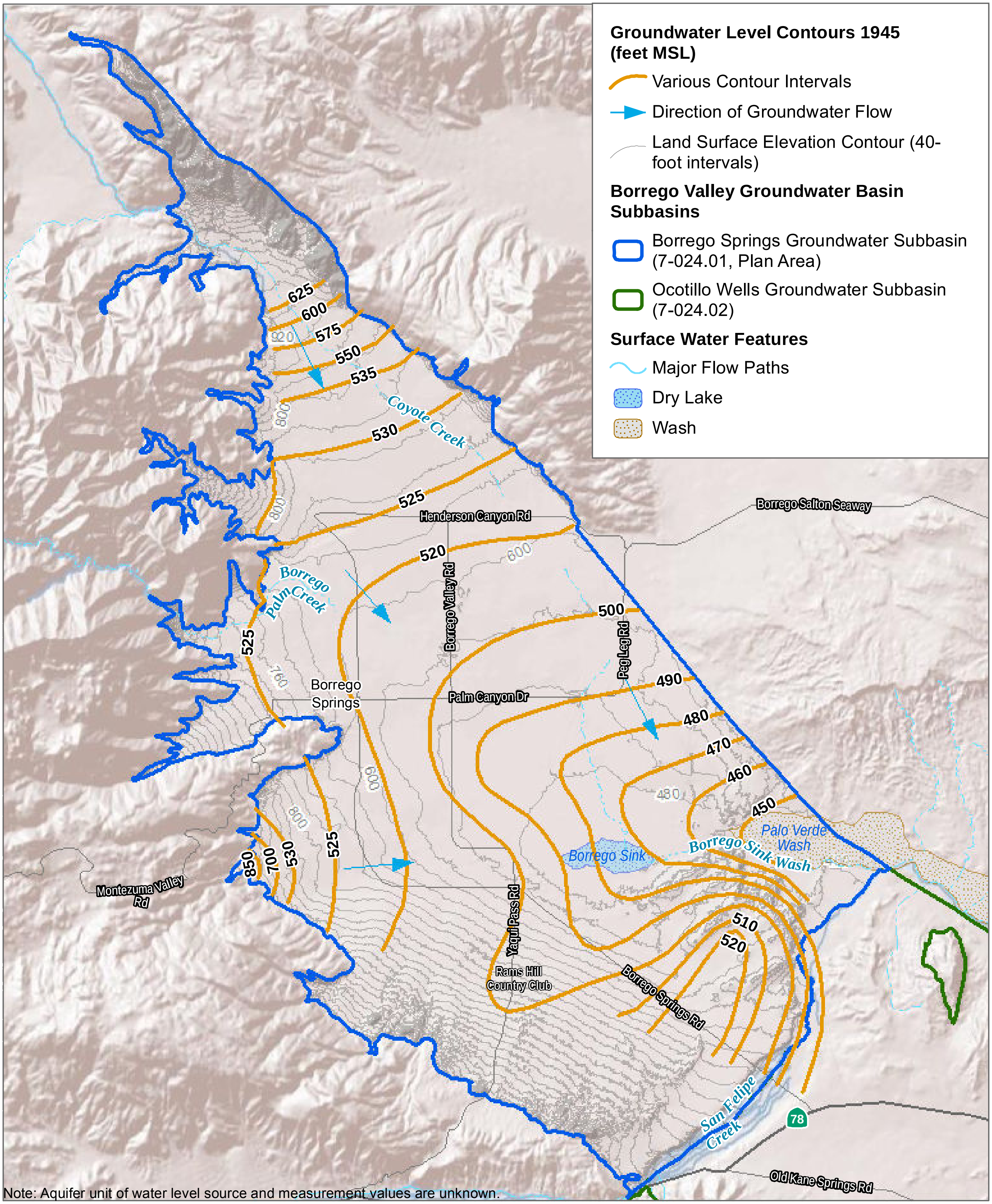

Note: Aquifer unit of water level source and measurement values are unknown.

August 2019

DATUM: NAD 1983. DATA SOURCE: USGS 2015; SanGIS

DUDEK

0 1 2 Miles

Figure 2.2-13D

Historical Groundwater Levels in the Plan Area (1945)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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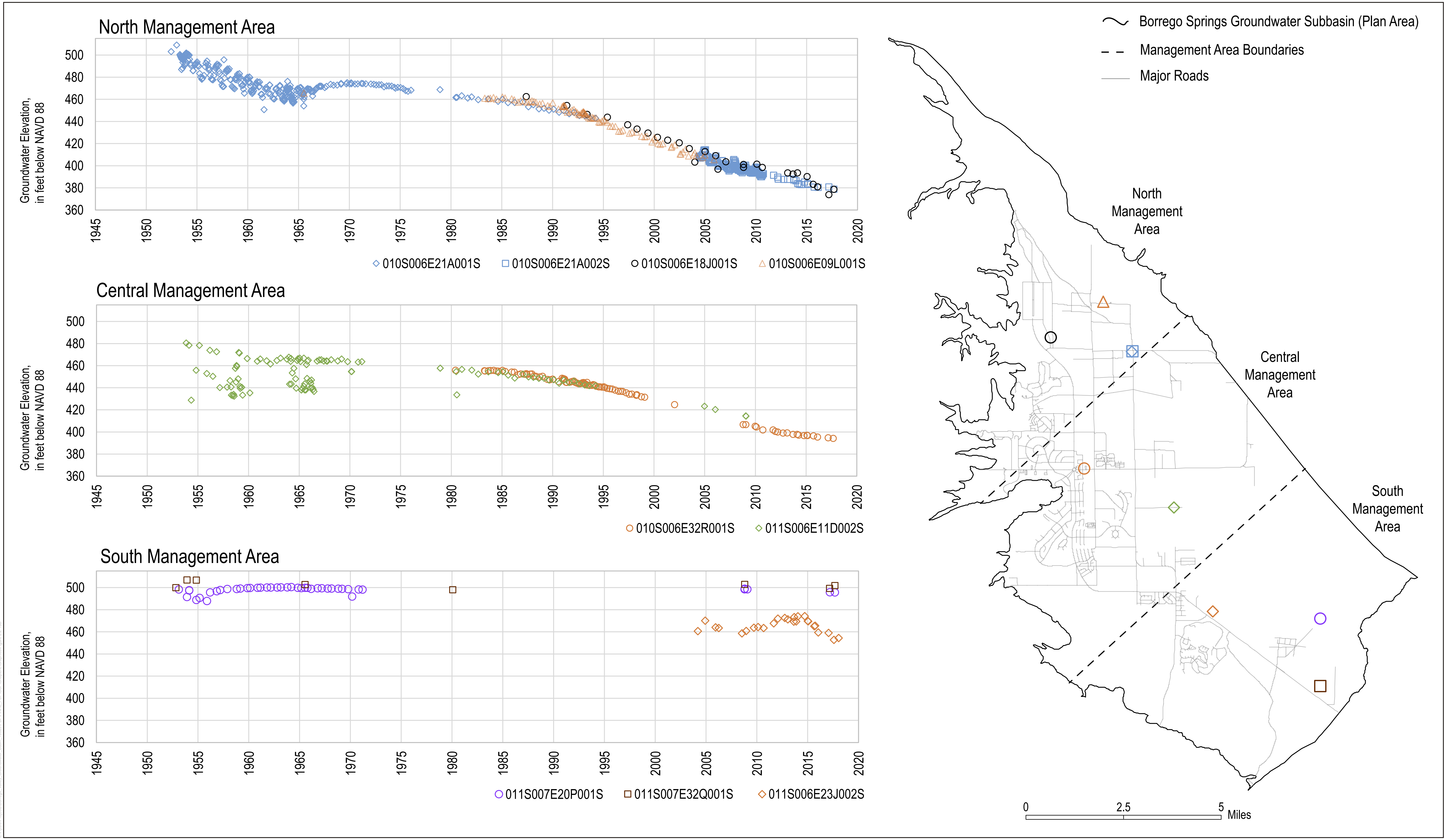

SOURCE: USGS 2015

FIGURE 2.2-13E

Groundwater Levels in Selected Wells in Parts of the Plan Area, 1952 - 2018

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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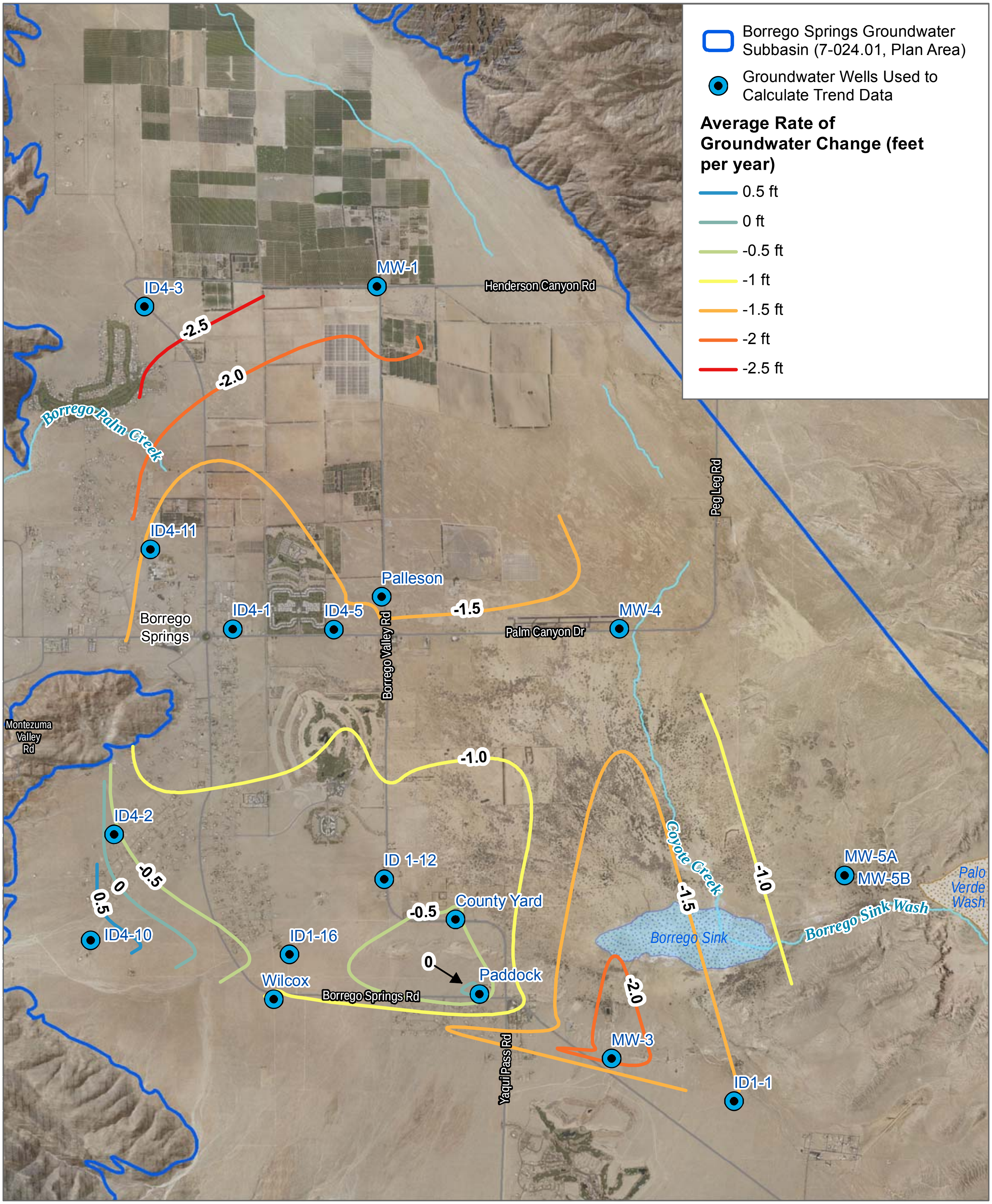

