# APPENDIX D4

***Borrego Springs Subbasin Groundwater Dependent Ecosytems***

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# DRAFT FINAL TECHNICAL MEMORANDUM

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| **To:** | Jim Bennett, Leanne Crow (County of San Diego) |
| **From:** | Trey Driscoll, PG, CHG; Dylan Duvergé, PG |
| **Subject:** | Borrego Springs Groundwater Subbasin Potential Groundwater Dependent Ecosystems |
| **Date:** | February 28, 2019 (Revised July 24, 2019; Finalized August 21, 2019) |
| **cc:** | Geoff Poole, Lyle Brecht, David Duncan (Borrego Water District) |
| **Attachment(s):** | Figures 1–22, Attachments 1–2 |

The Sustainable Groundwater Management Act (SGMA) requires that all beneficial uses and users of groundwater, including environmental users of groundwater (Groundwater Dependent Ecosystems [GDEs]), be considered in Groundwater Sustainability Plans (GSPs) (California Water Code [CWC] Section 10723.2).[1] Each plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes: identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information (Title 23 CCR Section 354.16[g]).[2] This memorandum has been prepared to comprehensively evaluate the status of mapped GDEs within the Borrego Springs Groundwater Subbasin (Subbasin).

# 1 Defining Interconnected Surface Waters and GDEs

The emergency regulations for the evaluation of GSPs adopted by the California Department of Water Resources (DWR) define interconnected surface waters 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" (Title 23 CCR Section 351[o]). The definition of an interconnected surface water specifies that a surface water need only be hydrologically connected *at any point* to a groundwater source. The perennial portions of mapped creeks in the Subbasin may be considered as interconnected surface waters because at least a portion of their flow is from groundwater springs and/or seepage from the fractured rock aquifer occurring outside the Plan Area. However, changing conditions within the Subbasin, including declining groundwater levels from pumping, does not have a substantial effect on groundwater within the fractured rock aquifer. This is because fractured rock aquifers operate very differently from alluvial aquifers, and because springs/seeps derive their flow from deep percolation of rainfall through bedrock fractures at higher elevations outside the Plan Area. Not only is the Subbasin's groundwater level elevation hundreds of feet lower than the springs/seeps that contribute to stream flow, but activities within the

[1] SGMA is codified in California Water Code (CWC), Part 2.75 (Sustainable Groundwater Management), Section 10720–10737.8, et al.

[2] GSP Regulations refers to the emergency regulations adopted by DWR as California Code of Regulations (CCR), Title 23 (Waters), Division 2 (Department of Water Resources), Chapter 1.5 (Groundwater Management), Section 350 et seq. Title 23 CCR Section 353.2(B) states, "The Department [DWR] shall provide information, to the extent available, to assist Agencies in the preparation and implementation of Plans, which shall be posted on the Department's website."

Subbasin have no effect on the amount or frequency of recharge received in the mountains. Therefore, aquifer depletion and/or declining groundwater levels within the Subbasin has no effect on the occurrence, volume or frequency of flow within the interconnected portions of Coyote Creek, Borrego Palm Creek, and other creeks that enter the fringes of the Subbasin.

GDEs are defined under SGMA's implementing regulations 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]). GDEs encompass a wide range of natural communities, such as seeps and springs, wetlands and lakes, terrestrial vegetation and, rivers, streams, and estuaries. Within the boundaries of the Plan Area, groundwater does not emerge from the Subbasin's aquifer, and groundwater does not occur near the ground surface:

- Seeps and Springs: There are no seeps or springs within the boundaries of the Subbasin. The only springs mapped in public databases that are within the Subbasin are Old Borrego Spring and Pup Fish Pond Spring. Old Borrego Spring dried up sometime before 1963, and the artificial Pup Fish Pond Spring (in addition to the pupfish pond near the Palm Canyon Trailhead in Borrego Palm Canyon Campground) is not a spring, but is a pond sustained by the Anza-Borrego Desert State Park (ABDSP) public water system.
- Depth to Groundwater: The shallowest groundwater recorded throughout the Subbasin occurs at the Rams Hill Wastewater Treatment Facility (WWTF) monitoring well (SWID No. 011S006E23H001S) in the northern part of the South Management Area. In this location, the groundwater table was recorded to be 26 feet below ground surface (bgs) in Fall 2018, where discharge of treated effluent into evaporation-percolation ponds causes localized mounding of groundwater. Aside from this location, the shallowest groundwater is recorded at MW-5B, located east-northeast of the Borrego Sink. In this location, the groundwater table was 55 feet bgs in Fall 2018. In locations where creeks, such as Coyote Creek and Borrego Palm Creek, enter the Subbasin on its northern and eastern margins, the shallowest groundwater level recorded from available monitoring wells (State Well ID Nos. 009S006E31E003SI and 010S005E25R002S) is in excess of 285 feet bgs. The depth to groundwater from the available wells closest to Tubb Canyon (ID4-2 and ID4-10) and Henderson Canyon (ID4-3 and ID4-18) is in the range of 315 to 433 feet bgs. In Fall 2018, groundwater levels within the Subbasin were on average 181 feet bgs, with a range between 26 and 433 feet bgs.

Although pumping within the Subbasin has no effect on the interconnected portions of streams outside the Plan Area, and groundwater neither emerges from the Subbasin's aquifer nor occurs near the ground surface, desert phreatophytes[3] (e.g., honey mesquite) have deep taproots specially adapted to access groundwater that does not exist near the ground surface. The Nature Conservancy (TNC) defines a GDE as "plants, animals, and natural communities that rely on groundwater to sustain all or a portion of their water needs" (TNC 2018). This definition of a GDE is broader and more inclusive than the definition under SGMA regulations. For this reason, and because SGMA also requires that stakeholder concerns be addressed and the unique characteristics of each basin be recognized, the GSA has not eliminated from consideration potential GDEs in the Subbasin based solely on lack of groundwater emerging from the aquifer and the high depth to groundwater. The presence of perennial surface waters and the accompanying ecological communities in the arid desert basin is unique, ecologically important, and the source of considerable draw to the region. The economy within the Subbasin relies heavily on recreational opportunities and tourism in the Plan Area, with the ABDSP attracting hundreds of thousands of visitors per year.

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

Accordingly, this memorandum evaluates the occurrence and historical trends in potential GDEs, using the best available science, to support development of the GSP.

# 2 Identifying Potential Groundwater Dependent Ecosystems

The Natural Communities Commonly Associated with Groundwater (NCCAG) dataset is provided by the Department of Water Resources (DWR) as a reference dataset and starting point for the identification of GDEs in groundwater basins (DWR 2018). Because the scale of the NCCAG dataset is statewide (i.e., coarse), and consists of a compilation of vegetation and surface hydrology feature (e.g., springs) mapping, it does not incorporate local, basin-specific groundwater conditions such as aquifer characteristics or current data on depth to groundwater. Therefore, the dataset is most appropriately used as an indicator of where GDEs, as defined by SGMA, are more likely to be present. A local, basin-specific analysis is required to verify the degree to which features mapped in the NCCAG dataset depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. Accordingly, features mapped as NCCAG dataset are referred to herein as “potential” GDEs.

The NCCAG dataset and its source data can be reviewed in context of local understanding of surface water hydrology, groundwater conditions, and geology. The NCCAG dataset is comprised of 48 publicly available state and federal agency mapping datasets.[4] After the vegetation, wetland, seeps, and springs data from these 48 datasets were compiled into the NCCAG dataset, data were screened to exclude vegetation and wetland types less likely to be associated with groundwater and retain types commonly associated with groundwater. This initial screening was conducted by DWR, California Department of Fish and Wildlife (CDFW) and the Nature Conservancy (TNC).

Potential GDEs were identified by completing a review of the NCCAG dataset and other pertinent datasets discussed further below. The GSA grouped potential GDEs mapped within the Borrego Springs Groundwater Subbasin (7-024.01; Subbasin) by the NCCAG dataset as follows: 1) GDE Unit 1 – Coyote Creek, 2) GDE Unit 2 – Borrego Palm Creek, and 3) GDE Unit 3 – Honey Mesquite (Borrego Sink) (Figure 1). In addition, the GSA grouped potential GDEs mapped outside of these three zones as “other” potential GDEs, which consist of areas are primarily located along the eastern flanks of the mountainous terrain that abuts the Subbasin to the west.

Watersheds contributing to the Subbasin were delineated using the U.S. Geological Survey’s (USGS) StreamStats application (USGS 2017) (Figure 2). The watersheds were delineated from the point of intersection of major drainages with the downstream edge of the Subbasin boundary. A total of 10 watersheds were delineated to complete a detailed review of the NCCAG dataset, along with additional dataset comprised of County of San Diego vegetation communities associated with primarily riparian habitat; USGS’s National Hydrography Dataset flow lines; perennial creeks, streams and springs mapped by the Anza-Borrego Desert State Park (ABDSP); springs identified

4 NCCAG dataset includes, but is not limited to, the following: VegCAMP – The Vegetation Classification and Mapping Program, California Department of Fish and Wildlife (CDFW); CALVEG – Classification and Assessment with Landsat Of Visible Ecological Groupings, USDA Forest Service; NWI V 2.0 – National Wetlands Inventory (Version 2.0), United States Fish and Wildlife Service; FVEG – California Department of Forestry and Fire Protection, Fire and Resources Assessment Program (CALFIRE FRAP); United States Geologic Survey (USGS) National Hydrography Dataset (NHD); and Mojave Desert Springs and Waterholes (Mojave Desert Spring Survey). NCCAG dataset viewer is available online at: https://gis.water.ca.gov/app/NCDatasetViewer/

on USGS quadrangle maps; land use data; and satellite color-infrared photography (Figure 3 through Figure 12).[5] Potential GDEs mapped within the contributing watersheds include, but are not limited to, Coyote Creek, Henderson Canyon, Borrego Palm Creek, Hellhole Palms Canyon, Culp Canyon, Tubb Canyon, San Felipe Creek, and other minor or unnamed stream segments entering the Subbasin (Figures 3 through Figure 12).

As the GSP is focused on the Subbasin, the potential GDEs should either be located within the Subbasin boundary or be sufficiently approximate to the boundary that there is a reasonable potential for a substantial nexus to exist between the Subbasin's regional groundwater levels and the potential GDEs.

## 2.1 Primary Potential GDEs

The three primary potential GDEs areas are discussed in the following subsections. These GDE "Units" were identified based on the presence of NCCAG mapped within the Subbasin boundary and their overlap/proximity to perennial segments of major streams that enter the Subbasin, namely Coyote Creek and Borrego Palm Creek.

Other potential GDEs identified in Figure 3 through Figure 12 include Henderson Canyon, Hellhole Canyon, Culp Canyon, Tubb Canyon, and other minor or unnamed stream segments entering the Subbasin. These areas were not selected for detailed evaluation because the potential GDEs mapped in these areas are edge cases confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front at the end of large watersheds indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin (which are storm fed and/or spring-fed). These contributing watershed and fringe areas are described in Section 2.2. Table 1 provides information on the dominant plant species within each GDE unit, global estimates of their maximum rooting depths, and the area in acres mapped for each.

### Table 1. Potential Groundwater Dependent Ecosystems within the Subbasin

| GDE Unit | Dominant Species | | Global Estimate of Maximum Rooting Depth | Area |
|---|---|---|---|---|
| | Common Name | Scientific Name | (Feet) | (Acres) |
| GDE Unit 1 (Coyote Creek) | Catclaw Acacia | *Acacia greggii* | 18.0 | 3.5 |
| | Desert Willow | *Chilopsis linearis* | 5.2 | 3.5 |
| | Honey Mesquite | *Prosopis glandulosa* | 6.9–65.6 | 0.5 |
| | Narrowleaf Willow | *Salix exigua* | -- | 1.3 |
| | Tamarisk[1] | *Tamarix spp.* | 32.8–65.6 | 0.4 |
| | | | *Subtotal* | 9.2 |
| GDE Unit 2 (Borrego Palm Canyon/Creek) | California Fan Palm | *Acacia greggii* | 18.0 | 0.4 |
| | Catclaw Acacia | *Chilopsis linearis* | 5.2 | 6.5 |
| | Desert Willow | *Washingtonia filifera* | -- | 0.3 |
| | | | *Subtotal* | 7.1 |

[5] The mapped location of springs was developed from multiple datasets including the ABDSP (2017), Water Quality Control Plan for the Colorado River Basin (Basin Plan) and National Hydrography Dataset.

## Table 1. Potential Groundwater Dependent Ecosystems within the Subbasin

| GDE Unit | Dominant Species Common Name | Dominant Species Scientific Name | Global Estimate of Maximum Rooting Depth (Feet) | Area (Acres) |
|---|---|---|---|---|
| GDE Unit 3 (Borrego Sink) | Honey Mesquite | *Prosopis glandulosa* | 6.9–65.6 | 13.2 |
| | | | *Subtotal* | *13.2* |
| Other | Catclaw Acacia | *Acacia greggii* | 18.0 | 3.2 |
| | Desert Willow | *Chilopsis linearis* | 5.2 | 1.7 |
| | Tamarisk[1] | *Tamarix spp.* | 32.8–65.6 | 0.1 |
| | | | *Subtotal* | *5.0* |
| | | | **TOTAL** | **34.6** |

**Source:** TNC 2018; Fan et al. 2017.
**Notes:** GDE = groundwater dependent ecosystem.
1 The species of tamarisk is not differentiated, so data provided is for the overall genera.

### 2.1.1 Coyote Creek Mapped GDEs (GDE Unit 1)

The NCCAG dataset has mapped both wetlands and vegetation within GDE Unit 1, Coyote Creek (Figures 1 and 3). These communities are narrowly focused within the riparian corridors associated with Coyote Creek. Potential GDE vegetation types mapped in association with Coyote Creek include: Desert Willow, Narrowleaf Willow, Honey Mesquite (*Prosopis glandulosa*), and Catclaw Acacia (drought deciduous [lacks leaves for most of the year]). The ecological conditions in Coyote Canyon have been evaluated by the ABDSP (Ostermann and Boyce 2002). The following information is excerpted from *Ecological Conditions in Coyote Canyon, Anza-Borrego Desert State Park® An Assessment of the Coyote Canyon Public Use Plan*:

> "Riparian vegetation covers approximately 120 acres at Lower Willows, 54 acres at Middle Willows, and 40 acres at Upper Willows" (Figure 3). "The biological importance of Coyote Canyon is largely a function of the perennial surface water and islands of tall-structured wetland vegetation in Lower, Middle and Upper Willows." "Five sensitive habitat or vegetation types occur in Coyote Canyon, including: Desert Fan Palm Oasis Woodland, Mesquite Bosque, Mojave Riparian Forest, Sonoran Cottonwood Willow Riparian Forest, and Sonoran Riparian Woodland. Several of these riparian vegetation associations have been recognized for their rarity and sensitivity by the state of California. Lower and Middle Willows are identified as Significant Natural Areas (SNA) in the California Department of Fish and Game's Natural Diversity Data Base because they contain sensitive Desert Fan Palm Oasis Woodland, Sonoran Riparian Forest, and nesting habitat for least Bell's vireo. Upper Willows contains the same resources but was not designated as an SNA due simply to an oversight (California Department of Parks and Recreation 1995). All riparian habitat in Coyote Canyon is considered wetlands and is protected under the Keene-Nejedly California Wetlands Preservation Act of 1976. There are a variety of vegetation types both within riparian areas, and canyon wide. The tall-statured willow-dominated vegetation in Coyote Canyon is largely dominated by red willow (*Salix laevigata*), accompanied by arroyo

> willow (*Salix lasiolepis*), cottonwood (*Populus fremontii*), desert fan palm (*Washingtonia filifera*), and desert grape (*Vitis girdiana*). Perennial shrub species such as mulefat (*Baccharis salicifolia*), narrow-leaved willow (*Salix exigua*), and arrow weed (*Pluchea sericea*) are mixed with willow-dominated vegetation. Wetter portions of the wetlands are dominated by annual and perennial herbs such as cattail (*Typha latifolia*), tule (*Scirpus americanus*), and scratchgrass (*Muhlenbergia asperifolia*) (California Department of Parks and Recreation 2002). The boundary between wetland and upland habitats in Coyote Canyon is typically defined by stands of honey [mesquite] (*Prosopis glandulosa*) and screw-bean (*P. pubescens*) mesquite (California Department of Parks and Recreation 2002). These species have deep rooting systems and are able to better access subsurface moisture. Higher areas within the floodplain support sparse shrublands of low-statured drought-deciduous species such as alkali goldenbush (*Isocoma acradenia*), broom lotus (*Lotus rigidus*), and desert baccharis (*Baccharis sergiloides*) (California Department of Parks and Recreation 2002). It is the diversity and spatial arrangement of vegetation associations (i.e., wetland vegetation, mesquite bosque, dry wash vegetation, creosote bush scrub) in the Canyon, in combination with perennial surface water, that allow for a dense array of habitats and wildlife species. Vegetation is a key component of riparian habitat. It provides structure and cover for animals, shade which influences water temperature, and plays an important role in nutrient cycling and soil stabilization" (Ostermann and Boyce 2002).

Dominant vegetation types identified in the NCCAG dataset include Catclaw Acacia, Desert Willow, Honey Mesquite, Narrowleaf Willow, and Tamarisk over an area of 9.2 acres.

### 2.1.2 Borrego Palm Canyon/Creek Mapped GDEs (GDE Unit 2)

The NCCAG dataset has mapped primarily vegetation within GDE Unit 2, Borrego Palm Canyon/Creek (Figures 1 and 6). These communities are narrowly focused within the riparian corridors associated with Palm Creek. Dominant vegetation types mapped in association with Borrego Palm Canyon/Creek include Desert Willow, California Fan Palm, and Catclaw Acacia, and are collectively mapped in the NCCAG dataset over an area of 7.1 acres.

### 2.1.3 Honey Mesquite (Borrego Sink) Mapped GDEs (GDE Unit 3)

The NCCAG dataset has mapped primarily vegetation within GDE Unit 3, which consists of Mesquite Bosque narrowly focused along the Borrego Sink Wash east of the Borrego Sink (Figures 1 and 13). The dominant vegetation type associated with the Borrego Sink is honey mesquite, which is mapped as having an area of 13.2 acres in the NCCAG dataset. DWR removed a previously large area around and north of the Borrego Sink from the NCCAG dataset because it was determined that the habitat no longer met the criteria for inclusion in the database.

## 2.2 Contributing Watersheds Potential GDEs

Contributing watersheds along the eastern flanks of the mountainous terrain that abuts the Subbasin to the west were evaluated to identify potential GDEs. Watersheds were delineated from the point of intersection of major drainages with the downstream side of the Subbasin boundary. A total of 10 watersheds, including 28 subwatersheds, were delineated as listed in Table 2 and described in the following subsections.

### 2.2.1 Coyote Creek Watershed

The Coyote Creek watershed is comprised of two subwatersheds referred to as the Coyote Creek and Coyote Creek South subwatersheds. The area of the Coyote Creek watershed contributing to the Subbasin encompasses approximately 94,506 acres (Figures 1 and 3). The watershed is located almost entirely within the boundary of the ABDSP. Upper portions of the watershed are developed with rural residences in the Terwilliger Valley located in Riverside County. The maximum elevation of the watershed is 8,615 feet above mean sea level (amsl) on the flank of Toro Peak in the Santa Rosa Mountains that reaches a maximum 8,716 feet amsl at the peak. The minimum elevation of the watershed is approximately 1,200 feet at the Lower Willows. The Coyote Creek watershed is discussed further in Sections 3 and 6.

## Table 2. Contributing Watersheds Area and Elevation

| Contributing Watershed | Subwatershed | Area (Acres) | Total Area (Acres)[a] | Elevation (Feet, amsl) | |
|---|---|---|---|---|---|
| | | | | Maximum | Minimum |
| Coyote Creek | Coyote Creek | 92,722 | 94,506 | 8,615 | 1,200 |
| | Coyote Creek South | 1,784 | | | |
| Horse Camp | North | 556 | 1,931 | 3,700 | 940 |
| | Middle North | 569 | | | |
| | Middle South | 677 | | | |
| | South | 129 | | | |
| Henderson Canyon | North 1 | 1,599 | 2,984 | 4,650 | 1,163 |
| | North 2 | 123 | | | |
| | North 3 | 209 | | | |
| | South 1 | 45 | | | |
| | South 2 | 582 | | | |
| | South 3 | 426 | | | |
| Borrego Palm Creek | NA | 14,994 | 14,994 | 6,404 | 1,300 |
| Hellhole Canyon | Panoramic Overlook Canyon | 407 | 6,667 | 6,142 | 962 |
| | North Fork | 504 | | | |
| | Middle Fork | 1,535 | | | |
| | South Fork | 4,221 | | | |
| Dry and Culp Canyons | Dry Canyon | 1,009 | 6,140 | 4,491 | 956 |
| | Culp Canyon | 5,131 | | | |
| Tubb Canyon | Tubb Canyon | 2,396 | 3,095 | 4,520 | 920 |
| | Road North | 265 | | | |
| | Road Middle | 190 | | | |
| | Road South | 244 | | | |
| Glorietta Canyon | Glorietta Canyon | 1,852 | 2,595 | 4,589 | 1,250 |
| | South Fork | 743 | | | |
| Yaqui Ridge | North 1 | 1,042 | 2,903 | 3,864 | 1,252 |
| | North 2 | 47 | | | |
| | North 3 | 979 | | | |
| | Yaqui Pass | 581 | | | |
| | Yaqui Ridge | 110 | | | |
| | Cactus Valley | 144 | | | |

## Table 2. Contributing Watersheds Area and Elevation

| Contributing Watershed | Subwatershed | Area (Acres) | Total Area (Acres)[a] | Elevation (Feet, amsl) | |
|---|---|---|---|---|---|
| | | | | Maximum | Minimum |
| San Felipe Creek | NA | 117,339 | 117,339 | 5,719 | 992 |

**Source**: Watersheds delineated using StreamStats, USGS 2017.
**Notes:** amsl = above mean sea level; NA = not applicable.
a. Total area of the contributing watersheds does not include areas within the Subbasin.

### 2.2.2 Horse Camp Watershed

The Horse Camp watershed is comprised of four subwatersheds referred to as the North, Middle North, Middle South and South subwatersheds (Figure 4). In total, the Horse Camp Watershed area is 1,931 acres. The Horse Camp subwatersheds are characterized by narrow canyons that drain the eastern foothills of the San Ysidro Mountains. The maximum elevation of the watershed is 3,700 feet amsl attained in the Middle South subwatershed and the minimum elevation is about 940 feet amsl in the South subwatershed. The NCCAG dataset indicates no mapped vegetation, wetlands or springs in the watershed. An isolated pocket of mapped vegetation is noted where the Horse Camp drainages converge in a wash on the edge of the valley. These potential GDEs are edge cases mapped in areas confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

### 2.2.3 Henderson Canyon Watershed

The Henderson Canyon watershed is comprised of six subwatersheds referred to as the North 1, North 2, North 3, South 1, South 2, and South 3 subwatersheds (Figure 5). The total Henderson Canyon watershed area is 2,984 acres. The maximum elevation of the watershed is 4,650 feet amsl attained in the North 1 subwatershed and the minimum elevation is about 1,163 feet amsl in the North Fork subwatershed. No springs are mapped in the watershed. Potential GDEs vegetation is mapped by the NCCAG dataset in the North 2 and South 2 subwatersheds. The mapped vegetation occurs along narrow corridors associated with ephemeral drainages. Mapped vegetation occurs in the Subbasin at the upper portion of the alluvial fans that originate from the watersheds. These potential GDEs are edge cases mapped in areas confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

### 2.2.4 Borrego Palm Creek Watershed

Borrego Palm Creek watershed encompasses approximately 14,994 acres (Figures 1 and 6). The watershed is located almost entirely within the boundary of the ABDSP. The watershed rises to a maximum elevation of 6,404 feet amsl near Hot Springs Mountain, the highest peak in San Diego County at an elevation of 6,535 feet amsl. The minimum elevation of the watershed in 1,300 feet amsl at the First Palm Grove. The Borrego Palm Creek Watershed is discussed further in Sections 3 and 6.

### 2.2.5 Hellhole Canyon Watershed

The Hellhole Canyon watershed is comprised of four subwatersheds referred to as the Panoramic Overlook Canyon, North Fork, Middle Fork, and South Fork subwatersheds (Figure 7). The total Hellhole Canyon watershed area is 6,667 acres. The maximum elevation of the watershed is 6,142 feet amsl attained in the South Fork subwatershed and the minimum elevation is about 962 feet amsl in the North 3 subwatershed. The Hellhole Canyon subwatersheds discharge through narrow canyons to the Subbasin where the constricted canyons broaden onto an alluvial fan. Vegetation on the alluvial fan is sparse compared to the dense vegetation in the South Fork subwatershed. The County vegetation layer maps a narrow corridor of riparian habitat in the South Fork. Satellite-color infrared photography reveals vegetation along additional drainage segments of the South Fork and lesser vegetation in the Middle Fork. One spring is mapped in the Middle Fork subwatershed. Four springs are mapped in the South Fork. None of the springs or GDEs identified within the watershed occur within the Subbasin.