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek 2018

DUDEK

Figure 2.2-13F

Contour Map of Average Rate of Groundwater Change (2010-2018)

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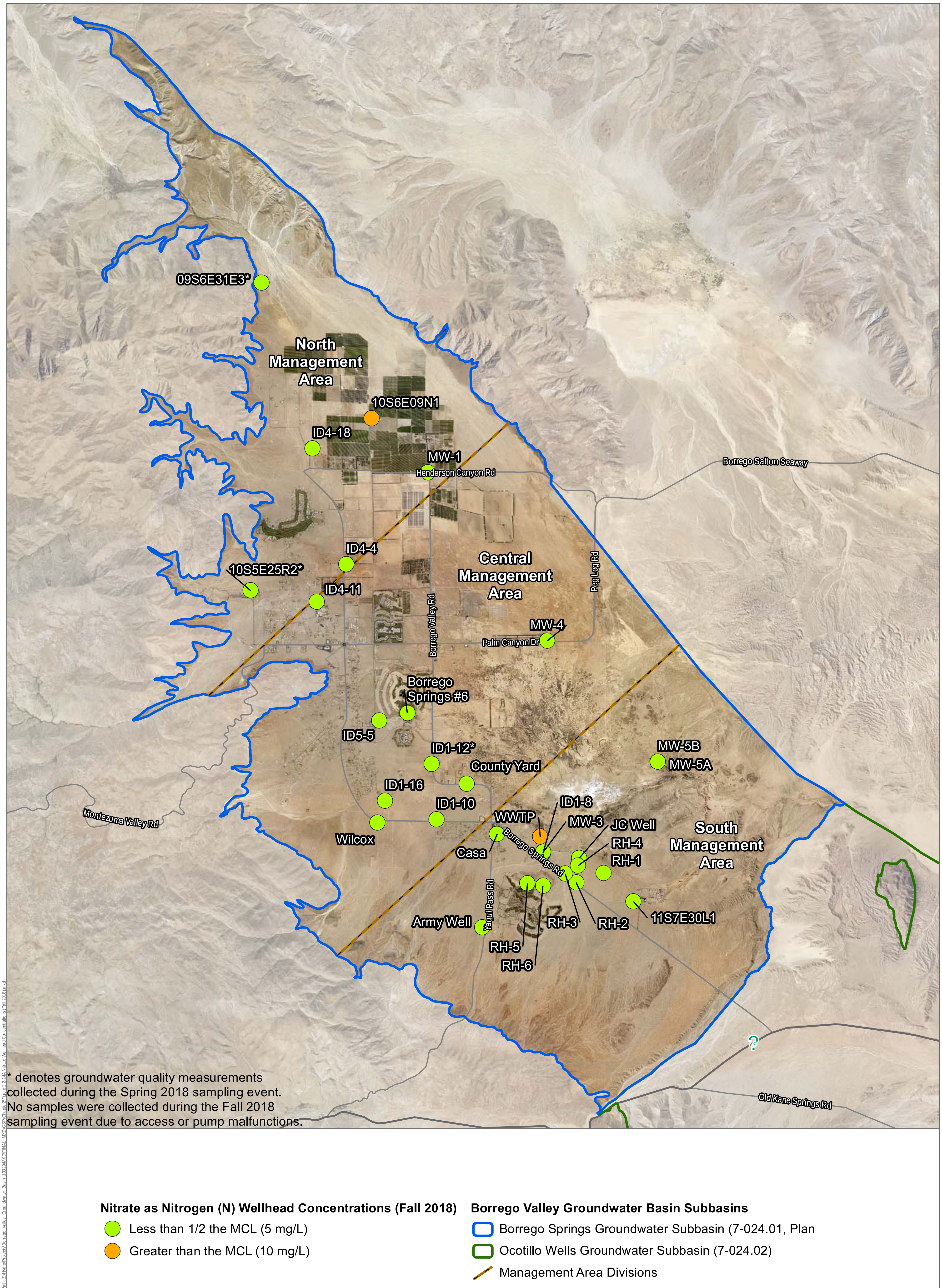

* denotes groundwater quality measurements collected during the Spring 2018 sampling event. No samples were collected during the Fall 2018 sampling event due to access or pump malfunctions.

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek & Geosyntec 2018

DUDEK

Figure 2.2-14A

Nitrate Wellhead Concentrations

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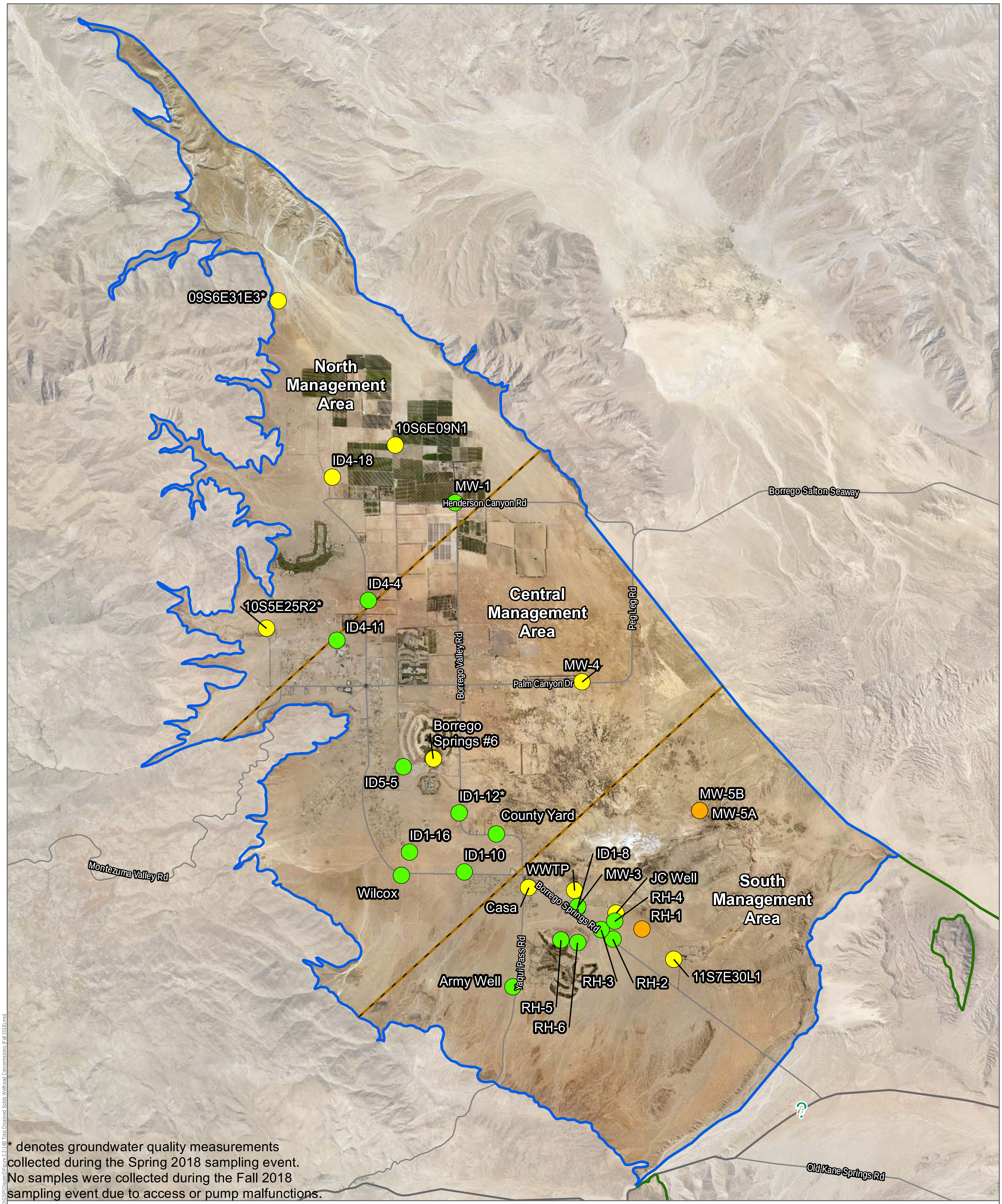

* denotes groundwater quality measurements collected during the Spring 2018 sampling event. No samples were collected during the Fall 2018 sampling event due to access or pump malfunctions.