### 2.2.6 Dry Canyon and Culp Canyon Watersheds

The Dry Canyon and Culp Canyon watersheds are comprised of two watersheds (Figure 8). The total Dry Canyon and Culp Canyon watersheds area is 6,140 acres. Dry Canyon is intersected by Montezuma Valley Road in the middle to lower part of the watershed. Dry Canyon is sparsely vegetated with no mapped potential GDEs or springs. Culp Canyon extends to a much higher elevation reaching 4,591 feet amsl where it abuts the community of Ranchita. Much of the watershed is located above 3,000 feet amsl where 14 springs are mapped. No vegetation is mapped in the area of the springs; however, review of aerial photography reveals narrow corridors of vegetation associated with the spring complexes. Where Culp Canyon enters the valley it joins with several canyons, including Tubb Canyon, to form an alluvial fan. The NCCAG dataset maps vegetation on the alluvial fan. These potential GDEs are edge cases mapped in areas confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

### 2.2.7 Tubb Canyon Watershed

Tubb Canyon is comprised of four subwatersheds referred to as Tubb Canyon, and Tubb Canyon Road North, Middle and South subwatersheds. The total Tubb Canyon watershed area is 3,095 acres. The maximum elevation of the watershed is 4,520 feet amsl and the minimum elevation (i.e., outlet) is about 920 feet amsl. Tubb Canyon watershed discharges through a narrow canyon to the Subbasin where it broadens into an alluvial fan (Figure 9). Three springs are mapped in the watershed and include Big Spring, Middle Spring, and Tubb Canyon Spring (ABDSP 2017). In the vicinity of Big Spring, seepwillow, catclaw, and mesquite have been identified (San Diego Reader 2010). The satellite color-infrared photography indicates green, healthy vegetation as the color red (high reflection of near-infrared wavelengths). In a desert environment, the green healthy vegetation could represent a potential GDE. A narrow band of habitat appears in the Tubb Canyon Creek channel primarily associated with the mapped springs. A band of vegetation is mapped by the NCCAG dataset where Tubb Canyon opens into the Subbasin near Dry and Culp Canyons. As previously discussed for the Dry and Culp Canyon watersheds, this potential GDE is supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

### 2.2.8 Glorietta Canyon Watershed

Glorietta Canyon watershed is comprised of two subwatersheds referred to as Glorietta Canyon and South Fork subwatersheds (Figure 10). The total Glorietta Canyon watershed area is approximately 2,595 acres. The maximum elevation of the watershed is 4,589 feet amsl and the minimum elevation (i.e., outlet) is about 1,250 feet amsl. The watershed discharges to the Yaqui Meadows area of the Subbasin. No springs are mapped in the Glorietta Canyon. The satellite color-infrared photography indicates limited vegetation associated with Glorietta Canyon, which agrees with the lack of mapped springs, vegetation, and wetlands. No springs or potential GDEs are mapped in the Subbasin in the vicinity of Glorietta Canyon watershed.

### 2.2.9 Yaqui Ridge Watershed

The Yaqui Ridge watershed is comprised of six subwatersheds scattered along the ridgeline and referred to as the North 1, North 2, North 3, Yaqui Pass, Yaqui Ridge South and Cactus Valley subwatersheds (Figure 11). The total Yaqui Ridge watershed area is 2,903 acres. The maximum elevation of the watershed is 3,864 feet amsl and the minimum elevation (i.e., outlet) is about 1,252 feet amsl. Yaqui Pass Road crosses the Yaqui Ridge South subwatershed. No vegetation or springs are mapped within the Yaqui Ridge Watershed. Sparse vegetation within the drainage channels is shown on aerial photography. No springs or potential GDEs are mapped in the Subbasin in the vicinity of Yaqui Ridge watershed.

### 2.2.10 San Felipe Creek Watershed

The San Felipe Creek watershed is comprised of one large watershed of approximately 117,339 acres (Figure 12). The watershed rises to a maximum elevation of 5,719 feet amsl in the Vulcan Mountains north of the town of Julian, and the minimum elevation (i.e., outlet) is about 992 feet amsl. San Felipe Creek enters the valley though a narrow canyon (“narrows”) that cuts through Yaqui Ridge. A deeply incised broad wash extends from the narrows to the valley floor and beyond to the Palo-Verde Wash. Borrego Springs Road crosses the broad San Felipe Creek wash at what is known as the “Texas dip.” This wash is often the location of periodic and dramatic flash floods. The San Felipe Creek wash forms the southern boundary of the Subbasin. The NCCAG dataset and County vegetation datasets map extensive vegetation in the upper portion of the watershed and in narrow corridors in the lower portions of the watershed. Limited vegetation is also mapped in the wash near where the San Felipe Creek enters the Subbasin. None of the potential GDE habitat identified occurs within the Subbasin.

# 3 Streamflow

## 3.1 Coyote Creek

Streamflow in the Coyote Creek watershed has been documented by USGS as the number one source of groundwater recharge to the Subbasin via stream flow leakage (i.e., infiltration of surface water runoff primarily during flood events). An estimated 65% of the surface water inflow to the Borrego Valley comes from Coyote Creek (USGS 1982).

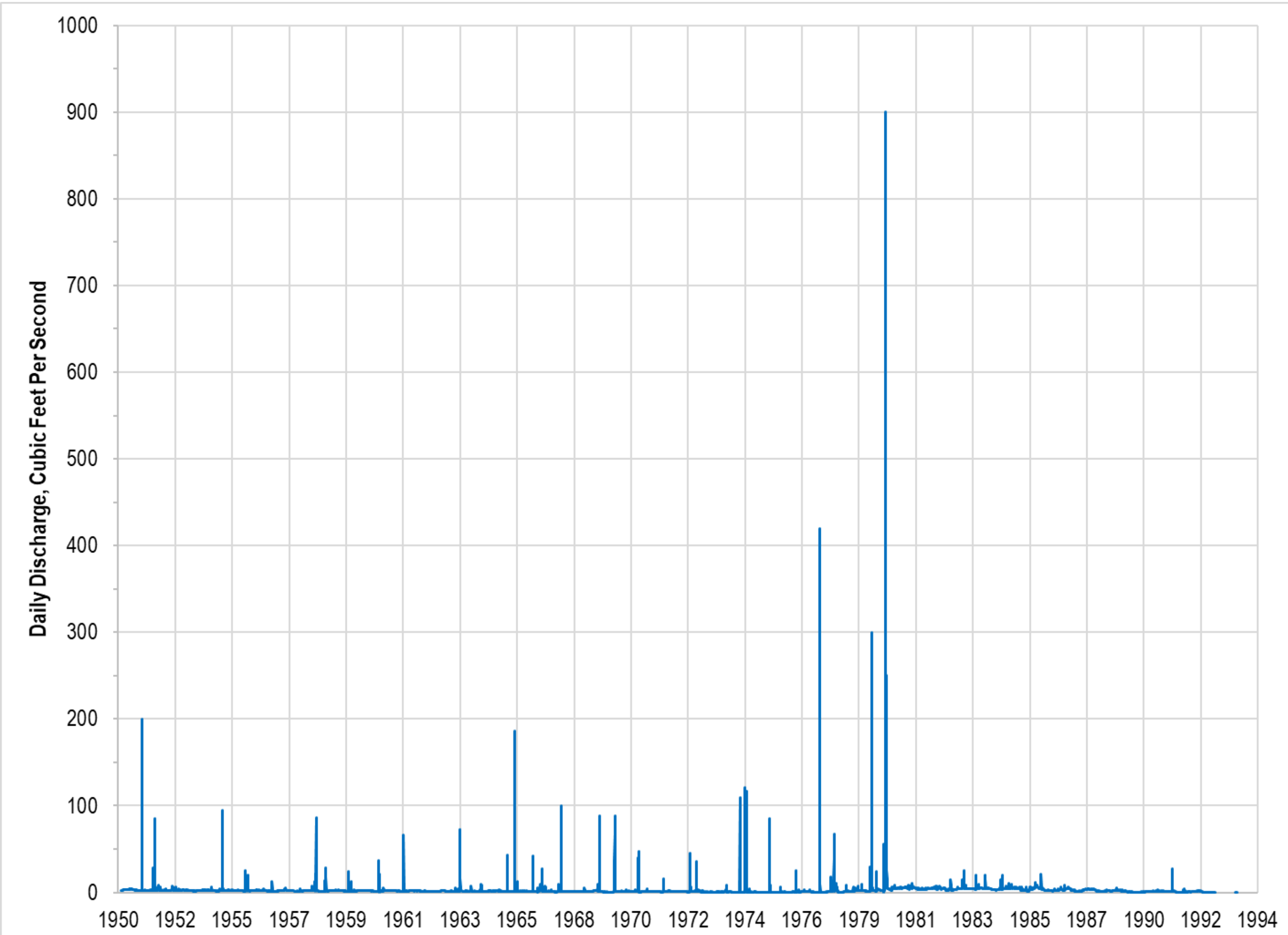
Perennial stream flow in Coyote Creek occurs in the northern most section of the Subbasin. Groundwater daylights at lower elevations in the Collins Valley at the Oasis at Santa Catarina Spring and Lower Willows Spring where the stream is restricted by a narrow hard rock canyon. The restrictive canyon appears to act as a subsurface dam causing groundwater to daylight at the spring and flow into the Subbasin as surface water flow in Coyote Creek. This occurs approximately 1 mile upstream from the Subbasin boundary at an elevation of about 1,300 feet amsl. The spring was first documented in 1774 by members of the Anza Expedition near the site of a large Cahuilla Indian village.[6] "The creek contains three reaches where bedrock forces groundwater to the surface throughout the year, resulting in perennial surface or near-surface water. These areas, referred to as Lower, Middle, and Upper Willows, form three of the most verdant riparian wetlands of the California desert" (Ostermann and Boyce 2002). As the creek flows through the Subbasin, the alluvium becomes deeper and the surface flow either infiltrates into the Subbasin, is consumed by the riparian vegetation through transpiration and/or evaporates. During high rainfall events, flow extends Coyote creek further into the Subbasin for short periods of time.

### Historical Stream Flow Measurements

There are two historical 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 10255800 (Upper–Northern) recorded daily discharge data from 1950–1983; at this station, annual average stream flow was measured to be 1,831 acre-feet per year (USGS 2019). USGS Station Number 10255805 (Lower–Southern) recorded daily discharge data from 1983–1993; at this station, annual average stream flow was measured to be 1,774 acre-feet per year (USGS 2019).

6 Over 85 archeological sites have been recorded along the main creek in the Coyote Canyon, including major villages, food processing centers, rock art, and ceremonial and cremation sites (Ostermann and Boyce 2002).

## Exhibit 1. U.S. Geological Survey 10255800 and 10255805 Coyote Creek Stream Flow 1950 to 1993




**Source:** USGS 2019.
**Notes:**
Discharge data from 1950 to 1983 was recorded at the upper-northern Coyote Creek USGS gage (10255800), while data from 1983 to 1993 was recorded at the lower-southern gage (10255805).

Annual variability of stream flow 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. Coyote Creek stream flow is generally correlated with precipitation and spring discharge from Clark Valley. Exhibit 1 shows the combined daily discharge from Coyote Creek USGS streamgages 10255800 and 10255805 for the period from 1950 to 1993.

### Manual Stream Flow Measurements

To evaluate the potential 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 commenced mapping 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 stream flow of 0.46 cubic feet per second (CFS) in Spring 2018, which converts to 206.5 gallons per minute. At that time, the former lower historical USGS streamgage station was observed to be dry.

In Spring 2018, the perennial extent of flow in Coyote Creek was documented to cease downstream of the third-crossing and upstream of the second crossing. No flow was observed in Spring 2018 at the lower inactive USGS streamgage, which is one of the permanent locations for manual flow readings. In Fall 2017, stream flow extended almost half-way from the second crossing to the first crossing. The crossings refer to where an unimproved trail crosses the creek bed, and are shown in Figure 1. In Fall 2017, there was a precipitation event in the Coyote Creek watershed that produced runoff in Coyote Creek; however, no stream flow measurements are available for this event. Flow in the stream was observed to decrease incrementally from the upper inactive USGS streamgage to two locations measured downstream.

"From 1951 to 1992, average daily streamflow in the creek measured at Lower Willows [USGS gages 10255800 and 10255805] was relatively stable and ranged from 0.5 cubic feet per second (cfs) to 4.9 cfs, with the exception of 1980, when the average was 14.8 cfs" (Ostermann and Boyce 2002). The streamflow measurements taken by the GSA at approximately the same location are within the range of historical measurements. The evidence gathered thus far indicates that the reach of Coyote Creek that was mapped as potential GDE by DWR is 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. The evidence points to a losing stream because despite having a watershed size of 94,506 acres, Coyote Creek loses flow with distance downstream (i.e., within 1–2 miles of its crossing into the Subbasin). Stream flow, or lack thereof, has a clear and immediate relationship with runoff events from precipitation. If groundwater emanating from the Borrego Springs Subbasin were contributing to base flow within Coyote Creek, there would be a less rapid and obvious response to precipitation, and rather than going dry upon entering the Subbasin, flow would be expected to be maintained (or even increase) with distance downstream. Additionally, the depth to the regional groundwater table in the Subbasin in the vicinity of Coyote Creek is hundreds of feet below ground surface (288 feet at State Well ID No. 009S006E31E003SI) and disconnected from surface flows.

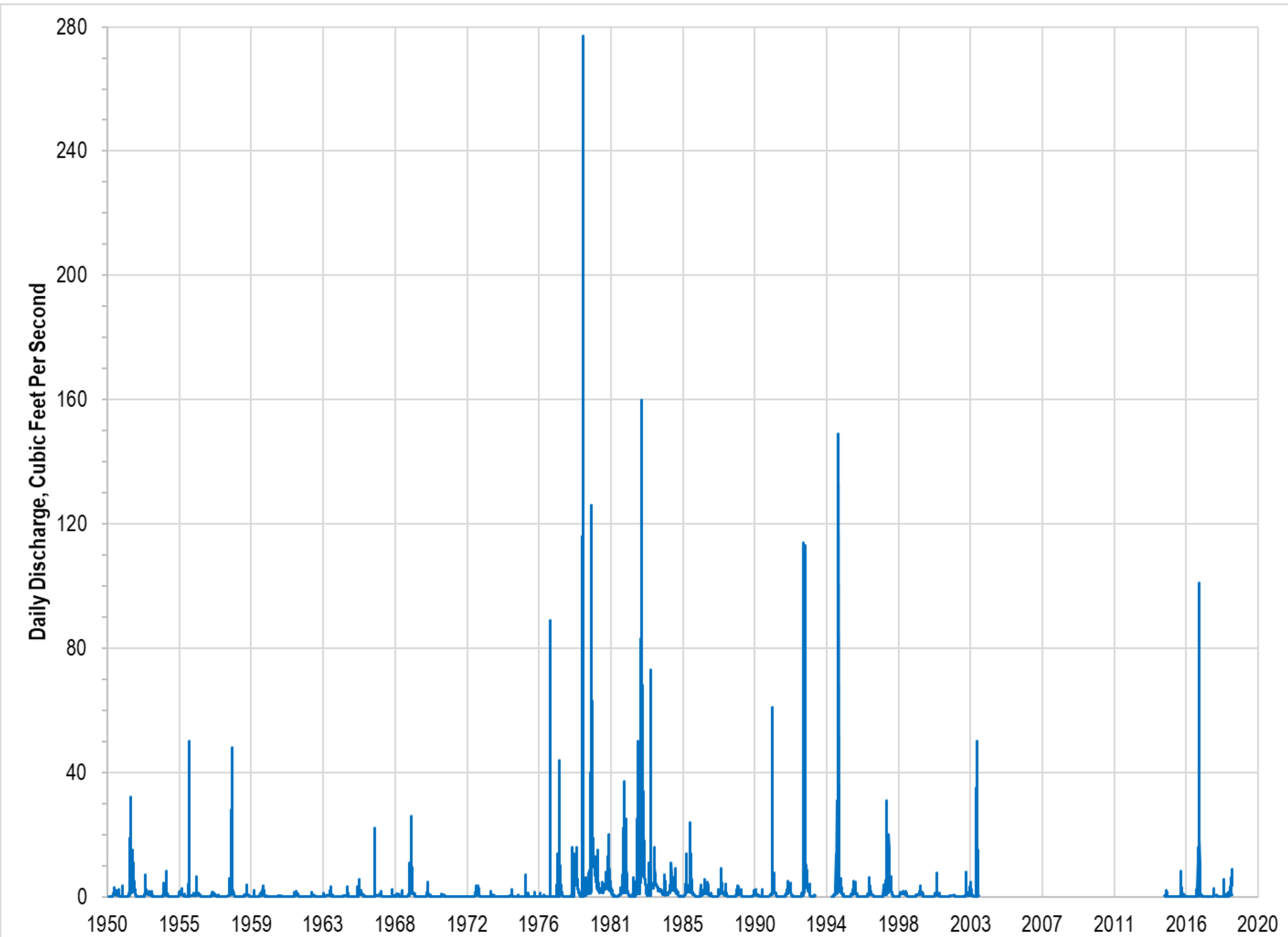
## 3.2 Borrego Palm Creek

Intermittent stream flow from the Borrego Palm Creek watershed is an important source of recharge to the Subbasin. Perennial flow occurs in Borrego Palm Creek upstream of the palm oasis but apart from wetter periods, the perennial flow infiltrates into the ground along the steep alluvial fan that emerges into the Subbasin.

### Historical/Active Stream Flow Measurements

An active streamgage, USGS Station Number 10255810, is located on Borrego Palm Canyon downstream on the palm oasis. This streamgage has a 55-year period of record with sub-daily data (15 minute) from 2015 to 2019, and daily data from 1950 to 2003 (USGS 2019). The data indicate little to no flow over most of the period of record punctuated by higher flows associated with individual precipitation events. During wet years, prolonged stream flow after individual precipitation events is often recorded, but in most years little to no base flow is recorded in the summer months. Brief runoff events occur during occasional thunderstorms. Exhibit 2 shows the daily discharge from Borrego Palm Canyon USGS streamgage 10255810 for the period from 1950 to 2003, and 2015 to 2019. Similar to Coyote Creek, Borrego Palm Creek shows a high annual variability in stream flow, but with a smaller watershed, base flows rarely persist throughout the year, and peak flows are lower. As shown in Exhibit 2, peak flows above 80 cfs have occurred in 1977, 1979, 1980, 1983, 1993, 1995, and 2017. In most years, peak flow remains under 10 cfs, The highest peak flows on have occurred in the summer and winter, while average baseflow peaks in the winter. Total average flow at Borrego Palm Creek streamgage over the period of record is just shy of 1 cfs.

## Exhibit 2. U.S. Geological Survey 10255810 Borrego Palm Canyon Stream Flow 1950 to 2019




**Source:** USGS 2019.
**Notes:** Streamgage was inactive September 30, 2003, to January 6, 2015.

### Manual Stream Flow Measurements

The USGS regularly performs manual streamflow monitoring of its active gages including the Borrego Palm Canyon streamgage. A total of 19 manual measurements were taken by USGS staff in 2018 and 2019 with recorded stream flow of no flow to 7.26 cubic feet per second (449 gpm) (USGS 2019). The clear and consistent relationship between seasonal and episodic precipitation and the patterns of recorded stream flow indicates that the reach of Borrego Palm Creek that was mapped as potential GDE by DWR is 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.

# 4 Honey Mesquite (Borrego Sink)

According to the USGS (2015), the Borrego Sink, a topographic low where the water table prior to development was within 10 feet of land surface, was the site of about 450 acres of honey mesquite and other native phreatophytes, indicating that shallow groundwater and occasional accumulations of surface water was historically sufficient to support a healthy groundwater dependent ecosystem. The chronic decline in groundwater levels that has occurred in the Subbasin since the 1940s caused a rapid decline in both the health and extent of the historical honey mesquite habitat early on in this period. As stated in General Plan Update Groundwater Study completed by the County of San Diego (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 green area in Figure 1 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 NCCAG dataset (DWR 2018).

## 4.1 Historical Accounts (Old Borrego Spring)

Prior to development, mesquite trees, salt grass, willow and rushes were reported to be abundant in the valley (USGS 1909). The habitat is thought to have covered an approximate four-square mile area. Its extent and health benefitted greatly from the presence of a flowing spring (Old Borrego Spring) and groundwater levels estimated to be 10 feet bgs. A shallow groundwater table and Old Borrego Spring is likely to have provided significant support for the recruitment of seedlings, asexual regeneration, and the early stages of maturity.

In 1963, 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. (Reed 2004)

The Old Borrego Spring was located in the vicinity of the Desert Lodge anticline, fold axes running perpendicular to the Veggie Line fault (notice uplifted sediments located south of the Old Borrego Spring and mapped NCCAG vegetation), Coyote Creek fault and Yaqui Ridge/San Felipe anticline associated with the San Jacinto fault zone (Steely 2009) (Figures 1 and 13). The faulting and folding effectively compartmentalize the deep sediments of the Subbasin from the adjacent Ocotillo Wells Groundwater Subbasin. When groundwater levels were closer to the surface in the Subbasin this resulted in 'daylighting' of groundwater at the Old Borrego Spring.

## 4.2 Ecology and Rooting Depth

Honey mesquite are an adaptable species characterized by a dimorphic root system capable of utilizing both surface water and groundwater resources opportunistically. Honey mesquite exhibit mechanisms of drought tolerance, including seasonally changing stomatal sensitivity and osmotic adjustment. Sharifi et al. (1982) stated: "Desert 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.

Within the Borrego Subbasin, this transition has manifested itself through a reduction in the extent, abundance, and health of the honey mesquite community. Figure 1 shows the historical extent of the honey mesquite habitat north and west of the Borrego Sink in pink and blue (as mapped by USGS and the County), and the current extent of the honey mesquite GDE in orange (from the NCCAG dataset). Since pre-development times, the honey mesquite's habitat has shrunk considerably, from about 450 acres in pre-development times to 13.2 acres today, as mapped in the NCCAG dataset. A significant decline in the health of the honey mesquite GDE is confirmed by a preliminary comparison of vegetation transects—one in Clark Valley and the other near the Borrego Sink—provided to the GSA by Mark Jorgenson (former ABDSP superintendent) (Jorgenson 2019). The percentage Honey Mesquite trees counted as dead was 11% in the Clark Valley, which overlies an undeveloped aquifer untapped by pumpers, compared with 53.8% in the Borrego Sink area. Though the methods and criteria used in the population count is not known by the GSA at this time, this further supports the information provided by USGS (2015), indicating that the Honey Mesquite community experienced significant stress and has desiccated, likely as a result of loss of access to groundwater.

Estimates of maximum rooting depths for honey mesquite vary considerably. According to the Fire Effects Information System compiled by the U.S. Forest Service, honey mesquite, in the absence of available subsurface water, can have taproots of up to 190 feet (Sosebee and Wan 1989, as cited in Steinberg 2001). For the genera as a whole (not limited to the *Prosopis glandulosa* species), *Prosopis* roots have been found at a depths of 52 meters (170 feet) in soils (Phillips 1963 as cited in Nilsen et al. 1983), and stands of Prosopis survive in regions with little to no recorded rainfall by tapping underground water resources (Mooney et al. 1980 as cited in Nilsen et al. 1983). The Nature Conservancy published a database of maximum rooting depths for GDE species from published scientific literature and expert opinion through a crowd sourcing campaign, including local and international studies. A compilation of 23 studies of *Prosopis* found their mean root depths to be 20 feet, with a standard deviation of 34 feet (Fan et al. 2017). As shown on Table 1, estimates for maximum rooting depth of honey mesquite species throughout the American southwest range from 6.9–65.6 feet, with the higher values in this range occurring in Texas (Fan et al. 2017).

While honey mesquite has been broadly reported to have extremely deep taproots, the best available information does not support the occurrence of extremely deep taproots. The USGS (2015) notes that the maximum rooting depth for phreatophytes found locally in around the Borrego Sink and areas to the north was 15.3 feet. This is within the range of the closest study of honey mesquite in TNC's database compiled in response to SGMA, which reports the maximum rooting depths to be between 13.12 and 19.69 feet at Harper's Well, California (Nilsen et al. 1983). Given Harper's Well is located approximately 20 miles southeast of the Subbasin, this is considered the best available information on the maximum honey mesquite rooting depth in the Plan Area. With the lack of site-specific information on the root depth of the honey mesquite community, there is very high uncertainty associated with these values. Given the characteristics of honey mesquite as a drought tolerant species with a dimorphic root system able to transition to a less than phreatophytic state, simple comparisons between known groundwater levels and maximum root depths likely oversimplifies the evaluation of impacts to GDEs. The degree to which honey mesquite relies upon surface water must be considered, along with an evaluation of trends over time. This analysis is provided in Section 6.3.

## 4.3 Groundwater Level Trends and Plant Water Use

Recent groundwater levels from wells adjacent to the current and historical honey mesquite habitat range shown in Figure 1 occur at depths from approximately 55 to 134 feet below the ground surface. Since 1955, pumping in the Subbasin has resulted in a groundwater level decline in the vicinity of the Borrego Sink (MW-5A/B) of about 44 feet. The average rate of decline over this period is approximately 0.67 feet per year. The 1955 groundwater level (as measured at Well No. "Sink-7N1") was about 11 feet below ground surface and the most recent groundwater level measured in Fall 2018 (MW-5A/B) was 55 feet below ground surface. As indicated above, this area is thought to have had groundwater levels nearly to the ground surface, based on the presence of a flowing Old Borrego Spring. The "Sink" wells shown in Figure 1 (i.e., 12G1 and 7N1) have become dry based on measurements performed by DWR. Groundwater level measurements collected in 2009 of Sink Well 12G1 and well MW-5B indicated similar groundwater level elevations, which suggests that well MW-5B is sufficiently representative of depth to the groundwater table in the area of the Borrego Sink.

Groundwater levels have long since declined below a level that can support the estimated rooting depth of the habitat, as evidenced by the lack of significant change in habitat health since 1985 (see Section 6.3). Natural discharge determined from the Borrego Valley Hydrologic Model (BVHM) attributable to evapotranspiration was approximately 6,500 acre-feet per year prior to development, but has been virtually zero in the last several decades (1990–2010) (USGS 2015). The BVHM includes a component of evapotranspiration in the water budget, and estimates close to 400 acre-feet of percolating surface water throughout the Subbasin is lost to evapotranspiration under existing conditions. Based on the land uses and mapped vegetation incorporated into the BVHM, this is dominated by losses from non-native tamarisk, and other land uses.

# 5 Potential GDEs Ecological Condition

To assess the ecological condition of potential GDEs, several additional datasets were reviewed.

## 5.1 Threatened and Endangered Species

The Environmental Conservation Online System (ECOS) contains spatial data of critical habitat for threatened and endangered species. Critical habitat for Peninsular bighorn sheep is identified in the Subbasin (Figure 14). Critical habitat for Least Bell's vireo is also identified in the vicinity of the Subbasin near where Coyote Creek enters the Subbasin. Potential effects to these critical habitats must be analyzed along with the endangered species themselves during the California Environmental Quality Act (CEQA) review of the GSP Projects and Management

Actions. The U.S. Fish and Wildlife Information for Planning and Consultation (IPaC) lists the other endangered species in the larger contributing watershed to the Subbasin: 2 mammals, 24 migratory birds, 1 reptile, 2 amphibians, 2 fishes, 2 insects, and flowering plants (USFWS 2018). An official consultation based on the CEQA project description is required with the resource agencies in order to evaluate potential impacts, get an official species list, and make species determinations. TNC has generated a list of freshwater species located within each groundwater basin in California. This list, included as Attachment 1, is provided as a reference to describe the environmental beneficial users of surface water in the Subbasin. Adoption of the GSP is not anticipated to have any adverse impact on this list of species because, as discussed in Section 1, there is no hydrologic connection between the Subbasin's groundwater aquifer and the overlying surface waters.

## 5.2 Areas of Conservation Emphasis

The Areas of Conservation Emphasis (ACE) is a California Department of Fish and Wildlife non-regulatory tool that brings together the best available map-based data in California to depict biodiversity, significant habitats, connectivity, climate change resilience, and other datasets for use in conservation planning. ACE project contains spatial data on native species richness, rarity, endemism, and sensitive habitats for six taxonomic groups: birds, fish, amphibians, plants, mammals, and reptiles. Information on the location of four sensitive habitat types (i.e., wetlands, riparian habitat, rare upland natural communities, and high-value salmonid habitat) are also summarized. The ACE dataset is available statewide based on watersheds using hydrologic units at the 12-digit code level (HUC12) for aquatic habitat. The Borrego Valley HUC12 subwatershed has a low Significant Aquatic Habitat Rank (Figure 15).

The ACE dataset is available statewide at a 2.5-square-mile hexagon grid for terrestrial habitat. The color ramp has been coded at the USDA Ecoregion level with each color approximate to the 20th percentile of land area in the Colorado Desert Ecoregion. The developed areas of Borrego Springs have a terrestrial habitat rank of 0 (Figure 16). Moving outward from the developed area of Borrego Springs the rank increases to higher terrestrial habitat values.

Species Biodiversity Summaries combine the three measures of biodiversity developed for ACE into a single metric. These three measures include: (1) native species richness, (2) rare species richness, and (3) irreplaceability. Much of western flank of the Subbasin is ranked as high species biodiversity [grey hexagons] depicted in Figure 17. Interestingly, the Species Biodiversity Rank seems to conflict with the previous Significant Terrestrial Habitat Rank for the hexagons located in the central portion of the Subbasin.

The California National Diversity Database (CNDDB) or California Special Status Species contains text and spatial information on California's special status species (rare plants and animals). It is a positive detection database. Records in the database exist only where species were detected. This means there is a bias in the database towards locations that have more survey work. Also, the database is proprietary and shall be displayed at such a scale (no larger than a scale of 1:350,000), or in such a way that the viewers/users cannot determine exact location information of the elements mapped in the system. Several positive detections are noted in the CNDDB within the Subbasin (Figure 18).

The California Protected Areas Database (CPAD) 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. This dataset shows that the majority of lands surrounding Borrego Springs are protected areas managed by the Anza Borrego Desert State Park (Figure 19). Additional parcels are managed within the Subbasin by the Anza Borrego Foundation, Borrego Water District (BWD) and County.

# 6 Potential GDEs Hydrogeologic Conceptual Model

A Hydrogeologic conceptual model has been developed for the entire Subbasin to provide the framework for the development of water budgets, analytical and numerical models, and monitoring networks. 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 20 presents the parameters of the HCM developed for the Subbasin, which conceptually depicts basin boundaries, stratigraphy, water table, land use, and the components of inflow and outflow from the Subbasin. In order to better evaluate potential GDEs, it was necessary to refine the Subbasin-wide HCM to address specific areas of the Subbasin representative of the GDE Units. As such, large scale HCMs have been developed for the ephemeral and perennial creeks and drainages (Contributing Watersheds) and the Borrego Sink (honey mesquite) to provide a better understanding of the physical setting, characteristics and processes that govern groundwater occurrence and movement in these unique settings within the larger HCM. The location-specific HCMs are described in the following subsections and shown where they occur in the context of the Subbasin-wide HCM in Figure 20.

## 6.1 Ephemeral and Perennial Creeks and Drainages (Contributing Watersheds)

A HCM was developed for the potential GDEs identified in the Subbasin and at the Subbasin margins. Figure 21 depicts a HCM applicable to GDE Unit 1 – Coyote Creek, GDE Unit 2 – Borrego Palm Creek and other similar canyons that drain mountainous terrain adjacent to the Subbasin. This HCM illustrates that the source of water for potential GDE Units 1 and 2, and other similar canyons is stream flow that originates from outside of the Subbasin. Ephemeral and perennial streams transition to disconnected streams as they flow across the numerous alluvial fans that descend on the Subbasin. Stream flow percolates into a thick unsaturated zone. The regional groundwater table is often hundreds of feet below the streams. At Coyote Creek, the nearest well, State Well ID No. 009S006E31E003SI, has a depth to groundwater of 288 feet below land surface. At Borrego Palm Canyon Creek, the nearest well, State Well ID No. 010S005E25R002S, has a depth to groundwater of 348 feet below land surface. Other wells located adjacent to the Subbasin margins all have depths to groundwater several hundred feet below land surface.

The hydrogeological conceptual model (HCM) of the Subbasin indicates that the groundwater table may shallow within the narrow “fingers” of alluvium that extend into the canyons on the northern and western margins of the Subbasin (fringe areas), because the subsurface boundary between the alluvium and bedrock steeply rises in these locations. The groundwater monitoring network does not extend into these fringe areas; however, the deepest groundwater levels in the Subbasin are consistently recorded in monitoring wells located less than one mile away (i.e., State Well ID Nos. 009S006E31E003SI and 010S005E25R002S, ID4-2, ID4-3, ID4-10, and ID4-18). Desert alluvial fans such as those abutting the mountain front are natural recharge zones, meaning that groundwater declines in the Subbasin do not affect surface water conditions underlying the mouths of the canyons or at the head of these alluvial fans. Alluvium extending into these canyons can be conceptualized as containing groundwater that is perched on bedrock shelves hundreds of feet above the Subbasin’s aquifer. Both field observations and aerial photography show that stream flows that emerge from the canyons, when present, rapidly diminish with distance from the canyons as flow is lost to recharge. The Subbasin as a whole is therefore a system whose surface waters are disconnected from the underlying groundwater table (i.e., losing streams), which exists at considerable depths.

Groundwater extraction from water wells in the Subbasin does not effect GDEs associated with ephemeral and perennial creeks and drainages because the groundwater accessed by the wells is not water that is accessible or available to the potential GDEs.

## 6.2 Borrego Sink (Mesquite Bosque)

A HCM was developed for the Borrego Sink (Mesquite Bosque) to evaluate potential GDEs. Figure 22 depicts a HCM for potential GDE Unit 3 - Borrego Sink (Mesquite Bosque). The Borrego Sink is a topographic low in the Subbasin. The sink in all but the most exceptional wet years acts as closed or terminal basin where flood waters pool and fine sediment settles. After flood events, most of the water that reaches the sink evaporates leaving a white crust of salt that is often visible on the surface of the sink. Some of the flood waters that reach the sink percolate into the fine sediment and may locally support perched groundwater zones. As previously discussed in Section 4, Old Borrego Spring no longer discharges to the Borrego Sink.

Driller's logs for wells located in the vicinity of the Borrego Sink were reviewed to characterize the subsurface lithology. In particular, the log for MW-5A and 5B and Rams Hill test borehole No. 12 were reviewed.

MW-5 is a multicompletion well constructed in 2006 drilled to a depth of 480 feet bgs under the oversight of the BWD and DWR. MW-5 is located about 1.2 miles northeast of the Borrego Sink.

> In general, the boring encountered variably thick interbedded materials (silt and clay). Based on the borehole cuttings and the geophysical logs, the geologic materials encountered can be separated into three main zones or sequences divided at prominent clay layers: an upper zone dominated by poorly consolidated coarse grained materials from the surface to about 165 feet bgs; a middle zone of moderately consolidated interbedded fine- and coarse-grained materials between 165 feet and 355 feet bgs; and a lower zone of consolidated or lithified beds for fine-grained and coarse-grained material between 355 to 480 feet bgs. (DWR 2007)

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 water table. MW-5A is screened 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.

Test borehole No. 12 was drilled in 2014 about 0.5 mile south of the Borrego Sink, immediately south of the Rams Hill Wastewater Treatment Facility. Interbedded sand, silt and clay was encountered to a total borehole depth of 764 bgs. Coarser material was only encountered at the surface to a depth of about 30 feet, and in one zone from 490 to 610 feet bgs. Thick clay zones with thin interbedded silty sands were encountered from 30 to 490 feet and form 610 feet to 764 feet (Dudek 2014). The depositional environment indicated by log is often one of low energy as evidenced by thick fine grain deposits. The depositional environment of the upper portion of the log is consistent with that of a desert playa (current depositional environment) and lacustrine setting (lake setting that occurred in desert basins during the last ice age [Pleistocene Epoch]). Deeper sections of the borehole may have encountered the Palm Springs Formation. The Borrego Sink HCM illustrates the predominantly fine sediment characterized in the subsurface in the vicinity of the Borrego Sink with coarser sediment shown proximal to mountainous terrain from which the sediments are derived (Figure 22).

Groundwater levels in the vicinity of the Borrego Sink have been measured at “Sink” wells 7N1 and 12G1 since 1953 and 1965, respectively, and MW-5A and MW-5B since 2006. The “Sink” wells have since become dry based on measurements performed by DWR in 2009. It is not known exactly when the Sink wells went dry; however, the groundwater level in well 7N1 was last measured by the USGS in 1965 at a depth of 36.0 feet bgs and well 12G1 was measured by the DWR in 2009 at a depth of 64.0 feet bgs. The total well depth of 7N1 is 30.0 feet and 12G1 is 65.2 feet as measured by DWR.[7] The overlap of a groundwater level measurement in 2009 of Sink Well 12G1 with MW-5B has a similar groundwater level elevation suggesting that well MW-5B is sufficiently representative of depth to the unconfined groundwater table in the area of the Borrego Sink. The depth to groundwater at MW-5B in Spring 2018 was 55 feet bgs. The groundwater table in the vicinity of the Borrego Sink has declined approximately 44 feet over the period from 1953 to 2019. The decline in the groundwater table in the vicinity of the Borrego Sink has resulted in the drying of Old Borrego Spring and desiccation of the honey mesquite as previously discussed in Section 4. Given that groundwater levels likely will not substantially recover under current climate conditions and pumping volumes, the impacts to the Borrego Sink are considered permanent and irreversible.

## 6.3 Evaluation of Remote Sensing Data

Comparison of aerial photography shows GDE Units 1 and 2, and other GDEs mapped around the western margins of the Subbasin have remained in place since the early 1950s, despite a long term and persistent trend of declining groundwater levels in the Subbasin. This suggests that these communities are being supported by surface water entering the Basin from perennial and ephemeral waters originating outside its boundaries, rather than the regional water table within the Subbasin. See Attachment 2 for aerial photograph comparison.

As discussed in Section 4.2, the estimate of rooting depth for honey mesquite is based on the best available data, but has a high degree of uncertainty. Based on the GDEs HCM discussed above (Section 6.2), water levels are believed to have dropped below the root depth of the honey mesquite early in the Subbasin’s history of pumping (i.e., prior to 1985). TNC’s GDE Pulse tool was used was used to evaluate if declining groundwater levels since 1985 have had any effect on the honey mesquite community (GDE Unit 3) mapped in the NCCAG dataset. The GDE pulse dataset provides annual data averaged for each NCCAG-mapped polygon that assess plant greenness and moisture indices (Klausmeyer et al. 2019):

- **The Normalized Difference Vegetation Index (NDVI)** is a satellite-derived index that represents the greenness of vegetation. The average NDVI for each GDE polygon from Landsat data during the driest part of the year (July 9-Sept 7) was calculated to estimate vegetation health when the plants are most likely dependent on groundwater.
- **The Normalized Difference Moisture Index (NDMI)** is a satellite-derived index that represents water content in vegetation. NDMI is derived from the Near-Infrared (NIR) and Short Wave Infrared (SWIR) channels. The average NDVI for each GDE polygon from Landsat data during the driest part of the year (July 9-Sept 7) was calculated to estimate vegetation health when the plants are most likely dependent on groundwater.

7 The total well depth of Sink well 7N1 measured by DWR at 30 feet is less than the last groundwater level measured by USGS in 1965 of 36.0 feet. Sink well 7N1 likely either collapsed at 30.0 or is filled with sediment in the bottom of the well.

Using the annual dry-month medoids, Klausmeyer et al. (2019) calculated the NDVI and NDMI vegetation metrics (VMs) as a useful means to provide a proxy for vegetation growth and water stress, which are helpful variables for inferring ecosystem health. Klausmeyer et al. (2019) states the following:

> Living vegetation absorbs radiation in portions of the visible spectrum and reflects in the near-infrared (NIR), whereas radiation in the red as well as shortwave-infrared (SWIR) is absorbed by water present in the vegetation. Therefore, NIR and red wavelengths are sensitive to variations in photosynthetic chlorophyll, and SWIR wavelengths are sensitive to variations in moisture. Numerous spectral vegetation indices have been used to study vegetation health, drought impacts on vegetation, and deforestation. NDVI is the most widely used VM in the literature and is a reliable measure of the photosynthetic chlorophyll content in leaves and vegetation cover (Figure 1) (Rouse et al. 1974; Jiang et al. 2006). NDVI has been used in several studies to identify terrestrial ecosystems and wetlands that depend on groundwater based on the principle that ecosystems that are able to maintain consistent greenness during a prolonged dry period, are defined as potentially groundwater-dependent (Gou, Gonzales, and Miller 2015; Barron et al. 2014; Doody et al. 2017). NDMI is based on the NIR and SWIR bands and is also widely used in the literature as a metric of vegetation moisture stress. (Wilson and Sader 2002; Jinand Sader 2005)

Because of the highly arid environment in Borrego Springs, NDVI is selected as the most useful metric to document plant health. Klausmeyer et. al (2019) provides an example that characterizes “healthy” vegetation as having a NDVI of 0.72 and an “unhealthy” vegetation as having an NDVI of 0.14. It should be noted that such qualifications are species specific, and that at the time that Landsat images are taken (summer), honey mesquite is in its dormant phase.

Tables 3a and 3b present yearly average NDVI by dominant species for NDVI and NDMI, respectively. For all species other than Tamarisk, the long term trend has been one of “little to no change” as categorized in TNC’s GDE Pulse mapper. Furthermore, When the data is summarized by GDE Unit, the picture is similar. NDVI changes very little in the period between 1985 and 2018. Exhibit 3 relates the average NDVI and NDMI in the NCCAG-mapped polygons to groundwater levels and annual precipitation. A statistical correlation analysis between the VMs, groundwater levels and precipitation found the following:

- There is no correlation between the NDVI index and groundwater levels between 1985 and 2018. During this time frame, groundwater levels are estimated to have declined by 21 feet, based on groundwater level monitoring in Well MW-5A/B and in Sink Wells 12G1 and 7N1.
- There is a moderately positive correlation between the NDVI index and precipitation.
- Changes in NCCAG plant health indices after 1985—throughout the Subbasin, and regardless of the time interval chosen—are on average flat, slightly increasing, or slightly decreasing.

Evaluation of plant health indices derived from Landsat data have shown that there have been minimal changes in vegetation moisture and/or greenness since 1985 within any of the potential GDEs mapped within the Subbasin. Changes observed by year between 1985 and 2015 have been minor, and have tracked consistently with changes in annual precipitation occurring over the same time frame, rather than the steady decline in groundwater levels.

If potential GDEs were relying primarily on the regional groundwater table, one would expect to see a steady decline in community health over the 20 year period.

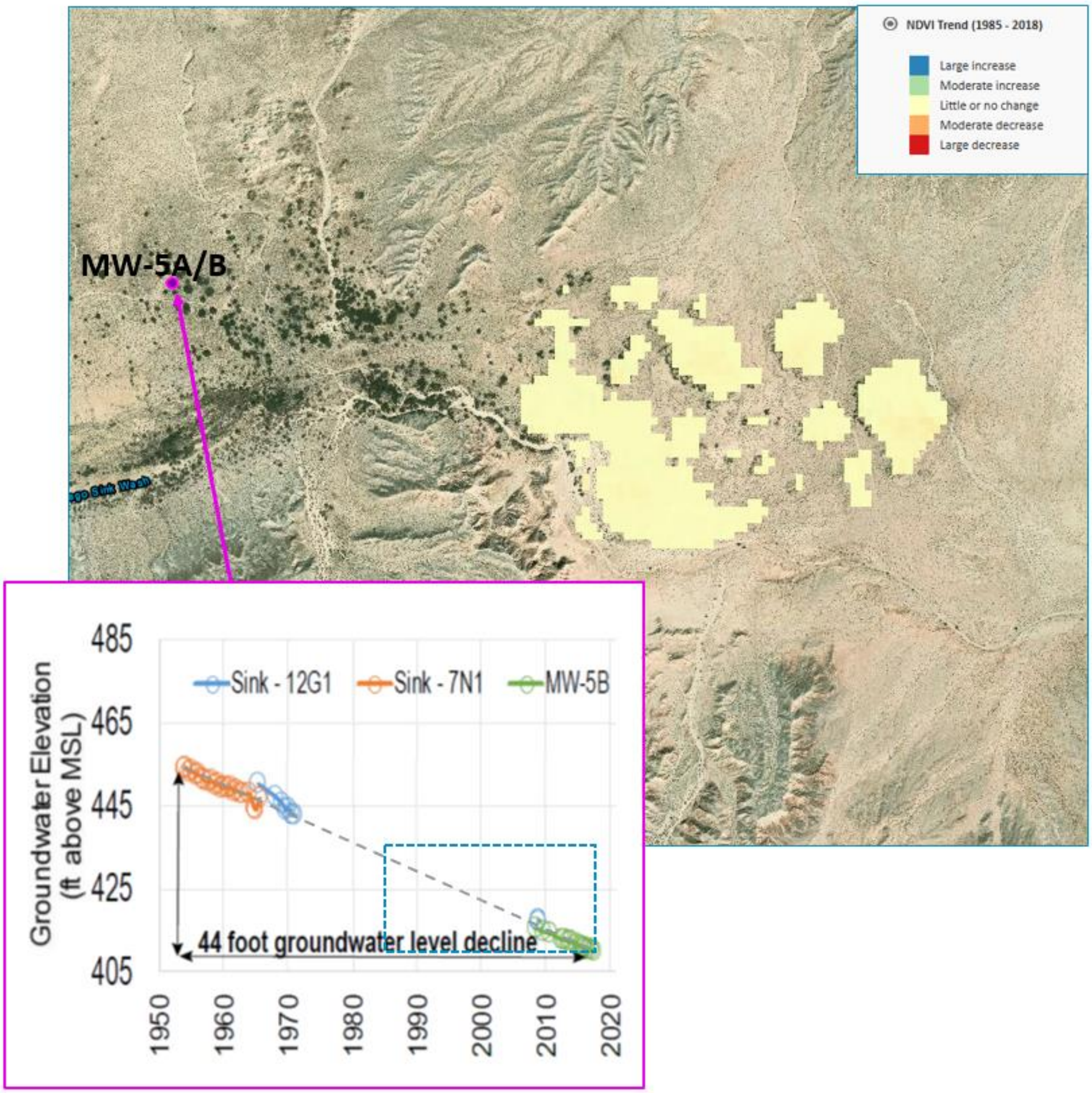
### Table 3a. Yearly Average Normalized Difference Vegetation Index Statistics by Dominant Species (1985–2018 )

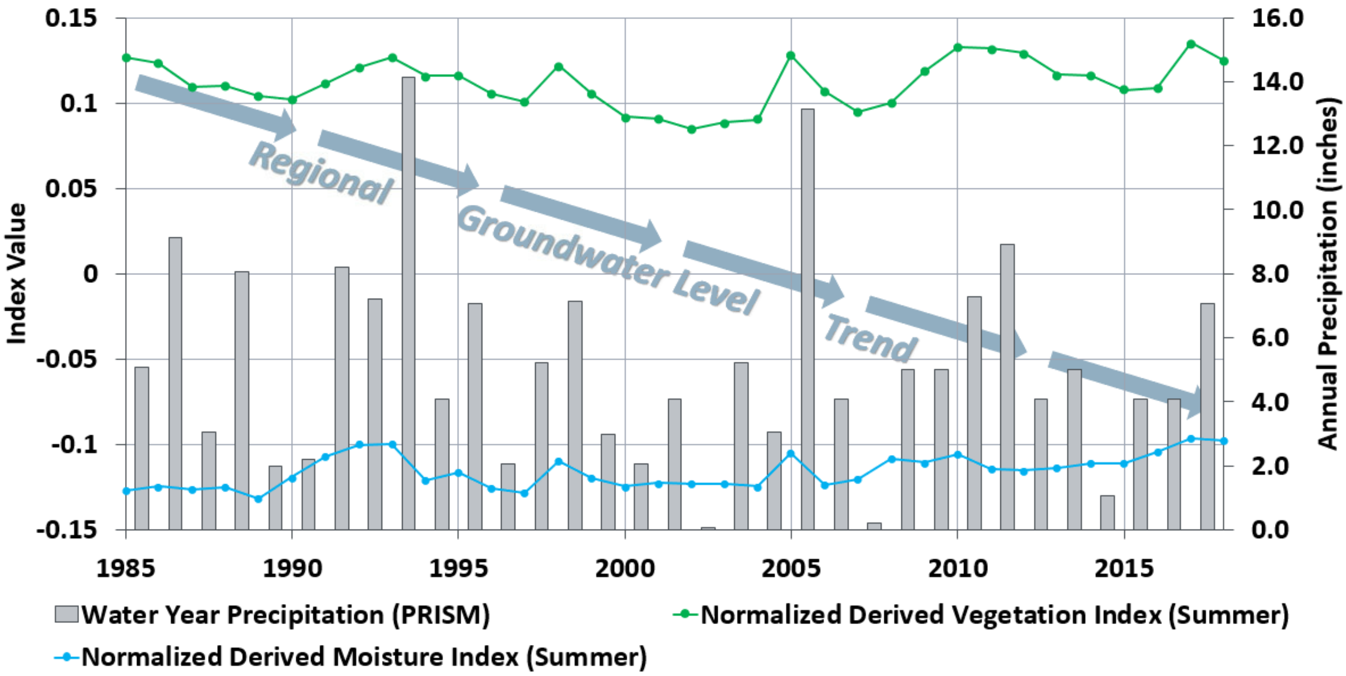
| | Catclaw Acacia | Desert Willow | Honey Mesquite | Narrowleaf Willow | Tamarisk | California Fan Palm |
|---|---|---|---|---|---|---|
| Average | 0.1211 | 0.1085 | 0.1161 | 0.1162 | 0.2621 | 0.2512 |
| Minimum | 0.0928 | 0.0783 | 0.0887 | 0.0889 | 0.2660 | 0.2501 |
| Maximum | 0.1458 | 0.1363 | 0.1379 | 0.1449 | 0.2702 | 0.2489 |
| Change (1985 to 2018) | 0.0075 | 0.0074 | -0.0006 | -0.0006 | -0.1540 | 0.0092 |

### Table 3b. Yearly Average Normalized Difference Vegetation Index Statistics by Groundwater Dependent Ecosystem Unit (1985–2018 )

| | GDE Unit 1 | GDE Unit 2 | GDE Unit 3 | Other |
|---|---|---|---|---|
| Average | 0.1481 | 0.1719 | 0.1002 | 0.1224 |
| Minimum | 0.1148 | 0.1138 | 0.0756 | 0.0986 |
| Maximum | 0.1783 | 0.2057 | 0.1271 | 0.1639 |
| Change (1985 to 2018) | 0.0348 | -0.0143 | -0.0150 | -0.0015 |

## Exhibit 3. Relationship between Groundwater Dependent Ecosystem Health Indicators, Groundwater Levels, and Precipitation






# 7 Evaluation of Nexus of GDEs with Subbasin Groundwater

The SGMA definition of GDEs was applied to evaluate reliance of ecological communities and species on Subbasin groundwater. The evaluation revealed that Subbasin creeks can be characterized as losing streams in that they primarily act as groundwater recharge areas rather than local discharge of groundwater from the Subbasin to the stream reach. Potential GDEs that exist within Subbasin creek drainages rely on both periodic surface flows and soil moisture, and not directly on the regional groundwater table, which based on groundwater levels recently measured adjacent to the creek drainages indicate groundwater levels are beyond the rooting depth zone of existing vegetation mapped as potential GDEs.

The impact of rapidly declining groundwater levels on GDE vegetation is most apparent in the Borrego Sink. The honey mesquite that previously flourished in the Borrego Sink has desiccated and its areal extent has decreased significantly as groundwater levels have dropped in response to increased groundwater extraction. Pumping in the Subbasin has resulted in a groundwater level decline of about 44 feet over the last 65 years in the vicinity of the Borrego Sink. Recent groundwater levels from wells adjacent to the main mapped habitat range from approximately 55 to 134 feet below the ground surface. Because of the long-term imbalance of pumping with available natural recharge, an irreversible impact has occurred to the honey mesquite, which is mostly desiccated prior to January 1, 2015.