Total Dissolved Solids (TDS) Wellhead Concentrations (Fall 2018)

- 🟢 Less than 1/2 the secondary MCL (500 mg/L)
- 🟡 Less than the secondary MCL (1,000 mg/L)
- 🟠 Greater than the secondary MCL (1,000 mg/L)

Borrego Valley Groundwater Basin Subbasins

- ▭ Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
- ▭ Ocotillo Wells Groundwater Subbasin (7-024.02)
- ⁄ Management Area Divisions

Date: 8/8/2019 - Last saved by: dpritchard-peterson - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.2-14B Total Dissolved Solids Wellhead Concentrations (Fall 2018).mxd

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek & Geosyntec 2018

DUDEK

0 0.75 1.5 Miles

Figure 2.2-14B

Total Dissolved Solids Wellhead Concentrations

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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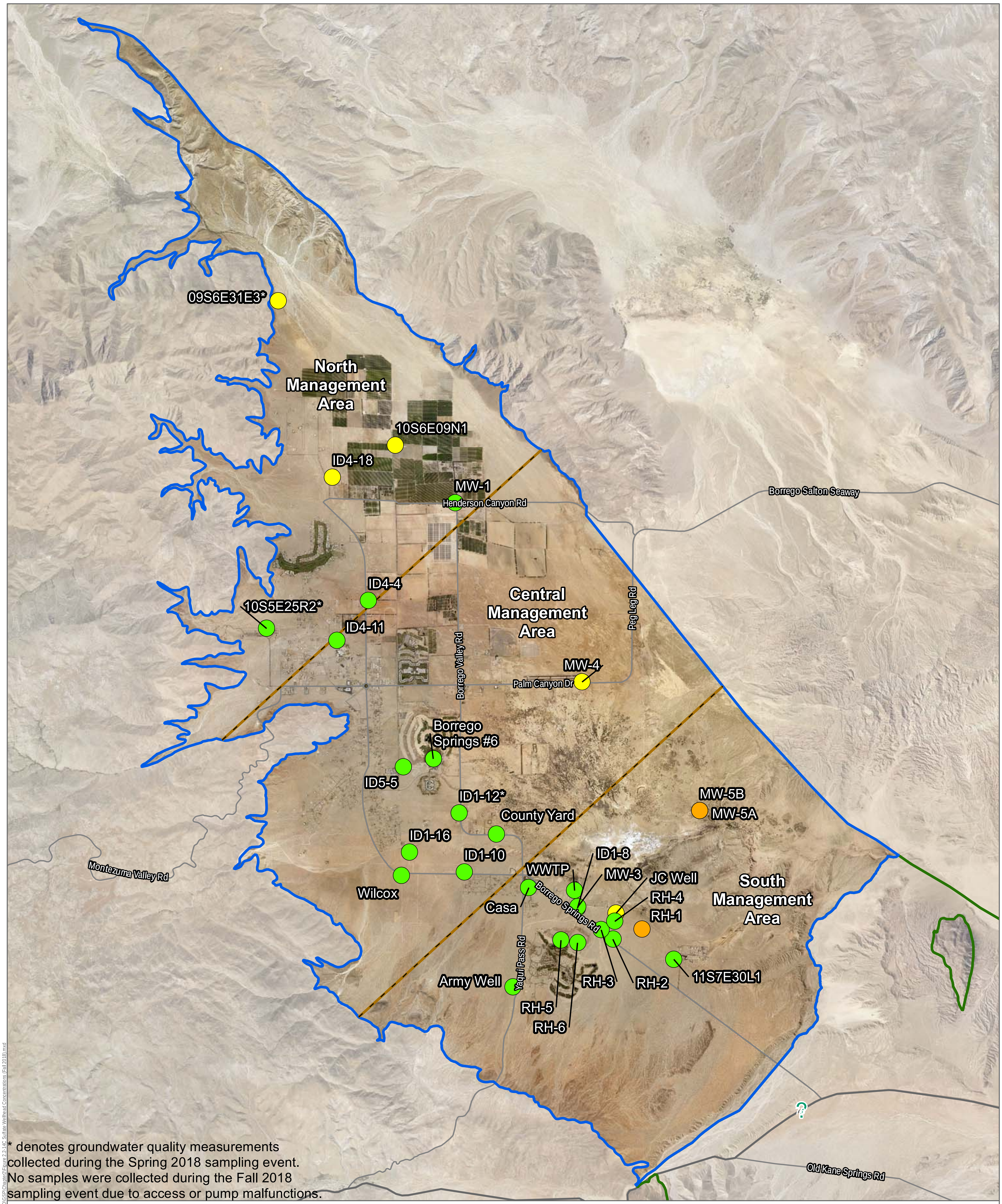

* denotes groundwater quality measurements collected during the Spring 2018 sampling event. No samples were collected during the Fall 2018 sampling event due to access or pump malfunctions.

Sulfate Wellhead Concentration (Fall 2018)

- ● Less than 1/2 the Secondary MCL (250 mg/L)
- ● Less than the Secondary MCL (500 mg/L)
- ● Greater than the Secondary MCL (500 mg/L)

Borrego Valley Groundwater Basin Subbasins

- ▭ Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
- ▭ Ocotillo Wells Groundwater Subbasin (7-024.02)
- ⁄ Management Area Divisions

Date: 8/8/2019 - Last saved by: dpritchard-peterson - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.2-14C Sulfate Wellhead Concentrations (Fall 2018).mxd

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek & Geosyntec 2018

DUDEK

0 0.75 1.5 Miles

Figure 2.2-14C

Sulfate Wellhead Concentrations

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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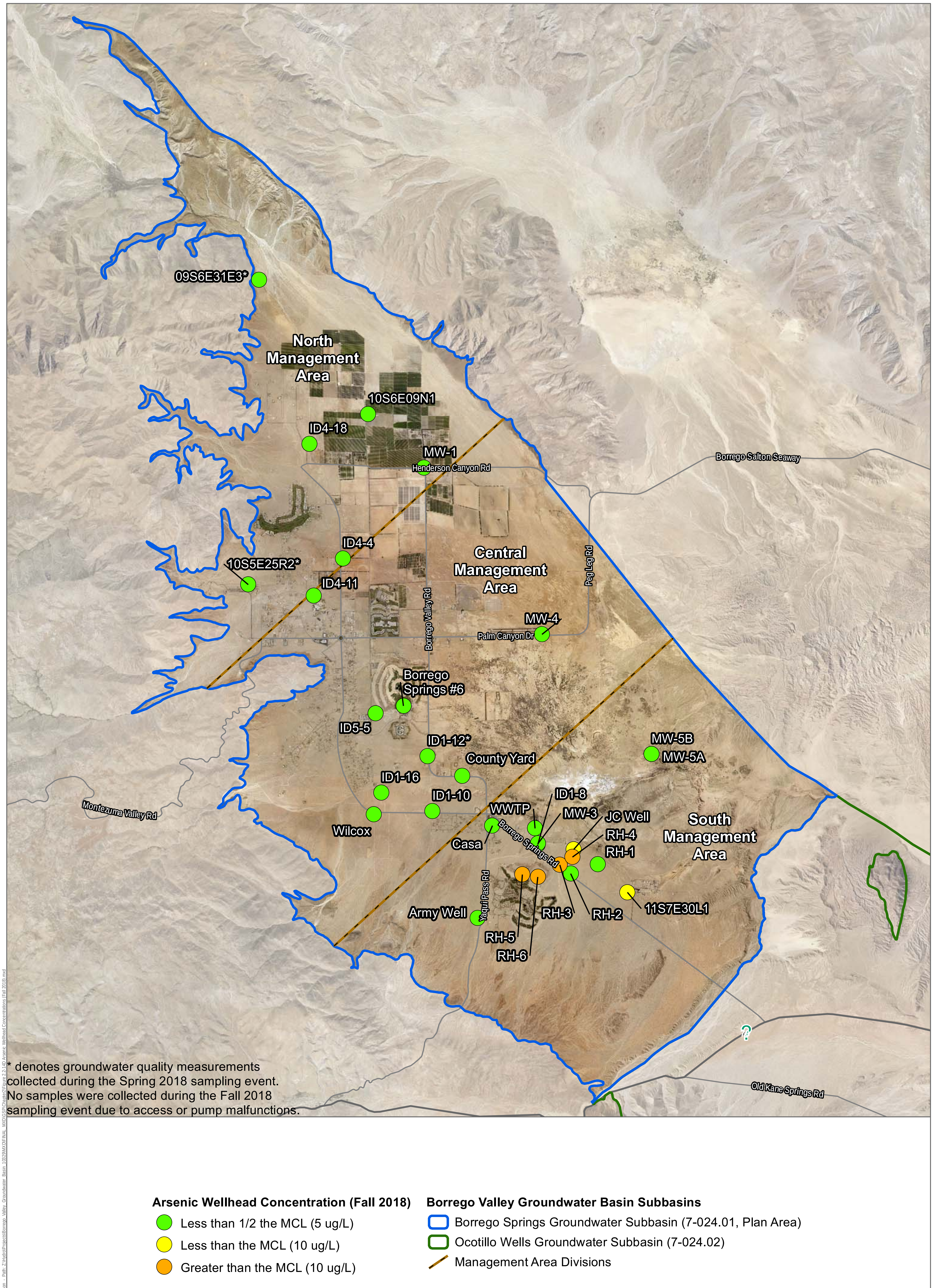

* denotes groundwater quality measurements collected during the Spring 2018 sampling event. No samples were collected during the Fall 2018 sampling event due to access or pump malfunctions.

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek & Geosyntec 2018

DUDEK

0 0.75 1.5 Miles

Figure 2.2-14D

Arsenic Wellhead Concentrations

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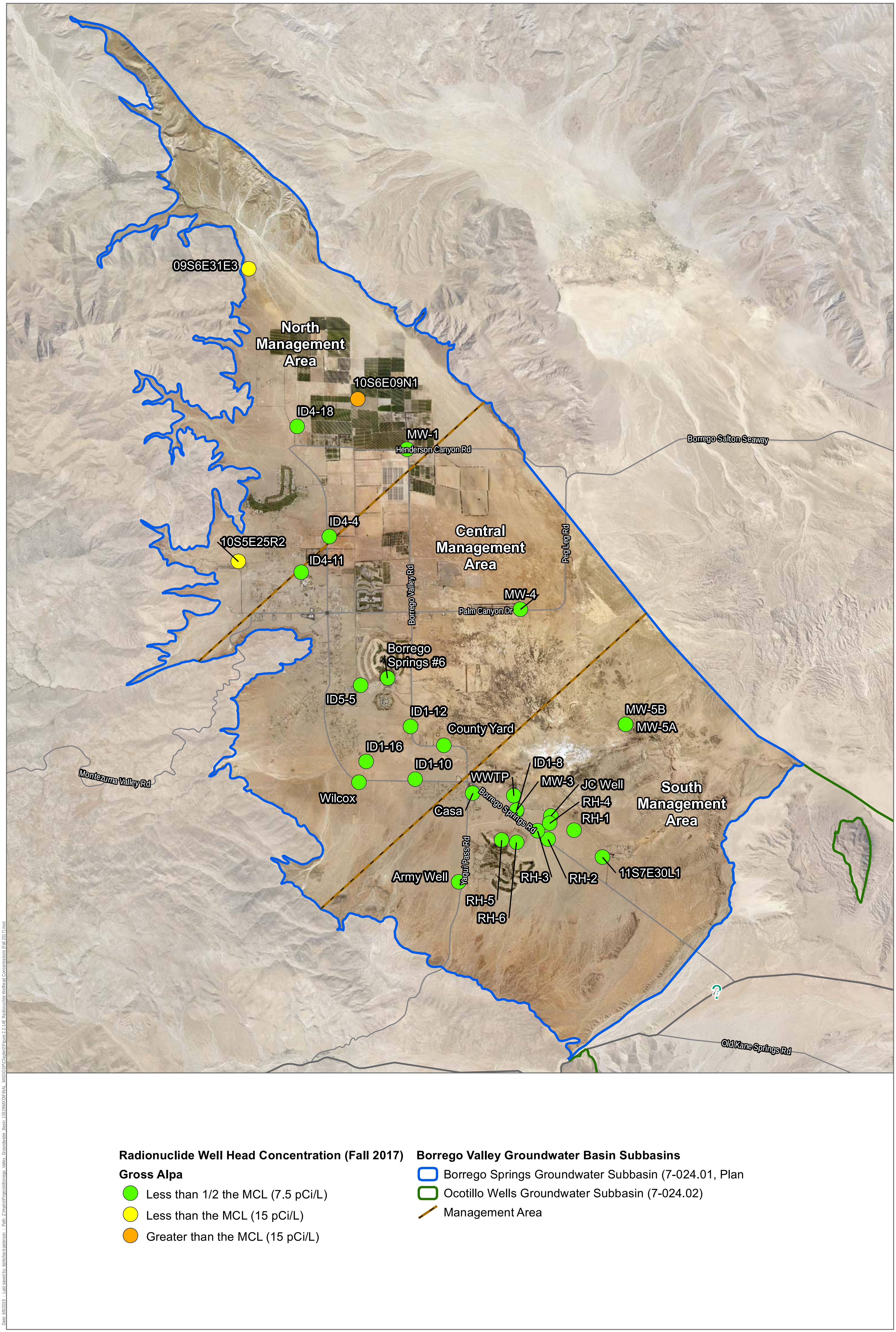

Date: 8/8/2019 - Last saved by: dpritchard-peterson - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.2-14E Radionuclide Wellhead Concentrations (Fall 2017).mxd

August 2019

DATUM: NAD 1983. DATA SOURCE: Dudek & Geosyntec 2017

0 0.75 1.5 Miles

Figure 2.2-14E

Radionuclide Wellhead Concentrations

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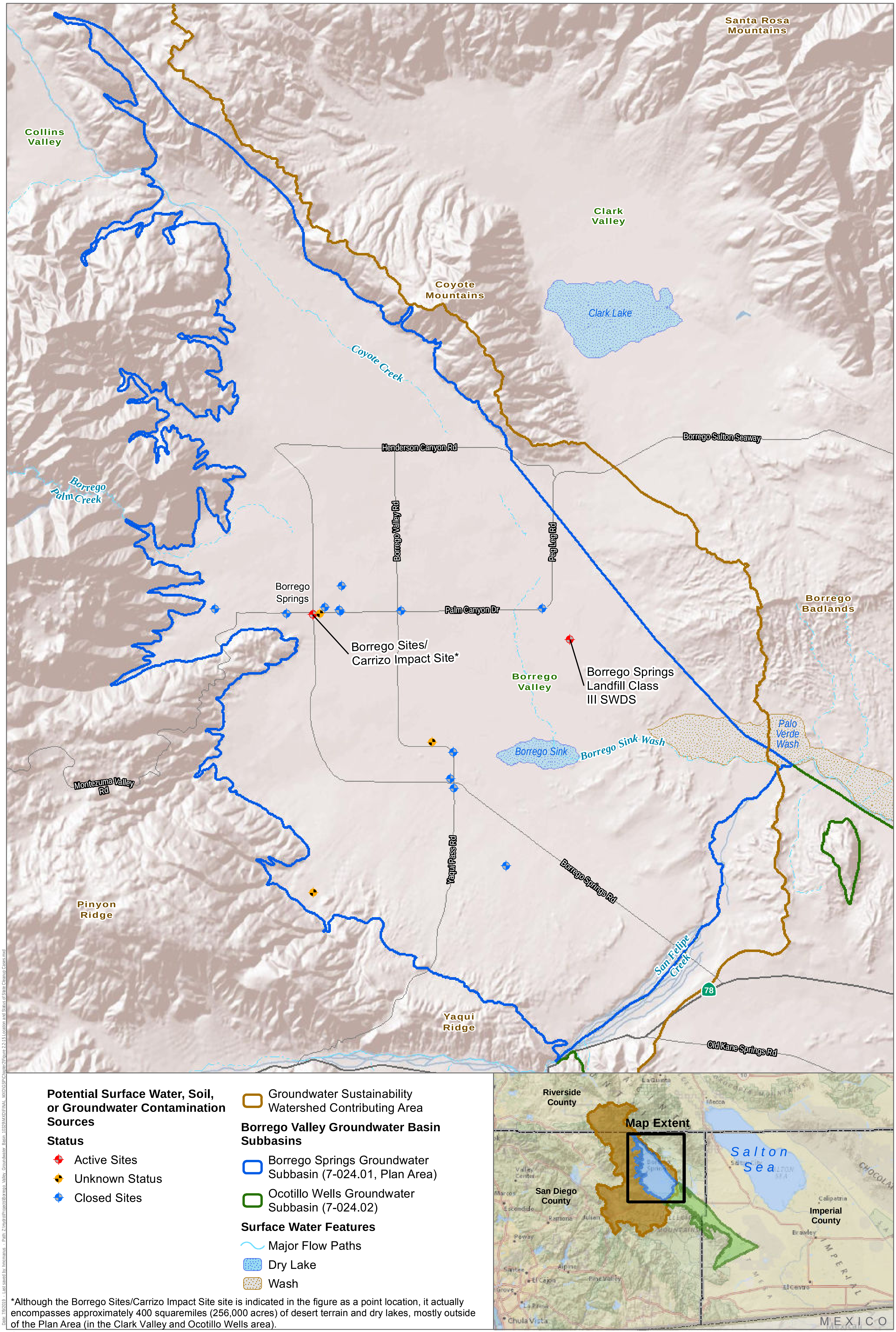

*Although the Borrego Sites/Carrizo Impact Site site is indicated in the figure as a point location, it actually encompasses approximately 400 squaremiles (256,000 acres) of desert terrain and dry lakes, mostly outside of the Plan Area (in the Clark Valley and Ocotillo Wells area).

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2016; GeoTracker 2017

DUDEK

0 0.75 1.5 Miles

Date: 7/9/2019 - Last saved by: hmcmanus - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.2-15 Location and Status of State Cleanup Cases.mxd

Figure 2.2-15

Location and Status of State Cleanup Cases

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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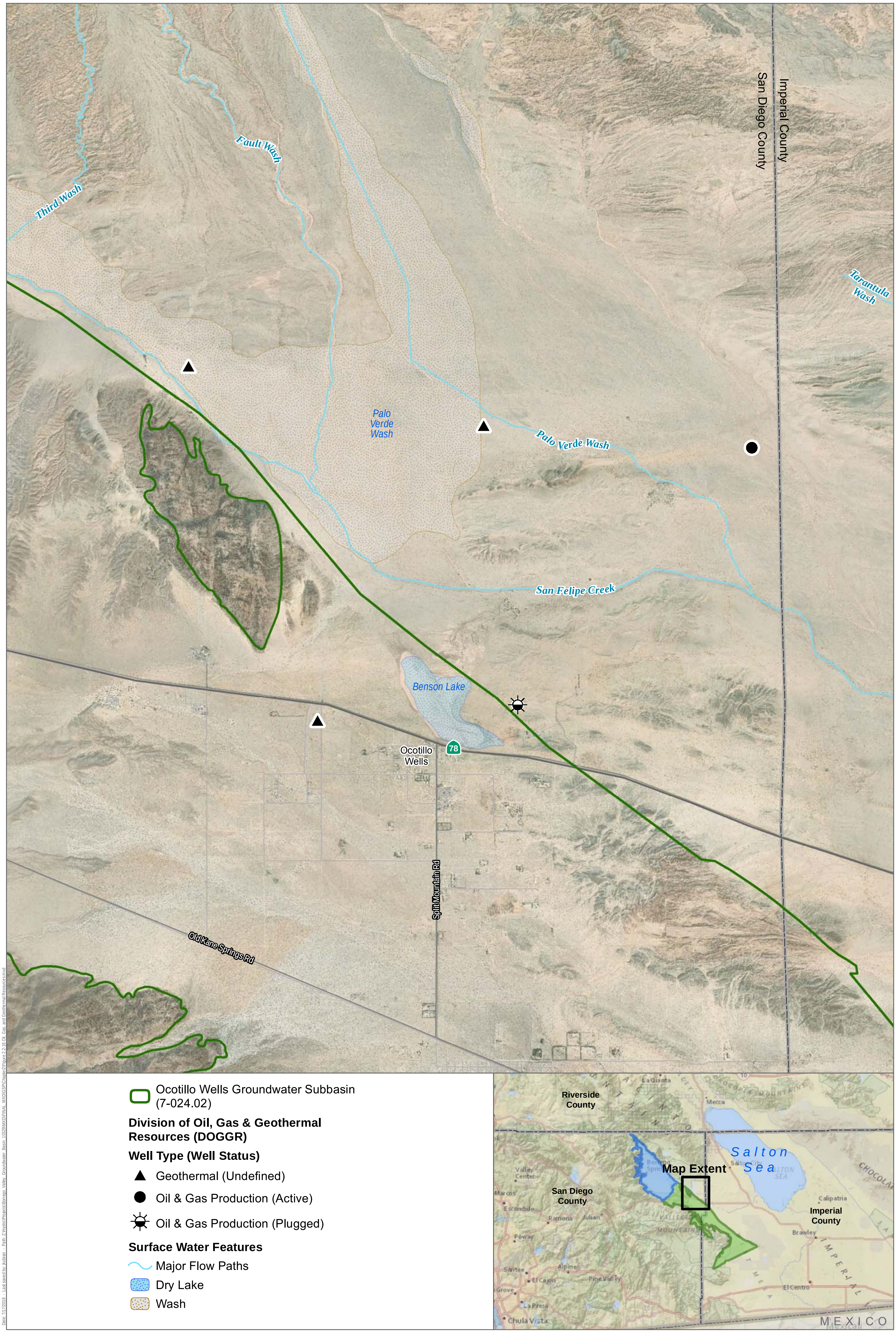