Vegetation that occurs in the Borrego Sink has access to soil moisture in the unsaturated zone and potentially perched groundwater where present. Perched groundwater consists of local pockets (or lenses) of low permeability sediment (e.g., clay and silt) that “pinch out,” meaning they are not laterally extensive enough to be considered a regionally significant aquitard. These zones are considered “perched” because they occur above the regional groundwater table, and thus are disconnected from changes experienced within regional aquifer (including outflows such as pumping). With these types of subsurface conditions, surface water may be slower to percolate into the underlying regional groundwater table, possibly providing conditions necessary to sustain remnant stands of honey mesquite and/or support ongoing recruitment in combination with periodic storm flow events. The percolating groundwater used by this vegetation removes water that would otherwise constitute recharge. In other words, rather than the regional aquifer being a water source for the vegetation, the vegetation subtracts from the water available for deep infiltration.

# 8 Conclusion and Recommendations

A review of available pertinent spatial datasets, historical data including stream flow and groundwater levels, satellite-derived vegetation metrics, and geology was completed to develop a robust HCM to evaluate nexus of GDEs with Subbasin regional groundwater levels. Because of the long-term imbalance of pumping with available natural recharge, an irreversible impact has likely occurred on the honey mesquite community from a decline in groundwater levels, an impact which, based on the best available science, was completed and became permanent sometime prior to 1985. The comprehensive assessment revealed potential GDEs identified within the Subbasin no longer have direct reliance on groundwater emerging from aquifers or on groundwater occurring near the ground surface, and instead are sustained by periodic stormwater flows, soil moisture, and potentially perched groundwater where present. These findings indicate that based on best available data there is no need for the GSP to address minimum groundwater level thresholds with respect to potential GDEs.

Detailed mapping of vegetation is lacking for the area in the vicinity of the Borrego Sink. Groundwater level monitoring of wells located in the vicinity of the Borrego Sink should continue.

# 9 References Cited

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

Ansley R.J., P.W. Jacoby, and R.A. Hicks. 1991. Leaf and whole plant transpiration in honey mesquite following severing of lateral roots. Journal of Range Management. 44(6). November 1991.

County of San Diego. 2010. Final County of San Diego Department of Planning and Land Use General Plan Update Groundwater Study. Prepared by James J. Bennett. April 2010.

DWR (California Department of Water Resources). 2007. An Interpretation of Geologic Materials Encountered in the Boring of Borrego Water District Monitoring Well MW-5. Technical Information Record SD-07-02. Prepared by D. Ellis and T. Ross. April 2007.

DWR. 2018. Summary of the "Natural Communities Commonly Associated with Groundwater Dataset and Online Web Viewer. April 2018.

Dudek. 2014. Log of Test Hole No. 12 Rams Hill. Borrego Springs, California. October 2014.

Fan, Y., G. Miguez-Macho, E.G. Jobbágy, R.B. Jackson, and C. Otero-Casal. 2017. Hydrologic Regulation of Plant Rooting Depth. PNAS Vol.114 No.40 (pp. 10572-10577). October 3, 3017.

Klausmeyer, K.R., T. Biswas, M.M. Rohde, F. Schuetzenmeister, N. Rindlaub, and J.K. Howard. 2019. GDE Pulse: Taking the Pulse of GroundwaterDependent Ecosystems with Satellite Data. San Francisco, California.Available at https://gde.codefornature.org.

Jorgensen, M. 2019. Comment Letter on the Draft GSP for the Borrego Springs Groundwater Subbasin. Addressed to Mr. Bennett, Planning and Development Services, County of San Diego. May 17, 2019.

Nilsen E.T., S.M. Rasoul, P.W. Rundel, W.M. Jarrell, and R.A. Virginia. 1983. Diurnal and Seasonal Water Relations of the Desert Phreatophyte Prosopis Glandulosa (Honey Mesquite) in the Sonoran Desert of California. Ecology, Vol. 64, No. 6 (Dec., 1983), pp. 1381-1393. December 1983.

Ostermann, S.D., and W.M. Boyce. 2002. Ecological conditions in Coyote Canyon, Anza-Borrego Desert State Park®: an assessment of the Coyote Canyon Public Use Plan. Report prepared for California State Parks Colorado Desert District. 67 pages. July 2002.

Reed, L. 2004 (1963 First Edition). Old Time Cattlemen and Other Pioneers of the Anza-Borrego Area. Third Edition, Second Printing. Published by the Anza-Borrego Desert natural History Association. Borrego Springs, California. 2004.

San Diego Reader. 2010. Tubb Canyon. Borrego Springs. Jerry Schad. March 3, 2010.

SANGIS. 2017. "ECO_VEGETATION_CN" Layer. Regional Vegetation to illustrate the vegetation communities and disturbed areas throughout San Diego County. Available at http://www.sangis.org/download/ available.html. Last update 10/29/2017.

Sharifi, R.M., E.T. Nilsen, P.W. Rundel. 1982. Biomass and net primary production of Prosopis glandulosa (Fabaceae) in the Sonoran Desert of California. American Journal of Botany. 69(5): 760-767. [5469].

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.

Steinberg, P. 2001. Prosopis glandulosa. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.fed.us/database/feis/plants/tree/progla/all.html [2019, July 24].

TNC (The Nature Conservancy). 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act Guidance for Preparing Groundwater Sustainability Plans. January 2018.

USFWS (U.S. Fish and Wildlife Service). 2018. Information for Planning and Consultation. Endangered Species List. Accessed at https://ecos.fws.gov/ipac/. 2018.

USGS (U.S. Geological Survey). 1909. Some Desert Watering Places in Southeastern California and Southwestern Nevada. Water-Supply Paper 224. Prepared by Walter C. Mendenhall.

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. 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. StreamStats, Version 4. Fact Sheet 2017-3046 4 p., [Supersedes USGS Fact Sheet 2008–3067.] Prepared by Ries, K.G., III, Newson J.K., Smith, M.J., Guthrie, J.D., Steeves, P.A., Haluska, T.L., Kolb, K.R., Thompson, R.F., Santoro, R.D., and Vraga, H.W. https://doi.org/10.3133/fs20173046.

USGS. 2019. The National Map. Watershed Boundary Dataset. Web Map Viewer. Accessed at https://viewer.nationalmap.gov/advanced-viewer/. Accessed June 2019.

# 10 Advisory Committee Meeting GDEs Presentations

GDE presentations by DUDEK at SGMA Borrego Valley GSP Advisory Committee meetings in chronological are as follows:

| | |
|---|---|
| ACM 2017.11.27 | Coyote Creek |
| ACM 2018.05.31 | Groundwater Dependent Ecosystems |
| ACM 2018.07.26 | Groundwater Dependent Ecosystems |
| ACM 2019.01.31 | Groundwater Dependent Ecosystems (GDEs) Approach in GSP |
| ACM 2019.07.25 | Groundwater Dependent Ecosystems Response to Public Comments |

Presentations are available from the County of San Diego's Borrego Valley Groundwater Basin website: https://www.sandiegocounty.gov/content/sdc/pds/SGMA/borrego-valley.html

# Tables, Figures, and Attachments

## Table List



## Exhibit List (exhibits are located within body of text)



## Figure List

## Attachments

Attachment 1 California Freshwater Species Database (Borrego Springs Groundwater Subbasin)
Attachment 2 Aerial Photography Comparison

# Figures 1–22

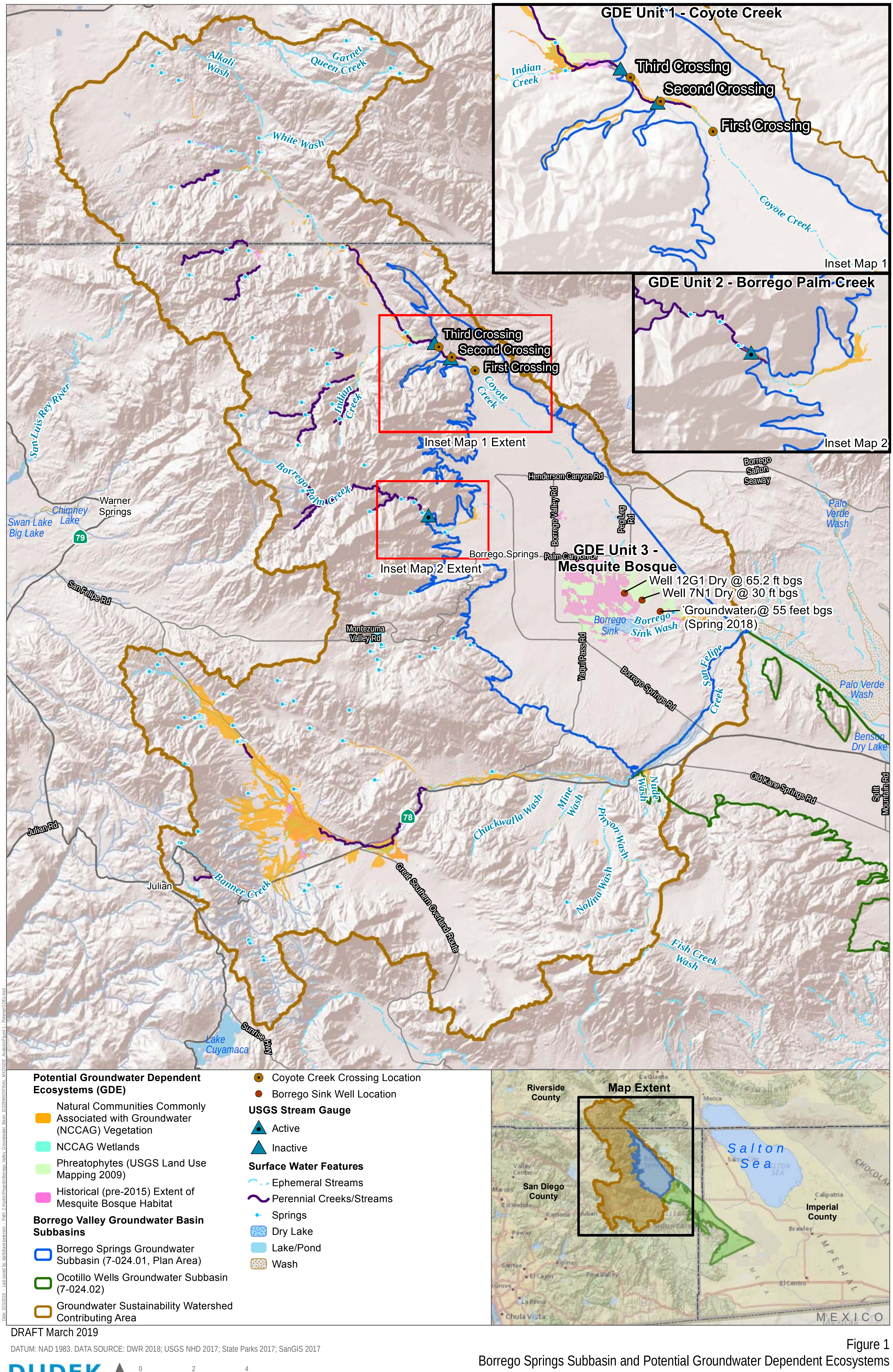
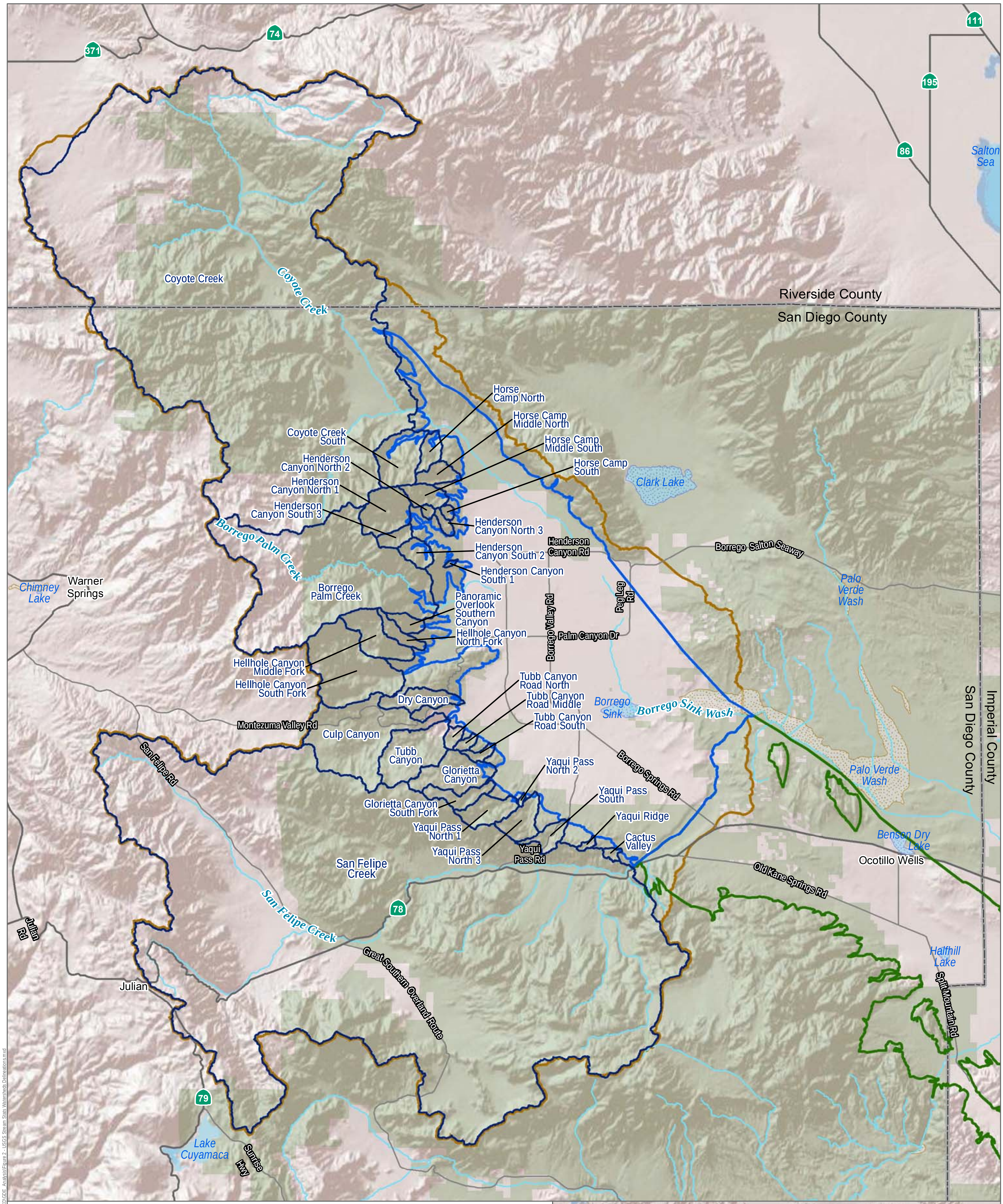



Figure 1
Borrego Springs Subbasin and Potential Groundwater Dependent Ecosystems




USGS Stream Stats Watershed Delineations

Groundwater Sustainability Watershed Contributing Area

California Department of Parks and Recreation (2012)

**Borrego Valley Groundwater Basin Subbasins**

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

Ocotillo Wells Groundwater Subbasin (7-024.02)

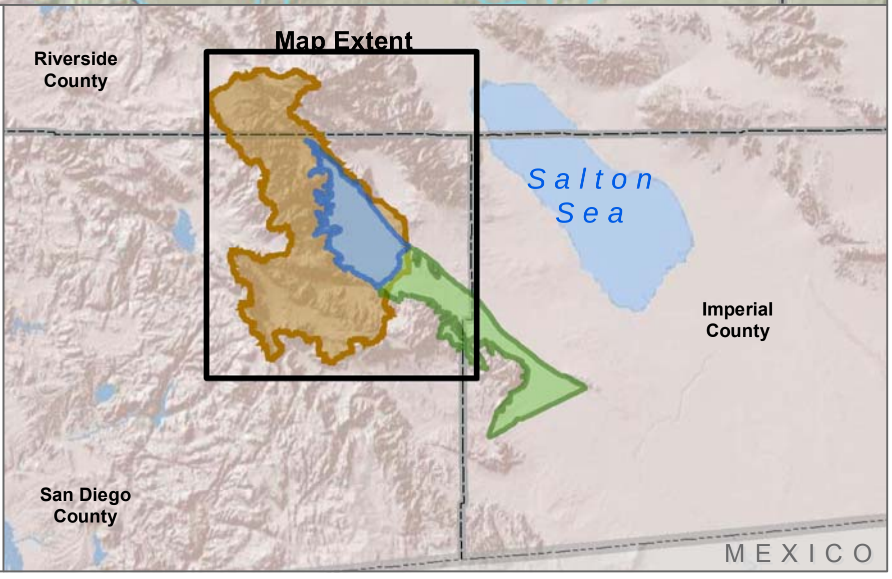
**Surface Water Features**

Major Flow Paths

Dry Lake

Lake/Pond

Wash




DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS Stream Stats 2018

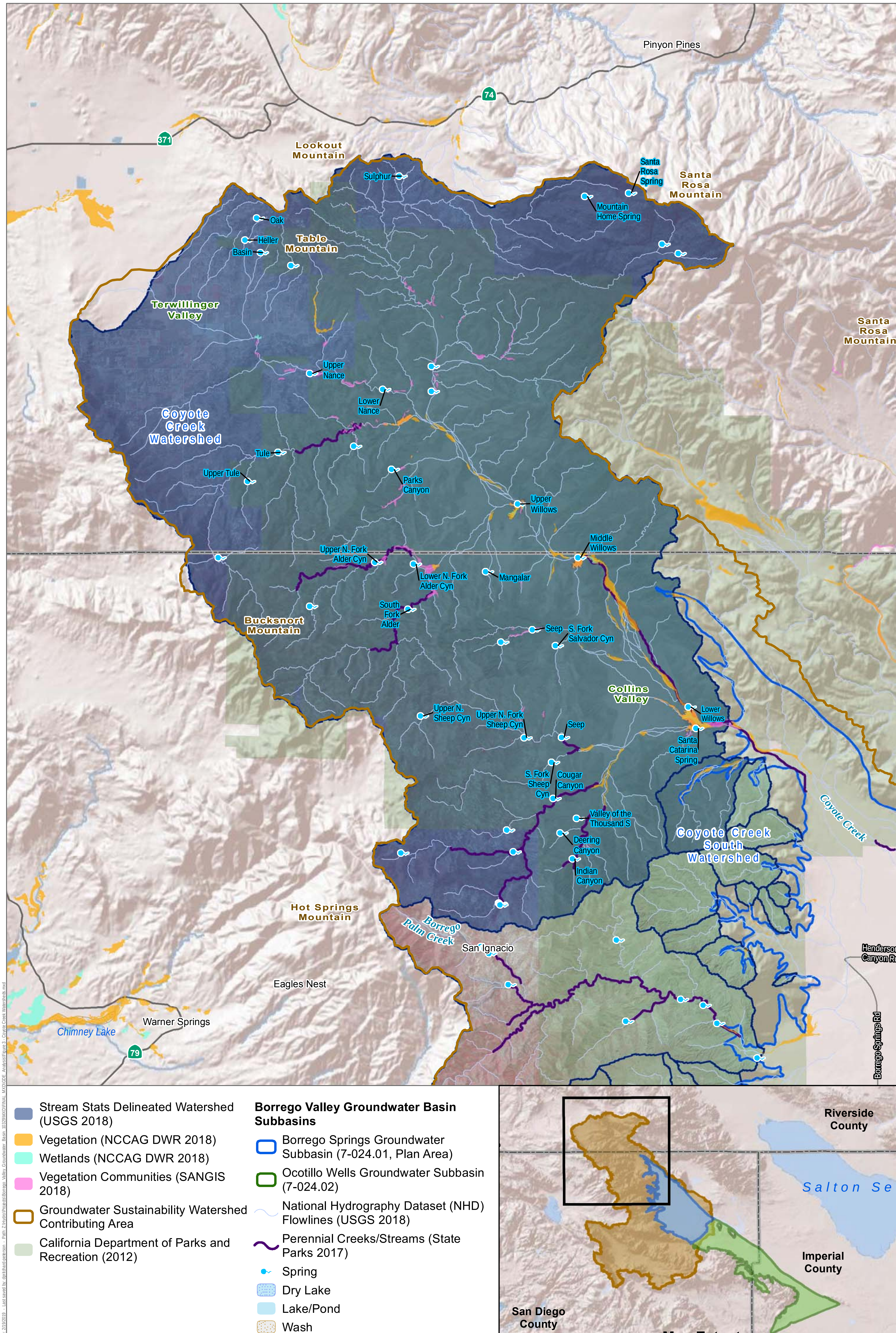
DUDEK

0 2 4 Miles

Figure 2

USGS Stream Stats Watershed Delineations

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




DRAFT February 2019

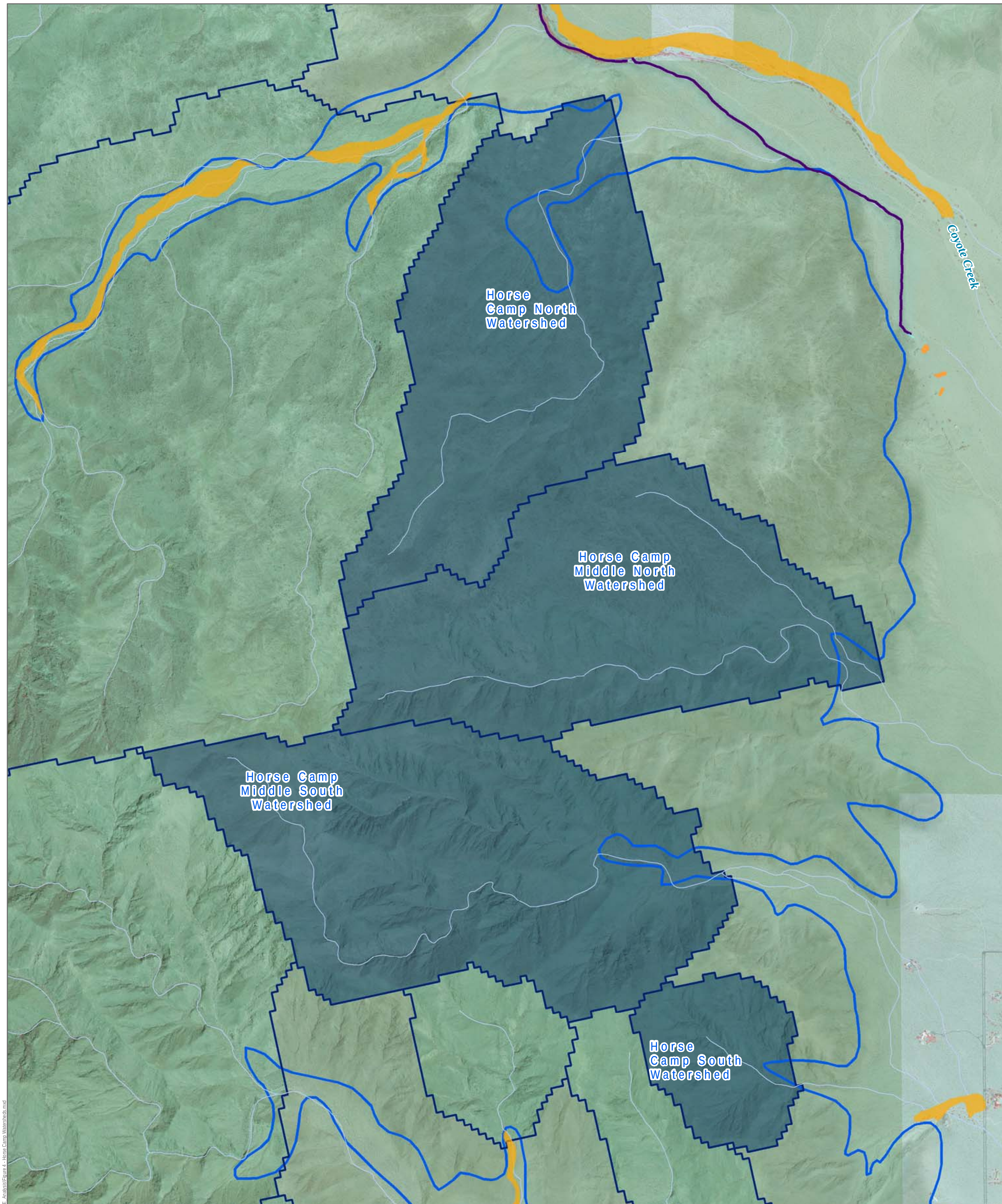
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 2 4 Miles

Figure 3
Coyote Creek Watersheds

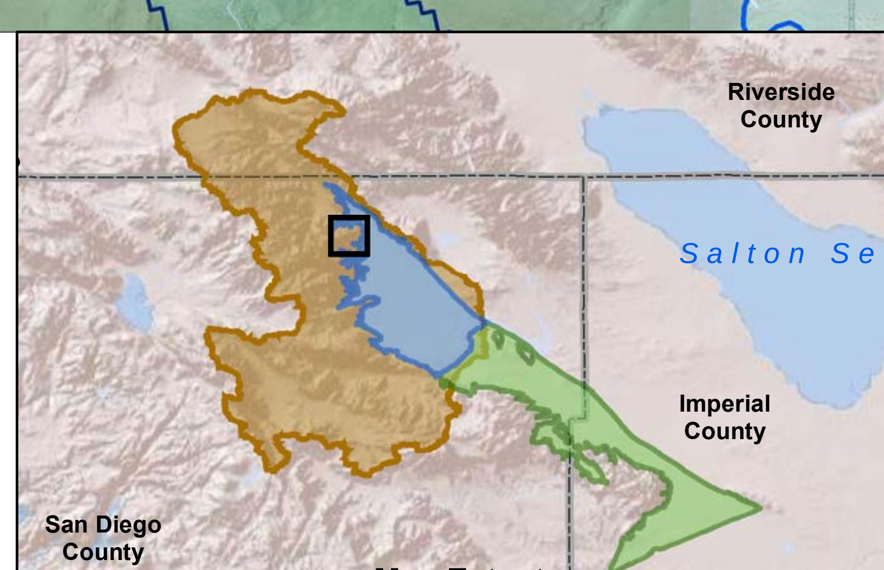
Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