Date: 7/17/2018 - Last saved by: jkubran - Path: Z:\Hydro\Projects\Borrego_Valley_Groundwater_Basin_10329\MXD\FINAL_MXD\GSP\Chapter2\Figure 2.2-16 Oil, Gas, and Geothermal Resources.mxd

August 2019

DATUM: NAD 1983. DATA SOURCE: DOGGR 2017

0 2,000 4,000 Feet

Figure 2.2-16

Oil, Gas, and Geothermal Resources

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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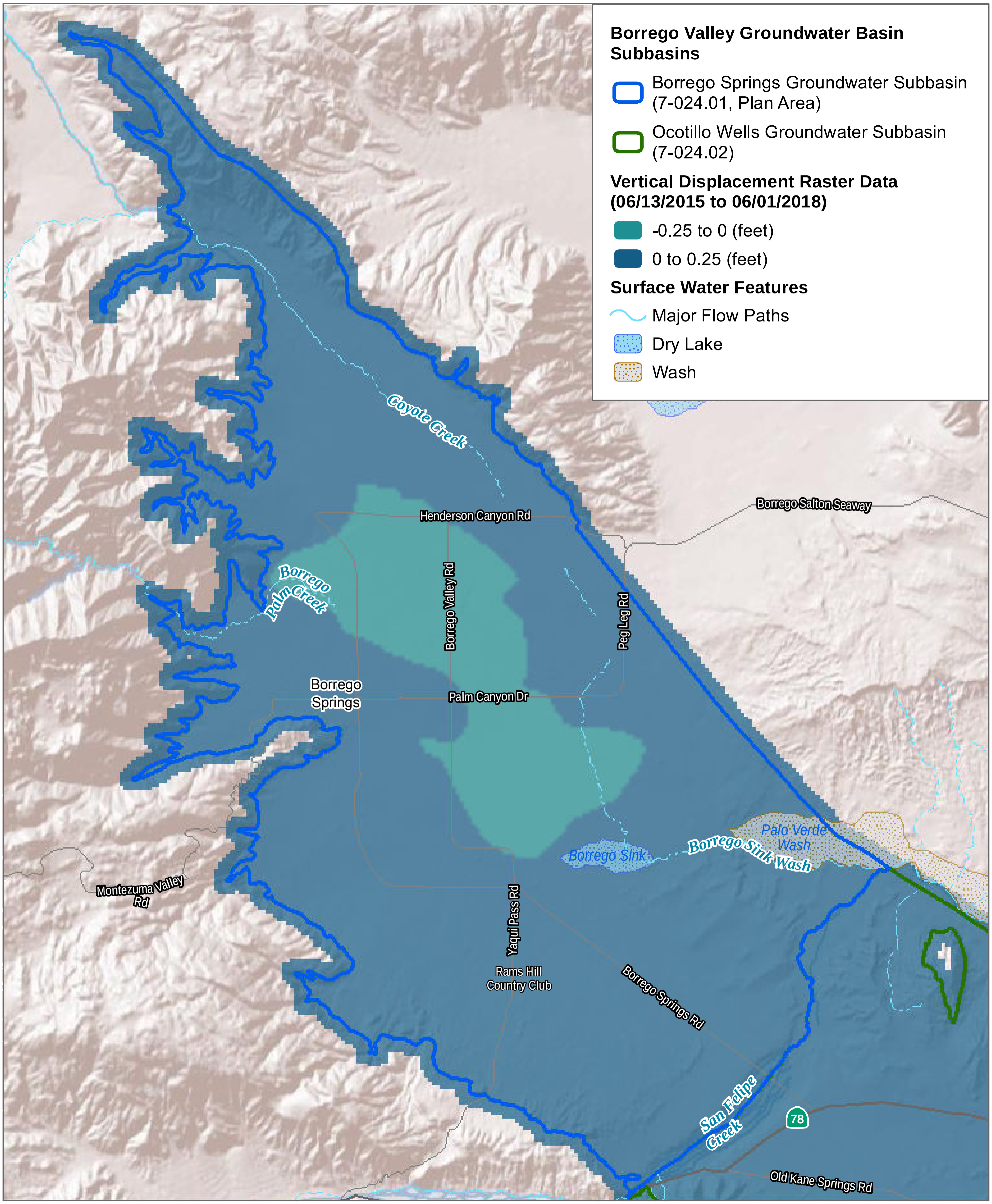

August 2019

DATUM: NAD 1983. DATA SOURCE: TRE Altamira InSAR Dataset

DUDEK

0 1 2 Miles

Figure 2.2-17

Land Subsidence

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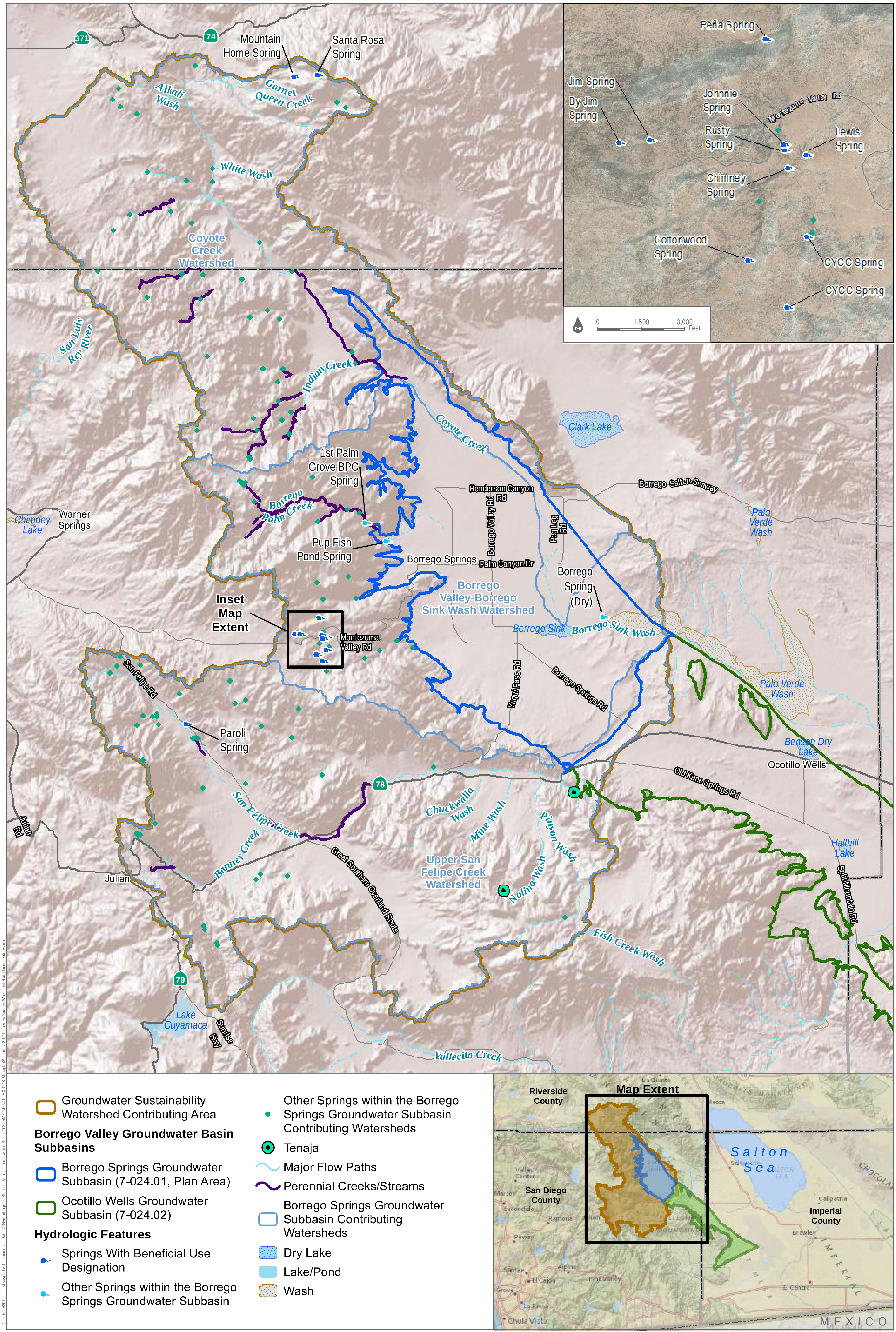

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015; USGS NHD 2017; State Parks 2017;