Stream Stats Delineated Watershed (USGS 2018)
Vegetation (NCCAG DWR 2018)
Wetlands (NCCAG DWR 2018)
Vegetation Communities (SANGIS 2018)
Groundwater Sustainability Watershed Contributing Area
California Department of Parks and Recreation (2012)

**Borrego Valley Groundwater Basin Subbasins**

Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
Ocotillo Wells Groundwater Subbasin (7-024.02)
National Hydrography Dataset (NHD) Flowlines (USGS 2018)
Perennial Creeks/Streams (State Parks 2017)




DRAFT February 2019

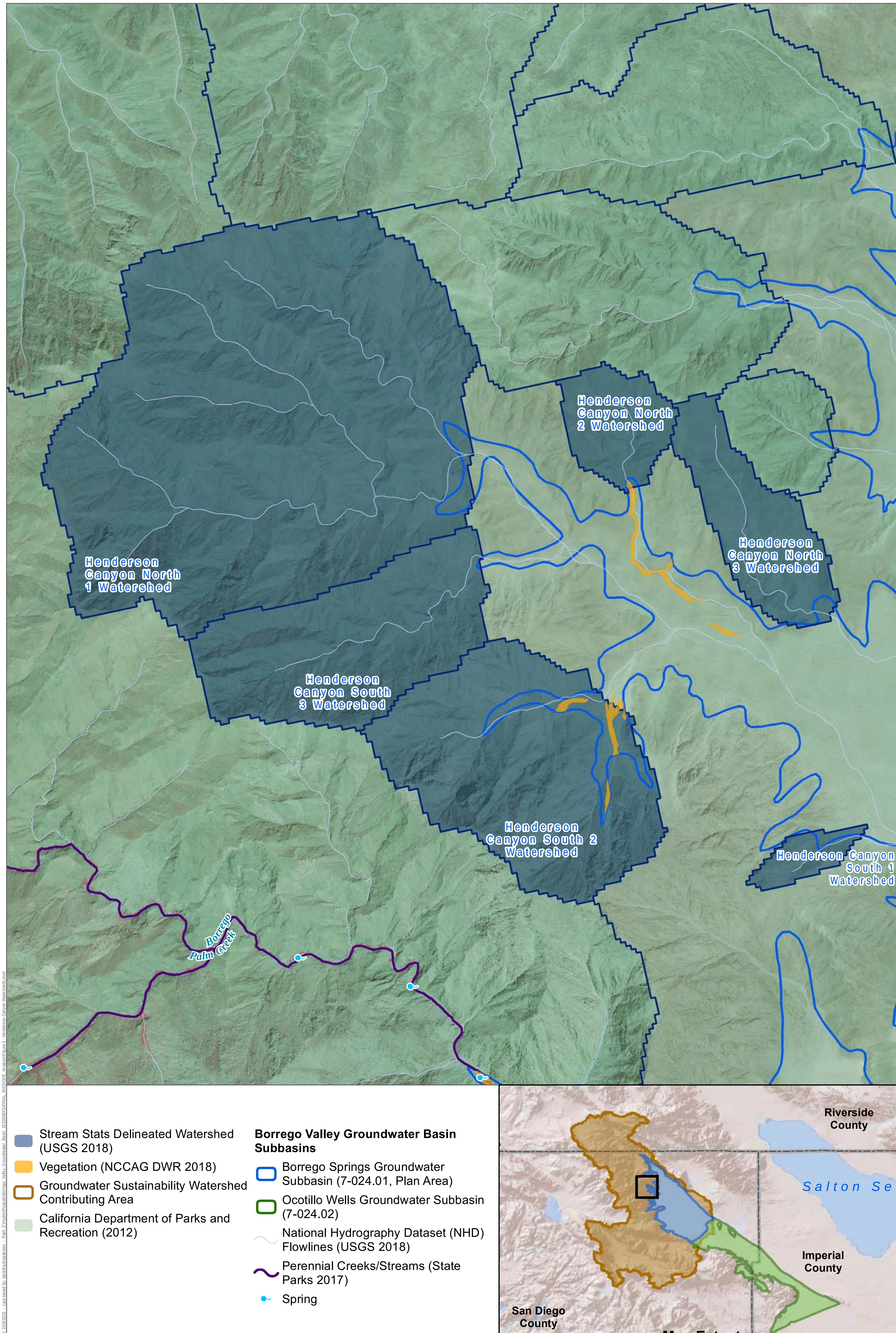
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.25 0.5 Miles

Figure 4
Horse Camp Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

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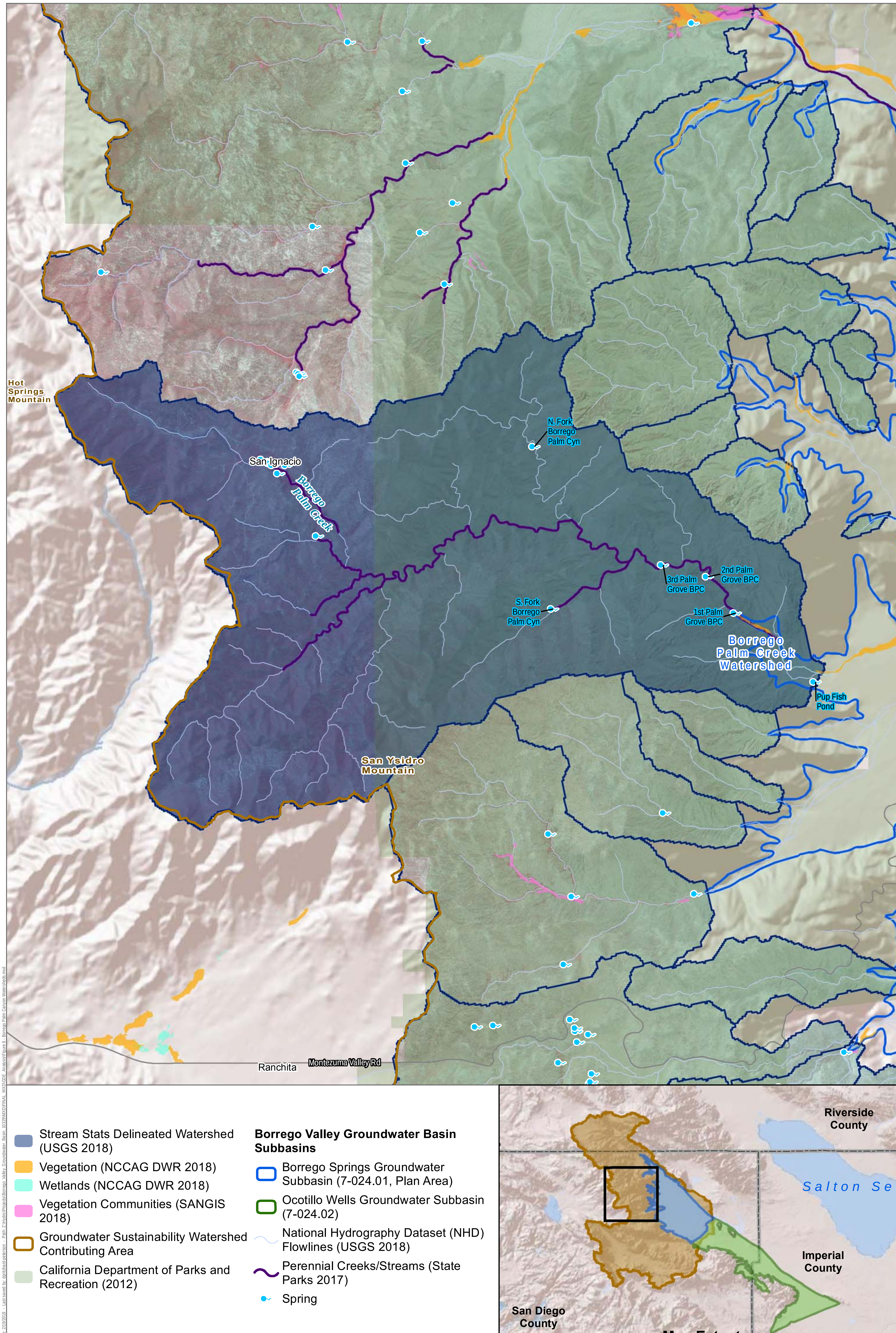
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 5
Henderson Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

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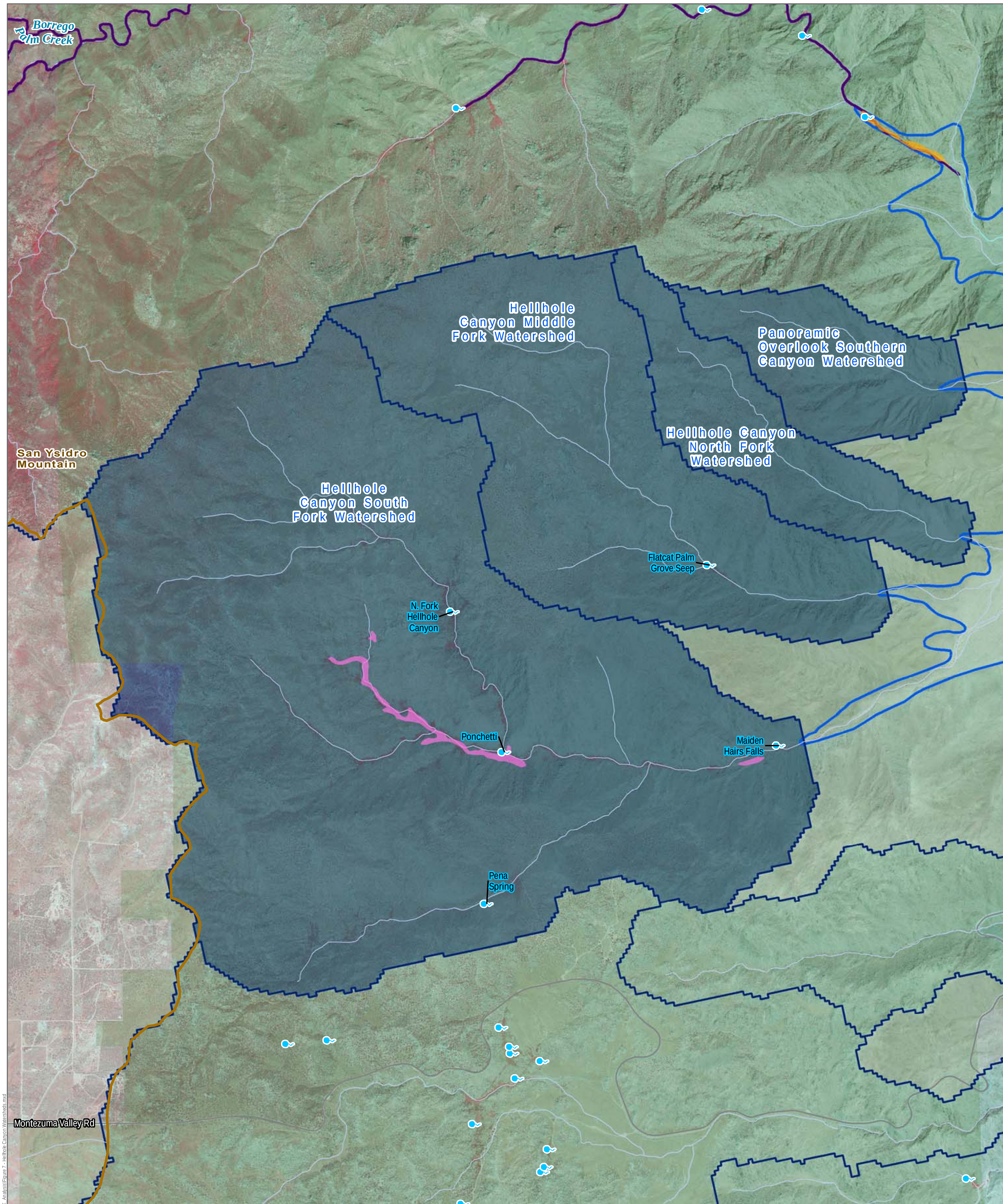
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 1 2 Miles

Figure 6
Borrego Palm Canyon Watersheds

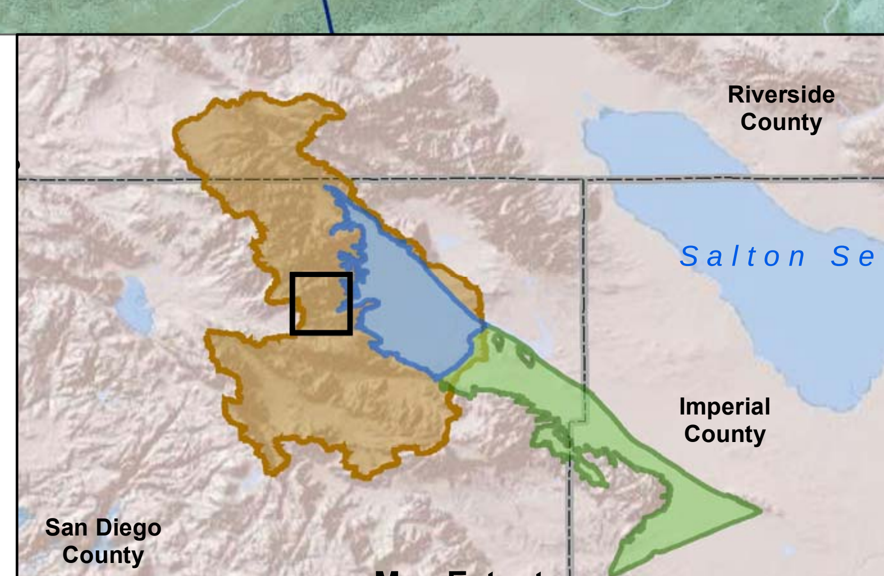
Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




Stream Stats Delineated Watershed (USGS 2018)
Vegetation (NCCAG DWR 2018)
Wetlands (NCCAG DWR 2018)
Vegetation Communities (SANGIS 2018)
Groundwater Sustainability Watershed Contributing Area
California Department of Parks and Recreation (2012)

**Borrego Valley Groundwater Basin Subbasins**

Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
Ocotillo Wells Groundwater Subbasin (7-024.02)
National Hydrography Dataset (NHD) Flowlines (USGS 2018)
Perennial Creeks/Streams (State Parks 2017)
Spring

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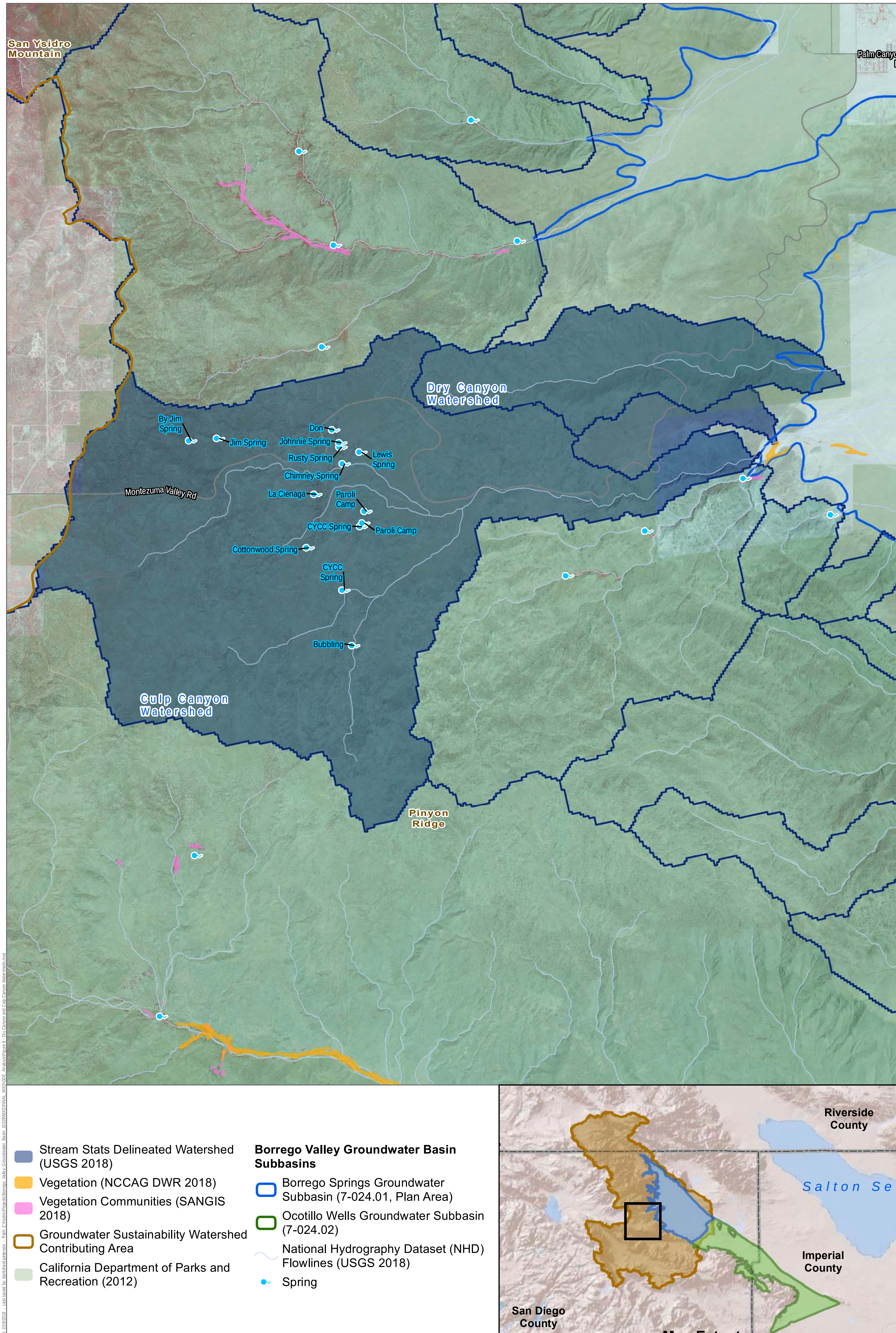
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 7
Hellhole Canyon Watersheds



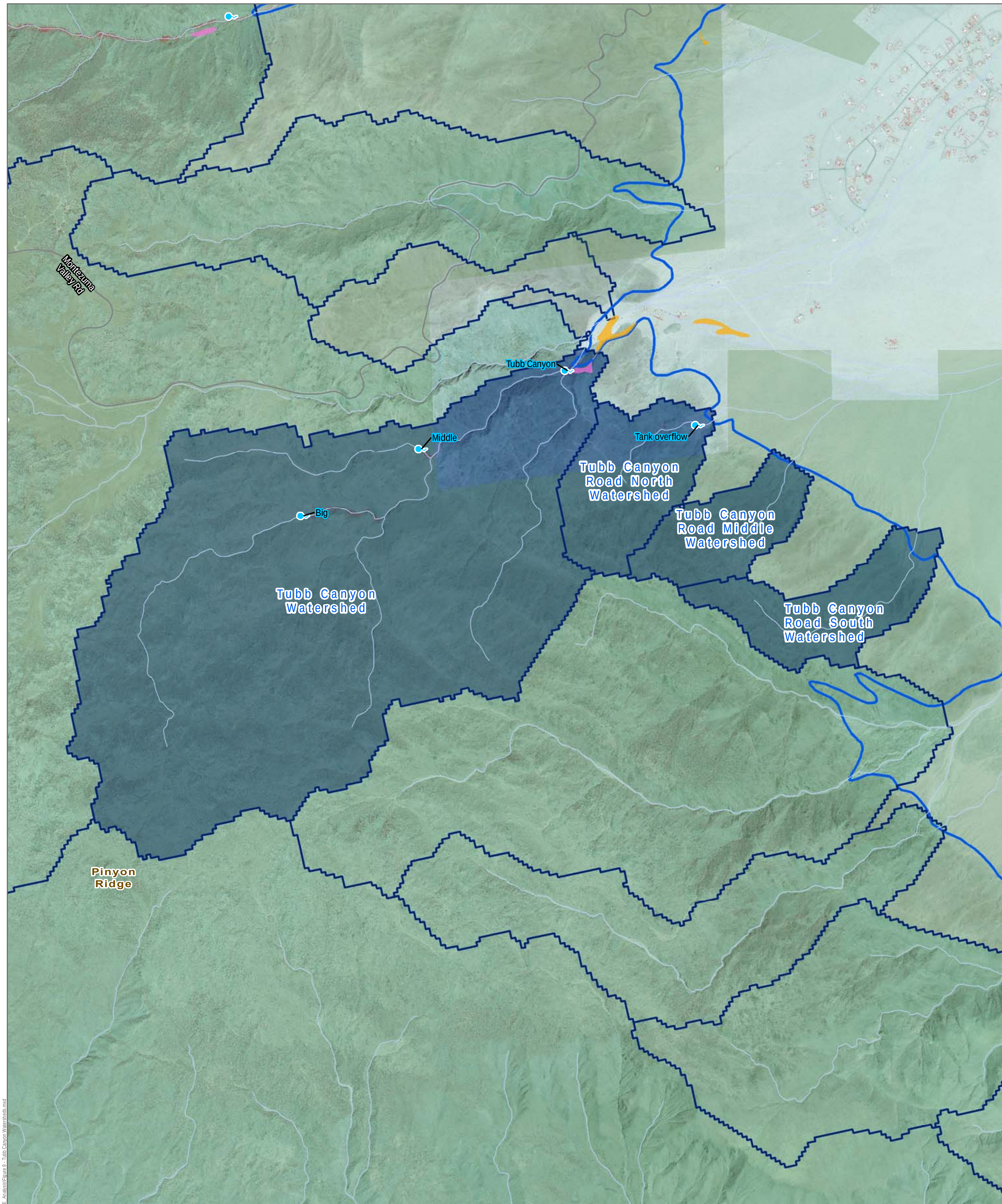

DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

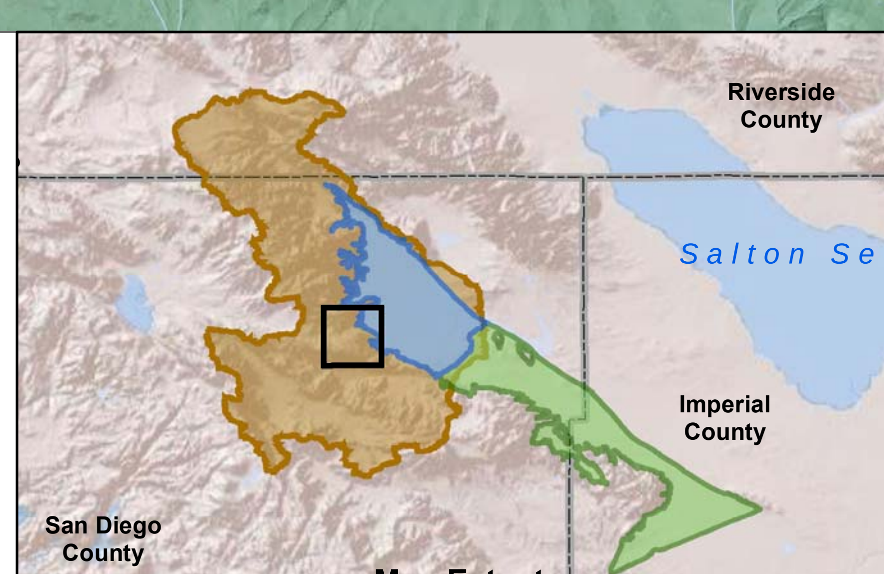
Figure 8
Dry Canyon and Culp Canyon Watersheds




Stream Stats Delineated Watershed (USGS 2018)
Vegetation (NCCAG DWR 2018)
Vegetation Communities (SANGIS 2018)
Groundwater Sustainability Watershed Contributing Area
California Department of Parks and Recreation (2012)

**Borrego Valley Groundwater Basin Subbasins**

Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
Ocotillo Wells Groundwater Subbasin (7-024.02)
National Hydrography Dataset (NHD) Flowlines (USGS 2018)
Spring




DRAFT February 2019

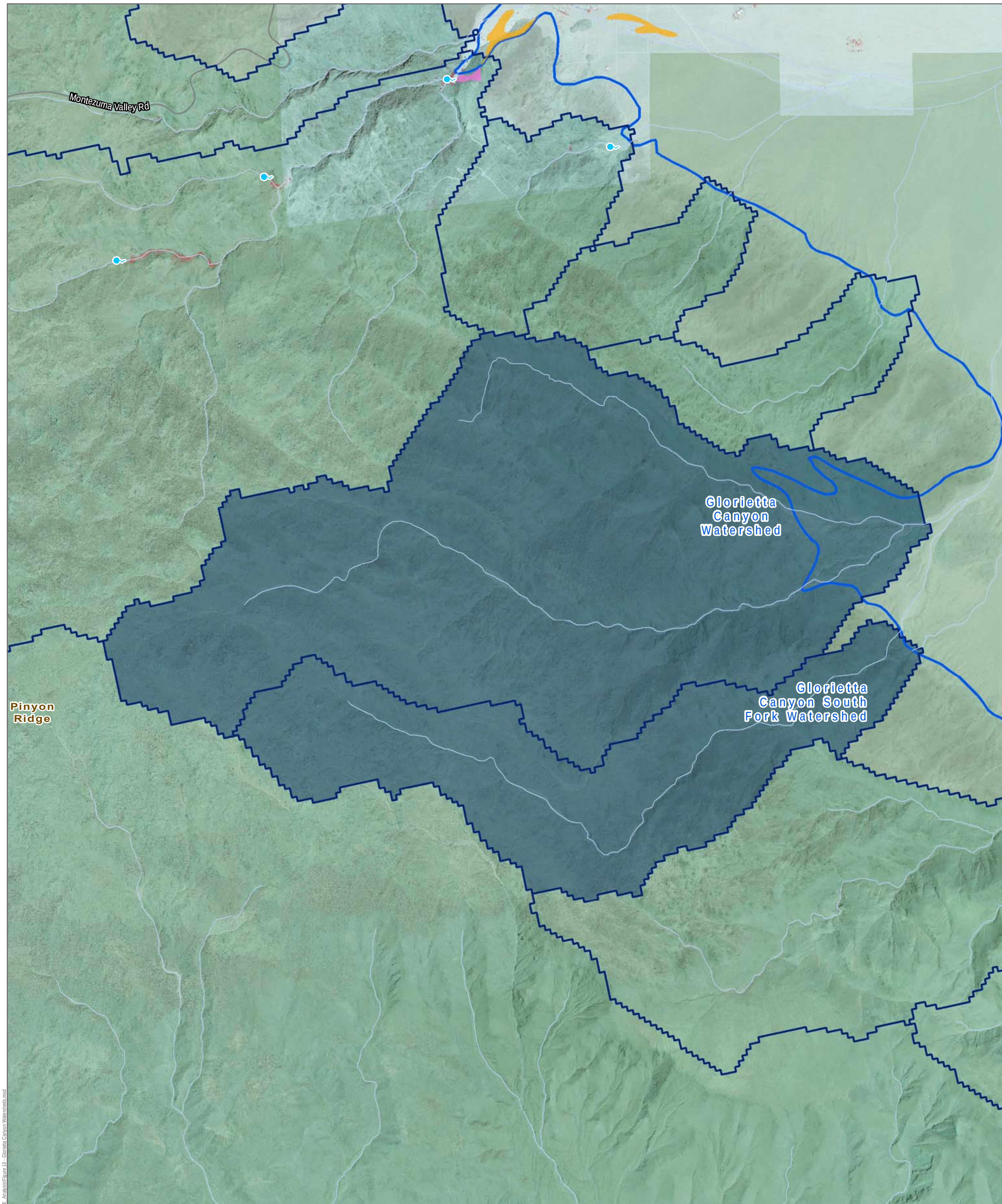
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

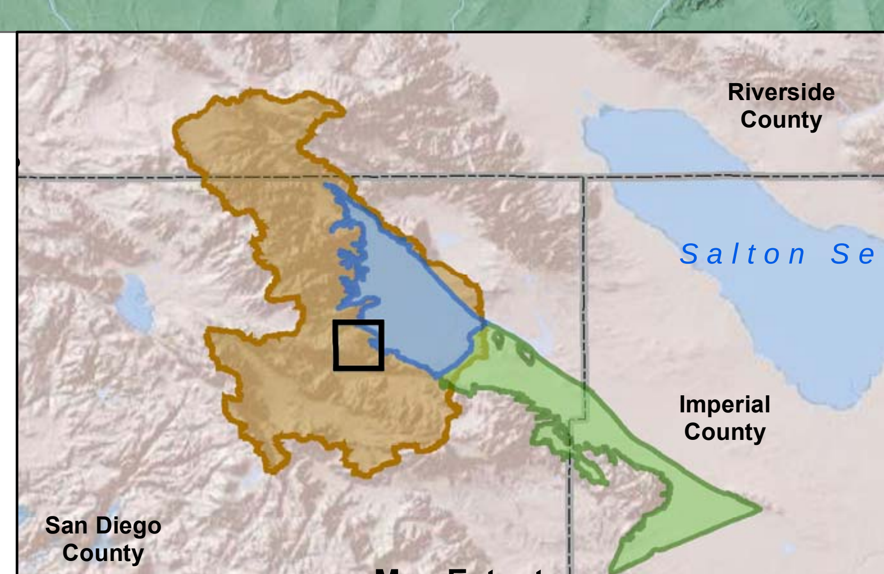
Figure 9
Tubb Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




Stream Stats Delineated Watershed (USGS 2018)
Vegetation (NCCAG DWR 2018)
Vegetation Communities (SANGIS 2018)
Groundwater Sustainability Watershed Contributing Area
California Department of Parks and Recreation (2012)

**Borrego Valley Groundwater Basin Subbasins**
Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
Ocotillo Wells Groundwater Subbasin (7-024.02)
National Hydrography Dataset (NHD) Flowlines (USGS 2018)
Spring



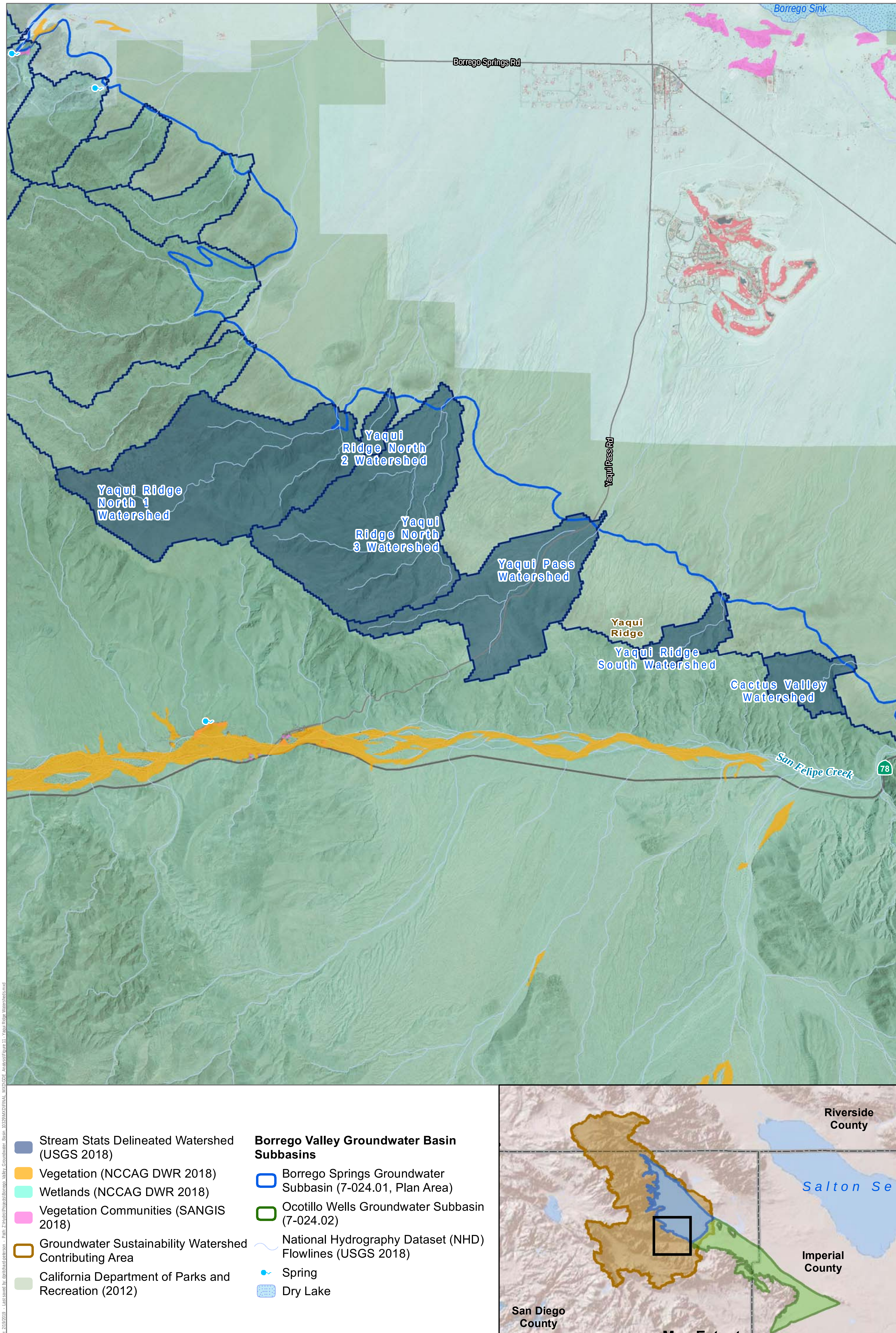

DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 10
Glorietta Canyon Watersheds




DRAFT February 2019

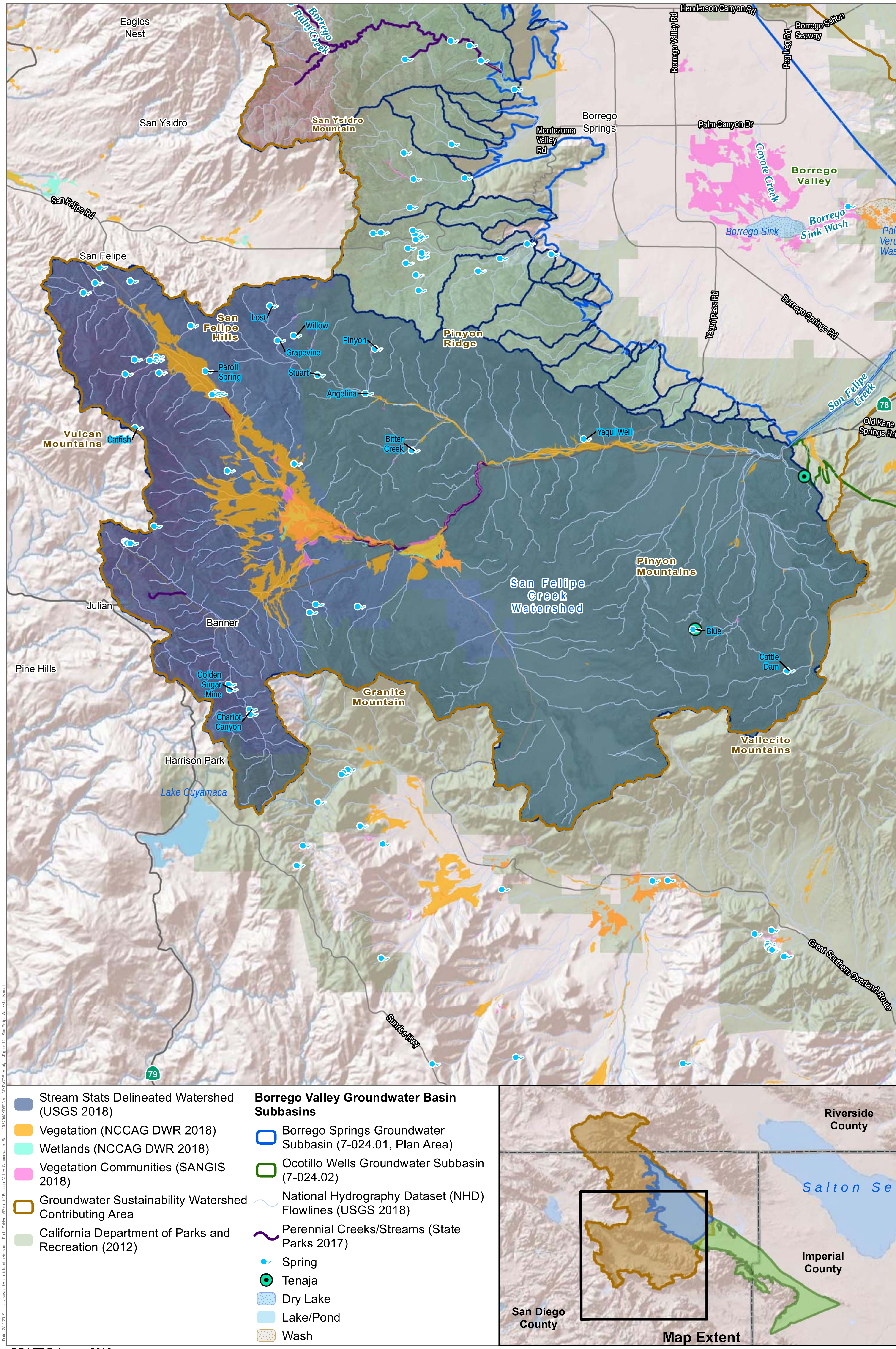
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 11
Yaqui Ridge Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




DRAFT February 2019

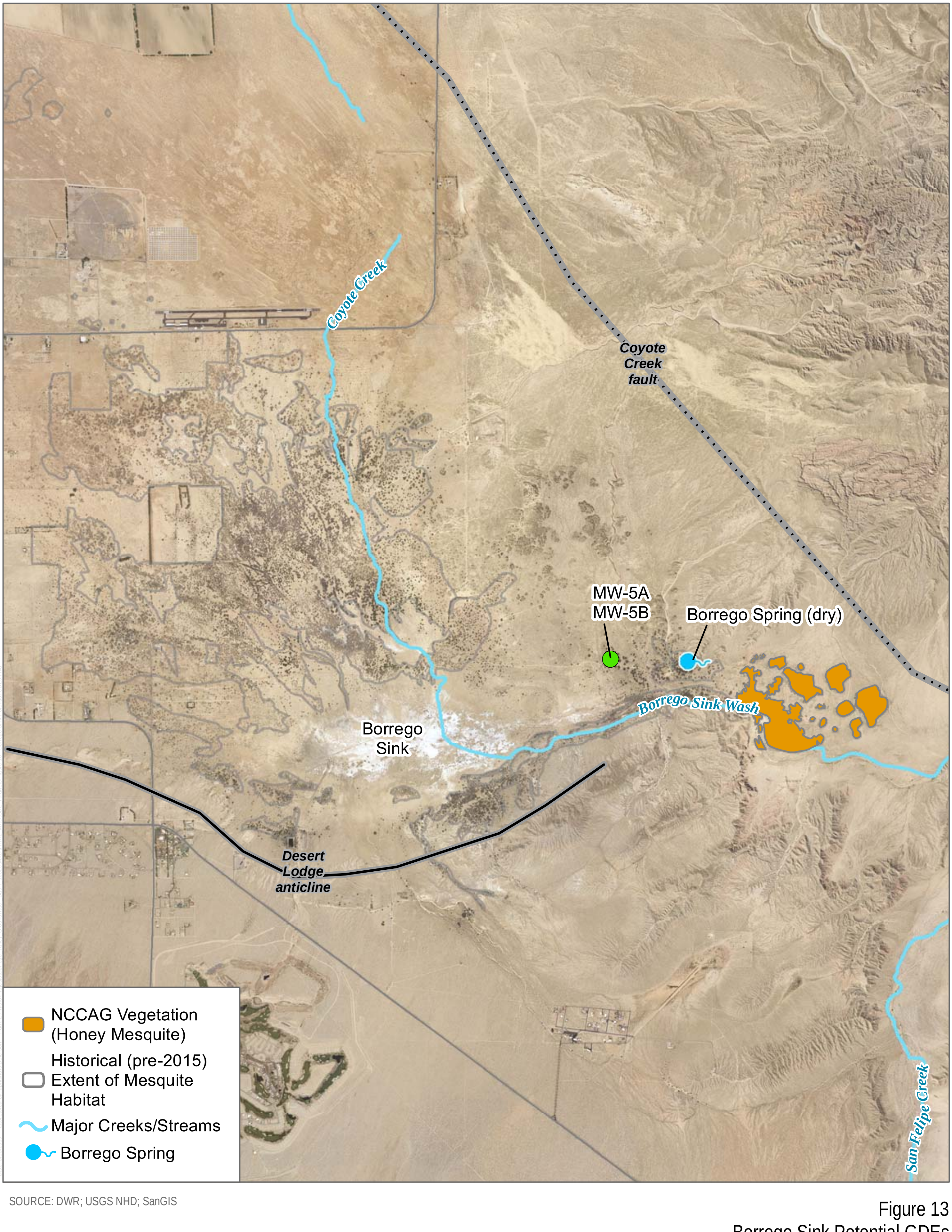
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 2 4 Miles

Figure 12
San Felipe Watersheds

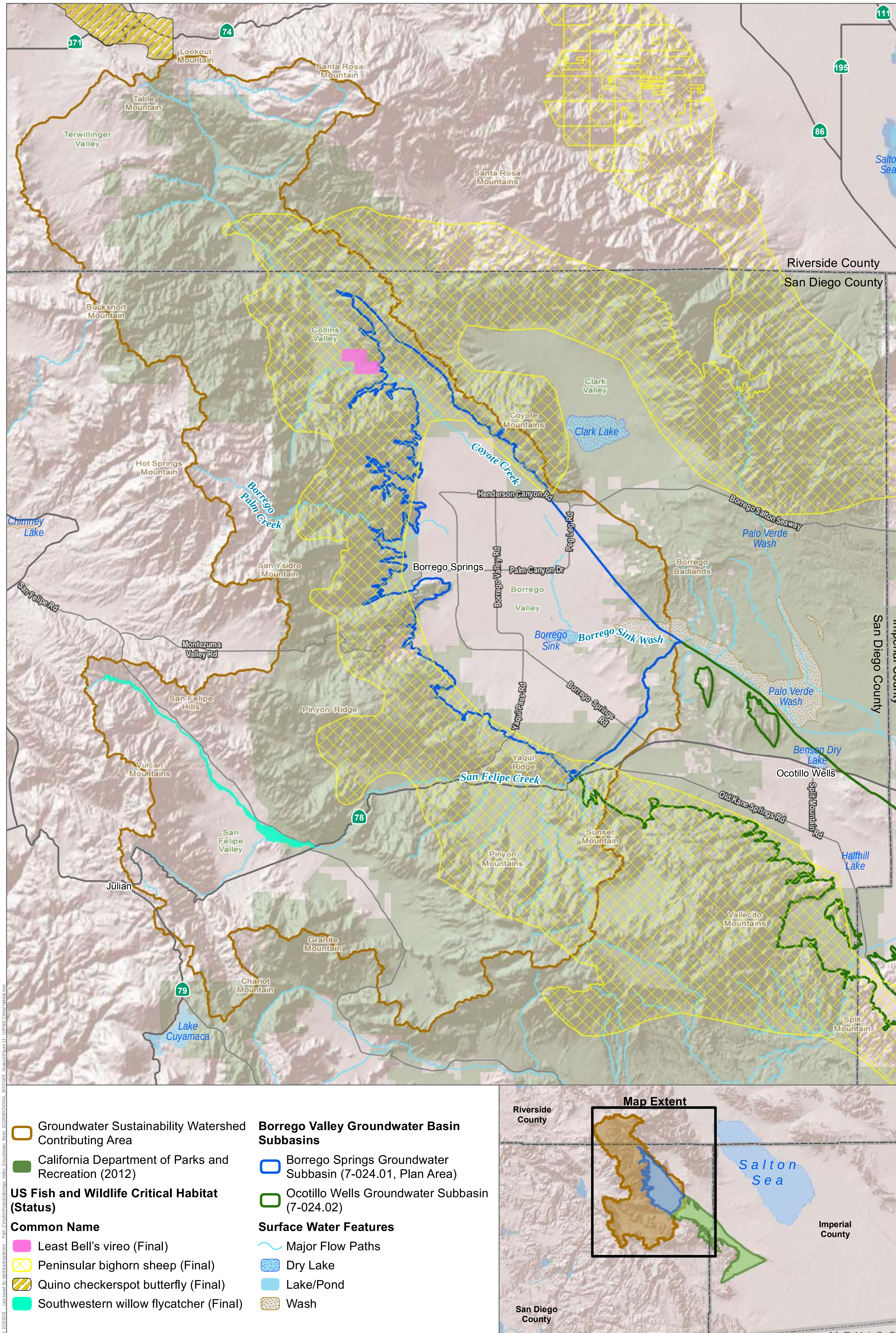
Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