DUDEK

0 1.5 3 Miles

Figure 2.2-18

Plan Area Surface Water and Hydrologic Features

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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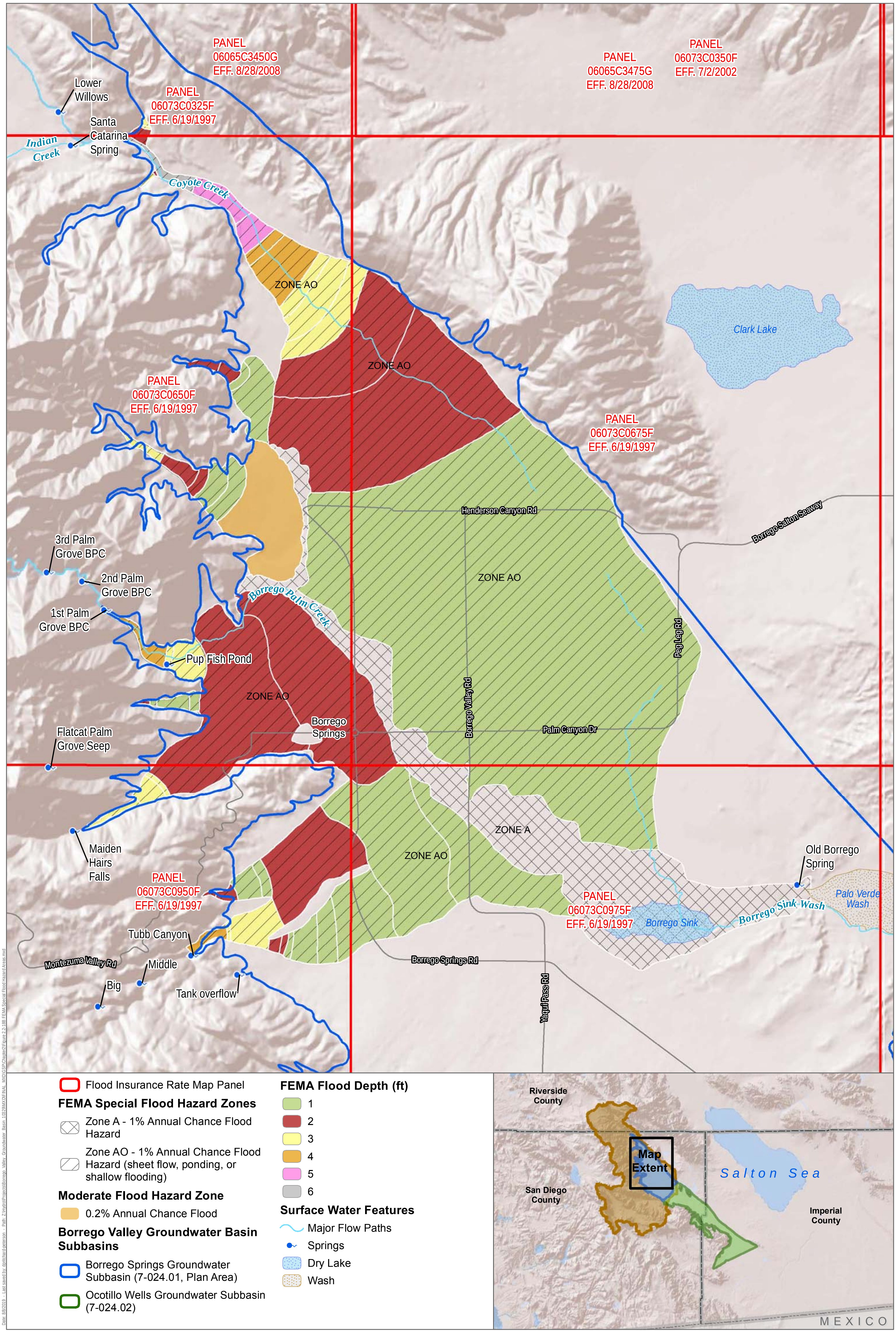

August 2019

DATUM: NAD 1983. DATA SOURCE: FEMA 2017

DUDEK

0 0.5 1 Miles

Figure 2.2-19

FEMA Special Flood Hazard Areas

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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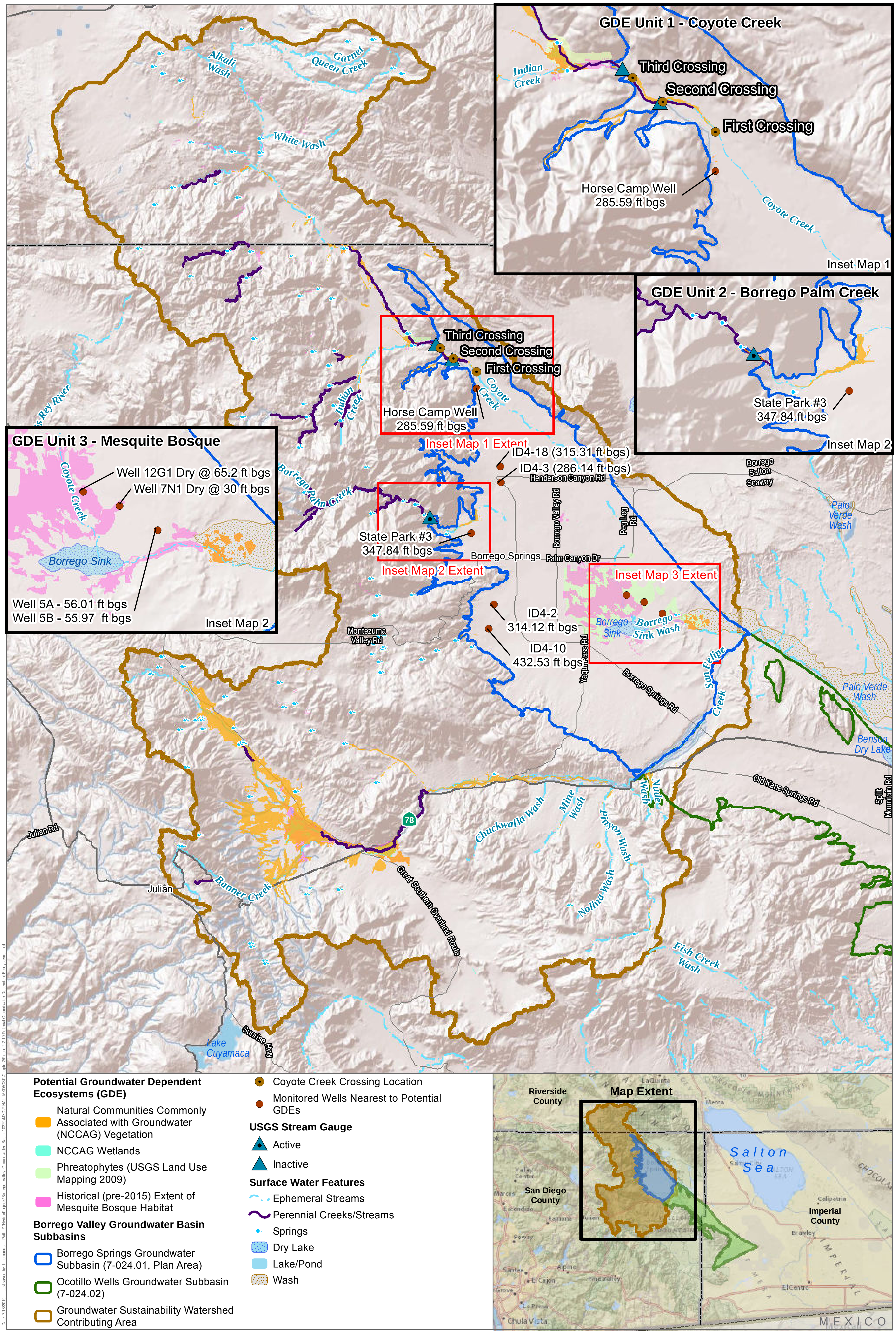

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2018; USGS NHD 2017; State Parks 2017; SanGIS 2017

DUDEK

0 1.5 3 Miles

Figure 2.2-20

Potential Groundwater Dependent Ecosystems

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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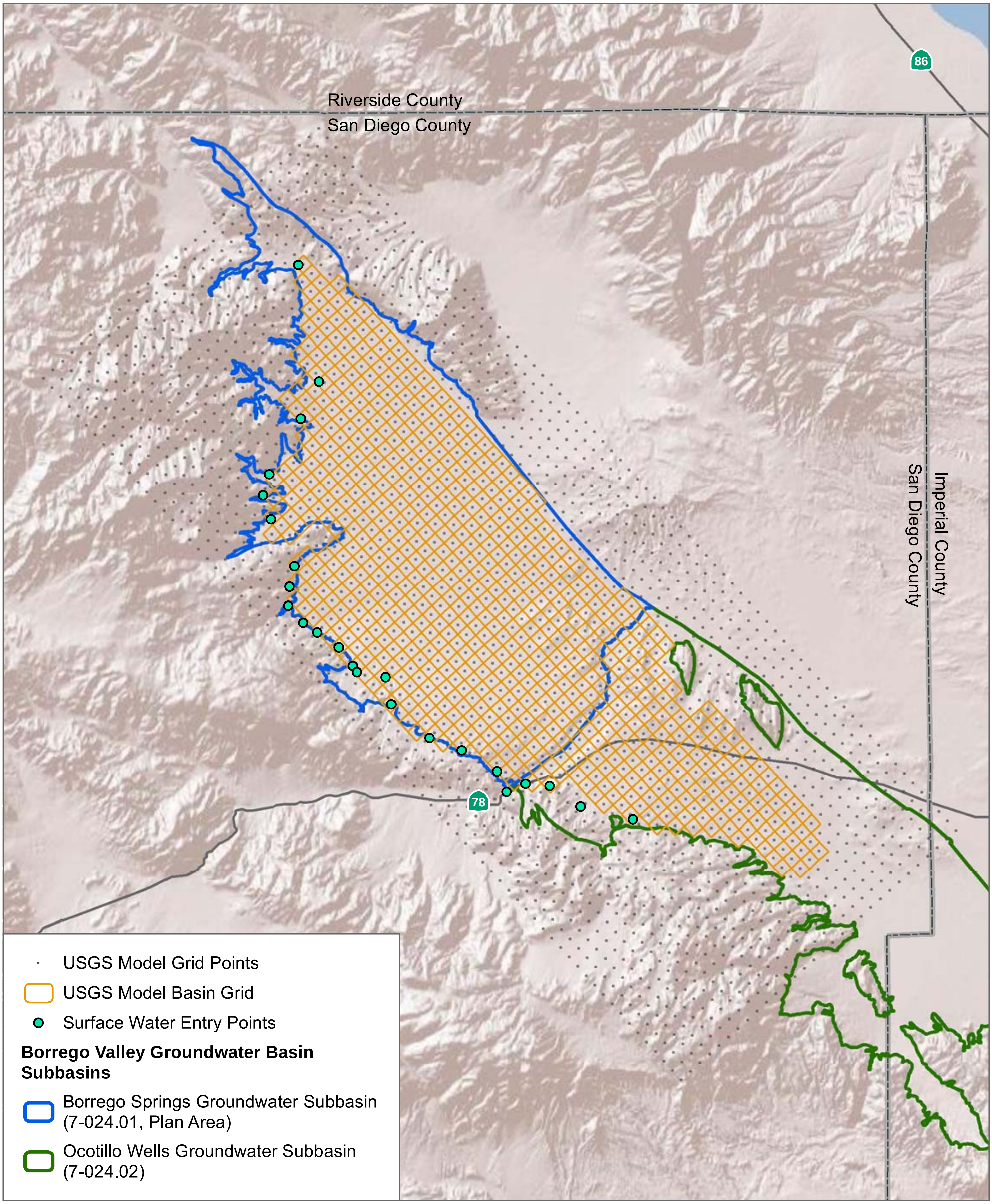

August 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2015, USGS 2015

Figure 2.2-21

Model Grid

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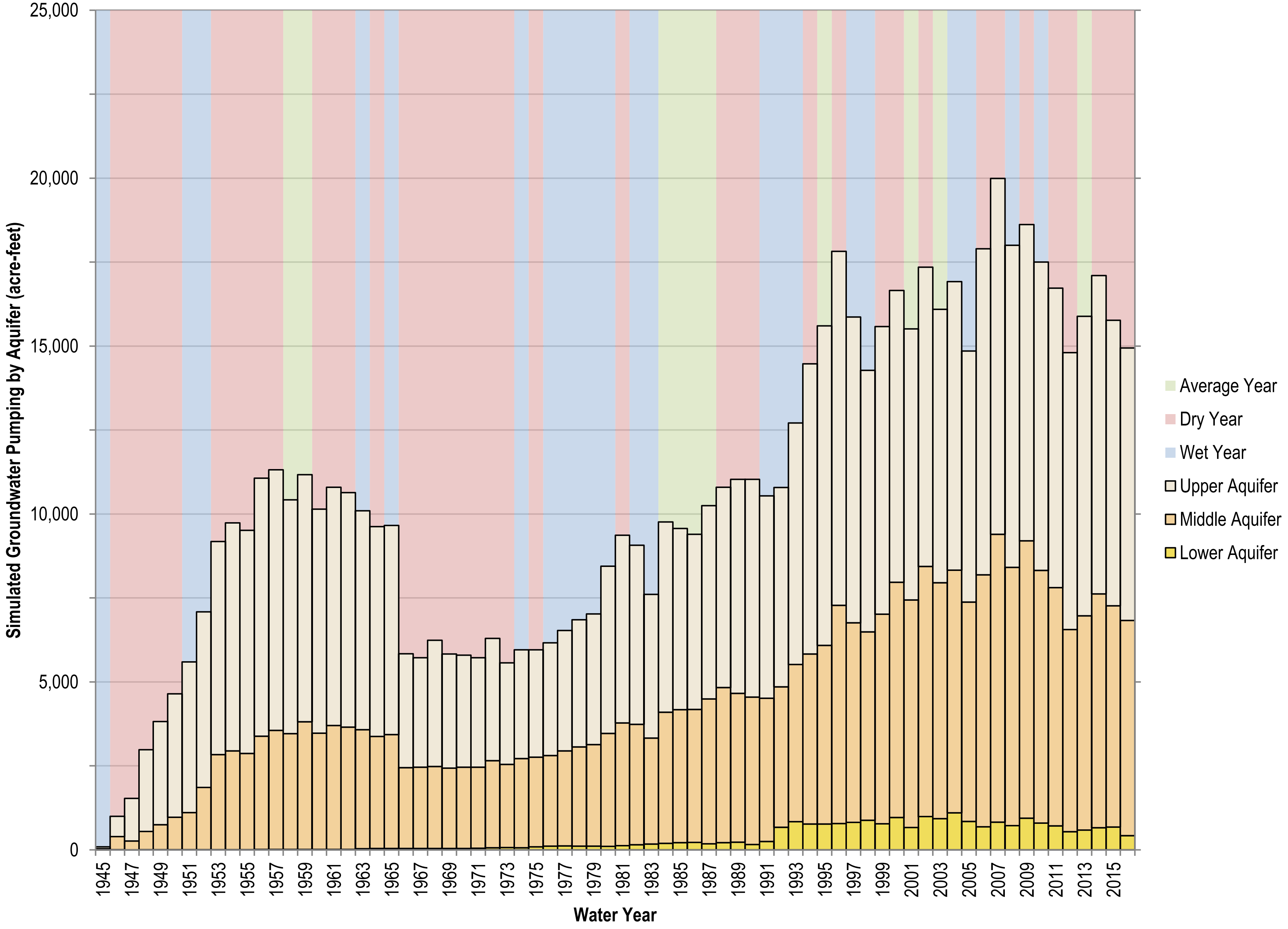

SOURCE: Modified from USGS 2015

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FIGURE 2.2-22A

Simulated Groundwater Pumpage by Aquifer (1945-2016)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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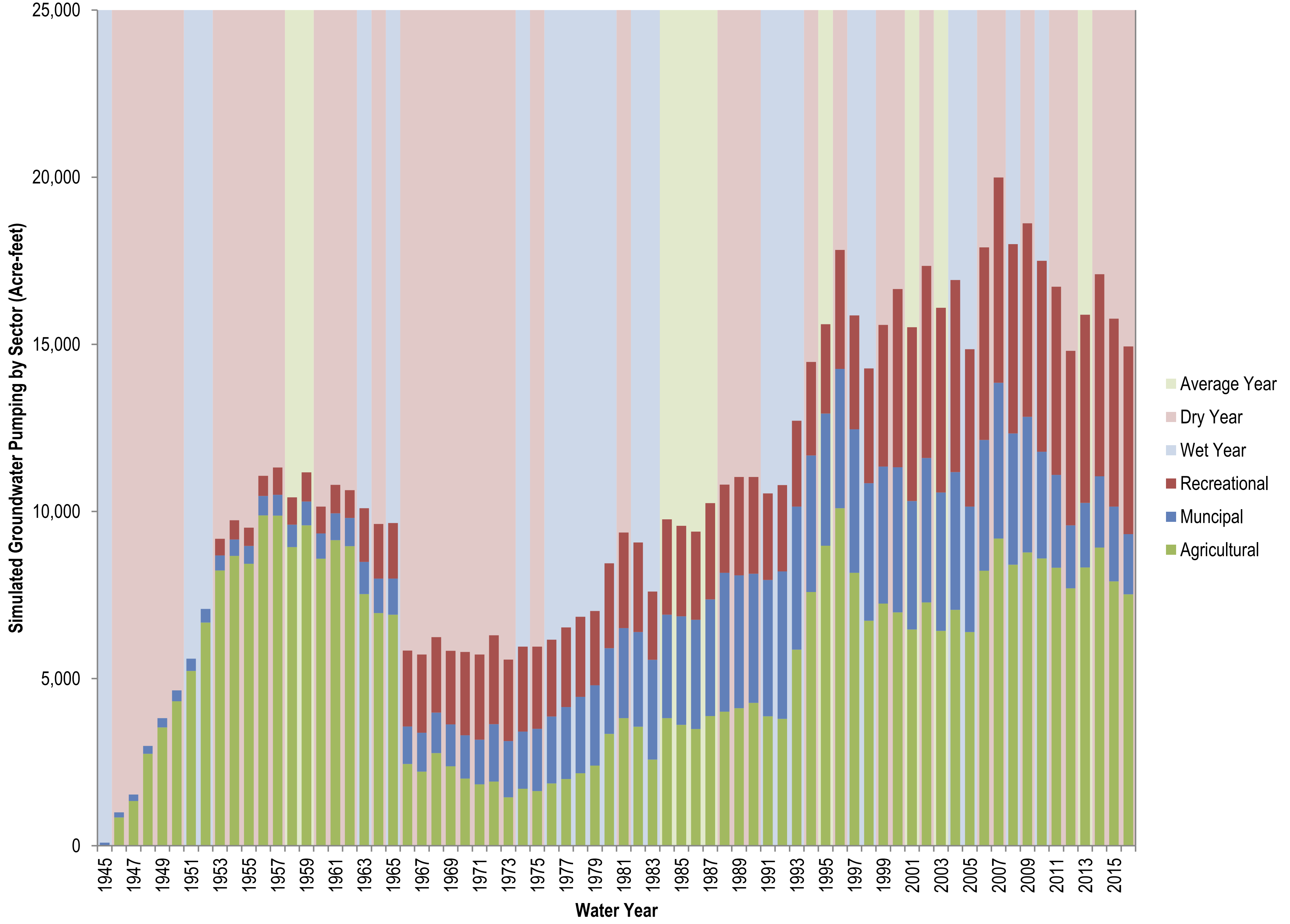

SOURCE: USGS 2015

DUDEK

FIGURE 2.2-22B

Estimated Water Use by Sector (1945 - 2016)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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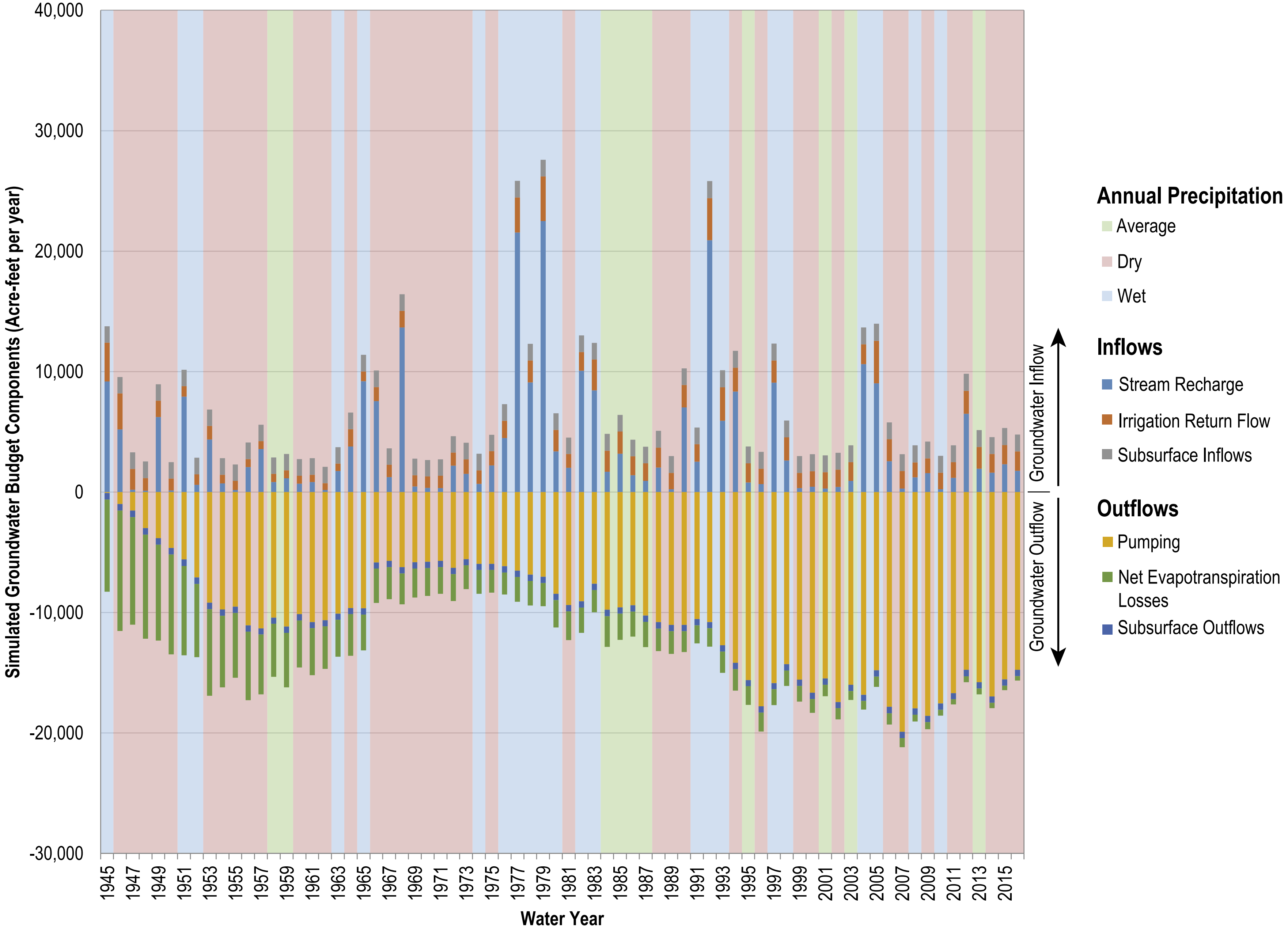

SOURCE: USGS 2015, Dudek 2017

DUDEK

FIGURE 2.2-23A

Groundwater Inflows and Outflows by Year (1945 - 2016)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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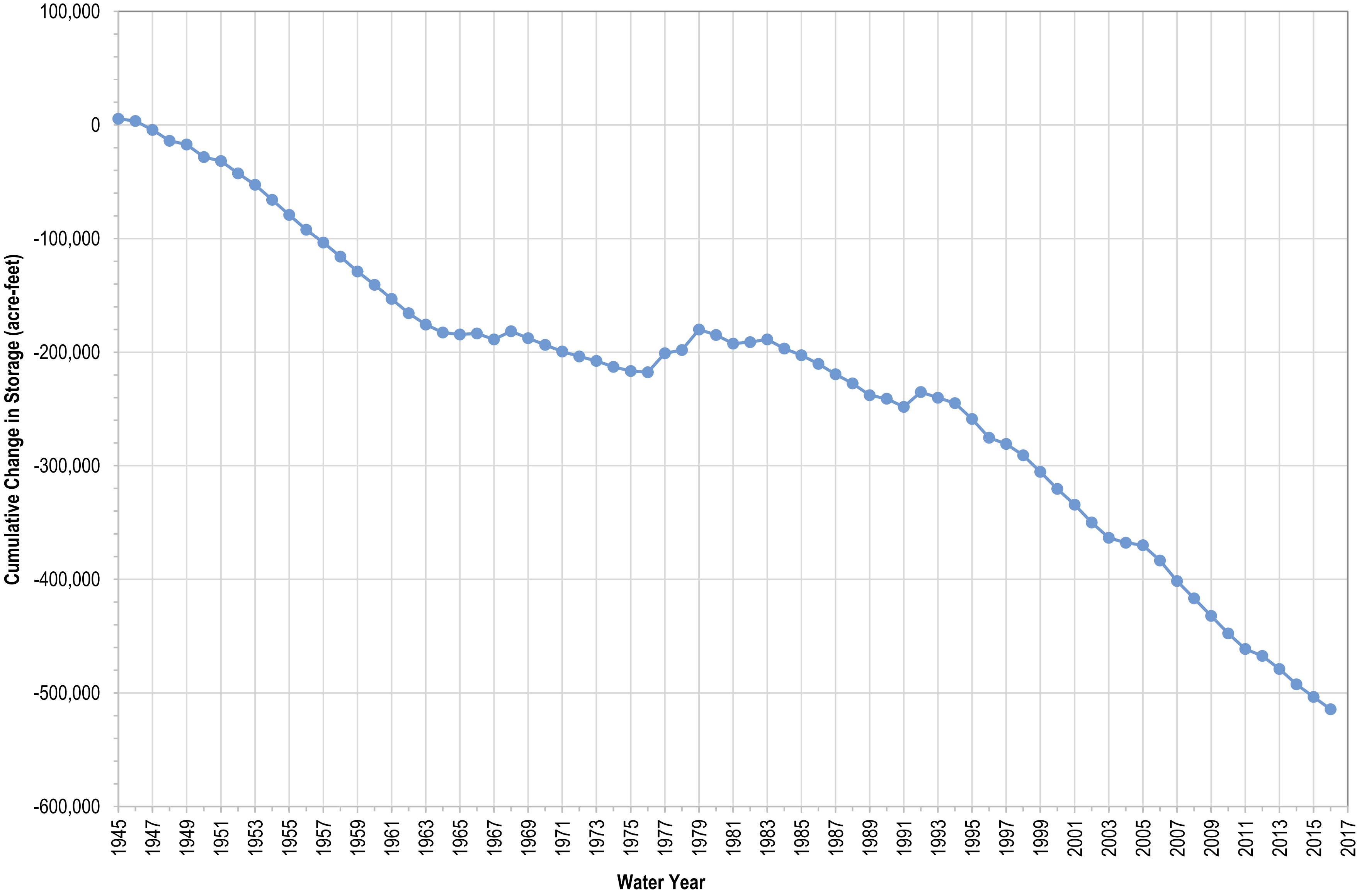

SOURCE: USGS 2015

DUDEK

FIGURE 2.2-23B

Cumulative Change in Storage by Year (1945 - 2016)

Groundwater Sustainability Plan for the Borrego Springs Groundwater Subbasin

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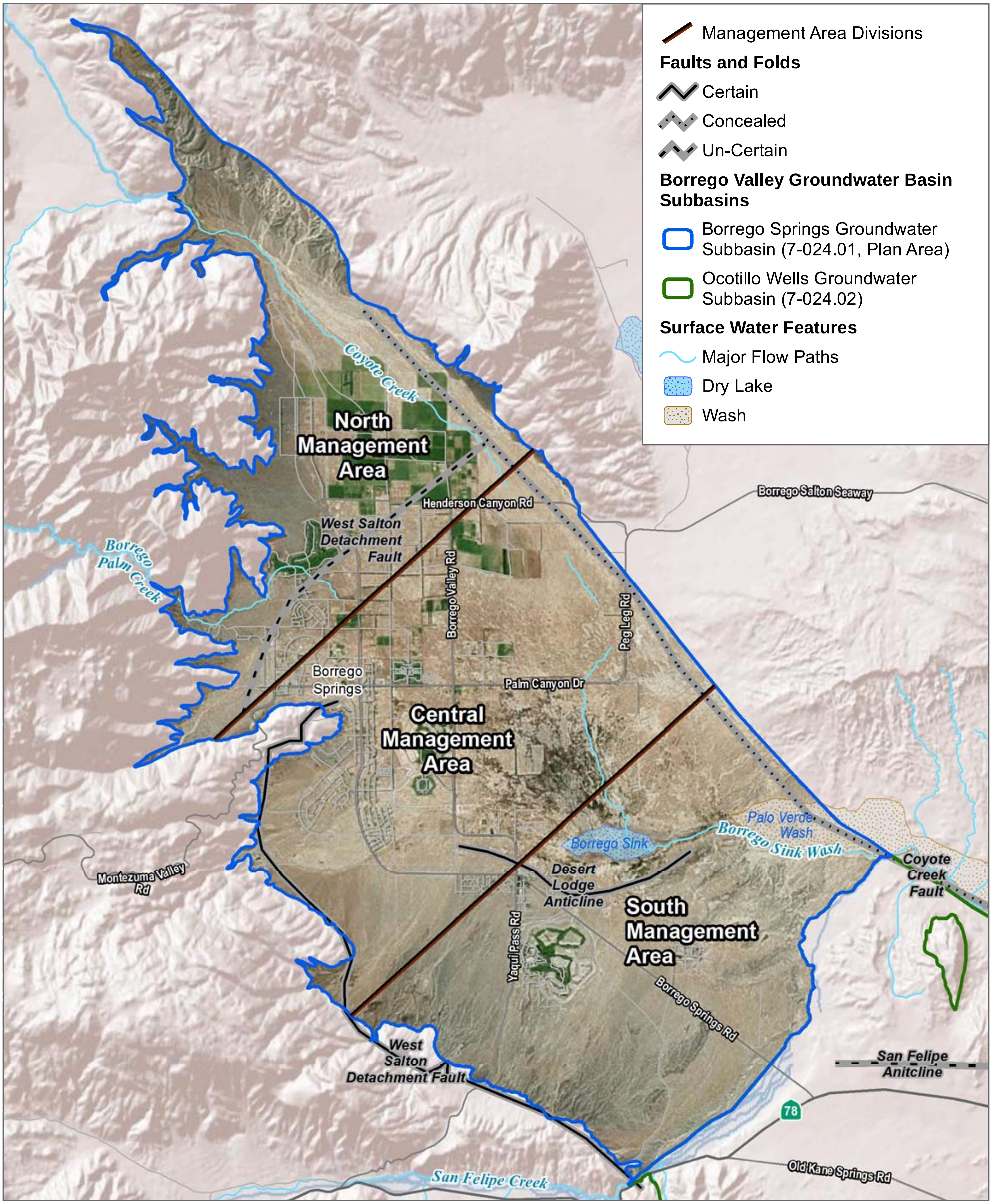

August 2019

DATUM: NAD 1983. DATA SOURCE: USGS; Steely et. al. 2009

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Figure 2.2-24

Groundwater Management Areas

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