SOURCE: DWR; USGS NHD; SanGIS

DUDEK

Figure 13
Borrego Sink Potential GDEs



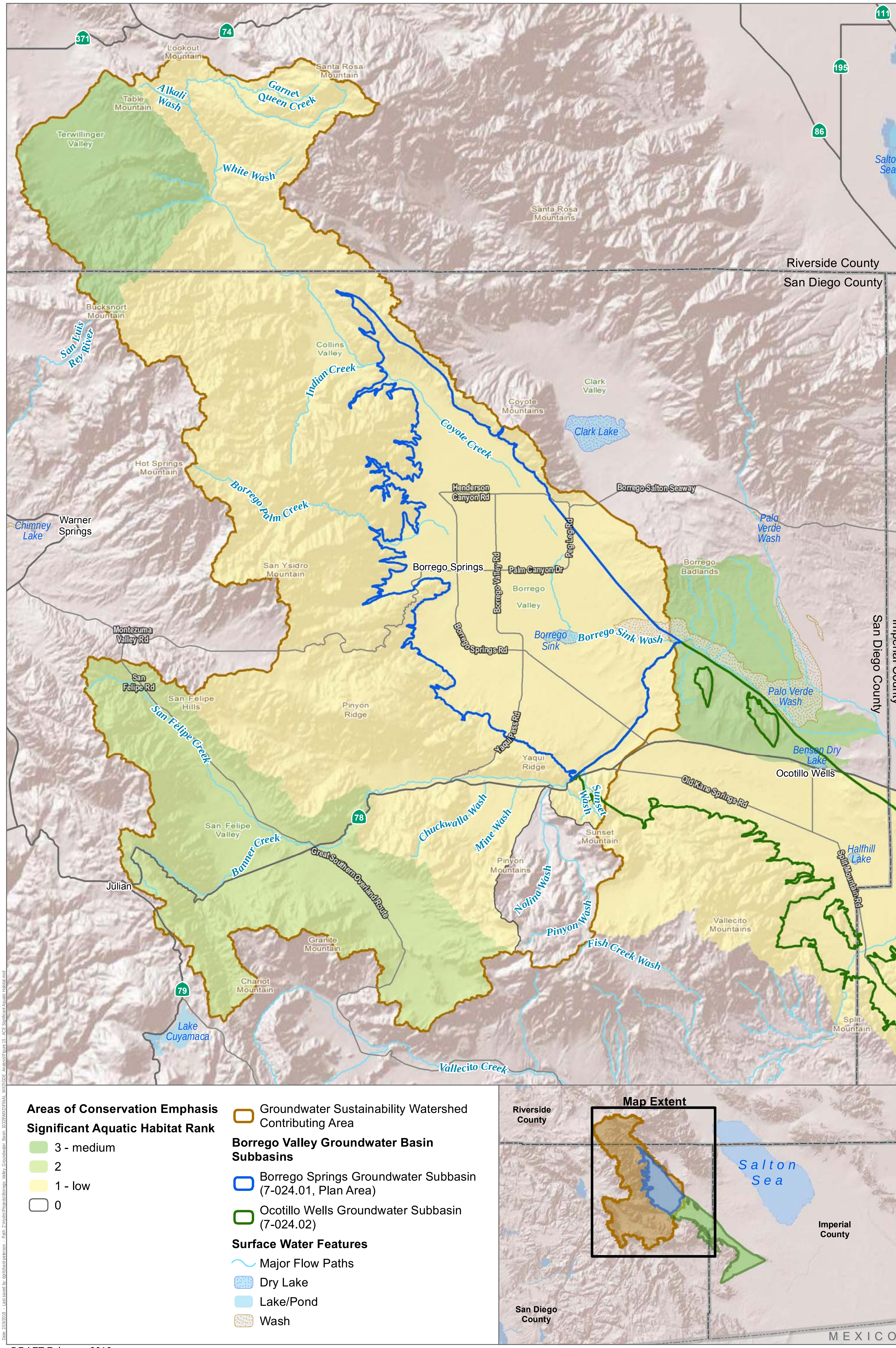

DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USFWS 2018

DUDEK

0 2 4 Miles

Figure 14
US Fish and Wildlife Critical Habitat




DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

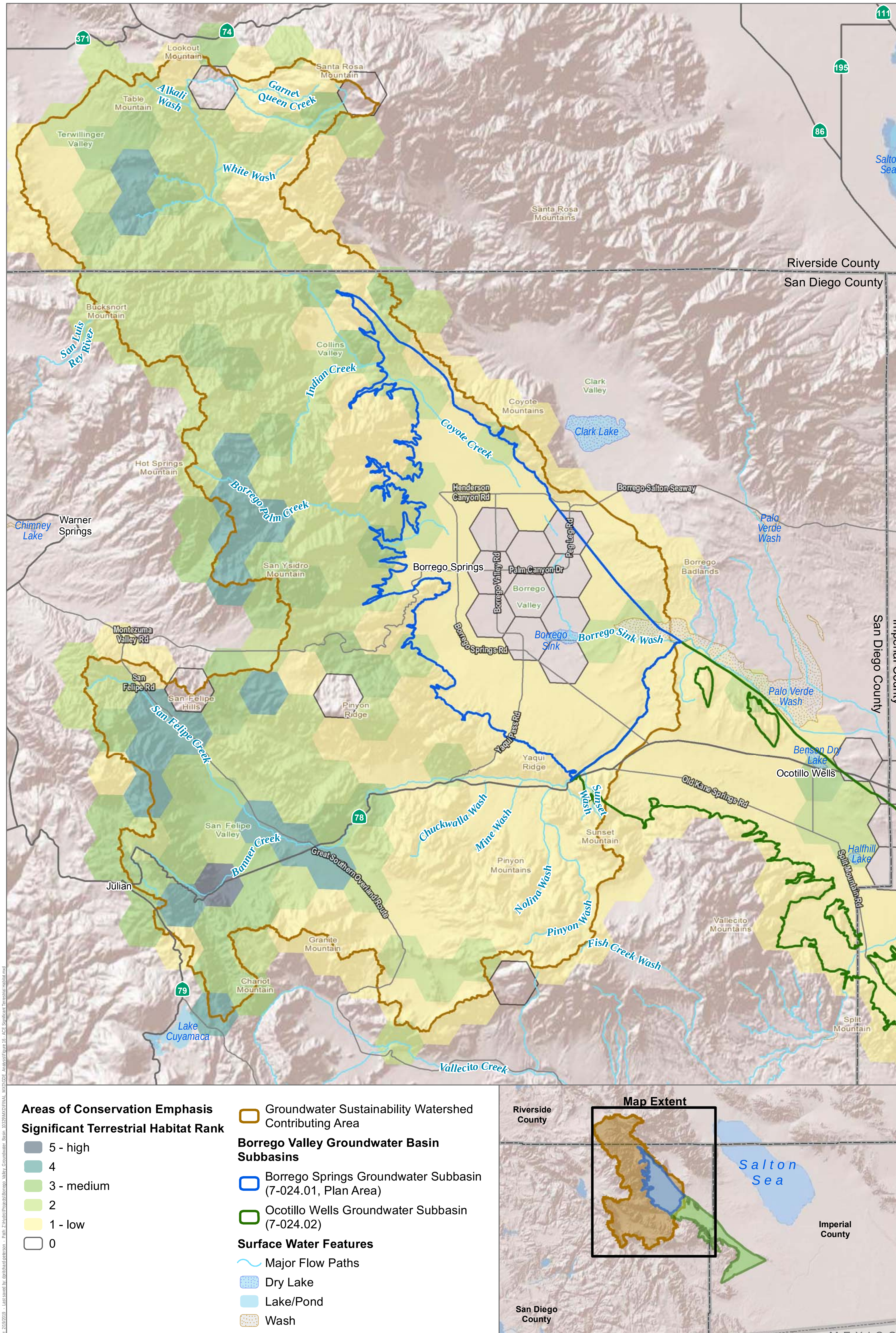
DUDEK

0 1.5 3 Miles

Figure 15

Areas of Conservation Emphasis (ACE) - Significant Aquatic Habitat

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

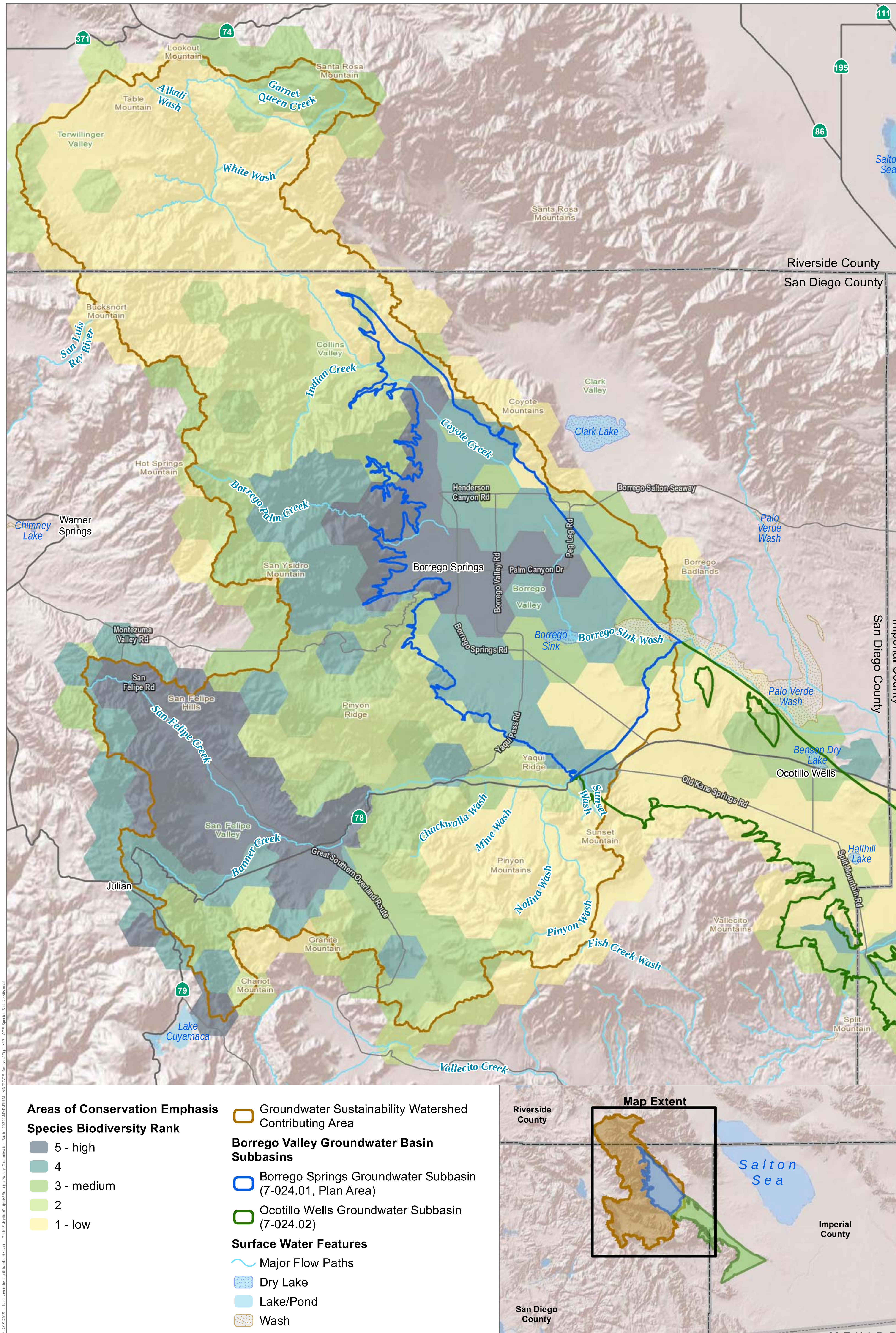
DUDEK

0 2 4 Miles

Figure 16

Areas of Conservation Emphasis (ACE) - Significant Terrestrial Habitat

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



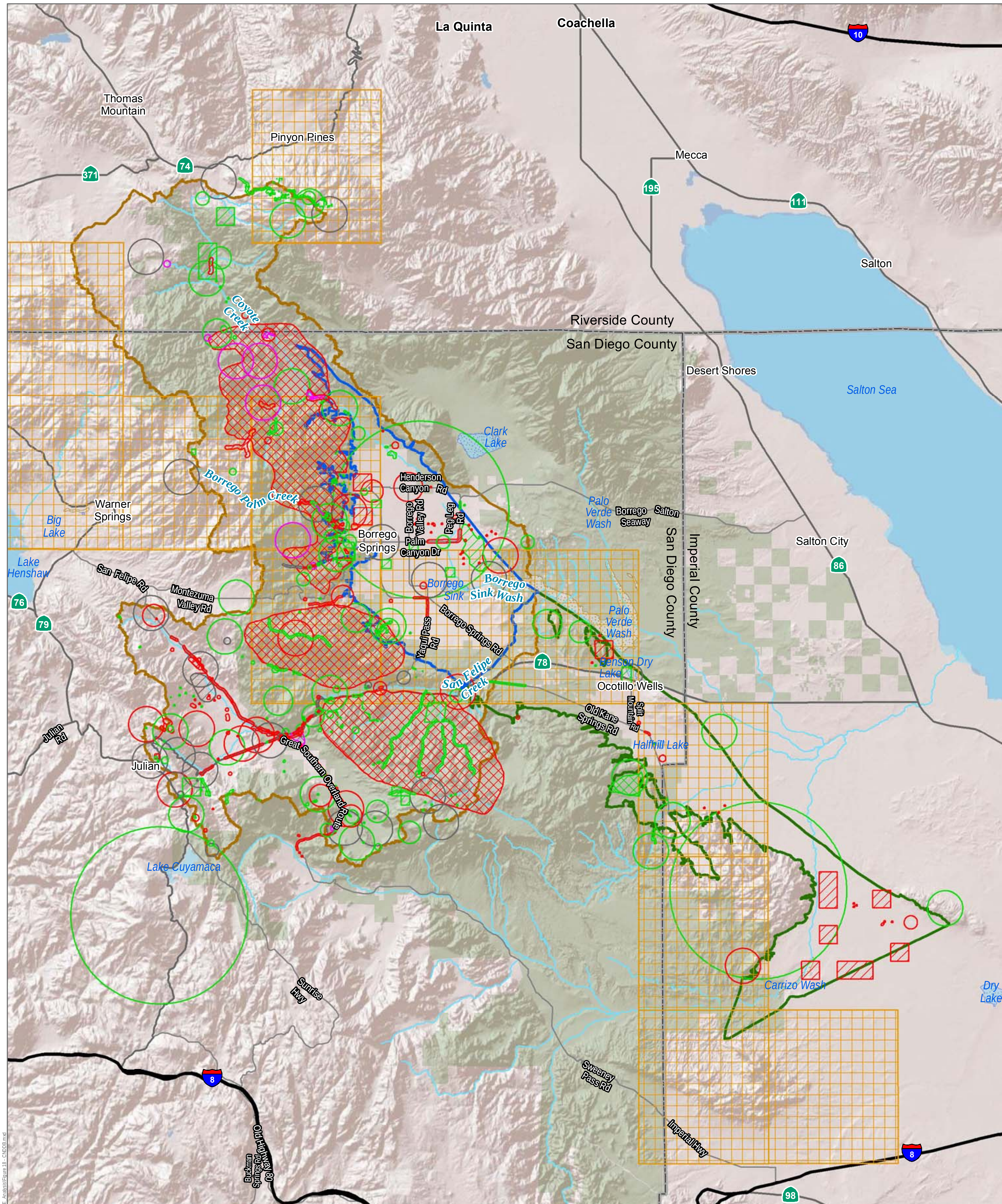

DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

DUDEK

0 2 4 Miles

Figure 17
Areas of Conservation Emphasis (ACE) - Species Biodiversity




Groundwater Sustainability Watershed Contributing Area

California Department of Parks and Recreation (2012)

**Borrego Valley Groundwater Basin Subbasins**

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

Ocotillo Wells Groundwater Subbasin (7-024.02)

**California Natural Diversity Database**

(Symbology Per CNDDB License

Plant (80m)

Plant (specific)

Plant (non-specific)

Plant (circular)

Animal (80m)

Animal (specific)

Animal (non-specific)

Animal (circular)

Terrestrial Comm. (specific)

Terrestrial Comm. (non-specific)

Terrestrial Comm. (circular)

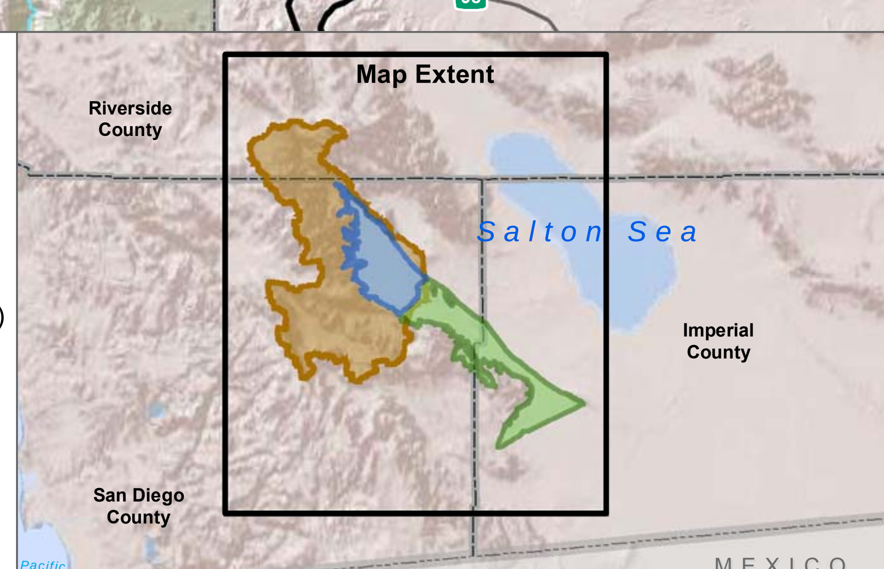
Multiple (80m)

Multiple (specific)

Multiple (non-specific)

Multiple (circular)

Sensitive Element Occurrences




DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

DUDEK

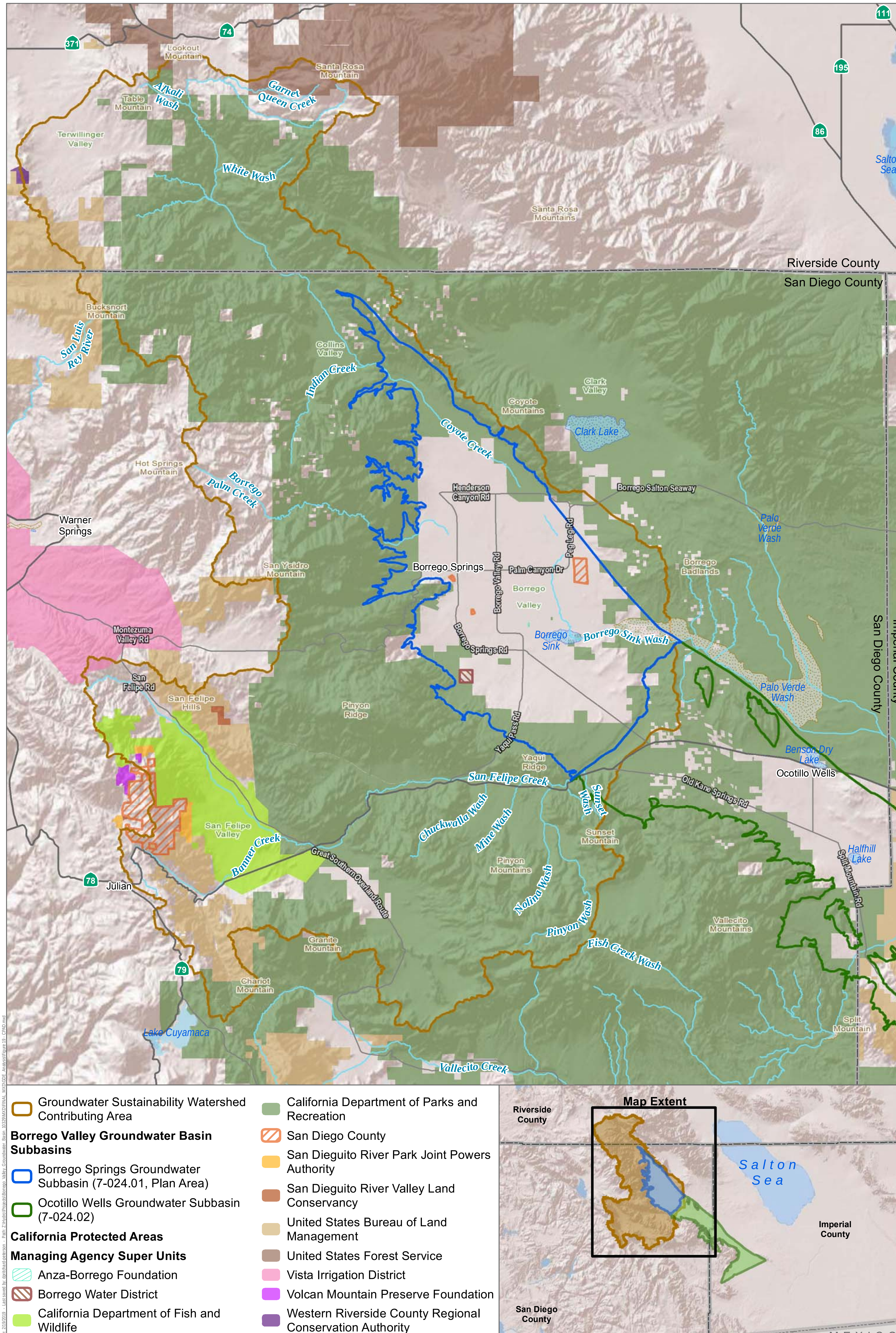
0 2.5 5 Miles

Scale Per CNDDB License Agreement

Figure 18

California Natural Diversity Database (CNDDB)

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




DRAFT February 2019

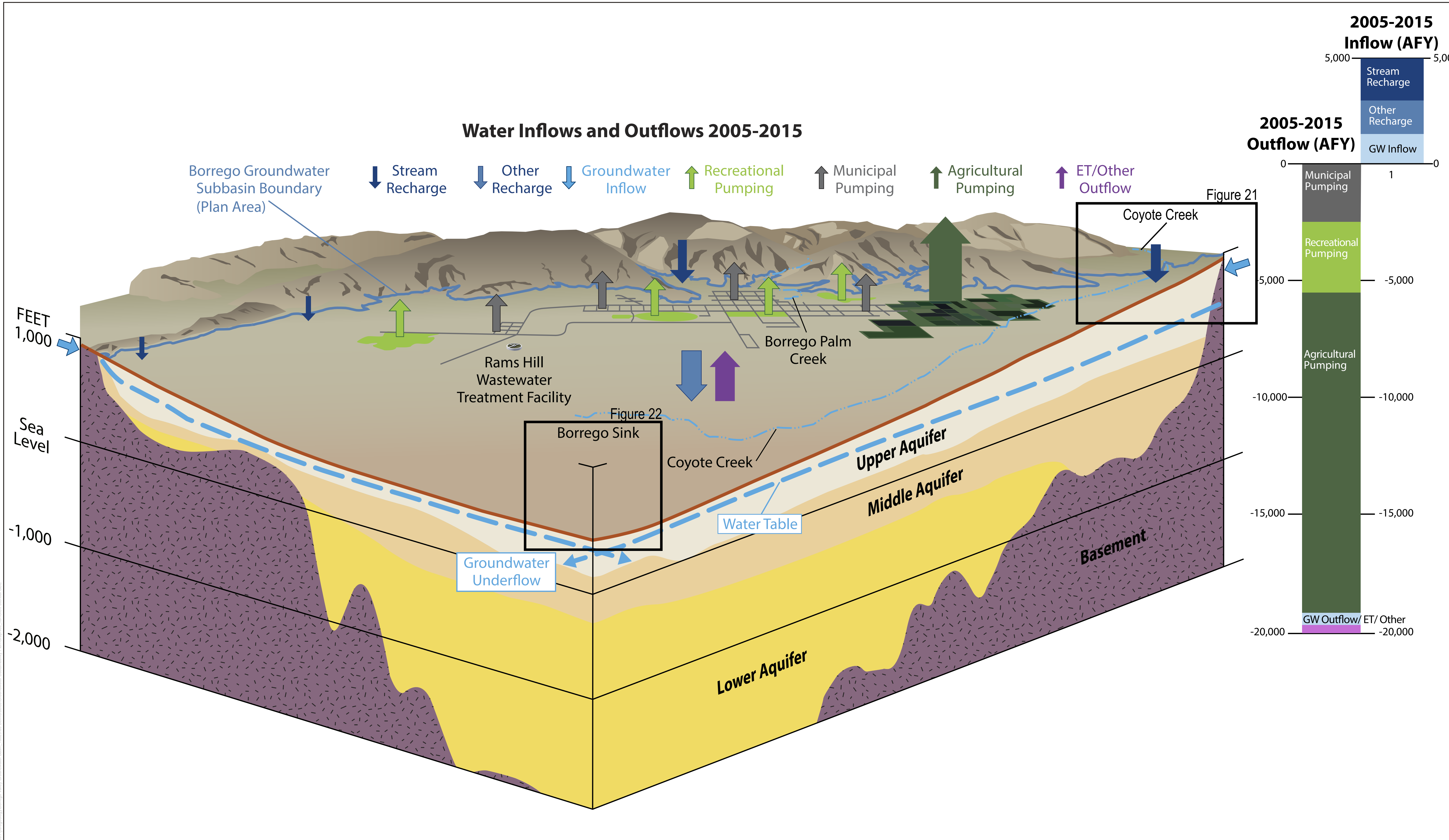
DATUM: NAD 1983. DATA SOURCE: CPAD 2017a

DUDEK

0 2 4 Miles

Figure 19
California Protected Areas Database (CPAD)

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




SOURCE: USGS 1982 and USGS 2015

**FIGURE 20**

Borrego Valley Hydrogeologic Conceptual Model

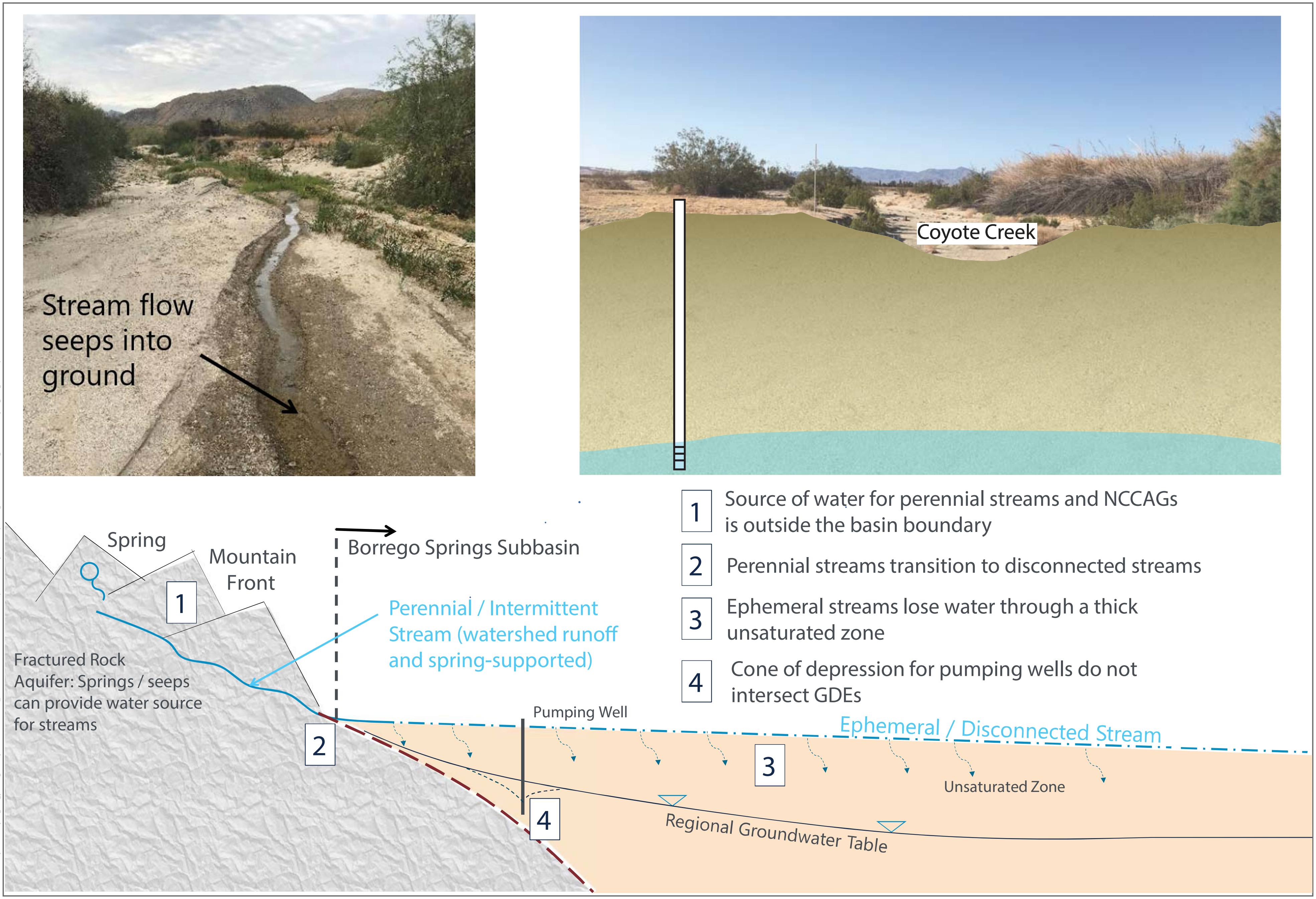



**FIGURE 21**

Contributing Watersheds Hydrogeologic Conceptual Model

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

DUDEK

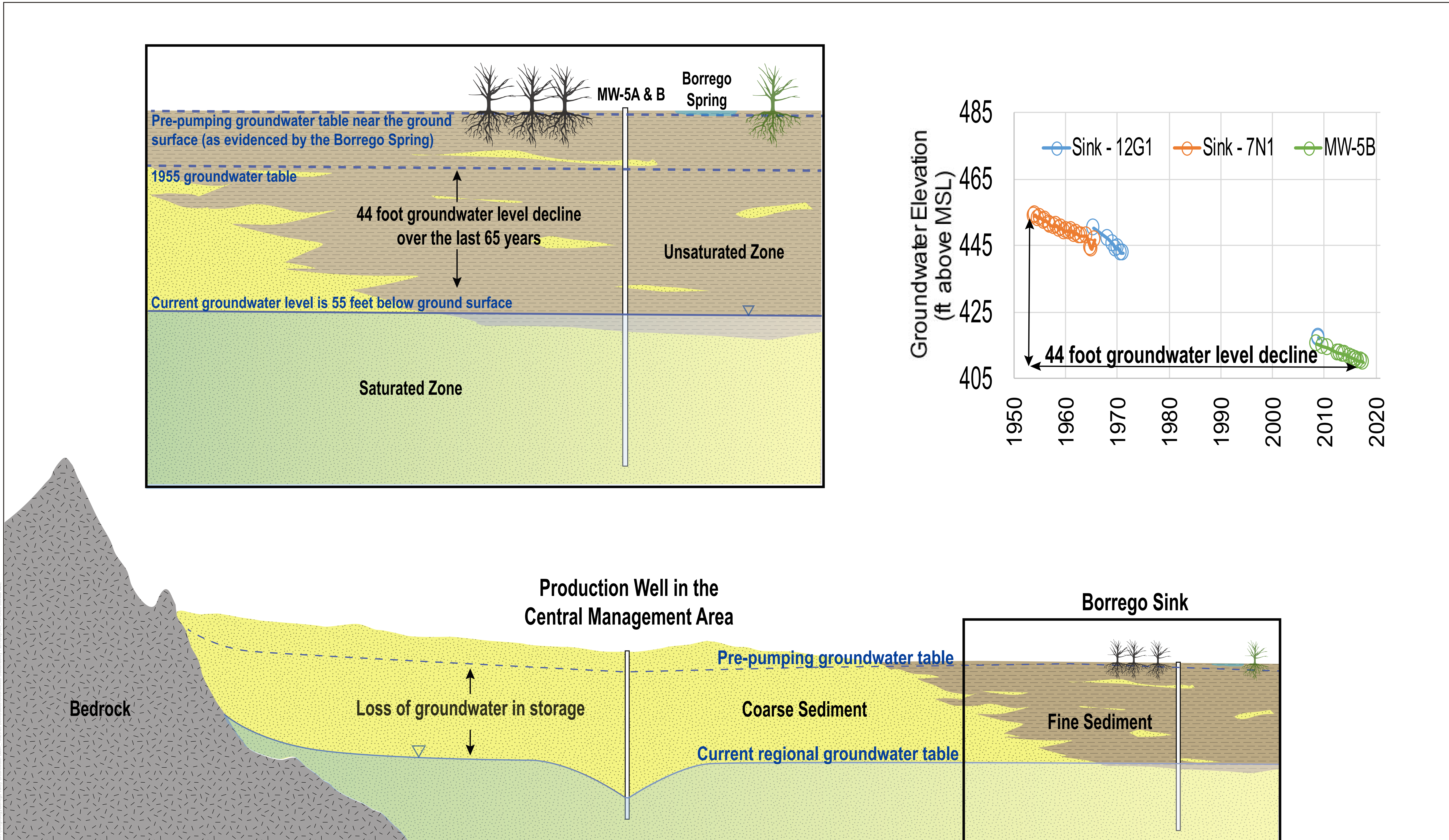



FIGURE 22

Borrego Sink (Mesquite Bosque) Hydrologic Conceptual Model



DUDEK

# Attachment 1

California Freshwater Species Database (Borrego Springs Groundwater Subbasin)

| Group | Scientific Name | Common Name | Federal List | State List | Other List | Agency | Type of Observation | Specificity | Source |
|---|---|---|---|---|---|---|---|---|---|
| Birds | Vireo bellii pusillus | Least Bell's Vireo | Endangered | Endangered | | BLM | Current observations (post 1980) | Polygon | California Natural Diversity Database (4/2016) |
| Herps | Actinemys marmorata marmorata | Western Pond Turtle | | Special Concern | ARSSC | BLM, USFS | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Herps | Anaxyrus boreas boreas | Boreal Toad | | | | | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Herps | Anaxyrus californicus | Arroyo Toad | Endangered | Special Concern | ARSSC | | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Herps | Anaxyrus punctatus | Red-spotted Toad | | | | | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Herps | Pseudacris cadaverina | California Treefrog | | | ARSSC | | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Herps | Thamnophis hammondii hammondii | Two-striped Gartersnake | | Special Concern | ARSSC | BLM, USFS | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Mammals | Castor canadensis | American Beaver | | | Not on any status lists | | Modeled habitat/ generalized observation | Polygon | California Wildlife Habitat Relationships |
| Birds | Actitis macularius | Spotted Sandpiper | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Aechmophorus occidentalis | Western Grebe | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Agelaius tricolor | Tricolored Blackbird | Bird of Conservation Concern | Special Concern | BSSC - First priority | BLM | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Aix sponsa | Wood Duck | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas acuta | Northern Pintail | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas americana | American Wigeon | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas americana | American Wigeon | | | | | Current observations (post 1980) | Point | CLO EBIRD_CA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Birds | Anas americana | American Wigeon | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Anas americana | American Wigeon | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Anas clypeata | Northern Shoveler | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas crecca | Green-winged Teal | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas crecca | Green-winged Teal | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Anas cyanoptera | Cinnamon Teal | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas cyanoptera | Cinnamon Teal | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Anas discors | Blue-winged Teal | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas platyrhynchos | Mallard | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas platyrhynchos | Mallard | | | | | Current observations (post 1980) | Point | CLO EBIRD_CAN |
| Birds | Anas platyrhynchos | Mallard | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Anas platyrhynchos | Mallard | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Anas strepera | Gadwall | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anas strepera | Gadwall | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Anser albifrons | Greater White-fronted Goose | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Anser albifrons | Greater White-fronted Goose | | | | | Current observations (post 1980) | Point | CLO EBIRD_CA |
| Birds | Anser albifrons | Greater White-fronted Goose | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Ardea alba | Great Egret | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Ardea alba | Great Egret | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Ardea herodias | Great Blue Heron | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Aythya affinis | Lesser Scaup | | | | | Current observations (post 1980) | Point | CLO EBIRD |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Birds | Aythya americana | Redhead | | Special Concern | BSSC - Third priority | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Aythya collaris | Ring-necked Duck | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Aythya collaris | Ring-necked Duck | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Aythya valisineria | Canvasback | | Special | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Aythya valisineria | Canvasback | | Special | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Botaurus lentiginosus | American Bittern | | | | | Current observations (post 1980) | Point | SDNHM Birds |
| Birds | Bucephala albeola | Bufflehead | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Butorides virescens | Green Heron | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Calidris mauri | Western Sandpiper | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Calidris minutilla | Least Sandpiper | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Calidris minutilla | Least Sandpiper | | | | | Current observations (post 1980) | Point | SDNHM Birds |
| Birds | Chen caerulescens | Snow Goose | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Chen rossii | Ross's Goose | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Chroicocephalus philadelphia | Bonaparte's Gull | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Chroicocephalus philadelphia | Bonaparte's Gull | | | | | Unknown | Point | SDNHM Birds |
| Birds | Cistothorus palustris palustris | Marsh Wren | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Egretta thula | Snowy Egret | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Egretta thula | Snowy Egret | | | | | Current observations (post 1980) | Point | CLO EBIRD_CA |
| Birds | Empidonax traillii | Willow Flycatcher | Bird of Conservation Concern | Endangered | | USFS | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Empidonax traillii brewsteri | Willow Flycatcher | Bird of Conservation Concern | Endangered | | | Current observations (post 1980) | Point | SDNHM Birds |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Birds | Fulica americana | American Coot | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Fulica americana | American Coot | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Fulica americana | American Coot | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Gallinago delicata | Wilson's Snipe | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Himantopus mexicanus | Black-necked Stilt | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Icteria virens | Yellow-breasted Chat | | Special Concern | BSSC - Third priority | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Limnodromus scolopaceus | Long-billed Dowitcher | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Lophodytes cucullatus | Hooded Merganser | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Megaceryle alcyon | Belted Kingfisher | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Megaceryle alcyon | Belted Kingfisher | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Mergus serrator | Red-breasted Merganser | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Nycticorax nycticorax | Black-crowned Night-Heron | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Nycticorax nycticorax | Black-crowned Night-Heron | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Oreothlypis luciae | Lucy's Warbler | | Special Concern | BSSC - Third priority | BLM | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Oreothlypis luciae | Lucy's Warbler | | Special Concern | BSSC - Third priority | BLM | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Oxyura jamaicensis | Ruddy Duck | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Oxyura jamaicensis | Ruddy Duck | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Oxyura jamaicensis | Ruddy Duck | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Pelecanus erythrorhynchos | American White Pelican | | Special Concern | BSSC - First priority | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Phalacrocorax auritus | Double-crested Cormorant | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Phalacrocorax auritus | Double-crested Cormorant | | | | | Current observations (post 1980) | Point | CLO EBIRD_CAN |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Birds | Phalacrocorax auritus | Double-crested Cormorant | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Piranga rubra | Summer Tanager | | Special Concern | BSSC - First priority | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Plegadis chihi | White-faced Ibis | | Watch list | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Plegadis chihi | White-faced Ibis | | Watch list | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Podiceps nigricollis | Eared Grebe | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Podiceps nigricollis | Eared Grebe | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Podilymbus podiceps | Pied-billed Grebe | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Porzana carolina | Sora | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Rallus limicola | Virginia Rail | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Rallus limicola | Virginia Rail | | | | | Unknown | Point | SDNHM Birds |
| Birds | Setophaga petechia | Yellow Warbler | | | BSSC - Second priority | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Setophaga petechia | Yellow Warbler | | | BSSC - Second priority | | Current observations (post 1980) | Point | iNaturalist Observations |
| Birds | Setophaga petechia | Yellow Warbler | | | BSSC - Second priority | | Current observations (post 1980) | Point | SDNHM Birds |
| Birds | Tachycineta bicolor | Tree Swallow | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Tachycineta bicolor | Tree Swallow | | | | | Current observations (post 1980) | Point | CLO EBIRD_CA |
| Birds | Tachycineta bicolor | Tree Swallow | | | | | Current observations (post 1980) | Point | CLO GBBC |
| Birds | Tringa melanoleuca | Greater Yellowlegs | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Tringa semipalmata | Willet | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Tringa solitaria | Solitary Sandpiper | | | | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Vireo bellii | Bell's Vireo | | | | | Current observations (post 1980) | Point | CLO EBIRD |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Birds | Vireo bellii arizonae | Arizona Bell's Vireo | Bird of Conservation Concern | Endangered | | BLM | Current observations (post 1980) | Point | SDNHM Birds |
| Birds | Xanthocephalus xanthocephalus | Yellow-headed Blackbird | | Special Concern | BSSC - Third priority | | Current observations (post 1980) | Point | CLO EBIRD |
| Birds | Xanthocephalus xanthocephalus | Yellow-headed Blackbird | | Special Concern | BSSC - Third priority | | Current observations (post 1980) | Point | SDNHM Birds |
| Fishes | Cyprinodon macularius | Desert pupfish | Endangered | Endangered | Endangered - Moyle 2013 | | Current observations (post 1980) | Point | California Natural Diversity Database (4/2016) |
| Herps | Anaxyrus boreas boreas | Boreal Toad | | | | | Current observations (post 1980) | Point | CAS HERP |
| Herps | Anaxyrus boreas boreas | Boreal Toad | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Herps | Anaxyrus boreas boreas | Boreal Toad | | | | | Current observations (post 1980) | Point | SDNHM Herps |
| Herps | Anaxyrus boreas halophilus | California Toad | | | ARSSC | | Current observations (post 1980) | Point | CAS HERP |
| Herps | Anaxyrus punctatus | Red-spotted Toad | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Herps | Pseudacris cadaverina | California Treefrog | | | ARSSC | | Current observations (post 1980) | Point | CAS HERP |
| Herps | Pseudacris cadaverina | California Treefrog | | | ARSSC | | Current observations (post 1980) | Point | iNaturalist Observations |
| Herps | Pseudacris cadaverina | California Treefrog | | | ARSSC | | Current observations (post 1980) | Point | SDNHM Herps |
| Herps | Pseudacris regilla | Northern Pacific Chorus Frog | | | | | Current observations (post 1980) | Point | CAS HERP |
| Insects & other inverts | Abedus spp. | Abedus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Anax junius | Common Green Darner | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Argia nahuana | Aztec Dancer | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Argia spp. | Argia spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Argia vivida | Vivid Dancer | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Argia vivida | Vivid Dancer | | | | | Unknown | Point | CASENT Arthropods |
| Insects & other inverts | Argia vivida | Vivid Dancer | | | | | Unknown | Point | LACMENT |
| Insects & other inverts | Baetis adonis | A Mayfly | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Baetis spp. | Baetis spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Belostomatidae fam. | Belostomatidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Callibaetis spp. | Callibaetis spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Chaetarthria pallida | | | | Not on any status lists | | Unknown | Point | SBMNH SBMNH-ENT |
| Insects & other inverts | Chironomidae fam. | Chironomidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Coenagrionidae fam. | Coenagrionidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Cricotopus spp. | Cricotopus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Cryptochironomus spp. | Cryptochironomus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Enallagma civile | Familiar Bluet | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Erpetogomphus compositus | White-belted Ringtail | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Erpetogomphus spp. | Erpetogomphus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Erythemis collocata | Western Pondhawk | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Eucorethra underwoodi | | | | Not on any status lists | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Eukiefferiella spp. | Eukiefferiella spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Fallceon quilleri | A Mayfly | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Fallceon spp. | Fallceon spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Gomphidae fam. | Gomphidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Helichus spp. | Helichus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Helicopsyche spp. | Helicopsyche spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Hetaerina americana | American Rubyspot | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Hetaerina americana | American Rubyspot | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Heterelmis obesa | | | | Not on any status lists | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Heterotrissocladius spp. | Heterotrissocladius spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Hydropsyche spp. | Hydropsyche spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Hydropsychidae fam. | Hydropsychidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Hydroptila spp. | Hydroptila spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Hydroptilidae fam. | Hydroptilidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Laccobius spp. | Laccobius spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Larsia spp. | Larsia spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Lauterborniella spp. | Lauterborniella spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Lethocerus americanus | | | | Not on any status lists | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Libellula croceipennis | Neon Skimmer | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Libellula saturata | Flame Skimmer | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Libellula saturata | Flame Skimmer | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Libellulidae fam. | Libellulidae fam. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Macrodiplax balteata | Marl Pennant | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Meropelopia spp. | Meropelopia spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Nilotanypus spp. | Nilotanypus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Ochrotrichia spp. | Ochrotrichia spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |

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|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Ophiogomphus spp. | Ophiogomphus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Orthemis ferruginea | Roseate Skimmer | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Pachydiplax longipennis | Blue Dasher | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Paltothemis lineatipes | Red Rock Skimmer | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Pantala flavescens | Wandering Glider | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Paracladopelma spp. | Paracladopelma spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Parametriocnemus spp. | Parametriocnemus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Paratendipes spp. | Paratendipes spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Peltodytes spp. | Peltodytes spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Pentaneura spp. | Pentaneura spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Perithemis intensa | Mexican Amberwing | | | | | Current observations (post 1980) | Point | iNaturalist Observations |

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|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Phaenopsectra spp. | Phaenopsectra spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Polypedilum spp. | Polypedilum spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Postelichus spp. | Postelichus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Pseudochironomus spp. | Pseudochironomus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Radotanypus spp. | Radotanypus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Rhagovelia spp. | Rhagovelia spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Rheotanytarsus spp. | Rheotanytarsus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Rhionaeschna multicolor | Blue-eyed Darner | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Sanfilippodytes spp. | Sanfilippodytes spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Simulium spp. | Simulium spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |

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|---|---|---|---|---|---|---|---|---|---|
| Insects & other inverts | Sperchon spp. | Sperchon spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Stictotarsus striatellus | | | | Not on any status lists | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Stictotarsus striatellus | | | | Not on any status lists | | Unknown | Point | SBMNH SBMNH-ENT |
| Insects & other inverts | Sympetrum corruptum | Variegated Meadowhawk | | | | | Current observations (post 1980) | Point | California dragonfly and damselfly database |
| Insects & other inverts | Sympetrum corruptum | Variegated Meadowhawk | | | | | Current observations (post 1980) | Point | iNaturalist Observations |
| Insects & other inverts | Sympetrum spp. | Sympetrum spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Tanytarsus spp. | Tanytarsus spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Insects & other inverts | Tinodes spp. | Tinodes spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Mollusks | Physa spp. | Physa spp. | | | | | Current observations (post 1980) | Point | SWAMP via CEDEN. Download 10 April 2014, Obs before 13 July 2012 |
| Plants | Baccharis salicina | | | | Not on any status lists | | Current observations (post 1980) | Point | SD SD |
| Plants | Castilleja minor minor | Alkali Indian-paintbrush | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Castilleja minor spiralis | Large-flower Annual Indian-paintbrush | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Castilleja minor spiralis | Large-flower Annual Indian-paintbrush | | | | | Current observations (post 1980) | Point | SD |

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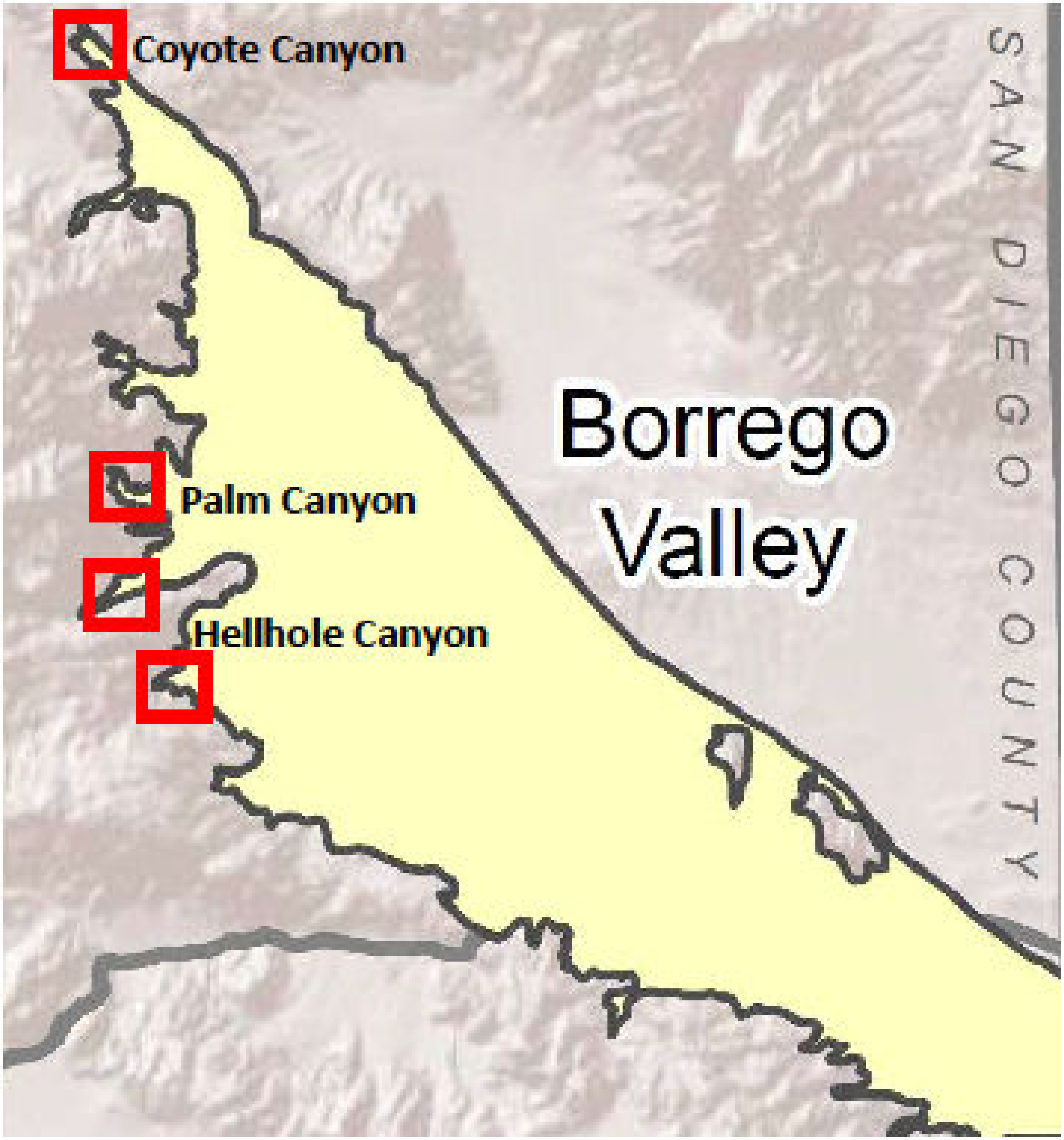
|---|---|---|---|---|---|---|---|---|---|---|
| Plants | Datisca glomerata | Durango Root | | | | | Current observations (post 1980) | Point | SD |
| Plants | Datisca glomerata | Durango Root | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Juncus dubius | Mariposa Rush | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Juncus rugulosus | Wrinkled Rush | | | | | Current observations (post 1980) | Point | SD |
| Plants | Juncus xiphioides | Iris-leaf Rush | | | | | Current observations (post 1980) | Point | SD |
| Plants | Juncus xiphioides | Iris-leaf Rush | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Lythrum californicum | California Loosestrife | | | | | Current observations (post 1980) | Point | Herbarium ARIZ |
| Plants | Lythrum californicum | California Loosestrife | | | | | Current observations (post 1980) | Point | SD |
| Plants | Lythrum californicum | California Loosestrife | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Lythrum californicum | California Loosestrife | | | | | Current observations (post 1980) | Point | SEINET |
| Plants | Mimulus guttatus | Common Large Monkeyflower | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Mimulus guttatus | Common Large Monkeyflower | | | | | Current observations (post 1980) | Point | SD |
| Plants | Phacelia distans | NA | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Phacelia distans | NA | | | | | Current observations (post 1980) | Point | SD |
| Plants | Phacelia distans | NA | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Phacelia distans | NA | | | | | Unknown | Point | UC UC |
| Plants | Platanus racemosa | California Sycamore | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Platanus racemosa | California Sycamore | | | | | Current observations (post 1980) | Point | SD |
| Plants | Platanus racemosa | California Sycamore | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Pluchea sericea | Arrow-weed | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Pluchea sericea | Arrow-weed | | | | | Current observations (post 1980) | Point | SD |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Plants | Pluchea sericea | Arrow-weed | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Salix exigua exigua | Narrowleaf Willow | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Salix exigua exigua | Narrowleaf Willow | | | | | Current observations (post 1980) | Point | RSA RSA |
| Plants | Salix exigua exigua | Narrowleaf Willow | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Salix gooddingii | Goodding's Willow | | | | | Current observations (post 1980) | Point | SD |
| Plants | Salix gooddingii | Goodding's Willow | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Salix laevigata | Polished Willow | | | | | Current observations (post 1980) | Point | SD |
| Plants | Salix laevigata | Polished Willow | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Schoenoplectus americanus | Three-square Bulrush | | | | | Current observations (post 1980) | Point | SD |
| Plants | Schoenoplectus americanus | Three-square Bulrush | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Typha domingensis | Southern Cattail | | | | | Current observations (post 1980) | Point | RSA |
| Plants | Typha domingensis | Southern Cattail | | | | | Current observations (post 1980) | Point | RSA RSA |
| Plants | Typha domingensis | Southern Cattail | | | | | Current observations (post 1980) | Point | SD |
| Plants | Typha domingensis | Southern Cattail | | | | | Current observations (post 1980) | Point | SD SD |
| Plants | Veronica anagallis-aquatica | NA | | | | | Current observations (post 1980) | Point | Calflora |
| Plants | Veronica anagallis-aquatica | NA | | | | | Current observations (post 1980) | Point | SD |
| Plants | Veronica anagallis-aquatica | NA | | | | | Current observations (post 1980) | Point | SD SD |

# Attachment 2

## Aerial Photography Comparison




GDE Areas of Interest

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

Coyote Canyon 1954

Coyote Canyon 2017

SOURCE: USGS

DUDEK

Groundwater Dependent Ecosystems Comparison

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

Palm Canyon 1954

Palm Canyon 2017

SOURCE: USGS

DUDEK

Groundwater Dependent Ecosystems Comparison

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

## Hellhole Canyon 1954

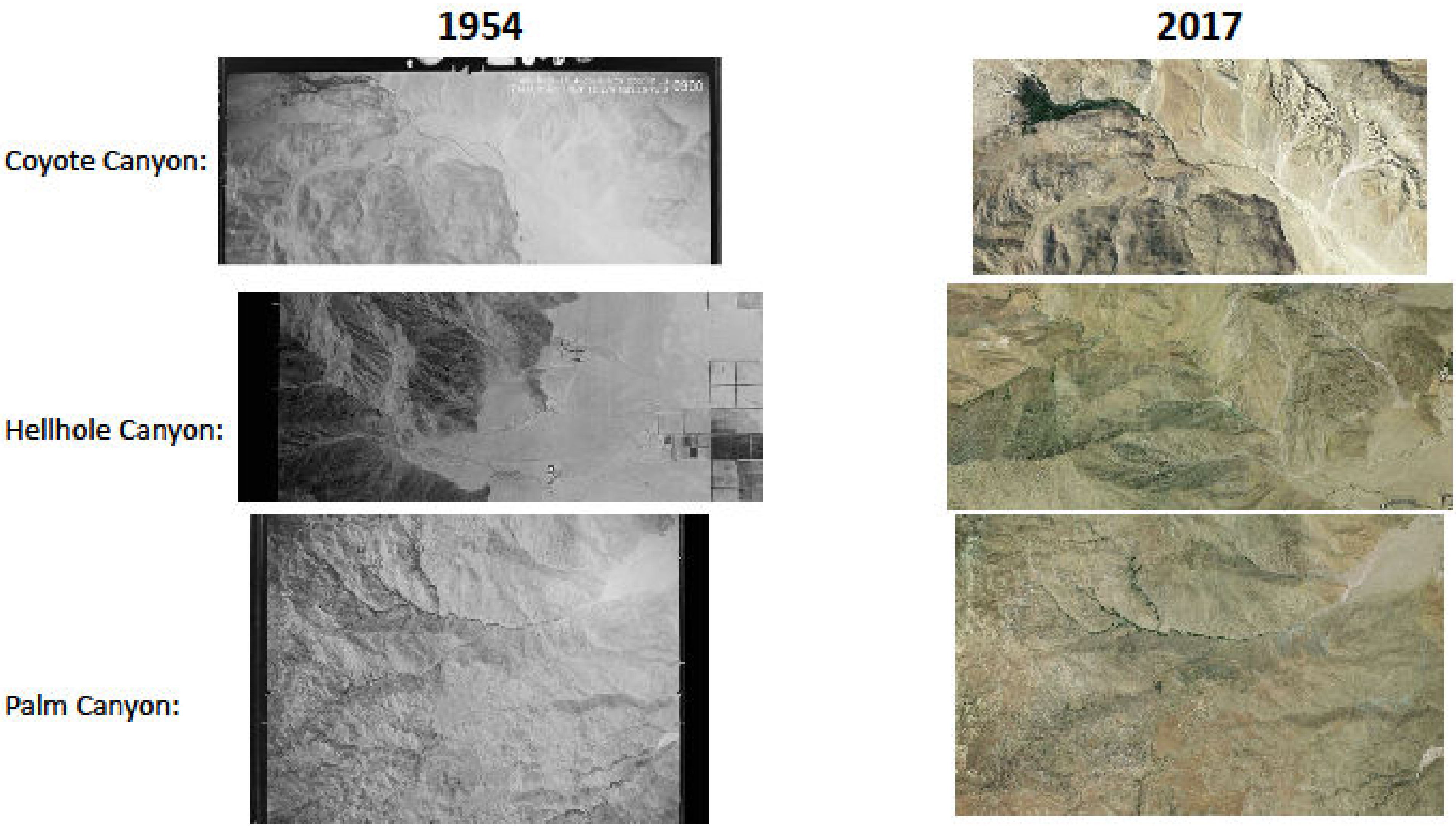

## Hellhole Canyon 2017

SOURCE: USGS

DUDEK

Groundwater Dependent Ecosystems Comparison

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems




SOURCE: USGS

Groundwater Dependent Ecosystems Comparison

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems