# SECTION 3: **Basin Setting [Article 5, Subarticle 2]**

**§354.12 Introduction to Basin Setting. This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.**

This section describes the basin setting based on existing studies related to the geology, climate, historical groundwater and surface water conditions. The purpose of this section is to provide an overview of what is currently know about the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, and principal aquifers and aquitards in the basin.

## 3.1 Hydrogeologic Conceptual Model [§354.14]

**§354.14 Hydrogeological Conceptual Model.**

**(a) Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.**

The hydrogeology of the basin has been studied extensively over the last 70 years in previous investigations. The most significant reports include the following:

- Upson, J.E. and Thomasson, H.G. (1951), Geology and Ground-Water Resources of the South-Coast Basins of Santa Barbara County, California, U.S. Geological Survey Water Supply Paper 1108.
- Lian, H.M (1952), The Geology and Paleontology of the Carpinteria District, Santa Barbara, California, unpublished Ph. D. dissertation, University of California at Los Angeles.
- Evenson, R.E., Wilson, H.D., Jr., and Muir, K.S. (1962), Yield of the Carpinteria and Goleta Ground Water Basins, Santa Barbara County, California, 1941 – 58, U.S. Geological Survey Open-File Report.
- Slade, R.C. (1975), Hydrogeologic Investigation of the Carpinteria Ground Water Basin, unpublished M.A. Thesis, University of Southern California.
- Geotechnical Consultants, Inc. (1976), Hydrogeologic Investigation of Carpinteria Ground Water Basin, prepared for Carpinteria County Water District.
- Geotechnical Consultants, Inc. (1986), Hydrogeologic Update, Carpinteria Groundwater Basin, prepared for Carpinteria County Water District.
- Sullwold, H.H. (1996), Carpinteria Groundwater Basin, A Geological Up-date, prepared for Carpinteria Valley Water District.
- Pueblo Water Resources, Inc. (2012), Carpinteria Groundwater Basin, Hydrogeologic Update and Groundwater Model Project, prepared for Carpinteria Valley Water District.

These documents describe the stratigraphy, structure, and hydraulic characteristics of the basin. Taken together, they also document the evolution of the understanding of the hydrogeology of the basin. The Hydrogeologic Conceptual Model (HCM) of the basin was initially developed by Geotechnical Consultants, Inc. (GTC) and is documented in their 1976 report. The 1976 GTC report is the most comprehensive report on the basin, and it built upon the previous work regarding the basin structure and hydraulic parameters to include a detailed analysis of the water budget for the basin. Sullwold (1996) later refined the structural and hydrostratigraphic delineations of the basin, taking into consideration water and oil wells drilled after 1975.

Most recently, PWR (2012) performed an update of the hydrogeologic conditions within the basin. Since the 1976 GTC report was published, significant additional information had been developed. In particular, the CVWD had constructed, tested, and operated several high-capacity municipal production wells in the basin, and had implemented basin-wide water level, water quality, and production data collection programs pursuant to the AB3030 Groundwater Management Plan. PWR (2012) also updated the water budget for the basin since the last time it was updated by GTC in 1986. The 2012 hydrogeologic update formed the basis for the development and calibration of the existing three-dimensional MODFLOW groundwater model of the basin (documented in **Appendix TBD**).

This section presents a current description of the HCM of the basin and is based largely on a compilation and synthesis of information from the sources listed above.

## 3.1.1 Regional Hydrology

### 3.1.1.1 Topography and Watershed Boundary [§354.14(d)(1)]

**§354.14 Hydrogeological Conceptual Model.**

**(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:**

**(1) Topographic information derived from the U.S. Geological Survey or another reliable source.**

The Carpinteria Groundwater Basin (basin) consists of a low-lying alluvial plain that is physically bordered on the south by the Pacific Ocean and on the north and east by bedrock. The western boundary is an administrative boundary with the Montecito Groundwater Basin. As originally described by Thomasson (1951), the watershed area of the basin can be broadly categorized into three main parts: 1) a mountainous headwaters area, the principal area of surface water runoff; 2) the marginal part of the groundwater basin, the principal area of groundwater recharge; and, 3) the central alluvial valley, which is underlain by low permeability deposits near the surface and constitute an area of confined groundwater conditions. A USGS topographic map of the basin area is shown on **Figure 3-1**. As shown, the basin is approximately seven miles long in an east-west direction and extends northward from the coastline a maximum of about two miles. The lowest ground surface elevations occur in El Estero, an active intertidal salt marsh west of the City of Carpinteria. From this area, the topography gradually rises northward to elevations of up to approximately 650 feet above sea level along the northern and eastern boundaries of the basin. North of the Basin boundary are the foothills of the Santa Ynez Mountains.

#### 3.1.1.2 Surface Water Bodies [§354.14(d)(5)]

**§354.14 Hydrogeological Conceptual Model.**

**(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:**

**(5) Surface water bodies that are significant to the management of the basin.**

There are five major creeks in the basin, each of which extends from the crest of the Santa Ynez Mountains and flows in a generally southerly direction across the basin to the Pacific Ocean. The creeks in the basin area are shown on **Figure 3-2**. As shown, Gobernador, Carpinteria and Santa Monica Creeks are the main drainages into the central portion of the basin. Rincon Creek crosses the east end of the basin and dissects the remnant terrace deposits and older alluvial fans in this area. Toro Creek enters the basin at the west end of the basin. Smaller drainages, including Franklin and Arroyo Paredon Creeks, are headed in the adjacent foothills and flow as a result of direct runoff following storms. It is noted that the channels of both Santa Monica and Franklin Creeks were concrete lined in 1973 to control flood flows.

There is only one active stream gage in the basin with a significant period of record, the USGS Carpinteria Creek gage (gage no. 11119500), located just downstream of the confluence of Gobernador and Carpinteria Creeks, as shown on **Figure 3-2**. This gage has a period of record of January 1941 through the current period, with annual discharge ranging between 0 and approximately 24,250 AFY and a long-term mean of approximately 2,700 AFY. Also shown on **Figure 3-2** are the locations of CVWD surface water sampling stations (discussed in Section 5).

The El Estero Salt Marsh is an approximate 215-acre intertidal marshland area west of the City of Carpinteria. Given the inter-tidal nature and location in the Confined Area of the basin (discussed in a later section), which limits the hydraulic connection between the marsh and the underlying principal aquifer, this surface water body is not considered to be significant to the management of the basin.

### 3.1.2 Regional Geology [§354.14(b)(1),(d)(2), and (d)(3)]

**§354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(1) The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.**

**(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:**

**(2) Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.**

**(3) Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.**

The basin is located on the south flank of the Santa Ynez Mountains, one of the east-west trending ridges of the Transverse Range Geomorphic Province. The basin represents the north limb of a synclinal geologic structure, the deepest parts of which terminate against the traces of the Rincon Creek Fault. This structural depression has subsequently been filled with younger water-bearing deposits. Water-bearing deposits in the basin include all unconsolidated and semi-consolidated sediments of Quaternary age, with older consolidated and generally non-water bearing rocks forming the definable boundaries of the basin.

Quaternary Age water-bearing basin deposits primarily consist of the following:

- Alluvial Deposits
- Carpinteria Formation (not exposed within or adjacent to the basin)
- Casitas Formation
- Santa Barbara Formation

Tertiary Age formations that form the primary bedrock boundaries of the basin include the following:

- Sisquoc Formation
- Monterey Formation
- Rincon Shale
- Vaqueros Formation
- Sespe Formation
- Coldwater Sandstone

The geologic contact between unconsolidated water-bearing deposits and bedrock formations delineates the northern and southeastern lateral boundaries and the definable bottom of the basin. The southwestern portion of the basin is bounded by the Pacific Ocean. The western boundary is a jurisdictional boundary with the Montecito Groundwater Sustainability Agency (discussed below).

The most recent published geologic maps covering the basin area were utilized to refine the delineation of the basin boundaries as part of a formal Basin Boundary Modification (BBM) through DWR in 2018 based on the geologic contacts described above. A geologic map showing the surficial geology from the recent geologic mapping and the corresponding current basin boundaries is presented on **Figure 3-3**. In addition, the 2018 BBM included removal of the Toro Canyon area from the formal Bulletin 118 basin delineation and created an approximate 3,000-feet long jurisdictional boundary at the western edge of the basin coinciding with the boundary between the CVWD and Montecito Water District (MWD).

Within the basin, the Rincon Creek Thrust Fault has created a barrier to subsurface groundwater movement within the basin, and the surface trace of the fault has been used to segregate the basin into two Storage Units: Storage Unit No. 1 (SU-1) is on the north side of the fault trace, and Storage Unit No. 2 (SU-2) is to the south. The southeastern portion of SU-1 is hydrogeologically separated from the ocean by the Rincon Creek Thrust Fault; however, west of El Estero, basin deposits are understood to be in contact with the ocean. SU-1 contains all of the CVWD's principal municipal supply wells and the vast majority of agricultural wells and has accordingly been the primary focus of previous basin investigations and data collection programs. A map showing the boundaries of the two Storage Units is presented on **Figure 3-4**.

#### 3.1.2.1 Soil Types

The soils of the basin are derived primarily from exposed geologic formations. Soil and vegetation affect how much precipitation can infiltrate into the soil to recharge the basin aquifer system. Soil data from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic

Service Database (SSURGO) is shown by the four hydrologic groups and two dual classes present in the basin (A/D and C/D) on **Figure 3-5**. The groups are defined as follows:

- **Group A.** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.
- **Group B.** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- **Group C.** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- **Group D.** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter describes the condition of soils that are actively drained and the second letter describes the condition of the soils in their natural (undrained) condition. Only the soils that in their natural condition are in group D are assigned to dual classes.

### 3.1.3 Principal Aquifers and Aquitards [§354.14(b)(4)(A)]

**§354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(4) Principal aquifers and aquitards, including the following information:**

**(A) Formation names, if defined.**

In the basin a single principal aquifer occurs primarily within unconsolidated and semi-consolidated sediments of the Pleistocene- and upper Pliocene-aged Carpinteria and Casitas Formations. In some local alluvial valleys of Basin Creeks (Figure 3-2), wells penetrate and may possibly screen the sediments of the younger alluvium, but available data indicate that these wells usually are also screened in the Casitas formation, which provides most of the productive yield. There is no consistent low permeability strata separating the alluvium from Casitas sediments; these sediments function as a single hydrogeologic unit. Such deposits are readily capable of absorbing, storing, transmitting and yielding water to wells. Holocene-aged alluvial deposits are present as a thin veneer along the coastal plain and along all creek channels and comprise the sediment of alluvial fan deposits at canyon mouths along the northern basin boundary. Older Tertiary sedimentary bedrock units are considered to be generally non-water-bearing and constitute the boundaries of the groundwater basin.

In the vicinity of the City of Carpinteria, the Holocene alluvial deposits are comprised predominantly of silt and clay to depths of approximately 150 to 250 feet. Because these deposits do not readily transmit water, they limit the downward percolation of water and also serve to confine water in the underlying principal aquifer under artesian pressure (discussed further later).

The Carpinteria Formation is not exposed in the basin, although some investigators report it occurs in the subsurface in SU-1 with a maximum thickness of 75 feet. The term Carpinteria Formation was evidently first used by Lian (1952) for the flat lying terrace deposits exposed in sea cliffs and Slade (1975) used the term similarly, although he considered the basal member to constitute the A Zone (discussed below). Subsequent investigators (Dibble 1987 and Sullwold 1996), however, did not find it useful to distinguish and largely ignored it. Lithologically, the sediments of the Carpinteria Formation are similar to deposits of older alluvium and the upper Casitas Formation, thus precluding definitive separation and distinction from well logs. Given these characteristics, the Carpinteria Formation cannot be reliably delineated on the geologic cross-sections in the basin (discussed below).

The principal aquifer system in the basin largely occurs in the Casitas Formation, which is contained in the entire basin area north of the Rincon Creek Fault and is exposed in outcrops along the northern and eastern boundaries (refer to Figure 3-3). The Casitas Formation is an assemblage of poorly to moderately consolidated clayey to gravelly sand with variable amounts of silt and cobbles reaching substantial thicknesses of 2,300 to 2,500 feet in SU-1. Sandy clay is abundant and sandy units are typically thin and lenticular and cannot be correlated over long distances. Notable exceptions to this are the major water producing zones delineated at the A, B, C and D Zones in the Confined Area of the basin (discussed in the following section).

Underlying the Casitas Formation is the marine Santa Barbara Formation, which unconformably overlies all older consolidated rocks in the basin. The formation is only exposed south of the Rincon Creek Fault in SU-2 where it unconformably overlies Miocene shales. The Santa Barbara formation consists of poorly to moderately consolidated, soft and massive, sandstone and siltstone with abundant clay shale. Available data indicate the formation is 750 to as much as 1,250 feet thick in SU-1 and at least 1,500 feet thick in SU-2. Although the formation represents a potential water-bearing deposit in the basin, no water wells are known to penetrate it and no major aquifers have been discerned within it (note: the wells shown on the cross-sections that do penetrate the Santa Barbara Formation are exploratory borings or wildcat oil wells).

### 3.1.3.1 Physical Properties of the Aquifers and Aquitards

#### 3.1.3.1.1. Basin Boundary (Vertical and Lateral Extent of Basin) [§354.14(b)(2),(b)(3), and (c)]

**§ 354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(2) Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.**

**(3) The definable bottom of the basin.**

**(4) Principal aquifers and aquitards, including the following information:**

**(c) The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.**

The geologic contact between unconsolidated water-bearing deposits and bedrock formations delineates the northern and southeastern lateral boundaries and the definable bottom of the basin. The southwestern portion of the basin is bounded by the Pacific Ocean. The western boundary is a jurisdictional boundary with the Montecito Groundwater Sustainability Agency (discussed below).

The most recent published geologic maps covering the basin area were utilized to refine the delineation of the basin boundaries as part of a formal Basin Boundary Modification (BBM) through DWR in 2018 based on the geologic contacts described above. A geologic map showing the surficial geology from the recent geologic mapping and the corresponding current basin boundaries is presented on **Figure 3-3**. In addition, the 2018 BBM included removal of the Toro Canyon area from the formal Bulletin 118 basin delineation and created an approximate 3,000-feet long jurisdictional boundary at the western edge of the basin coinciding with the boundary between the CVWD and Montecito Water District (MWD).

Water-bearing deposits in the basin include all unconsolidated and semi-consolidated sediments, with older consolidated non-water bearing rocks bounding the basin both laterally and vertically (refer to **Figure 3-3**). The top of bedrock represents the definable bottom of the basin. Structural contours of the top of bedrock for SU-1 and SU-2 based on the evaluation of wildcat oil wells in the basin (Sullwold, 1996) are shown on **Figures 3-6 and 3-7**, respectively. As shown, in the deepest portion of the basin bedrock is as much as 4,000 feet below sea level in SU-1 and rises to approximately 500 feet above sea level along the northern boundary of the basin. As also shown, the bedrock contours and overlying basin deposits extend offshore beyond the formal basin boundary at the Pacific Ocean coastline. In SU-2 (where there is relatively little geologic control) the bedrock is estimated to reach depths of approximately 1,000 feet below sea level.

Lithologically, the primary water bearing deposits in the basin consist of interbedded unconsolidated and semi-consolidated sand, gravel, silt and clay (and combinations thereof) deposits. The coarser grained sandy/gravelly strata in these deposits comprise the individual primary water producing zones (A through D Zones) for wells in the central portion of the basin. These primary producing zones are generally on the order of 50 to 100 feet thick each. Finer grained strata of silt and clay are generally thicker and form a series of aquitards between the primary producing zones in this area. These aquitards are laterally extensive in the central alluvial plain portion of the basin and confine water held in the primary aquifers under artesian pressure. This area of the basin is referred to as the Confined Area (**Figure 3-8**).

Outside the Confined Area of the basin and extending to the bedrock boundaries, the A – D Zones become laterally discontinuous and generally non-correlatable. The alluvial deposits and Casitas Formation in these areas contain laterally discontinuous layers of both permeable and impermeable materials, and water held in these areas is generally unconfined (although various degrees of local confinement likely do occur). The source of recharge water to the basin is primarily by infiltration of precipitation, irrigation water and streamflow seepage (discussed later); however, in the Confined Area, downward percolation of water is limited due to the presence of fine-grained low-permeability materials overlying most of the area of the principal aquifers; therefore, recharge to the primary aquifers occurs primarily in the areas between the Confined Area and the boundaries of consolidated bedrock. This area is referred to as the Recharge Area (Figure 3.8).

It is noted that no new information since 2012 (i.e., correlatable producing zones and/or aquitards from recently drilled wells) indicates that the previous delineations of the Confined and Recharge Areas should be modified at this time; therefore, the previous delineations of these areas of the basin have been adopted for this GSP. A map showing the Confined and Recharge Areas is presented on **Figure 3-8**.

Well logs obtained for new wells in the basin have been used to refine the previous interpretations of the hydrostratigraphy of the Basin and prepare six geologic cross-sections through the Basin. The locations of the cross-section lines are shown on **Figure 3-3**. The cross-sections are shown on **Figures 3-9 through 3-14**. As shown, the cross-sections depict the overall basin structure and distribution of the A through D Zones discussed above.

The western edge of cross-section A – A' (**Figure 3-9**), and bedrock structural contours for SU-1 (**Figure 3-6**) show that basin sediments at the jurisdictional boundary with the MWD range from a maximum thickness of approximately 500 feet at the coastline and rapidly thinning to northern bedrock boundary. Given these conditions, groundwater can move freely across this boundary, depending on hydrologic conditions and water-level gradients at the boundary.

The western portion of cross-section B - B' (**Figure 3-10**) shows the current understanding of the relationship between the basin deposits and the Pacific Ocean. It is noted that the available geologic control offshore is limited to oil wells that have been drilled in the area, from which the geologic contact between unconsolidated sediments and the underlying bedrock have been established, but the lithologic descriptions for the overlying deposits are insufficient to reliably delineate the A – D Zones within the Carpinteria and Casitas Formations. The delineations of the A – D Zones shown are based on extrapolation of the structure from the onshore area the offshore area and is accordingly shown as queried on the cross section. As shown, these zones are conceptualized to outcrop at (or near) the sea floor. It is noted that offshore geologic mapping does indicate that the seafloor surface consists of undifferentiated continental shelf sediments of unknown thicknesses, which may limit the hydraulic continuity between the Pacific Ocean and the basin deposits to an unknown extent.

The other cross-sections also show the physical relationship between the basin deposits and the Rincon Creek Fault and the northern and eastern basin boundaries. As shown, the thickness of basin deposits terminating at the base of the Rincon Creek Fault range between approximately 1,500 to over 3,000 feet and gradually thin towards the basin boundaries and contacts with the bedrock.

In the southeastern extent of the Basin in Ventura County, Younger Alluvium is present at the surface along Rincon Creek. The Rincon Creek Fault is mapped through this portion of the Basin, with the Casitas Formation exposed at the surface in the hills north of the fault and east of Rincon Creek, and the older Santa Barbara Formation cropping out south of the fault. The Monterey Formation is exposed along the ridge southeast of the Basin boundary. Most wells in this area are located in the low-lying area along Rincon Creek. However, as discussed previously, available well data indicate that wells in this area may screen some alluvial sediments, but usually penetrate through the Younger Alluvium to screen the underlying sediments of the Casitas Formation.

#### 3.1.3.1.2. Groundwater Flow Barriers [§354.14(b)(4)(C)]

**§ 354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(4) Principal aquifers and aquitards, including the following information:**

**(C) Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.**

As discussed previously, the Rincon Creek Thrust Fault represents a hydraulic flow barrier within the basin. The fault plain has been intersected by several wildcat oil wells. As shown on **Figure 3-3**, the surface trace of the fault extends westerly across the basin from the Ventura County side of Rincon Creek, through El Estero, and then offshore. As shown on the cross-sections, in the central portions of the basin consolidated bedrock have been thrust up and over basin sediments. Subsurface data indicate fault plane dips south at angles ranging from 50 to 70 degrees with displacement as much as 3,000 to 4,000 feet. Analysis of available hydrogeologic data by previous investigators (GTC) strongly suggests that Rincon Creek Fault has created a barrier of the southward movement of groundwater in the basin and forms the basis for the delineation of SU-1 and SU-2 discussed previously.

As discussed above, west of El Estero in SU-1, the water-bearing deposits of the basin are in contact with the Pacific Ocean. Otherwise, the remainder of the basin is hydrogeologically separated from the Pacific Ocean by the Rincon Creek Fault or by consolidated bedrock exposed near the shoreline in SU-2 as a result of smaller displacement (approximately 300 to 400 feet) of the Santa Barbara Formation by the Carpinteria Fault.

#### 3.1.3.1.3. Hydraulic Properties [§354.14(b)(4)(B)]

**§354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(4) Principal aquifers and aquitards, including the following information:**

**(B) Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.**

The primary aquifer parameters necessary to characterize the hydraulics of groundwater movement and calculate basin storage include transmissivity, hydraulic conductivity, and storativity. Transmissivity and hydraulic conductivity are related (transmissivity is the product of hydraulic conductivity and aquifer thickness) and characterize the permeability of aquifer materials. Storativity is a measure of the aquifer's ability to store and release water. These aquifer parameters are used in the construction of the numerical groundwater flow model of the basin (Appendix TBD). Estimates of these parameters are ideally obtained from analysis of pumping test data; however, the number of controlled pumping tests conducted in the basin is relatively limited. Transmissivity can also be roughly estimated from specific capacity data (ratio of well yield to drawdown), which are a commonly measured parameter at pumping wells and are, therefore, more plentiful than pumping test data.

Data available to most previous investigations was generally limited to specific capacity data. Formal post-construction pumping tests conducted at the CVWD High School, El Carro, and Headquarters wells have been analyzed to determine aquifer parameters at those locations. In addition to pumping tests, transmissivities have also been estimated from specific capacity data for this GSP. For wells where only specific capacity data are available, the methods presented in Driscoll (1995, pg. 1021) to estimate transmissivity were utilized. Hydraulic conductivities were calculated by dividing transmissivity by total screen length of each well. Summaries of the aquifer parameters derived for the Confined and Recharge Areas are presented below:

**Confined Area.** Transmissivities derived from pumping test and specific capacity data in the Confined Area range between approximately 5,500 and 21,600 gallons per day per foot (gpd/ft) and average approximately 12,100 gpd/ft. Storage coefficients average approximately $6.5 \times 10^{-4}$ (dimensionless), indicative of confined conditions. Estimated hydraulic conductivities for the primary producing zones in the Confined Area range between approximately 9 and 18 feet per day (ft/d).

**Recharge Area.** Transmissivities derived from pumping test and specific capacity data in the unconfined Recharge Area range between approximately 400 and 18,000 gpd/ft, averaging approximately 3,200 gpd/ft. Hydraulic conductivities range between 0.2 and 7 ft/d, averaging approximately 1.4 ft/d. Storage coefficients could not be calculated from the available pumping test data in the Recharge Area due to a lack a nearby monitoring well to base calculations.

### 3.1.3.2 Groundwater Recharge and Discharge Areas [§354.14(d)(4)]

**§354.14 Hydrogeological Conceptual Model.**

**(d) Physical characteristics of the basin shall be represented on one or more maps that depict the following:**

**(4) Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.**

As discussed previously, outside the Confined Area of the basin and extending to the bedrock boundaries, the Carpinteria and Casitas Formations contain laterally discontinuous layers of both permeable and impermeable materials, and water held in these areas is generally unconfined. The primary sources of recharge to the Basin are percolation of precipitation, subsurface inflow, and percolation of irrigation water. This area is delineated as the Recharge Area as shown on Figure 3-8.

Groundwater within the principal aquifer of SU-1 does not discharge directly to the ocean in the southeastern portion of the basin due to the presence of overlying confining layers and the barrier created by the Rincon Creek Thrust Fault. Subsurface outflow from SU-1 is believed to occur in the general area from Serena Park to Sand Point (a distance of approximately 9,000 ft.) where there is no fault barrier between basin sediments and the Pacific Ocean. In SU-2, significant subsurface outflow is not believed to occur due to the onshore contact of unconsolidated water-bearing materials with consolidated bedrock, which effectively isolates SU-2 from the ocean (refer to Figures 3-3, 3-13, and 3-14).

### 3.1.3.3 Water Quality [§354.14(b)(4)(D)]

**§354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(4) Principal aquifers and aquitards, including the following information:**

**(D) General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.**

Groundwater quality within the basin has historically been monitored as part of the CVWD's AB 3030 Groundwater Management Plan program through the analysis of samples collected from 25 wells located throughout the basin. Water samples are also collected from six surface water stations when surface water is present. The laboratory analytical program for the samples includes total dissolved solids and basic inorganic chemical constituents, including chloride and nitrate. Chemical hydrographs for the 25 wells monitored are presented on **Figures 3-15 and 3-16**. **Figure 3-15** presents water quality data for wells located generally in the western portion of the basin and **Figure 3-16** presents data for wells located in the eastern portion.

In general, the chemistry of groundwater within the basin has a calcium-bicarbonate character, with concentrations of total dissolved solids (TDS) within the range of 600 to 900 milligrams per liter (mg/L) mg/L, and chloride ion concentrations in the range of 40 mg/L to 80 mg/L (notable exceptions are discussed later). Specific constituents of concern are discussed in detail below:

**TDS and Chloride.** There are some notable trends in the basin with respect to TDS and chloride ion concentrations. At most of the monitored private wells in the western portion of the basin, TDS and chloride concentrations have been relatively stable; however, increasing trends have been observed wells 19E1 and 19K5 (refer to **Figure 3-15**).

At 19E1, beginning in about 2010, the TDS concentration has increased steadily from approximately 1,100 mg/L to 1,500 mg/L, while the chloride concentration over this same period rose from about 300 mg/L to 500 mg/L, peaking at 600 mg/L in 2019, exceeding the secondary Maximum Contaminant Level (MCL) for chloride of 250 mg/L. At Well 19K5, the TDS concentration rose from about 1,200 mg/L to 1,370 mg/L between 2008 and the end of 2019, with some higher spikes in between. Similarly, the chloride concentration at that well rose from 160 mg/L to 190 mg/L during that period with some spikes in the middle of that period.

At well 19M1, on the other hand, the TDS concentration increased from approximately 1,000 mg/L to 2,500 mg/L between 1990 and 2006, but has since declined to about 1,750 mg/L. The chloride concentration at this well showed a similar trend, increasing from 100 mg/L to 500 mg/L between 1990 and 2005. Since 2005, the chloride concentration has been variable at 19M1, possibly experiencing a slight declining trend, with a concentration of 370 mg/L observed in 2019.

In the eastern portion of the basin, TDS and chloride concentrations have also been relatively stable at most of the monitored private wells. TDS and chloride concentration increases have been observed at wells 27E1, 28H1, and 34B4 (refer to **Figure 3-16**).

Increasing trends of these constituents at well 27E1 began in the late 1990's. In the early 1990's the TDS concentration at this well was approximately 600 mg/L, peaking in 2006, and has generally been declining since then with a level of 860 recorded in 2019. The pattern of chloride concentrations at this well has been similar, starting at 20 mg/L, peaking at 55 mg/L, with an observed level of about 40 mg/L in 2019. At well 28H1, TDS and chloride concentrations have been steadily increasing since about 2013. In 2013, the TDS at this well was approximately 690 mg/L. The concentration at the end of 2019 was 907 mg/L. The chloride concentration in 2013 was about 30 mg/L and was 55 mg/L at the end of 2019. The TDS and chloride concentration at well 34B4 has also increased since monitoring of this well began in 2005, when the TDS concentration was 650 mg/L and the chloride concentration was 35 mg/L. The TDS and chloride concentrations in well 34B4 at the end of 2019 were 700 mg/L and 76 mg/L, respectively.

At well 22R4, while the TDS concentration has remained relatively stable over the monitoring period, the chloride concentration at this well has displayed an increasing trend, starting at approximately 20 mg/L in the early 1990's, reaching a level of 88 mg/L at the end of 2019.

The GSA will continue to track the above-described trends during GSP implementation to assess the potential cause of the trends discussed above, including whether degradation of groundwater quality is caused by groundwater extractions and is, hence, a sustainability issue that must be addressed by the GSA.

**Nitrate.** Nitrate concentrations (as $NO_3$) in the basin are generally lower in wells that are completed in relatively deep aquifer units, and higher in shallow wells located in agricultural areas. Some trends of increasing nitrate concentrations have been identified. In the western portion of the basin (refer to **Figure 3-**

**15**), nitrate concentrations have been increasing at wells 19E1 and 19K5 since about 2005, coincident with increasing TDS and chloride concentrations during this same period at each of these two wells discussed above. For 19E1, nitrate concentrations were below 10 mg/L during the mid- to late-2000's and have increased to 56 mg/L by the end of 2019. At 19K5, nitrate concentrations were at around 170 mg/L in the mid-1980's, peaked at 280 mg/L in 2010, and during 2019 were reported to be at 190 mg/L.

Nitrate concentration increases have also been occurring at private wells in the eastern portion of the basin (refer to **Figure 3-16**), most notably at wells 27E1 and 28H1. At 27E1, the nitrate concentration at this well was approximately 10 mg/L in 1980, peaked at 63 mg/L in 2009, and dropped to 50 mg/L in 2019. The MCL for nitrates in drinking water in California is 45 mg/L (as $NO_3$). The increases in nitrate concentrations in the noted wells appear to be localized and may be associated with well completion depths and/or agricultural practices.

**CVWD Municipal Wells.** Water quality at the CVWD municipal production wells is also monitored through the AB 3030 program. Chemical hydrographs for CVWD wells are also presented on **Figures 3-15 and 3-16**. In the western portion of the basin at the Headquarters well (29D8) (refer to **Figure 3-15**), while the TDS concentration has been relatively stable over the period of record, generally within the range of 640 mg/L to 680 mg/L, the chloride concentration at this well increased slowly from approximately 40 mg/L in 2015, to about 50 mg/L at the end of 2018, to 65 mg/L at the end of 2019. While the chloride concentration at the Headquarters Well is well below the secondary MCL of 250 mg/L, the steady increase over the past several years is noteworthy. Unlike other private wells in the western portion of the basin where increases in TDS and chlorides were sometimes accompanied by increases in nitrate concentrations, the nitrate concentration at the Headquarters Well has been stable and less than 10 mg/L over the period of record.

The CVWD production wells in the eastern portion of the basin are the El Carro No. 1 and 2 wells (28D2 and 28D4, respectively), Lyons (28F7) and the Smillie (27F2) wells (refer to **Figure 3-16**). At the El Carro well site[1], there does not appear to be any notable or significant trends in water quality, with concentrations of TDS, chlorides, and nitrates at the end of 2019 at 691 mg/L, 38 mg/L, and 12 mg/L, respectively. At the Smillie well, water quality also appears to be stable with no notable trends, with concentrations of TDS, chloride, and nitrate at the end of 2019 of 658 mg/L, 32 mg/L, and 13 mg/L, respectively.

The Lyons well is currently inactive and has not been sampled since 2014, however; some notable trends of increasing concentrations of TDS, chlorides, and nitrates are apparent for this well during the period of record. Prior to 2000, the TDS concentration at this well was consistently under 600 mg/L. Since 2005, the TDS concentration at Lyons has ranged between about 730 mg/L and 770 mg/L, although the TDS concentration at this well does not appear to be recently increasing. Chloride concentrations at the Lyons well generally shows a steady increase from about 25 mg/L in the early 1980's to 62 mg/L in 2014. Nitrate concentrations have also increased over the period of record at this well, going from concentrations generally below 10 mg/L prior to 2005 to a concentration of 39 mg/L in 2013. It is noted that this well has a relatively shallow annular seal depth (50 feet), which may allow the vertical migration of poor-quality shallow water through the gravel-packed annular space into the screen zones of this well.

**Surface Water Quality.** Available surface water-quality data are presented on **Figure 3-17** and the locations of the surface water sampling locations are shown on **Figure 3-2**. As shown, a long-term trend of slightly increasing TDS concentrations for the surface water quality is apparent over the period of record, particularly on Arroyo Paredon Creek, although most recently the TDS concentrations were relatively stable, if not slightly diminished. Nitrate and chloride concentrations at surface water sampling stations appear to be relatively stable since monitoring began. It is noted that Arroyo Paredon Creek, located in the western portion of the basin, generally has significantly higher concentrations of both TDS and chloride compared to the other

[1] El Carro No. 1 was drilled in 1990 and was replaced by the El Carro #2 well in 2010.

creeks in the basin. The reason(s) for this are not known but may be a contributing factor to the elevated levels of these constituents in groundwater at wells in this area discussed above (i.e., wells 19E1, 19K5 and 19M1).

#### 3.1.3.4 Primary Beneficial Uses [§354.14(b)(4)(E)]

**§354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(4) Principal aquifers and aquitards, including the following information:**

**(E) Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.**

The primary uses of the principal aquifer in the basin are municipal and agricultural water supply. To the extent non-municipal small domestic wells provide water supply in the basin, it is considered de minimis and historically has not been quantified. Municipal pumping by the CVWD is metered and agricultural pumping is estimated by CVWD via annual land use surveys. The average proportion of pumping by these two user types from WY 1985 through WY 2020 is summarized below:

- Municipal = 36%
- Agricultural = 64%

### 3.1.4 Data Gaps and Uncertainty [§354.14(b)(5)]

**§354.14 Hydrogeological Conceptual Model.**

**(b) The hydrogeologic conceptual model shall be summarized in a written description that includes the following:**

**(5) Identification of data gaps and uncertainty within the hydrogeologic conceptual model.**

There is relatively good general hydrogeologic conceptual understanding of the central portion of the basin in SU-1, primarily because this is where the municipal and the majority agricultural production and monitoring wells, as well as wildcat oil wells, have been historically drilled and been the focus of previous hydrogeologic investigations in the basin. There are specific areas where the hydrogeologic conceptual understanding is less understood due to data limitations:

1. The stratigraphy of basin sediments offshore and the nature of the connection with the Pacific Ocean. While there is geologic control for the depth to bedrock formations and the trace of the Rincon Creek Fault offshore from oil well drilling, the geometry of the A – D Zones is currently based on extrapolation of the onshore surfaces to the offshore area.
2. The structure and aquifer parameters of SU-2 are not well understood due to the lack of wells drilled and pumping tests performed in this unit.

3. The structure, aquifer parameters and amounts of pumping in the Ventura County portion of the basin are not well understood, largely due to this area being outside the boundaries of the CVWD and a historical lack of hydrogeologic investigation in this area of the basin.
4. The hydraulic parameters of the individual A through D producing zones in the central portion of the basin can only be roughly estimated because most wells in the basin (except the recently drilled Sentinel Wells, discussed later) penetrate two or more of the main producing zones, and data developed from pumping tests therefore represent a composite of all of the zones penetrated by any given well.

# 3.2 Groundwater Conditions [§354.16]

## 3.2.1 Groundwater Elevations [§354.16(a)]

### 3.2.1.1 Groundwater Elevation Contours [§354.16(a)(1)]

**§354.16 Groundwater Conditions. 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 the following:**

**(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:**

**(1) Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.**

Analysis of water-level hydrographs (discussed below) led to the identification the historical basin high and the basin low periods within the WY 1985 – WY 2020 historical water budget base period (discussed in a later section). Water-level contours have been prepared for the basin high and low periods within the base period, as well as for January 2015 and current conditions. The specific periods for which water-level contours were prepared include:

- Fall 1991 –base period historical low
- Spring 1998 – base period historical high
- January 2015 - SGMA effective date
- Spring 2020 – current seasonal high
- Fall 2020 – current seasonal and historic low

The water-level contours for these periods are presented on Figures 3-18 through 3-22, respectively.

The primary purpose of the water-level contours is to help to identify general patterns in the flow regime within the basin, including those attributable to recharge sources and associated with discharge areas. The water-level contours show that in SU-1, groundwater generally flows in a northeast to southwesterly direction in the eastern half of the basin, and north to south in the western half of the basin. The directions of groundwater flow generally reflect the movement of groundwater from the primary sources of recharge in the Recharge Area to the primary sources of extraction (groundwater pumping) in the Confined Area in the central portion of the basin. It is noted that available data for SU-2 are limited and water-level contours are not depicted for unit this reason.

The water-level contours for the base-period historical low of Fall 1991 (**Figure 3-18**), coinciding with the extended drought period of 1987 – 1991, show the development of a water-level depression centered in the central portion of SU-1. In the center of the depression, water levels during this period declined to an elevation of more than 50 feet below msl.

The water-level contours for the base period historic high of Spring 1998 (**Figure 3-19**) show the depression earlier in the decade being filled as a result of basin recharge, with water levels recovering to levels of as much as 50 feet above msl in the same area and a seaward gradient restored throughout the basin.

Water levels for January 2015 (**Figure 3-20**) show the development of a water-level depression again centered in the central portion of the basin. It is noted that this time period coincides with the most recent drought period of WY 2012 through WY 2016. This depression persists into the current period of WY 2020, with water levels as much as 50 to 60 feet below msl in both Spring and Fall 2020 (**Figures 3-21 and 3-22**, respectively), which are presented as the current seasonal high and low, as required in the GSP Emergency Regulations.

These water-level conditions result in a reversal of the natural seaward groundwater gradient, creating the potential for seawater intrusion in the western portion of the basin (i.e., in the general area from Sand Point to Serena) where basin deposits are exposed to the Pacific Ocean. It is noted that prior to 2019 seawater intrusion had not historically been detected in existing wells in the basin; however, prior 2019 there were no monitoring wells along the coast that that could have detected seawater intrusion. As discussed below, the CVWD has recognized this deficiency in the historical monitoring well network in the basin and recently drilled seawater intrusion "sentinel" wells near the coastline just west of El Estero (discussed in a later section).

#### 3.2.1.2 Groundwater Elevations [§354.16(a)(2)]

**§354.16 Groundwater Conditions. 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 the following:**

**(a) Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:**

**(2) Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.**

Hydrographs for water-level monitoring wells in the CVWD database have been prepared for the GSP. The hydrographs are essential for understanding basin dynamics. They are used to identify water-level trends and assess aquifer response to various hydrogeologic conditions. They are also used as groundwater model calibration targets.

Water-level data in the basin have historically been collected and maintained by the USGS and the CVWD. The USGS database contains water-level records for 75 wells in the basin, dating back to as early as 1919 (State Well No. 4N/25W-28J1); however, most records begin in either the 1940s or 1970s. The USGS database does not extend beyond 2001. The CVWD has historically made monthly measurements at over 40 wells in the basin, and until 2001, provided the USGS with these data to supplement the USGS database. After 2001 the CVWD continued measuring water levels at these wells as part of the AB 3030 Groundwater

Management Plan program and assumed the responsibility for maintaining the water-level records. Currently, there are records for 48 wells in the CVWD database. The locations of the monitoring wells are shown on **Figure 3-23** and hydrographs for selected wells are presented on **Figures 3-24 through 3-28.** The following discussion pertains to these selected hydrographs. A complete set of hydrographs with all available data is included in **Appendix TBD.**

In general, the long-term hydrographs for SU-1 display seasonal and small amplitude annual fluctuations superimposed upon some larger, more prominent trends. Prior to the historical water budget period of WY 1985 – WY 2020, the most notable trends occurred during the late-1940's through the mid-1950's when water levels in the basin declined substantially, and between approximately the early 1960's and about 1975 when water levels in the basin increased significantly. These trends are evident in the hydrographs depicted in Figures 3-24, 3-25, 3-27, and 3-28 (wells 19F4, 26A1, 28J1, in the Recharge Area (Figure 3-8) and well 30D1 in the confined area.

There are notable trends within the historical WY 1985 – WY 2020 water budget period as well. Water levels declined relatively sharply starting at the beginning of the base period through the fall of 1991, corresponding to the extended six-year drought of 1987 – 1992. This was followed by a relatively steep upward trend in water levels peaking around the spring of 1998, which was the wettest year on record (approximately 55.5 inches of rainfall). After 1998, water levels throughout most of the basin displayed a gradual declining trend until the early- to mid-2000's when water levels essentially stabilized until around 2012. Water levels at most wells steadily declined during the extreme drought period of 2012 through 2016. Water levels have generally been stable or slightly rising at many, but not all, wells since 2016. It is notable that recent (2020) water levels at many locations are at lower elevations than occurred in during the 1987 – 1992 drought period and are approaching the historical lows observed during the 1950's at some locations. In wells 19F4 and 28J1 (Figures 3-24 and 3-27), current water levels are comparable to those observed in the 1940s/1950s drought, In wells 26A1 and 30D1 (Figures 3-25 and 3-28), water levels in the 1940s/1950s drought are lower than current water levels. All five hydrographs indicate that current water levels are lower than water levels observed in the 1980s/1990s drought.

### 3.2.2 Change in Storage [§354.16(b)]

**§354.16 Groundwater Conditions. 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 the following:**

**(b) A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.**

The amount of groundwater in storage in the basin generally reflects changes in groundwater elevations over time as discussed above. **Figure 3-29** shows the changes in storage from WY 1985 through WY 2020 as calculated by the difference between annual inflows and outflows according to the historical water budget (refer to Section 3.3 below). As discussed above, during this period groundwater elevations were depressed in SU-1 during the late 1980s/early 1990s when groundwater pumping was between approximately 3,300 and 5,400 acre-feet per year (AFY) and during the more recent period of 2012 through 2020 when groundwater pumping was between approximately 3,400 and 6,700 AFY. As discussed later in the Water Budget section, these periods coincide with below-normal rainfall and recharge of the basin aquifers. **Figure 3-29** shows how groundwater was consistently lost from storage most years during these dry periods as a result of the imbalance between recharge and pumping in the basin.

### 3.2.3 Seawater Intrusion [§354.16(c)]

**§354.16 Groundwater Conditions. 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 the following:**

**(c) Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.**

As discussed previously, the primary producing zones of SU-1 north of the Rincon Creek Fault to the vicinity of Serena Park is believed to be exposed to the Pacific Ocean and, therefore, at potential risk for seawater intrusion. From limited water-quality data from the 1930's for shallow wells in the vicinity of Serena Park, Upson (1951) observed that, although chloride ion concentrations in this area were relatively high, such concentrations were present in wells further inland as well. He concluded that seawater intrusion had not occurred in the basin but could occur if excessive pumping caused a lowering of groundwater levels in the basin. Subsequent studies conducted by the USGS during the 1950s showed that shallow wells near the coastline maintained relatively consistent chloride concentrations around 30 mg/L even though water levels had declined in areas of the basin to as much as 40 feet below msl.

GTC (1976) further concluded that the relatively high chloride concentrations in shallow wells discussed by Upson appeared to be the result of the chemical nature of the sediments (e.g., connate water still incompletely flushed), local degradation by irrigation returns and/or minor amounts of degradation of the shallow deposits where they are in direct communication with the Pacific Ocean. In the central Confined Area of the basin, the low-permeability confining layer was believed to prevent the vertical communication between the shallow and deeper aquifer system, although vertical communication between zones likely occurs at the western margins of the basin outside the Confined Area.

Thus, seawater intrusion has not historically been documented by previous investigations in the basin. Evaluation of basin conditions over recent years through the AB 3030 program, however, led to the identification of gaps in the existing monitoring well network, one of which was a monitoring well capable of the detection of seawater intrusion into the primary producing zones of the basin (i.e., the absence of evidence is not evidence of absence). This important data gap was initially identified in the above-referenced 2012 report documenting the Hydrogeologic Update and Groundwater Model Project (PWR) with a recommendation that the CVWD should install at least one coastal sentinel monitoring well in the northwest portion of SU-1 of the basin that has dedicated monitoring wells completed in the A, B and C Zones. This recommendation was repeated in each subsequent AB 3030 annual reports.

Sentinel Monitoring Wells. In 2019 the CVWD implemented the CGB Sentinel Well Project, which consisted of the installation of a cluster of monitoring wells near the northwestern margin of the Carpinteria Salt Marsh (El Estero), a location considered to be key for the collection of water-level and water-quality data related to evaluating the potential for seawater intrusion in the basin. The primary purposes of the Sentinel Well Project were:

1) Determine baseline water-quality conditions at this key location in the basin;
2) Allow for the collection of water-level and water-quality data through routine monitoring;
3) Establish a mechanism to track water-quality changes in distinct water bearing zones through routine induction logging; and,
4) Serve as an early warning indicator (i.e., "sentinel") for seawater intrusion into the basin.

It is noted that, in addition to providing the first monitoring location capable of detecting seawater intrusion in the principal aquifer of the basin, the Sentinel Wells are also the first monitoring well cluster in the basin with discrete and isolated completions within the three main producing zones in the Confined Area (A, B and C Zones).

The drilling and construction of the wells occurred between May 20 and August 1, 2019. The wells are identified as the CGB Sentinel Monitoring Well Nos. 1, 2, and 3, with well completions (screens) within the C, B, and A zones of the basin, respectively. Well construction and completion details are provided in **Table 3-1** below:

**Table 3-1. Sentinel Well Completion Summary**

| Parameter | MW-1 | MW-2 | MW-3 |
|---|---|---|---|
| Total Drilled Depth, (ft.) | 1240 | 880 | 350 |
| Casing Depth (ft.) | 1130 | 870 | 340 |
| Casing Diameter (in.)/PVC Grade | 3 / sch. 120 | 3 / sch. 80 | 3 / sch. 80 |
| Screened Interval (ft.) | 1,020 – 1,120 | 780 to 860 | 190 – 330 |
| Depth of Cement Grout Annular Seal (ft.) | 955 | 709 | 150 |
| Screened Producing Zone | C | B | A |

Depictions of the monitoring well completions with respect to the hydrostratigraphic conditions at the Sentinel Well site are provided on **Figure 3-30**.

Following well completion, water-level transducer/dataloggers were installed in each of the Sentinel wells to continuously measure and record water levels. Water-quality samples are also collected on a quarterly basis, which includes chloride ion, a key indicator of seawater intrusion. The water-level and chloride data collected since the construction of the wells are presented graphically on **Figures 3-31 through 3-33** (MW-1 through MW-3, respectively). The hydrographs on **Figures 3-31 through 3-33** also show daily well production data from the CVWD Headquarters and El Carro No. 2 wells to provide a holistic presentation of these interrelated hydrogeologic data.

As shown on **Figure 3-31**, the baseline chloride concentration in July 2019 in MW-1 (C Zone) was less than the recommended Secondary Maximum Contaminant Level (SMCL) of 250 mg/L at a level of 44 mg/L with the initial water level in August 2019 at an elevation of approximately -2.7 feet msl. **Figure 3-31** displays the correlation between pumping in the Basin and water levels. (Figures 3-31 through 3-33 display pumping in the CVWD Headquarters and El Carro #2 wells because of data availability; however, there are numerous other pumpers in the Basin and these data should be viewed as a proxy for total Basin pumping.) As shown, during periods of limited pumping at the El Carro #2 well, such as during the winter/spring period of 2020/2021, water levels recovered to levels slightly above sea level. During periods of continuous pumping at El Carro #2, such as fall/winter period 2021/2022, the water level declined to as much as 12 to 15 feet below sea level.

As also shown on **Figure 3-31**, chloride concentrations at MW-1 have been steadily increasing throughout the limited period of record, beginning to exceed the SMCL as early as December 2019 with the most recent concentration in February 2022 at 1,530 mg/L. Although the rate of increase does appear to moderate somewhat during periods of relatively higher water levels, such as winter/spring of 2021/2022, the overall increasing trend appears to be relatively insensitive to the approximate 10 to 15 feet of water level fluctuations observed to date at this well.

At MW-2 (**Figure 3-32**, B Zone) was also below the SMCL at a level of 24 mg/L with the initial water level in August 2019 well below sea level at an elevation of approximately -17.5 feet msl. The water levels at MW-2 appear to respond rapidly to Basin pumping. During periods of limited pumping, such as during the winter/spring of 2020/2021, water levels increased to levels just below sea level at elevations of approximately -3 to -5 feet msl. During periods of significant continuous pumping at Headquarters and El Carro #2, such as the fall/winter of 2021/2022, water levels declined to levels greater than 30 feet below msl (as shown on **Figure 3-32**, the water levels during some of this period declined below the depth setting of the water-level transducer, which has recently been lowered). Interestingly, chloride concentrations have fluctuated significantly at this well, ranging between 44 and 577 mg/L, without an apparent correlation with either water level conditions or estimated pumping. Most recently, the chloride concentration was at the lowest recorded level of 44 mg/L in February 2022, well below the SMCL.

As shown on **Figure 3-33** (A Zone), the baseline chloride concentration in July 2019 was less than the SMCL of 250 mg/L, at a level of 22 mg/L, with the initial water level in August 2019 at an elevation of approximately -12.9 feet msl. Similar to MW-2, the water levels at MW-3 appear to respond rapidly to Basin pumping. During periods of limited pumping, such as the winter/spring of 2020/2021, water levels increased to elevations of approximately -4 to -5 feet msl. During periods of significant continuous pumping at Headquarters and El Carro #2, such as the fall/winter of 2021/2022, water levels declined up to 17 feet below msl. Chloride concentrations at MW-3 have remained stable throughout the period record, fluctuating only between 21 and 24 mg/L, well below the SMCL of 250 mg/L.

In addition to the water-level and water-quality data discussed above, downhole induction logging is being performed at MW-1 on a quarterly basis. Induction logging measures the bulk electroconductivity of the aquifer materials and formation water within an approximate 6-foot diameter sphere of the tool. The tool is lowered down the well and captures the combined conductivity of the fluid and solids surrounding the casing for the length of the well. Its ability to capture changes in water quality is based on the fact that the solids (silt, sand and clay) that comprise the materials outside the casing have constant conductivities, whereas the conductivity of the pore fluid can change over time. If water of poorer or better quality replaces existing pore water in the formation, conductivities will increase or decrease, respectively, and the relative changes can be measured through induction logging. Sequential logging captures temporal conductivity changes in the aquifer system.

The results of the quarterly induction logging surveys performed at MW-1 are shown on **Figure 3-34**. A total of 10 surveys have been performed to date, with the baseline survey performed following well construction in August 2019 and the most recent performed in May 2022. As shown, there have been very limited changes occurring at this location in the A Zone. Some variations in the bulk conductivity have been occurring in B Zone, but the most recent log shows lower conductivity than was observed during several previous surveys and reverting close to baseline values.

In contrast to the observations in the A and B Zones, the induction surveys show consistent increases in bulk conductivity in the C Zone with every survey. The induction survey results are consistent with the water-quality sampling results discussed above. In particular both the induction surveys and water-quality sampling results display consistent increasing trends in conductivity and chloride concentrations in the C Zone, suggesting that seawater intrusion is likely occurring in this zone.

**ERT Geophysical Surveys.** In April 2021, electrical resistivity tomography (ERT) geophysical surveys were performed by BGC Engineering, Inc. (BGC) under contract with the CVWD for the purpose of mapping the presence (or absence) of seawater intrusion into the A, B, and C Zones. The ERT survey built upon the foundation of information acquired through the Sentinel Well project and was intended to provide three-dimensional characterization of basin stratigraphy and water quality conditions within the basin in the vicinity of the Sentinel Well site and the Carpinteria Salt Marsh (El Estero).

ERT is a geophysical technique for imaging the distribution of subsurface electrical resistivity in a cross-sectional format. Resistance data are collected through rolling linear arrays of electrodes, coupled to a DC resistivity transmitter and a receiver. Current is injected over specified time intervals between two electrodes. During each injection interval, voltages are measured between reception electrodes. The electrical resistivity of a given geological unit is related to the pore-fluid conductivity, clay content, liquid saturation, temperature, and matrix composition, and is used to map the extent of units with similar electrical properties when bounded by units with contrasting electrical properties. The final product of each line of survey is a 2-D cross-section plotting electrical resistivity versus depth. Raw geophysical and positional data is post-processed, and cross sections of the resistivity signatures along each survey line are generated.

Four ERT profiles were collected along lines shown on **Figure 3-35**. and the ERT profile results are shown on **Figures 3-36 through 3-39**. The full BGC report is presented in **Appendix TBD**, the details of which will not be repeated here. In summary, the suspected seawater intrusion into the C Zone based on the Sentinel Well data discussed above was not imaged in the ERT data. This has been attributed to an insufficient contrast in the electrical conductivities between the C Zone and the overlying confining layer, but could also be due to the C Zone being too deep, too thin, and/or at the limits of the ERT's spatial resolution. The ERT profile along the beach (refer to **Figure 3-38** ERT Profile 3) exhibited high electrical conductivities indicative of saltwater, including within the general depth range of the A Zone; however, there is no indication of seawater intrusion into the A or B Zones under the northern boundary of the saltmarsh in the ERT data (refer to **Figure 3-37** ERT Profile 2). BCG also interpreted that the A Zone may be thicker in places, as based on the ERT data, than what had been logged in the Sentinel Well boreholes.

Based on the results of the ERT survey, it was recommended that additional monitoring wells be installed to "ground-truth" ERT zones of interest, along with performing future ERT surveys to detect changes in these zones (i.e., time series of ERT surveys similar to the time-series of induction surveys at MW-1 discussed previously) would help to further refine the geophysical interpretation. Forward modelling in order to predict at what electrical conductivity the C Zone must reach to be resolvable by the ERT could help to determine the timing of future ERT surveys. In addition, extension of the beach ERT profile (**Figure 3-38** ERT Profile 3) to the northwest, in addition to a parallel profile northwest-southeast through the saltmarsh, would further improve the overall understanding of conditions in this area of the basin.

### 3.2.4 Groundwater Quality Distribution and Trends [§354.16(d)]

**§354.16 Groundwater Conditions. 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 the following:**

**(d) Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes**

An inventory of known contamination sites in the basin in 2022 was developed by searching the GeoTracker database maintained by the SWRCB. GeoTracker is a data management system for managing sites that impact groundwater in the State. The database contains information on leaking underground storage tanks (LUSTs), spills-leaks-investigations-cleanups (SLICs), landfills, military and other cleanup sites. The locations of the known contaminated sites and their current status is shown on **Figure 3-40**.

As shown, a total of 43 site have been identified in the basin. Of these, 38 have had their cases closed without land use restrictions and an additional 3 are closed cases with land use restrictions, which no longer pose a threat to aquifers used for drinking water supply. There are only 2 open sites, both of which are located on Carpinteria Avenue within the Confined Area. One is in the assessment stage (4819 Carpinteria Ave.) and the other is being actively remediated (5661-5675 Carpinteria Ave.); however, as discussed previously, in the Confined Area downward percolation of water is limited due to the presence of fine-grained low-permeability materials overlying the principal aquifer system; therefore, it is unlikely that contaminates associated with these sites would migrate vertically into the deep aquifer system.

### 3.2.5 Land Subsidence [§354.16(e)]

**§354.16 Groundwater Conditions. 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 the following:**

**(e) The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.**

Land subsidence is the gradual (or sudden) lowering of the land surface. For land subsidence to occur certain conditions are needed, such as:

- Drainage and decomposition of organic soils,
- Underground mining, oil and gas extraction, hydrocompaction, natural compaction, sinkholes, and thawing permafrost, or,
- Aquifer-system compaction.

None of these conditions are known to be present in the basin and there is no known or anecdotal evidence of subsidence related to groundwater extraction in the basin. As discussed previously, there have been periods of historical water levels declines in the basin during the 1950s, the late 1980s/early 1990s, and the current period of the mid-to-late 2010s/early 2020s associated with prolonged droughts when water level declines on the order of 100 to 150 feet have occurred in some places in the basin. Even during these periods of significant groundwater level declines, no subsidence has been documented in the basin.

The DWR provides subsidence related data to support the development of GSPs from their "SGMA Data Viewer" (DWR, 2020b). These data include ground surface elevation estimates derived from Interferometric Synthetic Aperture Radar (InSAR) data provided by DWR are shown on **Figure 3-41**. These InSAR data are derived from satellite imagery to generate vertical deformation time series data, calibrated using data from ground-based, continuously operating Global Navigation Satellite System (GNSS) stations located throughout the state of California. Presented on **Figure 3-41** is total vertical displacement as of July 1, 2022, relative to June 13, 2015, which is the period of record for the data provided by DWR.

The accuracy of the InSAR data is presented in a report (Towill, 2020), which states that "InSAR data accurately models change in ground elevation to an accuracy tested to be 16 millimeters (mm) at 95% confidence." The measurement accuracy when converting from the raw InSAR data to the maps provided by DWR is 0.048 feet with 95% confidence level. Therefore, the total estimated error is 0.1 ft.

As shown on **Figure 3-41**, the total vertical displacement during this period in ranges between approximately -0.129 and 0.0034 feet. Areas falling within the reported accuracy are shown in gray on Figure 3-79. Areas depicted in color indicate measurable subsidence above the accuracy tolerance. As shown, the highest total displacement occurs in the central portion of the Basin, immediately east of the City of Carpinteria. This area is not covered by InSAR data.

InSAR results do not differentiate between subsidence caused by groundwater withdrawal and other potential causes, such as tectonic activity. The Basin is located in an area characterized by high tectonic activity.

This lack of evidence of subsidence linked to substantial groundwater level declines indicates the inapplicability of the subsidence sustainability indicator in the basin.

## 3.2.6 Interconnected Surface Water Systems [§354.16(f)]

**§354.16 Groundwater Conditions. 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 the following:**

**(f) Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.**

The potential interactions between surface water bodies (such as creeks) and groundwater in a basin can take place in three basic ways:

1. A gaining stream or creek that receives water from groundwater,
2. A losing stream or creek that recharges basin aquifers from surface water, or
3. A stream or creek that may be separated from groundwater by a hydrologic formation, such as a low-permeability aquitard that prevents interaction between surface water and groundwater completely.

As discussed previously, in the Confined Area of the basin is defined by the presence of fine-grained low-permeability materials overlying the principal aquifer; therefore, the third situation described above applies to the reaches of basin creeks in this area of the basin.

In the Recharge Area, for groundwater to discharge into a Basin creek (i.e., a gaining creek), the elevation of the water table in the vicinity of the creek must be higher than the elevation of the surface-water body surface. Conversely, for surface water to seep into groundwater (i.e., a losing creek), the elevation of the water table in the vicinity of the creek must be lower than the elevation of the surface-water body surface. Based on previous investigations in the basin, the current understanding of the basin HCM is that in the Recharge Area, basin creeks are all losing creeks and represent principal sources of recharge to the basin (discussed in the Water Budget section).

To corroborate this understanding, depth-to-water was calculated for the spring water levels for three different water year types in the recent past:

- WY 2005 – Wet water year type
- WY 2010 – Normal water year type
- WY 2015 – Critically Dry water year type

Groundwater elevations were contoured for each of these periods and these groundwater elevation surfaces subtracted from the Digital Elevation Model (DEM) of ground surface elevations to estimate depth-to-water contours in SU-1 (as discussed previously, available water-level data for SU-2 are limited and contours for this unit are not presented). This approach provides accurate contours of depth-to-water along the creeks. The depth-to-water contours for each of the above periods are shown on **Figures 3-42 through 3-44**, respectively.

The areas where the depth-to-water is less than 0 feet below ground surface are highlighted in a light blue color on the figures to indicate those areas where the aquifer water-level elevations are higher than the creek bottom elevations, indicating artesian conditions (note this condition only exists in the WY 2005 map). As shown, the water table elevations are below the creek bottom elevations at all locations in the Recharge Area during all three water year type conditions. The only areas where the water level elevations are higher than the creek bottom elevations are along Santa Monica and Franklin Creeks within the Confined Area, and this only occurred during the spring of wet water year of 2005 (refer to **Figure 3-42**). It is also noted that both of the creeks are concrete lined in the basin.

Based on the foregoing, it is concluded that there are no interconnected surface water systems in the basin.

### 3.2.7 Groundwater Dependent Ecosystems [§354.16(g)]

**§354.16 Groundwater Conditions. 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 the following:**

**(g) 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.**

GSP Emergency Regulations require the identification of groundwater dependent ecosystems (GDEs) that could be adversely affected by lowered groundwater levels in principal aquifer.

As a starting point, the Natural Communities Commonly Associated with Groundwater Dataset (NC Dataset) GIS shapefiles were downloaded from DWR and mapped in the basin to identify potential GFEs. The NC Dataset covering the basin consists of both vegetation and wetlands areas, the locations of which are shown on **Figures 3-45 and 3-46**, respectively, with each potential GDE area consisting of a mapped polygon with an associated Polygon ID number, which are summarized in **Table 3-2** below:

**Table 3-2. NC Dataset Potential GDEs Summary**

| NC Dataset Polygon ID | Coverage Type | Description | T/R-Section | Nearest Creek |
|---|---|---|---|---|
| 51879 | Vegetation | Coast Live Oak | 19 | Arroyo Paredon |
| 52597 | Vegetation | Riparian Mixed Hardwood | 19 | Arroyo Paredon |
| 52596 | Vegetation | Riparian Mixed Hardwood | 24 | Arroyo Paredon |
| 51872 | Vegetation | Coast Live Oak | 20 | Santa Monica |
| 51866 | Vegetation | Coast Live Oak | 21 | Franklin |
| 48436 | Vegetation | Coast Live Oak | 22 | Carpinteria |
| 49435 | Vegetation | Coast Live Oak | 27 | Carpinteria |
| 42300 | Vegetation | Riparian Mixed Hardwood | 28 | Carpinteria |
| 52294 | Vegetation | Riparian Mixed Hardwood | 28 | Carpinteria |
| 52295 | Vegetation | Riparian Mixed Hardwood | 32 | Carpinteria |

| | | | | |
|---|---|---|---|---|
| 48540 | Vegetation | Coast Live Oak | 23 | Gobernador |
| 48537 | Vegetation | Coast Live Oak | 26 | Unnamed Tributary |
| 51854 | Vegetation | Coast Live Oak | 25 | Unnamed Tributary |
| 52200 | Vegetation | Riparian Mixed Hardwood | 25 | Unnamed Tributary |
| 51848 | Vegetation | Coast Live Oak | 25 | Casitas |
| 49340 | Vegetation | Coast Live Oak | 25 | Casitas |
| 49326 | Vegetation | Coast Live Oak | 35 | Rincon |
| 49319 | Vegetation | Coast Live Oak | 35 | Rincon |
| 49318 | Vegetation | Coast Live Oak | 36 | Unnamed Tributary |
| 51844 | Vegetation | Coast Live Oak | 36 | Unnamed Tributary |
| | | | | |
| 94554 | Wetlands | Palustrine, Forested, Seasonally Flooded | 23 | Toro |
| 94526 | Wetlands | Palustrine, Forested, Seasonally Flooded | 23 | Toro |
| 94525 | Wetlands | Palustrine, Forested, Seasonally Flooded | 19 | Arroyo Paredon |
| 94530 | Wetlands | Palustrine, Forested, Seasonally Flooded | 24 | Arroyo Paredon |
| 102946 | Wetlands | Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded | 19, 24 | Arroyo Paredon |
| 94533 | Wetlands | Palustrine, Forested, Seasonally Flooded | 19 | Arroyo Paredon |
| 200640 | Wetlands | Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded | 18 | Arroyo Paredon |
| 94531 | Wetlands | Palustrine, Forested, Seasonally Flooded | 19 | NA |
| 201660 | Wetlands | Palustrine, Forested, Seasonally Flooded | 20 | NA |
| 94527 | Wetlands | Palustrine, Forested, Seasonally Flooded | 20 | NA |
| 92340 | Wetlands | Palustrine, Emergent, Persistent, Seasonally Flooded - Fresh Tidal | 29 | Franklin (El Estero) |
| 102679 | Wetlands | Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded | 30 | Santa Monica (El Estero) |
| 91225 | Wetlands | Palustrine, Emergent, Persistent, Seasonally Flooded | 22, 27 | NA |
| 93680 | Wetlands | Palustrine, Forested, Seasonally Flooded | 23 | Gobernador |
| 93681 | Wetlands | Palustrine, Forested, Seasonally Flooded | 23 | Gobernador |
| 102073 | Wetlands | Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded | 23 | Gobernador |
| 93679 | Wetlands | Palustrine, Forested, Seasonally Flooded | 25 | Rincon |
| 95850 | Wetlands | Palustrine, Scrub-Shrub, Seasonally Flooded | 25 | Rincon |

As shown on **Figures 3-45 and 3-46**, the potential GDEs are largely concentrated along the primary creeks in the basin. As shown in **Table 3-2**, there are a total of 20 vegetation and 18 wetland individual polygon areas, respectively. The potential GDE vegetation areas consist of the following types:

- Coast Live Oak
- Riparian Mixed Hardwood

The potential GDE wetland areas consist of the following types:

- Palustrine, Forested, Seasonally Flooded
- Riverine, Upper Perennial, Unconsolidated Bottom, Permanently Flooded
- Palustrine, Emergent, Persistent, Seasonally Flooded - Fresh Tidal
- Riverine, Unknown Perennial, Unconsolidated Bottom, Semipermanently Flooded
- Palustrine, Scrub-Shrub, Seasonally Flooded

Verification of whether the mapped potential GDE areas in the NC Dataset are likely to be dependent on groundwater from the principal aquifer consisted of the use of the best currently available science on the hydrogeologic setting and groundwater levels in the basin to screen the mapped areas for further analysis. The initial screening consisted of determining whether a mapped potential GDE area is located in the Confined Area or unconfined Recharge Area of the basin. As discussed previously, the principal aquifer in the Confined Area consists of the A, B and C Zones which underly a low-permeability confining layer, and groundwater management is not likely to affect water levels in the overlying shallow zone or the ecosystems in the area.

In the unconfined Recharge Area, using the depth-to-water to the rooting depth of the vegetation is a reasonable method to infer the groundwater dependence of potential GDE areas. As discussed in the previous section, basin creeks in the Recharge Area are disconnected from groundwater; therefore, stream depletion due to pumping is not expected to occur. Similarly, if the groundwater levels are well below the rooting zone of the plants and any wetland features, groundwater management is not likely to affect the ecosystem in the area.

Depth-to-water groundwater levels of less than 30 feet[2] of the land surface is a generally accepted method to initially screen potential GDEs for groundwater dependence; however, many of the potential GDEs in California have adapted to dealing with intermittent periods of water stress; therefore, utilizing groundwater data from one point in time can misrepresent groundwater levels required by GDEs. To consider the interannual variability of the areas of the basin where the depth-to-water has been less than 30 feet, depth-to-water was calculated as described in the preceding section for the spring water levels for three different water year types in the recent past:

- WY 2005 – Wet water year type
- WY 2010 – Normal water year type
- WY 2015 – Critically Dry water year type

As described in the previous section, groundwater elevations were contoured for each of these periods and these groundwater elevation surfaces subtracted from the DEM of ground surface elevations to estimate depth-to-water contours across the basin. Again, this approach provides accurate contours of depth-to-water along the creeks (and other land surface depressions) where the potential GDEs tend to be located. The areas of the basin where the depth-to-water is less than 30 feet for each of the above periods are shown on **Figures 3-47 through 3-49**, respectively.

Each potential GDE polygon was inspected with respect to whether the depth-to-water was less than 30 feet under each of the above water year types. Potential GDEs that had depth-to-water *greater than 30 feet* during two or more of the above water year types were deemed to not be dependent on groundwater from the principal aquifer and is, therefore, not considered a GDE. Potential GDE polygons areas located outside of the Confined Area that had depth-to-water *less than 30 feet* under at least two of the above conditions

[2] The Nature Conservancy (2018), *Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans*.

were retained for further evaluation. The results of the initial GDE screening are summarized in **Table 3-3** below:

**Table 3-3. Potential GDE Initial Screening Summary**

| NC Dataset Polygon ID | Coverage Type | Nearest Creek | Basin Area | Spring DTW < 30 ft bgs? | | |
|---|---|---|---|---|---|---|
| | | | | 2005 [2] | 2010 [3] | 2015 [4] |
| 51879 | Vegetation | Arroyo Paredon | Recharge | No | No | No |
| 52597 | Vegetation | Arroyo Paredon | Recharge | No | No | No |
| **52596** | **Vegetation** | **Arroyo Paredon** | **Recharge** | **Yes** | **Yes** | **No** |
| 51872 | Vegetation | Santa Monica | Recharge | No | No | No |
| 51866 | Vegetation | Franklin | Recharge | No | No | No |
| 48436 | Vegetation | Carpinteria | Recharge | Yes | No | No |
| 49435 | Vegetation | Carpinteria | Recharge | No | No | No |
| 42300 | Vegetation | Carpinteria | Both | Yes | No [5] | No |
| 52294 | Vegetation | Carpinteria | Confined | Yes | Yes | No |
| 52295 | Vegetation | Carpinteria | Confined | No | No | No |
| 48540 | Vegetation | Gobernador | Recharge | No | No | No |
| 48537 | Vegetation | Unnamed Tributary | Recharge | No | No | No |
| 51854 | Vegetation | Unnamed Tributary | Recharge | No | No | No |
| 52200 | Vegetation | Unnamed Tributary | Recharge | No | No | No |
| 51848 | Vegetation | Casitas | Recharge | Yes | No | No |
| 49340 | Vegetation | Casitas | Recharge | No | No | No |
| **49326** | **Vegetation** | **Rincon** | **Recharge** | **Yes** | **Yes** | **No** |
| 49319 | Vegetation | Rincon | Recharge | No | No | No |
| 49318 | Vegetation | Unnamed Tributary | Recharge | No | No | No |
| 51844 | Vegetation | Unnamed Tributary | Recharge | No | No | No |
| | | | | | | |
| 94554 | Wetlands | Toro | Recharge | No | No | No |
| 94526 | Wetlands | Toro | Recharge | Yes | No | No |
| **94525** | **Wetlands** | **Arroyo Paredon** | **Recharge** | **Yes** | **Yes** | **No** |
| 94530 | Wetlands | Arroyo Paredon | Recharge | No | No | No |
| 102946 | Wetlands | Arroyo Paredon | Recharge | Yes | No | No |
| 94533 | Wetlands | Arroyo Paredon | Recharge | No | No | No |
| 200640 | Wetlands | Arroyo Paredon | Recharge | No | No | No |
| 94531 | Wetlands | NA | Recharge | No | No | No |
| 201660 | Wetlands | NA | Recharge | No | No | No |
| 94527 | Wetlands | NA | Recharge | No | No | No |
| 92340 | Wetlands | Franklin (El Estero) | Confined | Yes | Yes | No |
| 102679 | Wetlands | Santa Monica (El Estero) | Confined | Yes | Yes | No |
| 91225 | Wetlands | NA | Recharge | No | No | No |
| 93680 | Wetlands | Gobernador | Recharge | No | No | No |
| 93681 | Wetlands | Gobernador | Recharge | No | No | No |

| | | | | | | |
|---|---|---|---|---|---|---|
| 102073 | Wetlands | Gobernador | Recharge | No | No | No |
| **93679** | **Wetlands** | **Rincon** | **Recharge** | **Yes** | **Yes** | **Yes** |
| 95850 | Wetlands | Rincon | Recharge | Yes | No | No |

Potential GDE Polygon areas meeting screening criteria shown in **BOLD TYPE**.

1 - Ground surface elevation at center of GDE polygon.

2 - Wet Water Year Type

3 - Normal Water Year Type

4 - Critically Dry Water Year Type

5 - Portion of mapped polygon area in unconfined Recharge Area.

As shown on **Figure 3-45 and 3-46** and **Table 3-3**, three of the vegetation and two of the wetlands potential GDE polygons are located in the Confined Area and, as such are not considered dependent on groundwater in the principal aquifer subject to basin management. Of the remaining 17 vegetation and 16 wetlands potential GDE polygons located in the unconfined Recharge Area, two vegetation and two wetlands areas met the screening criteria of having depth-to-water less than 30 feet under at least two of the above water-year types. As shown in **Table 3-3**, these four potential GDE polygons are located in and along Arroyo Paredon and Rincon Creeks. The remaining 15 vegetation and 14 wetlands potential GDE polygons areas, located primarily along the upper reaches of Carpinteria and Gobernador Creeks, are not considered GDE's based on consistent groundwater depths occurring below the root zone.

The remaining four potential GDE polygon areas located along Arroyo Paredon (GDE Detail Area A) and Rincon Creeks (GDE Detail Area B) are shown in greater detail on **Figures 3-50 and 3-51** (refer to **Figures 3-45 and 3-46** for the detail area map locations). These potential GDEs were analyzed further by identifying existing monitoring wells in the vicinity of each area, also shown on **Figures 3-50 and 3-51**. Well logs (where available) and water-level hydrographs for these monitoring wells were reviewed to further examine seasonal and interannual variability in ground water levels in the vicinity of the potential GDEs.

The available information for the existing monitoring wells in the vicinity of these remaining potential GDE polygon areas is summarized in **Table 3-4** and discussed below:

**Table 3-4. Potential GDE Water-Level Monitoring Well Summary**

| NC Dataset Polygon ID | GS Elev [1] | Nearest MWs | Distance (ft) [2] | WCR? (y/n) | Water Level Record | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | Start | End | |
| 52596 | 38 | 19F4 | 1145 | n | 12/8/49 | 8/27/20 | Up to 9 yrs DTW > 30 ft during extended dry periods |
| | | 19M3 | 1020 | n | 12/14/49 | 12/18/13 | Up to 7 yrs DTW > 30 ft during extended dry periods |
| 94525 | 27 | 19F4 | 1920 | n | 12/8/49 | 8/27/20 | Up to 6 yrs DTW > 30 ft during extended dry periods |
| | | 19M3 | 1390 | n | 12/14/49 | 12/18/13 | **Available data show DTW consistently < 30 ft** |
| 93679 | 206 | 25L3 | 68 | n | 5/30/96 | 8/26/20 | **Available data show DTW consistently < 30 ft** |
| | | 25N5 | 125 | y | 5/30/96 | 2/14/17 | Available data show DTW consistently > 30 ft |
| 49326 | 142 | 35A3 | 195 | n | 1/25/78 | 2/24/05 | **Available data show DTW consistently < 30 ft** |
| | | 35B6 | 870 | n | 6/18/96 | 4/27/07 | **Available data show DTW consistently < 30 ft** |

Potential GDE Polygon areas meeting screening criteria shown in **BOLD TYPE**.

NA - Not Available

1 - Ground surface elevation at center of GDE polygon.

2 - Distance from subject well to center of GDE polygon.

First, and perhaps foremost, as shown in **Table 3-4**, only one of the monitoring wells in the vicinity of the subject potential GDE's has a well log available (25N5). Although water-level data are available for all of these proximate wells, and represent the best currently available information, their depths and screened intervals are unknown.

Nevertheless, water-level hydrographs for the two existing monitoring wells located in the vicinity of the Arroyo Paredon Creek potential GDEs (19F4 and 19M3) are shown on **Figures 3-52 and 3-55**, respectively. Also shown are the bottom elevations of the potential GDE polygons (at the center nearest the subject monitoring well) and the associated 30 feet depth-to-water distances. As shown on the hydrographs for 19F4 (**Figures 3-52 and 3-53**), there are up to 6 to 9 consecutive years (depending on the GDE polygon) during which water levels are greater than 30 feet below the potential GDE.

As shown on the hydrographs for 19M3 (**Figures 3-54 and 3-55**), there are up to 6 consecutive years where the depth-to-water below potential GDE polygon 52596 (vegetation - riparian mixed hardwood) is greater than 30 feet; however, for potential GDE polygon 94525 (wetlands - palustrine, forested, seasonally flooded), the depth-to-water is consistently less than 30 feet during the period of record. It is noted that the period of record for 19M3 ends in December 2013; therefore, water-level data during the current cumulatively dry period of WY 2012 through WY 2020 are not available.

Based on the water-level data available for monitoring wells 19F4 and 19M3, there are numerous consecutive years when depths-to-water are greater than 30 feet below the potential GDE. Based on these observations, it appears that these potential GDEs along Arroyo Paredon Creek may not be dependent on groundwater; however, as discussed previously, well logs for these two monitoring wells are unavailable. These potential GDE polygons will be further evaluated during GSP implementation.

Water-level hydrographs for the four existing monitoring wells located in the vicinity of the Rincon Creek potential GDEs (25L3, 25N5, 35A3 and 35B6) are shown on **Figures 3-56 through 3-59**, respectively. As shown for wells 25L3, 35A3 and 35B6, depth-to-water levels are consistently less than 30 feet below the bottom elevations of both potential GDE polygon 93679 (wetlands - wetlands - palustrine, forested, seasonally flooded) and GDE polygon 49326 (vegetation – coast live oak), whereas for well 25N5 (**Figure 3-57**), depth-to-water levels are consistently greater than 30 feet below the bottom elevations of potential GDE polygon 93679. However, screen interval information for 3 of the 4 monitoring wells is not currently available. These potential GDEs will be further evaluated during GSP implementation.

It is also noted that there is anecdotal information suggesting that these two creeks may be fed by springs and/or seeps located in the bedrock areas outside the basin boundaries. If so, the potential GDEs could be supported during dry periods by these surface water flows emanating from outside the basin rather than being dependent on groundwater. However, as noted previously, there are no streamflow monitoring data for either of the two creeks to definitively support this. Historical satellite imagery (Google Earth) was examined, but the available imagery resolution was insufficient to visually determine if surface water has historically been present in Arroyo Paredon and Rincon creeks during dry periods or not. Each of these creeks was subsequently visually inspected in the field at bridges located upstream of the potential GDEs in July 2022. During these field visits, the creek beds were observed to be dry at all locations.

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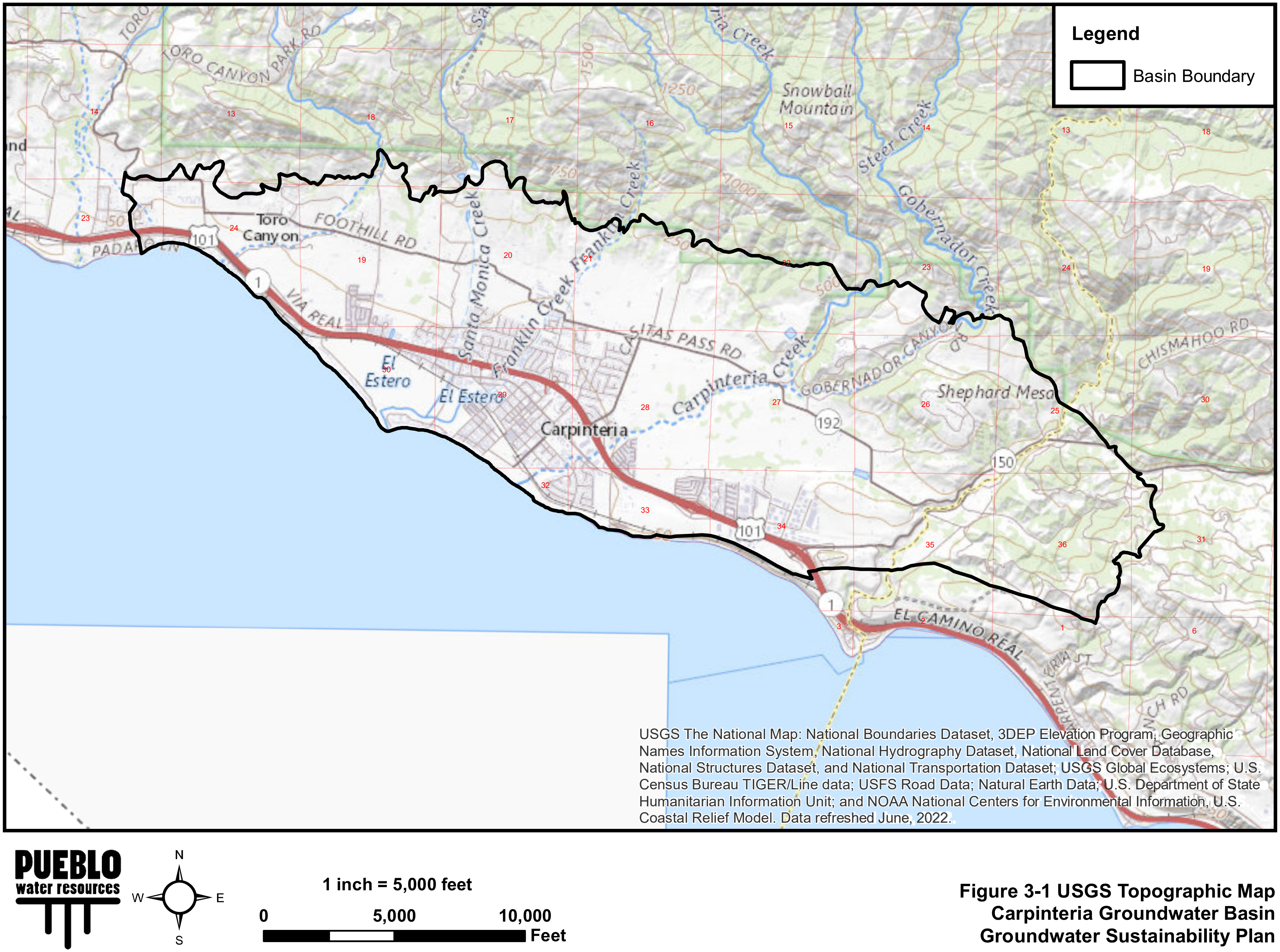


**Figure 3-1 USGS Topographic Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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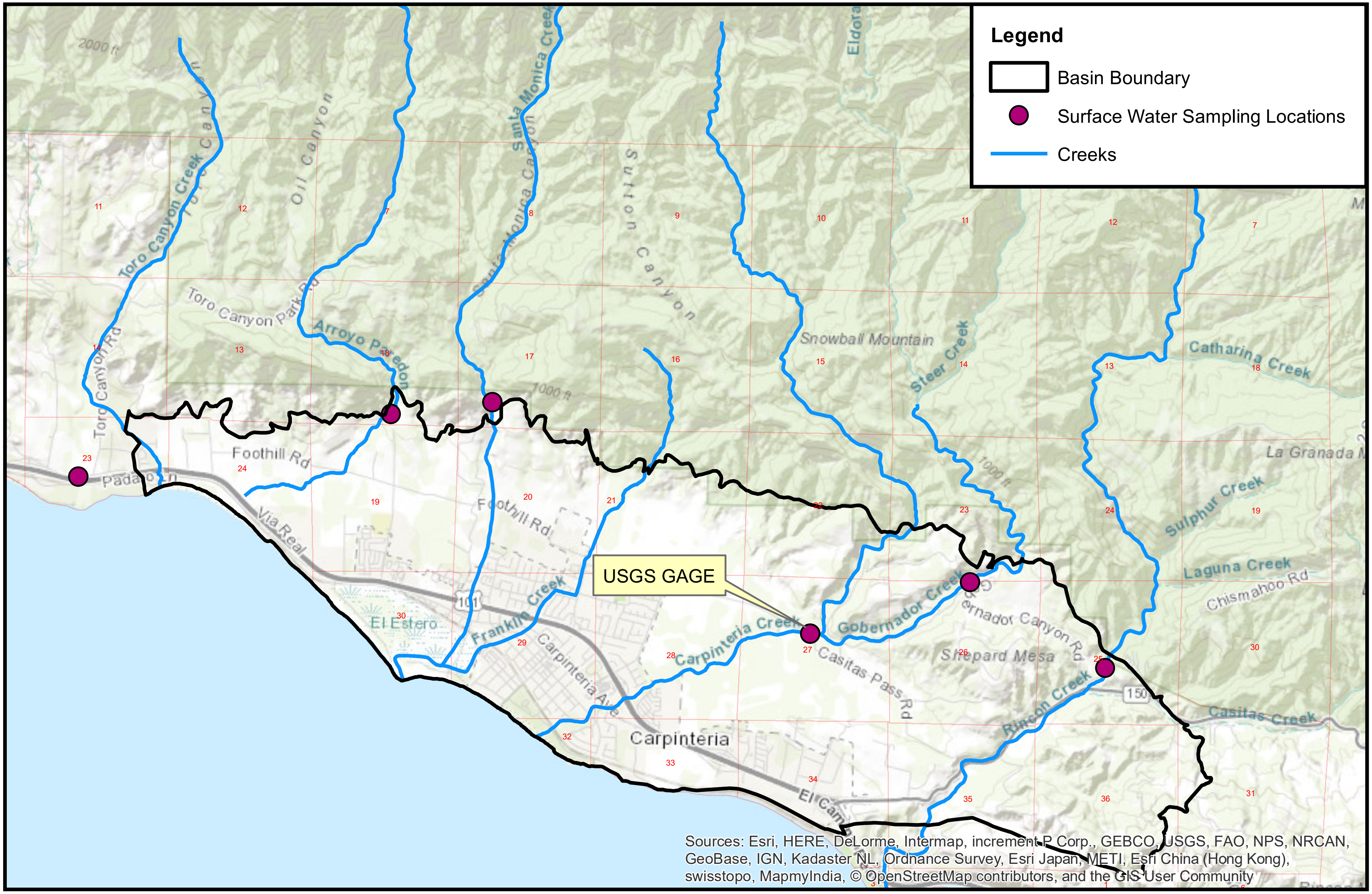


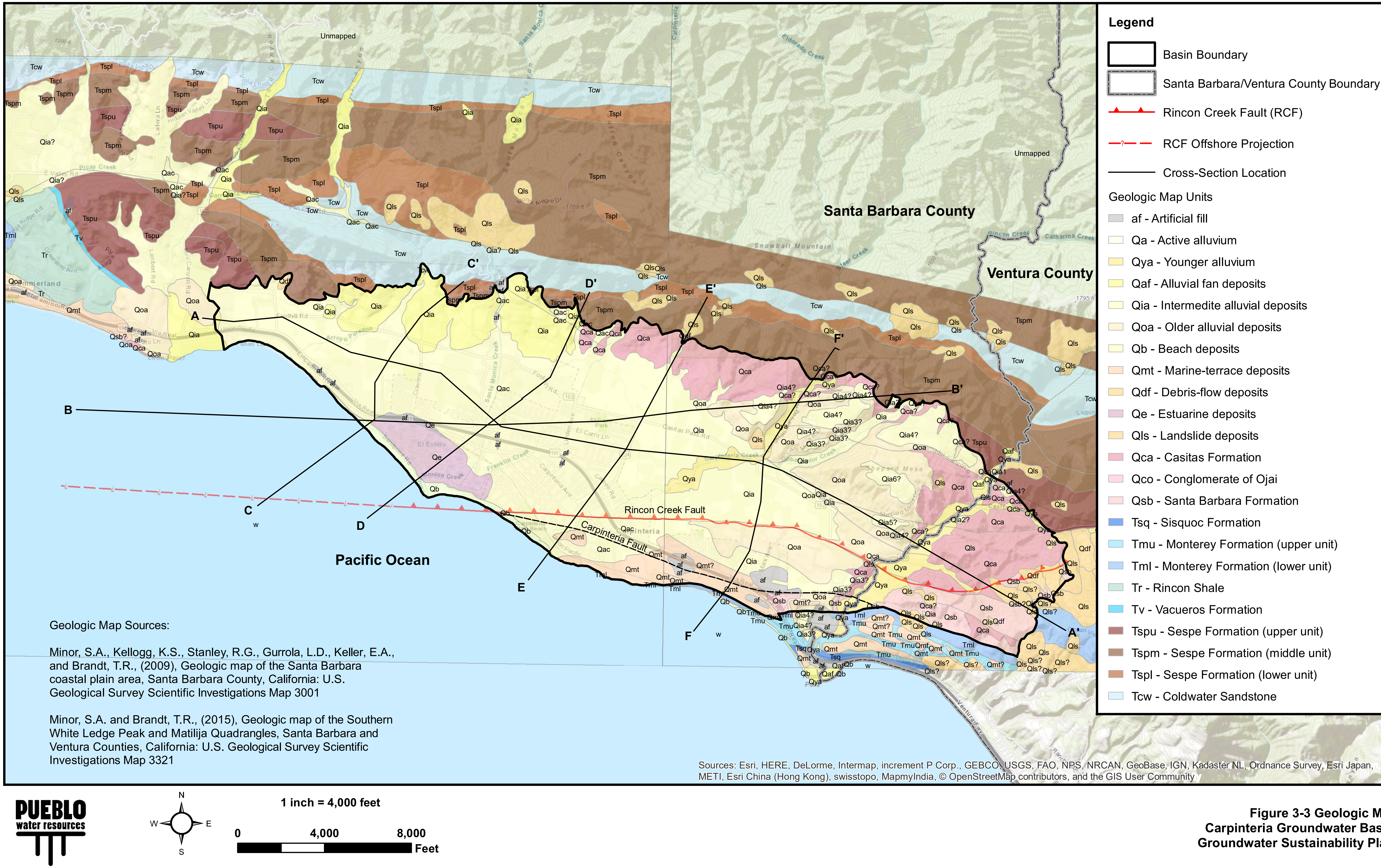

PUEBLO water resources

N W E S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-2 Creek Location Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




**Legend**

- Basin Boundary
- Santa Barbara/Ventura County Boundary
- Rincon Creek Fault (RCF)
- RCF Offshore Projection
- Cross-Section Location

Geologic Map Units

- af - Artificial fill
- Qa - Active alluvium
- Qya - Younger alluvium
- Qaf - Alluvial fan deposits
- Qia - Intermedite alluvial deposits
- Qoa - Older alluvial deposits
- Qb - Beach deposits
- Qmt - Marine-terrace deposits
- Qdf - Debris-flow deposits
- Qe - Estuarine deposits
- Qls - Landslide deposits
- Qca - Casitas Formation
- Qco - Conglomerate of Ojai
- Qsb - Santa Barbara Formation
- Tsq - Sisquoc Formation
- Tmu - Monterey Formation (upper unit)
- Tml - Monterey Formation (lower unit)
- Tr - Rincon Shale
- Tv - Vacueros Formation
- Tspu - Sespe Formation (upper unit)
- Tspm - Sespe Formation (middle unit)
- Tspl - Sespe Formation (lower unit)
- Tcw - Coldwater Sandstone

Geologic Map Sources:

Minor, S.A., Kellogg, K.S., Stanley, R.G., Gurrola, L.D., Keller, E.A., and Brandt, T.R., (2009), Geologic map of the Santa Barbara coastal plain area, Santa Barbara County, California: U.S. Geological Survey Scientific Investigations Map 3001

Minor, S.A. and Brandt, T.R., (2015), Geologic map of the Southern White Ledge Peak and Matilija Quadrangles, Santa Barbara and Ventura Counties, California: U.S. Geological Survey Scientific Investigations Map 3321

Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

PUEBLO water resources

**Figure 3-3 Geologic Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
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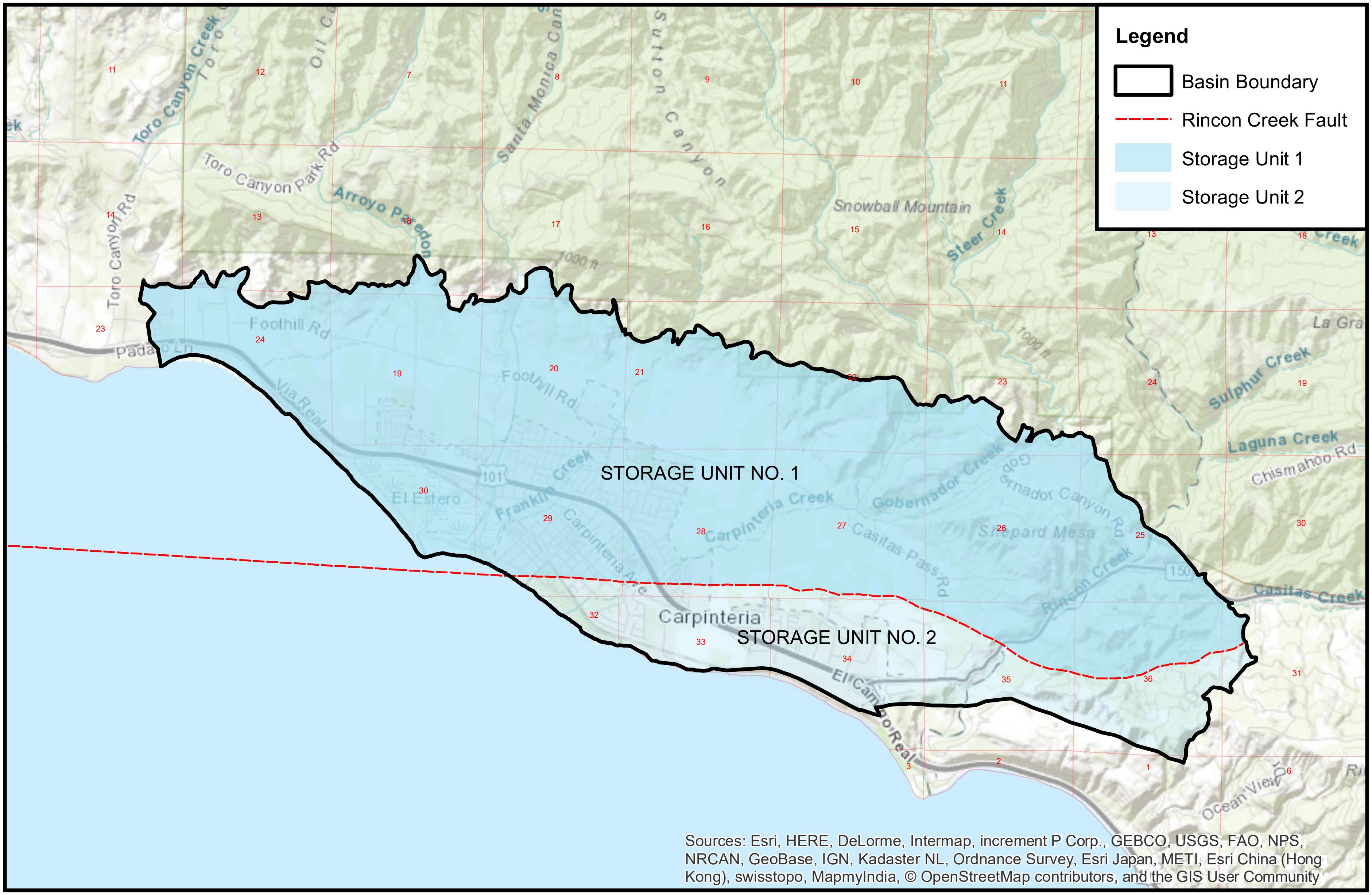


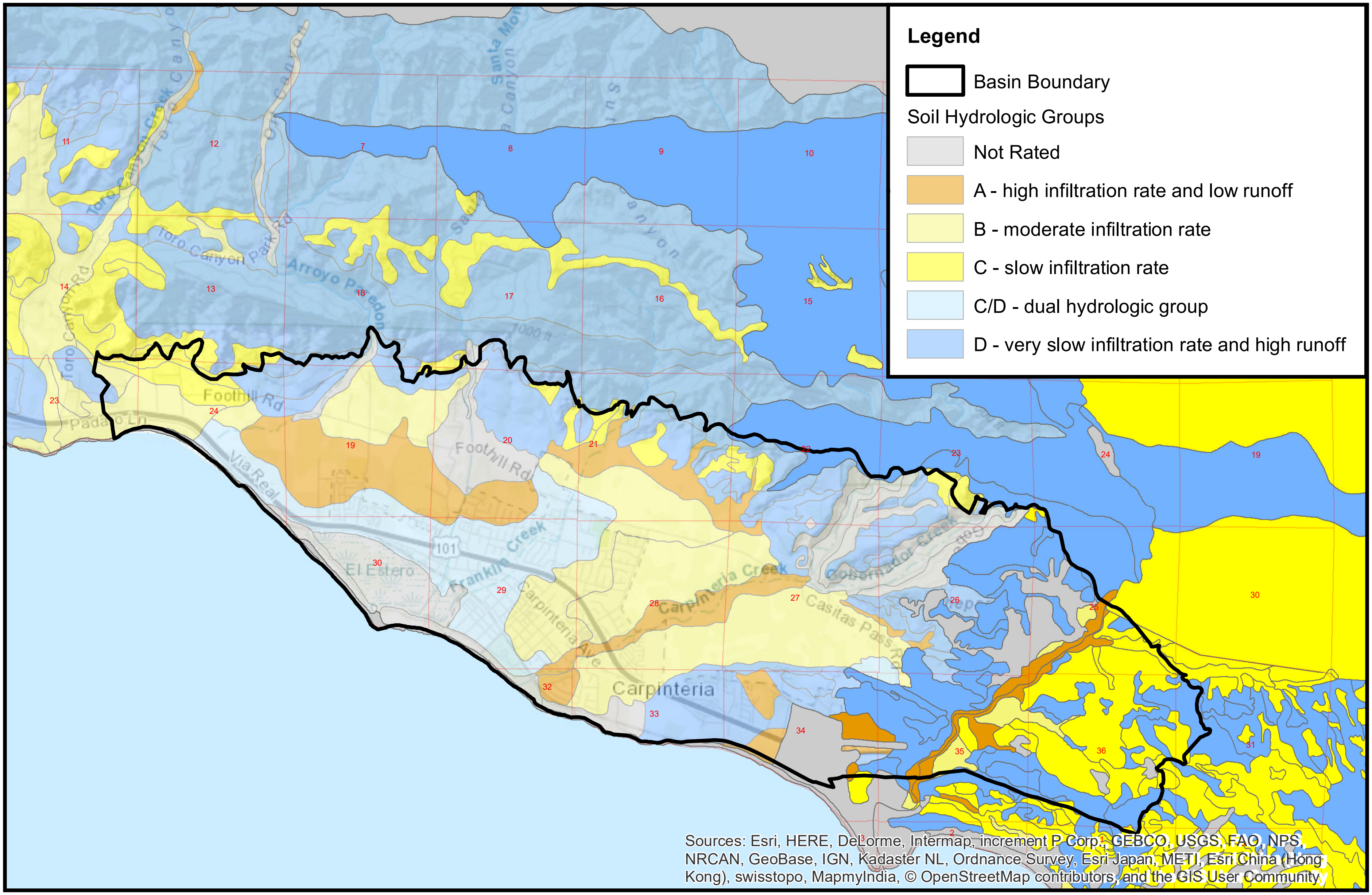

PUEBLO water resources

N W E S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-4 Storage Units 1 and 2 Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

N W E S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-5 Soil Survey Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
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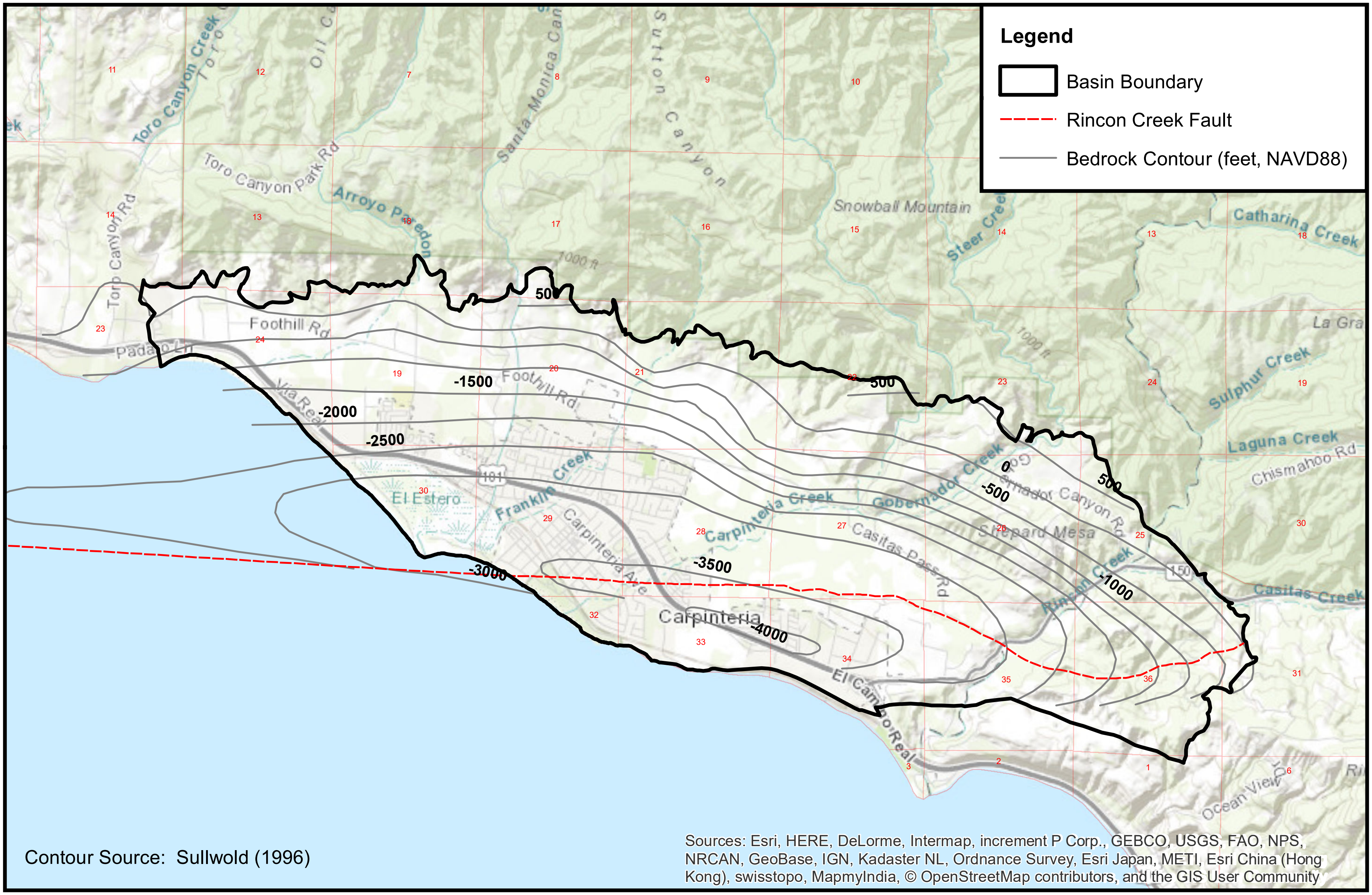



PUEBLO water resources

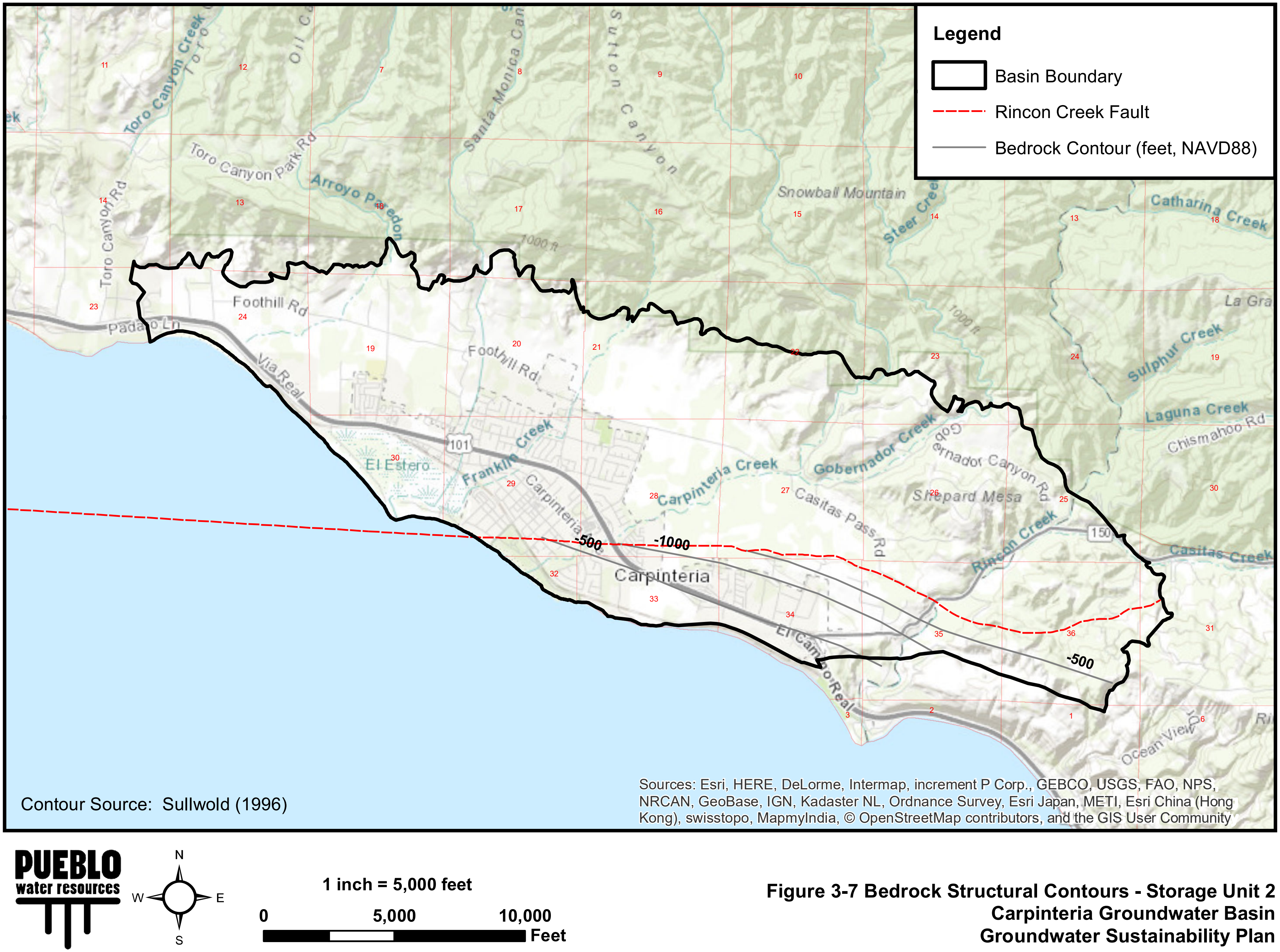
N W E S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-6 Bedrock Structural Contours - Storage Unit 1**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

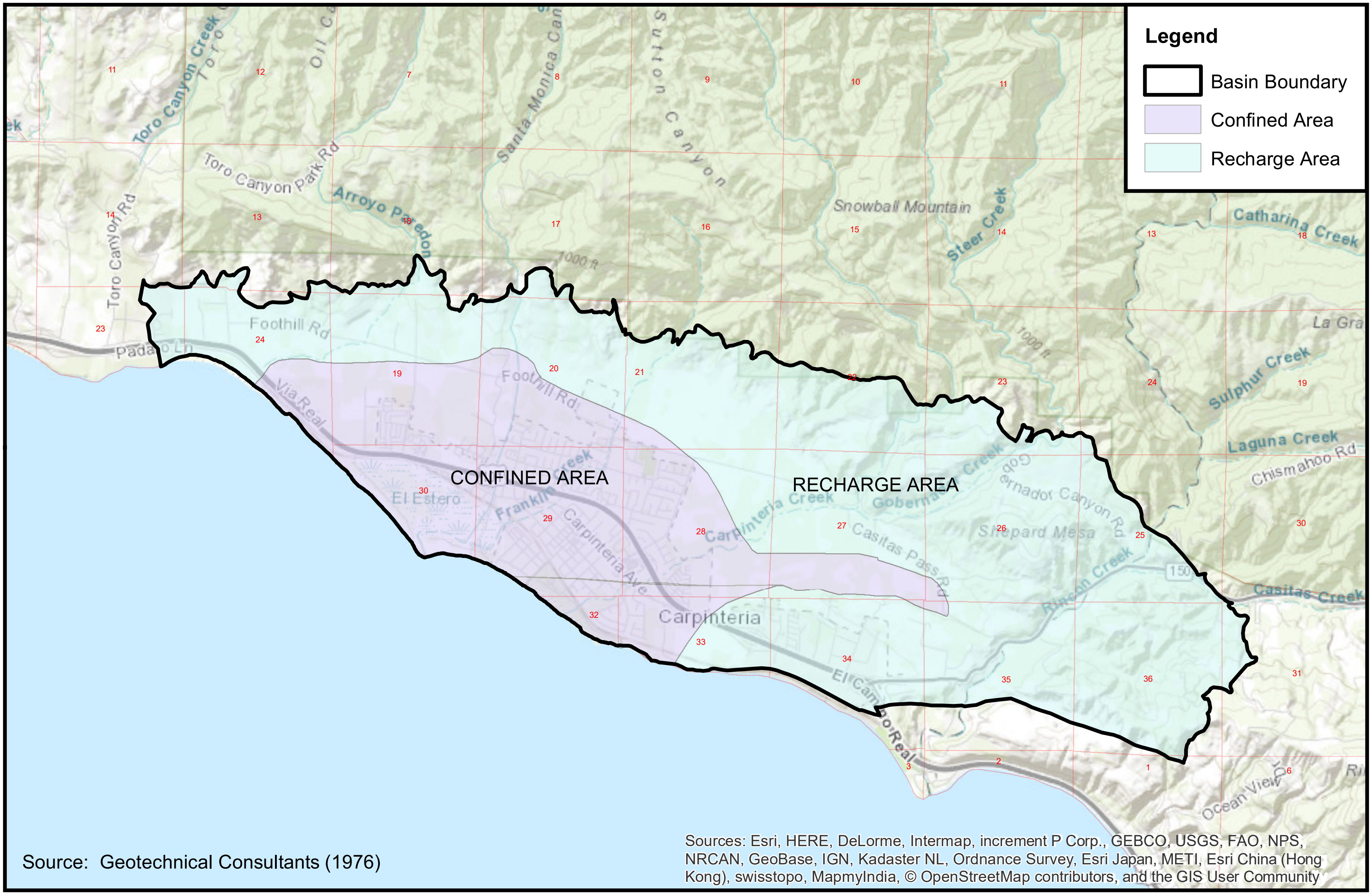
September 2022
DRAFT




PUEBLO water resources

**Figure 3-7 Bedrock Structural Contours - Storage Unit 2**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

**September 2022**
**DRAFT**




PUEBLO water resources

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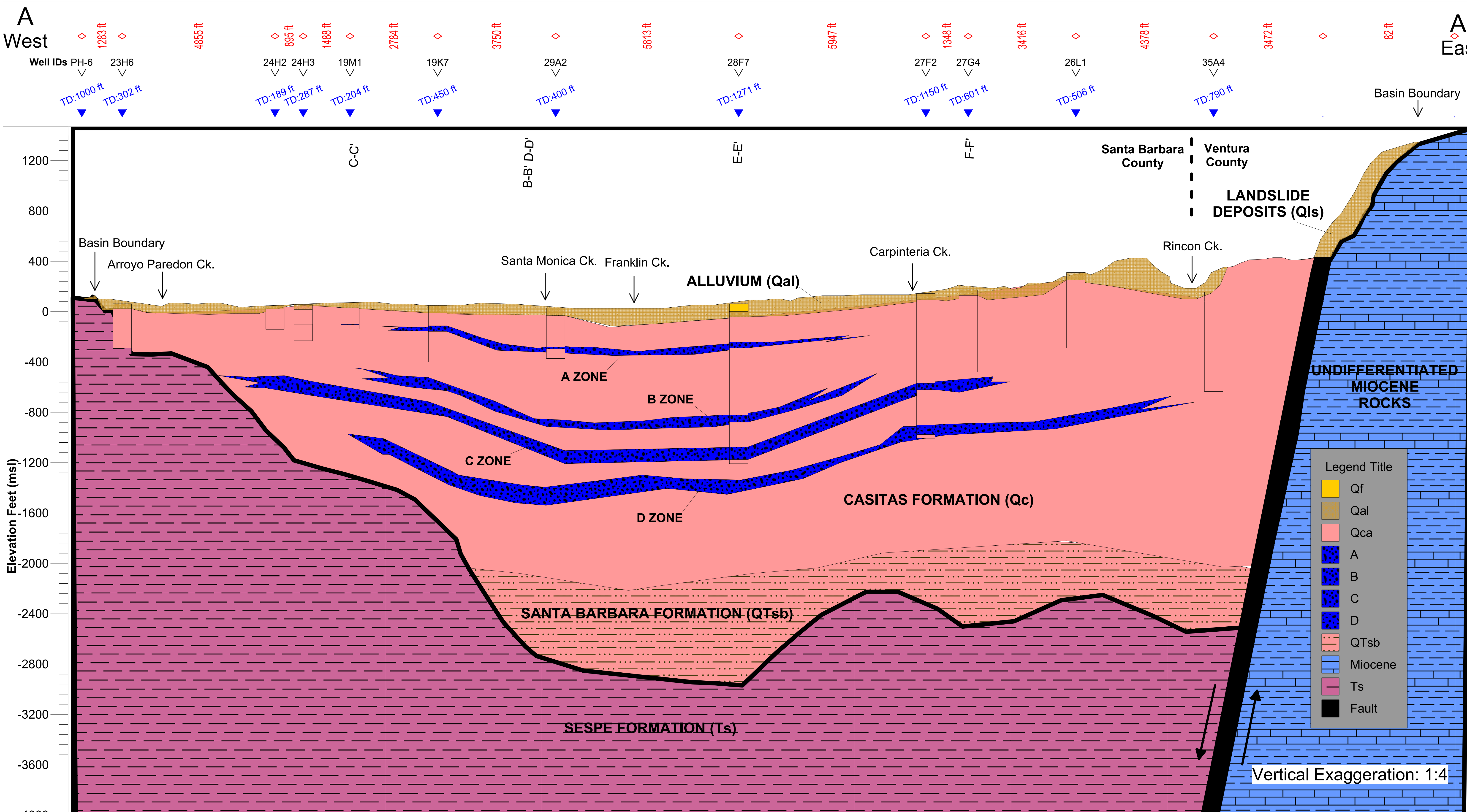
1 inch = 5,000 feet

0 5,000 10,000 Feet

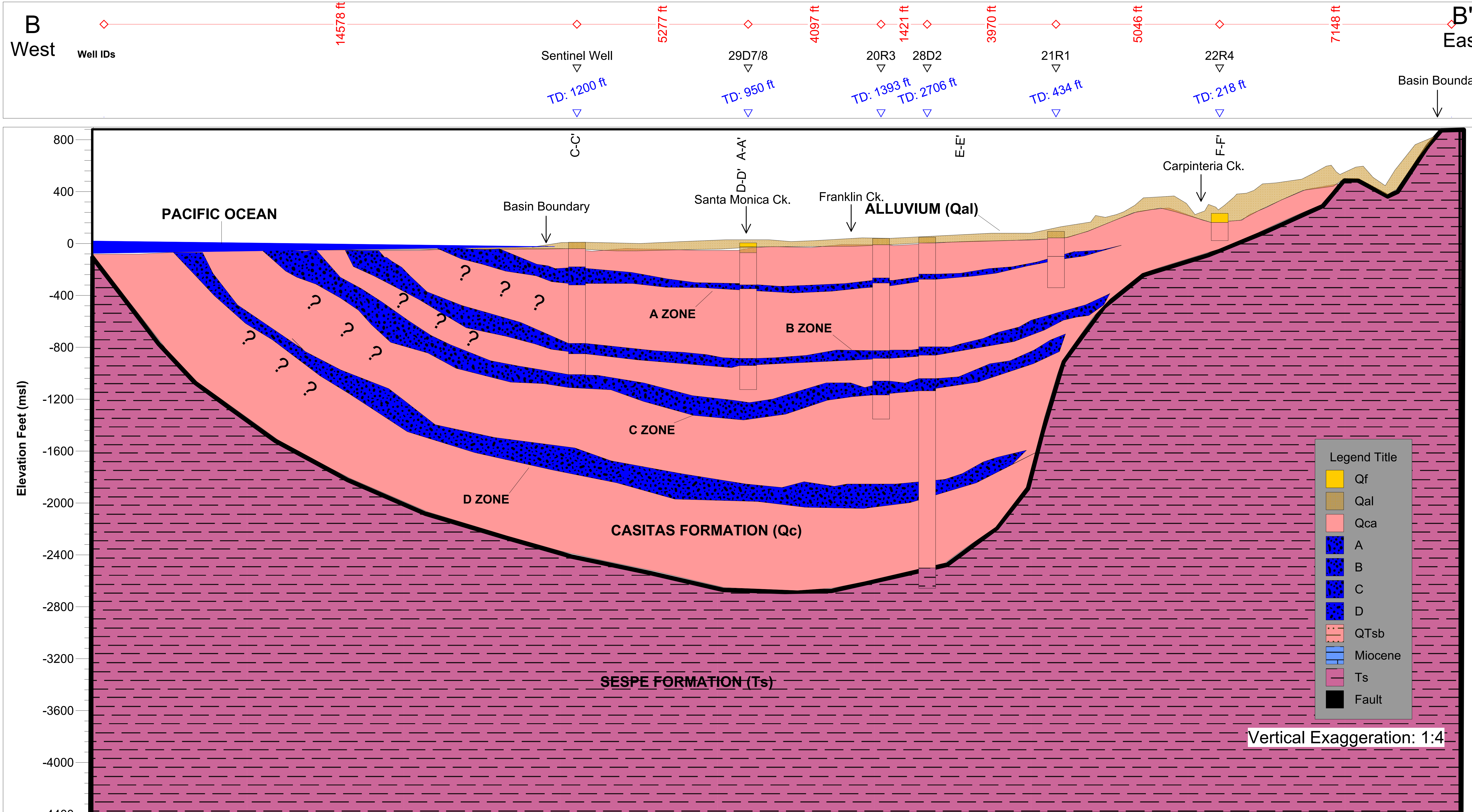
**Figure 3-8 Confined and Recharge Areas Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




Notes:
Well ID - Well Identification
TD - Total Depth

PUEBLO water resources

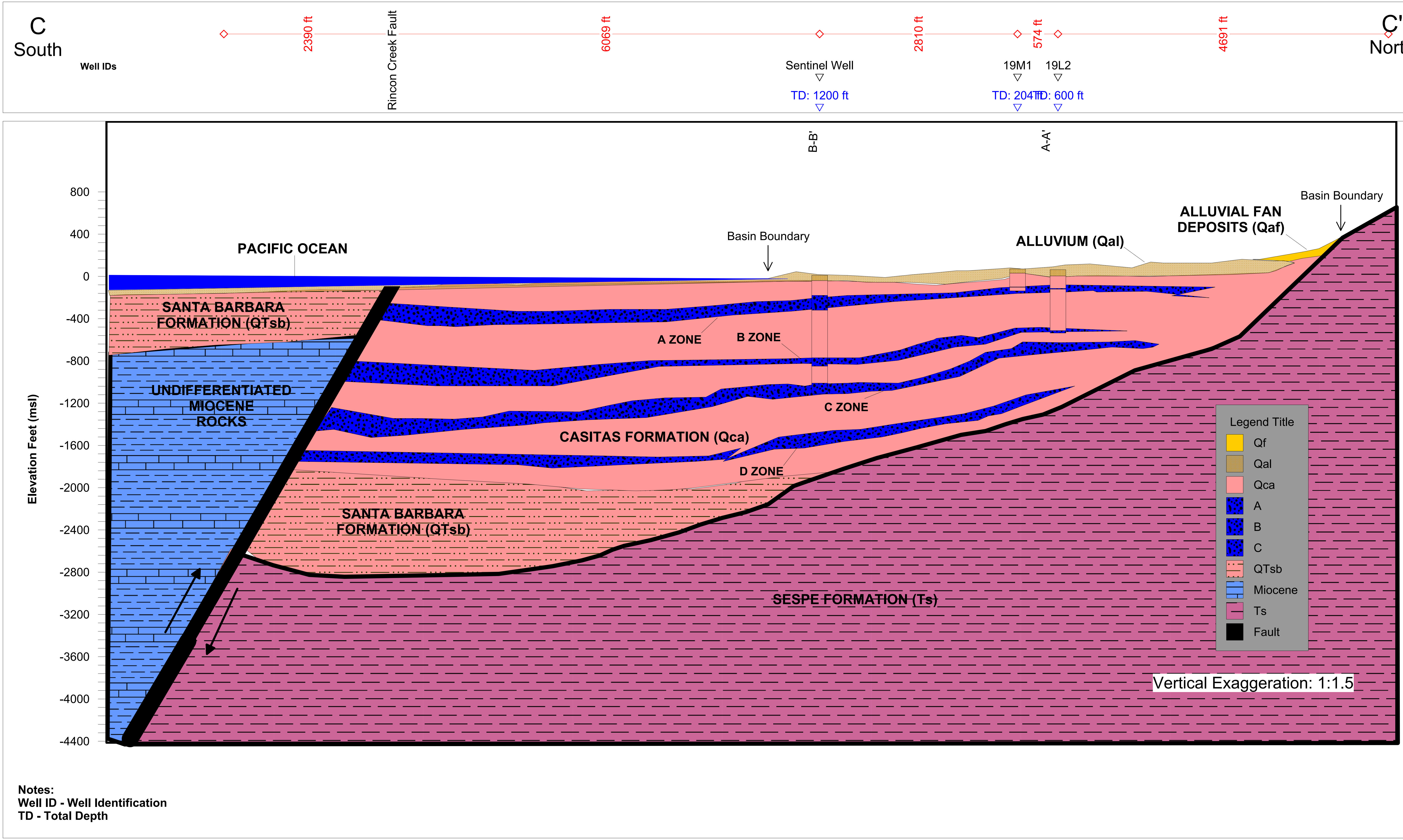
**Figure 3-9 Geologic Cross-Section A - A'**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




**Notes:**
**Well ID - Well Identification**
**TD - Total Depth**
**?? - Queried Where Uncertain**

PUEBLO water resources

**Figure 3-10 Geologic Cross-Section B - B'**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




**Notes:**
**Well ID - Well Identification**
**TD - Total Depth**

PUEBLO water resources

**Figure 3-11 Geologic Cross-Section C - C'**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

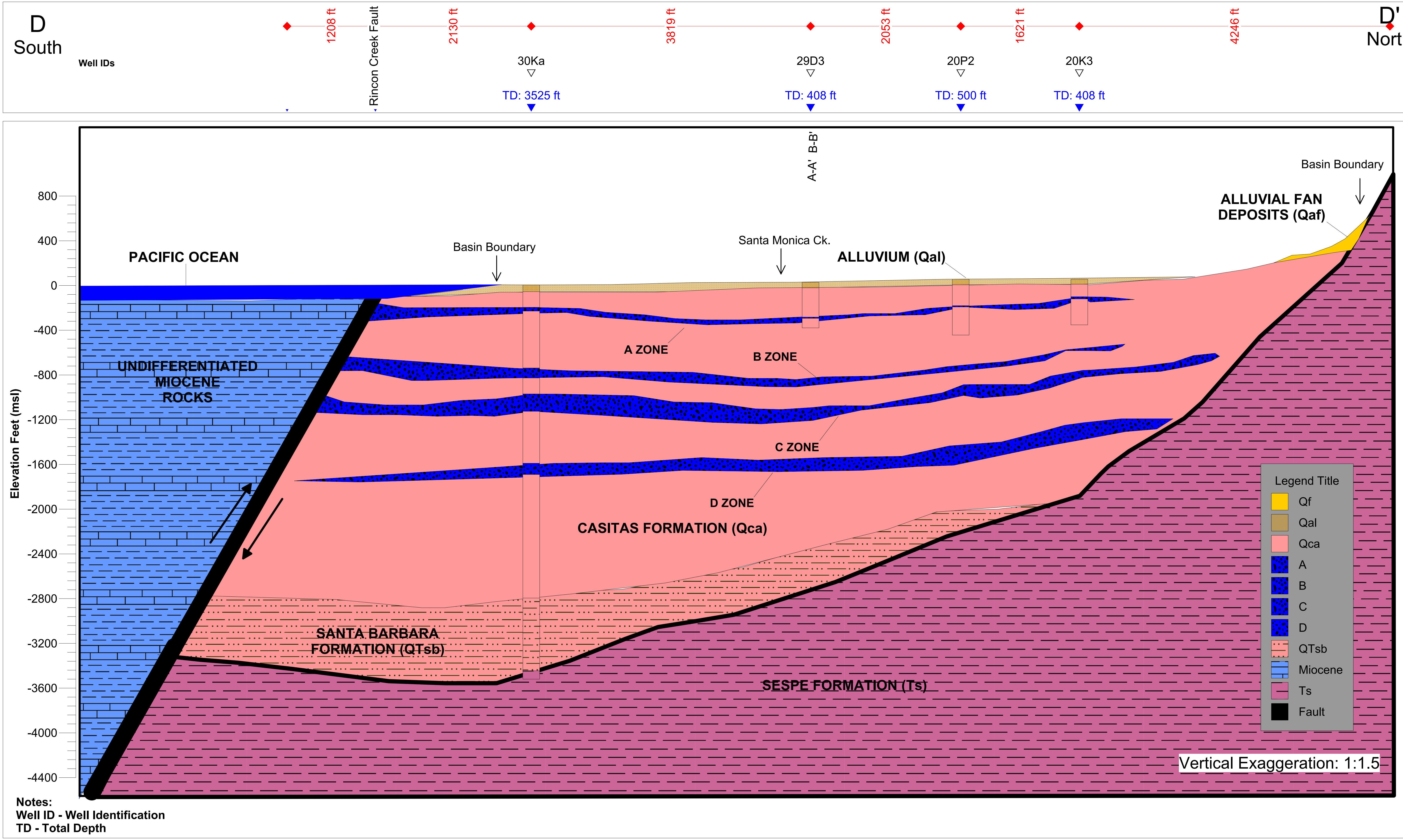
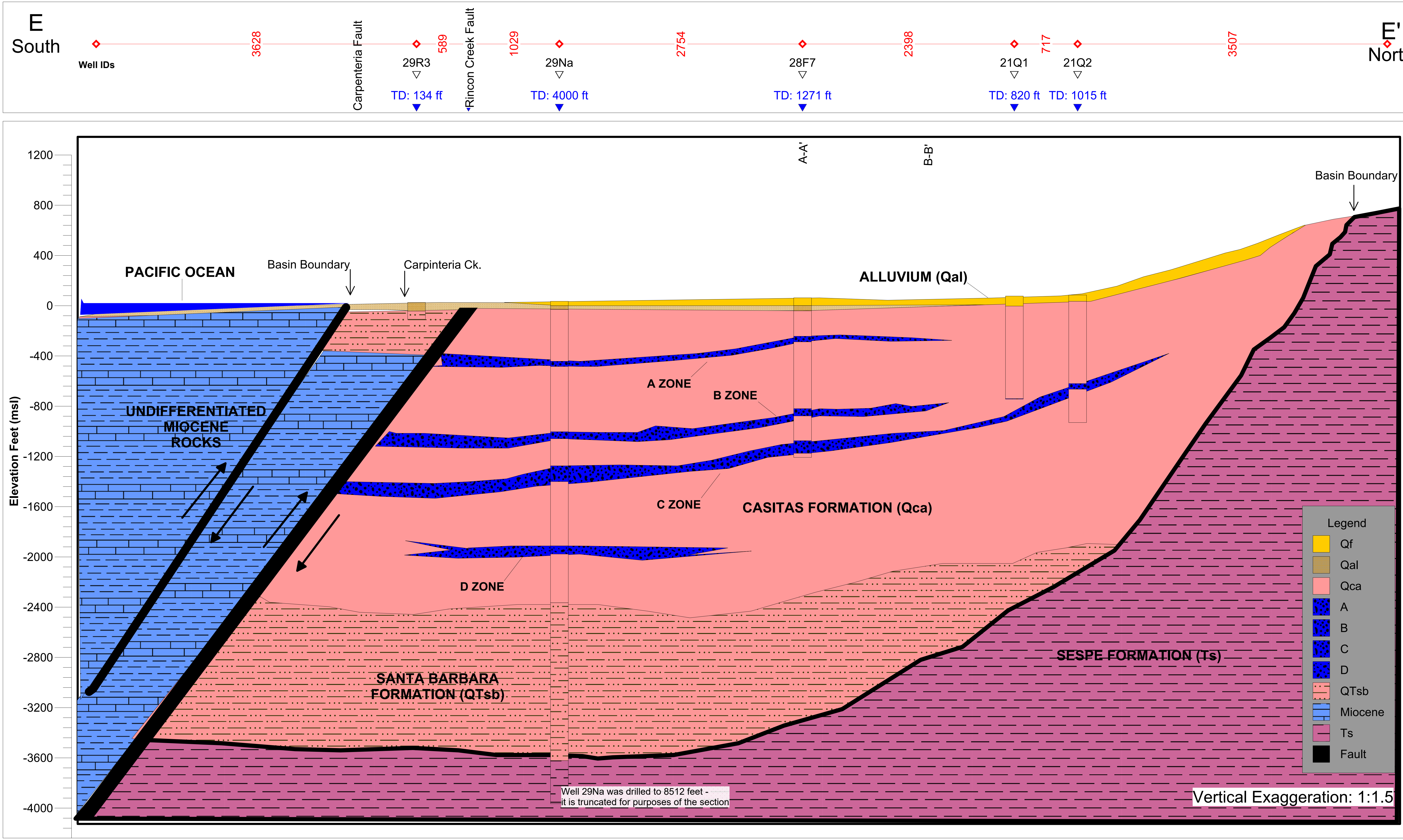


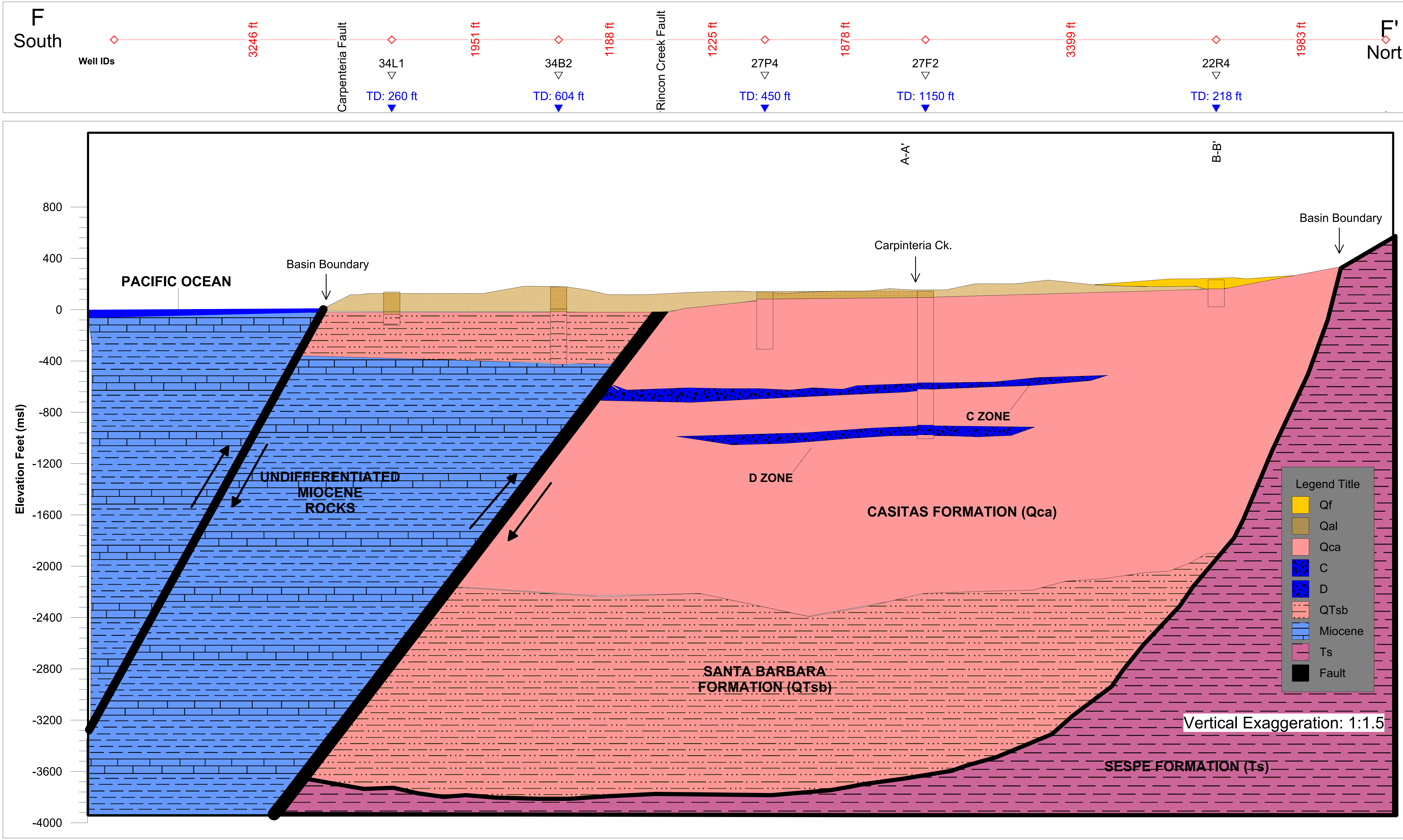

**Figure 3-12 Geologic Cross-Section D - D'**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

**Notes:**
**Well ID - Well Identification**
**TD - Total Depth**

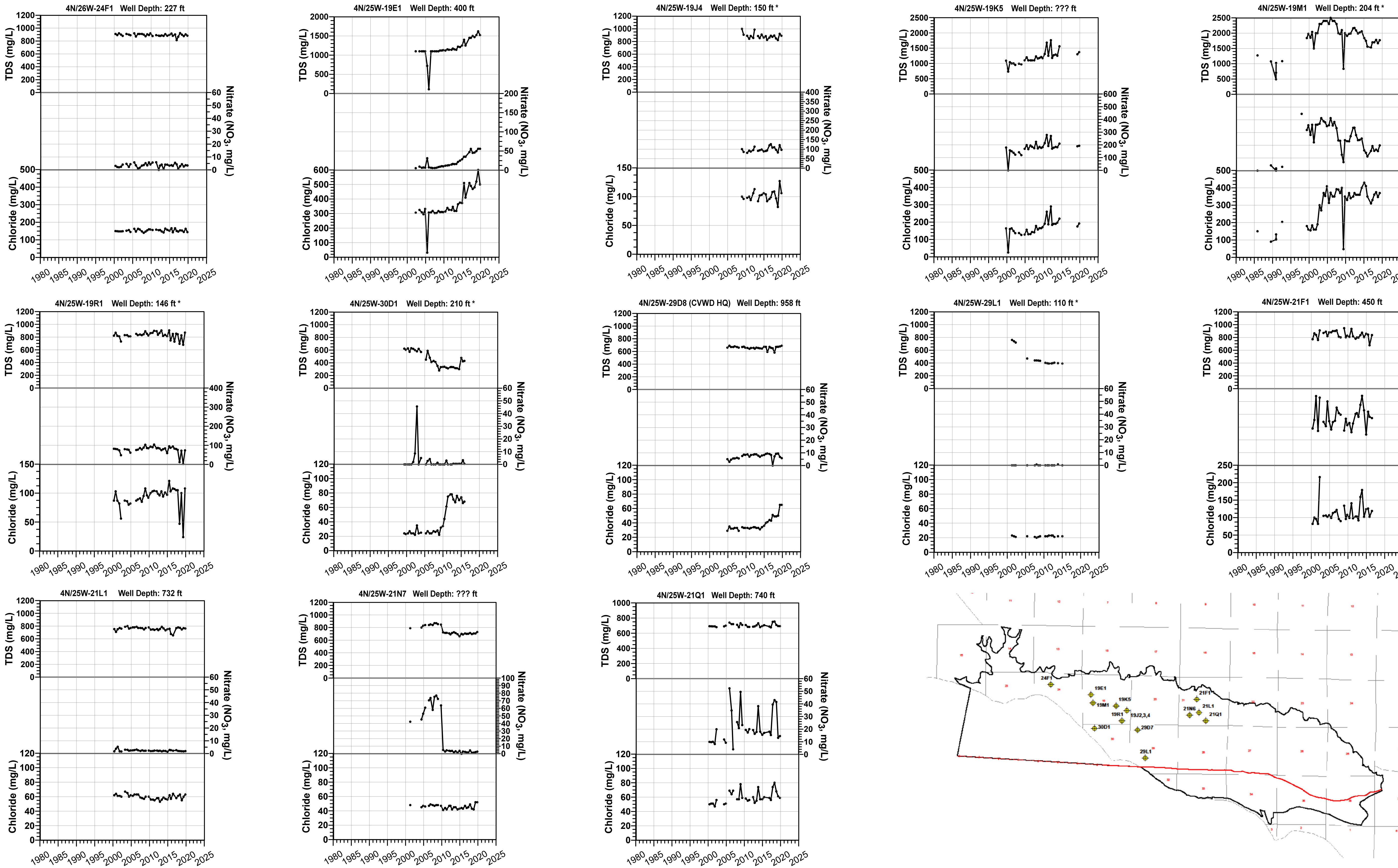
**Figure 3-13 Geologic Cross-Section E - E'**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

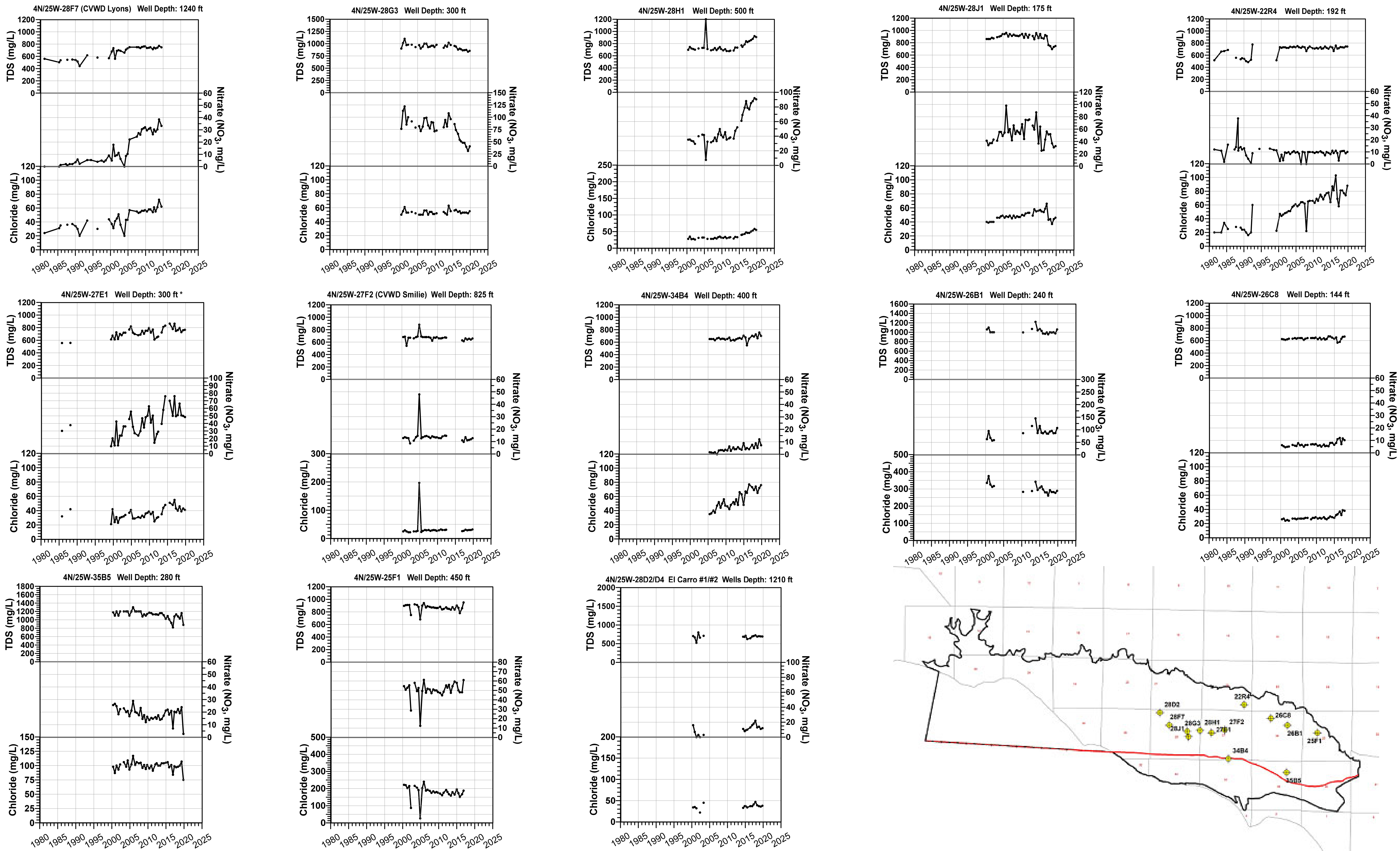
**Notes:**
**Well ID - Well Identification**
**TD - Total Depth**

**Figure 3-14 Geologic Cross-Section F - F'**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**



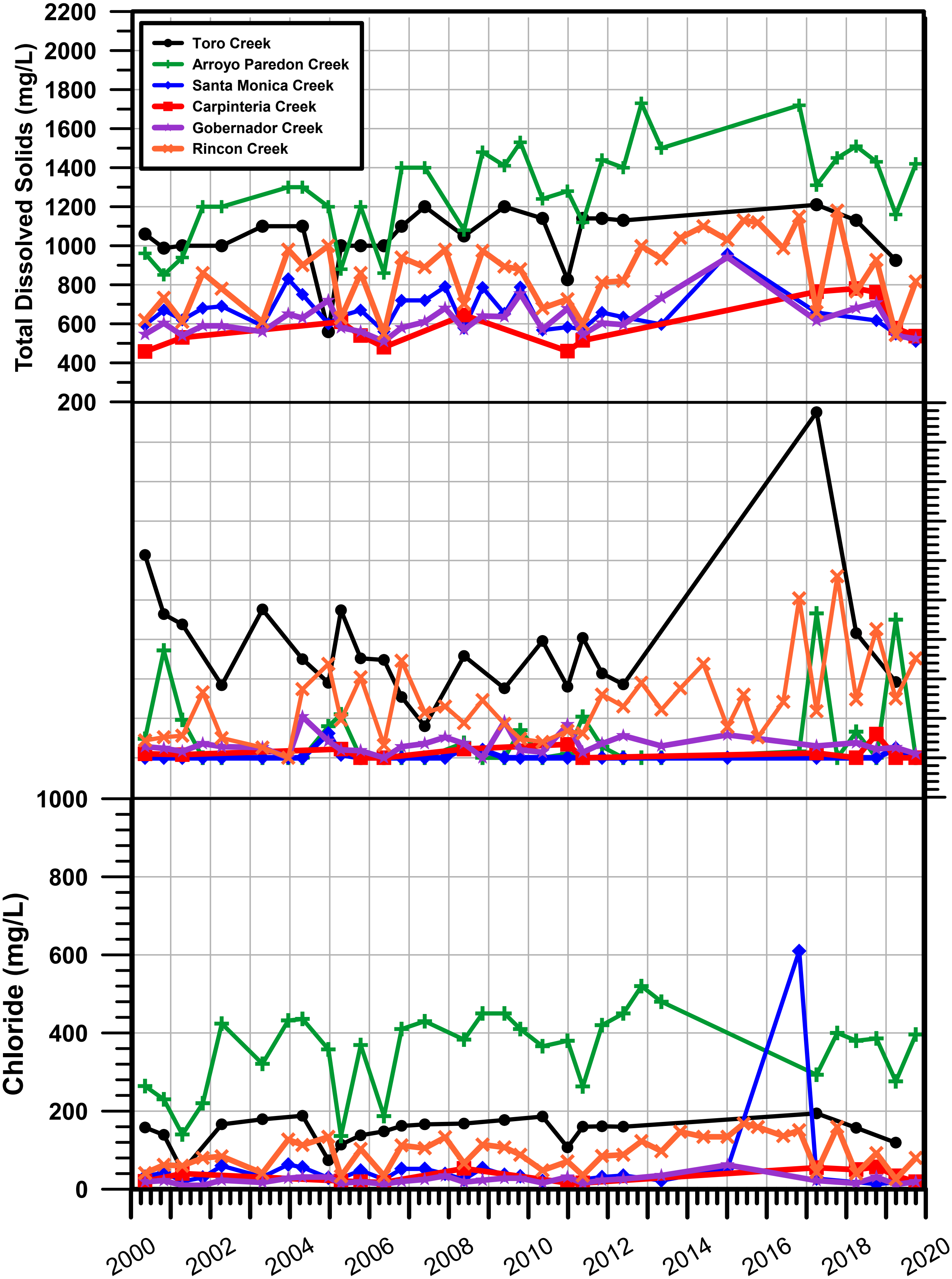

PUEBLO water resources

**Figure 3-15 Water Quality Data - West Carpinteria Groundwater Basin Groundwater Sustainability Plan**




PUEBLO
water resources

**Figure 3-16 Water Quality Data - East**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

**Figure 3-17 Water Quality Data - Surface Water**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
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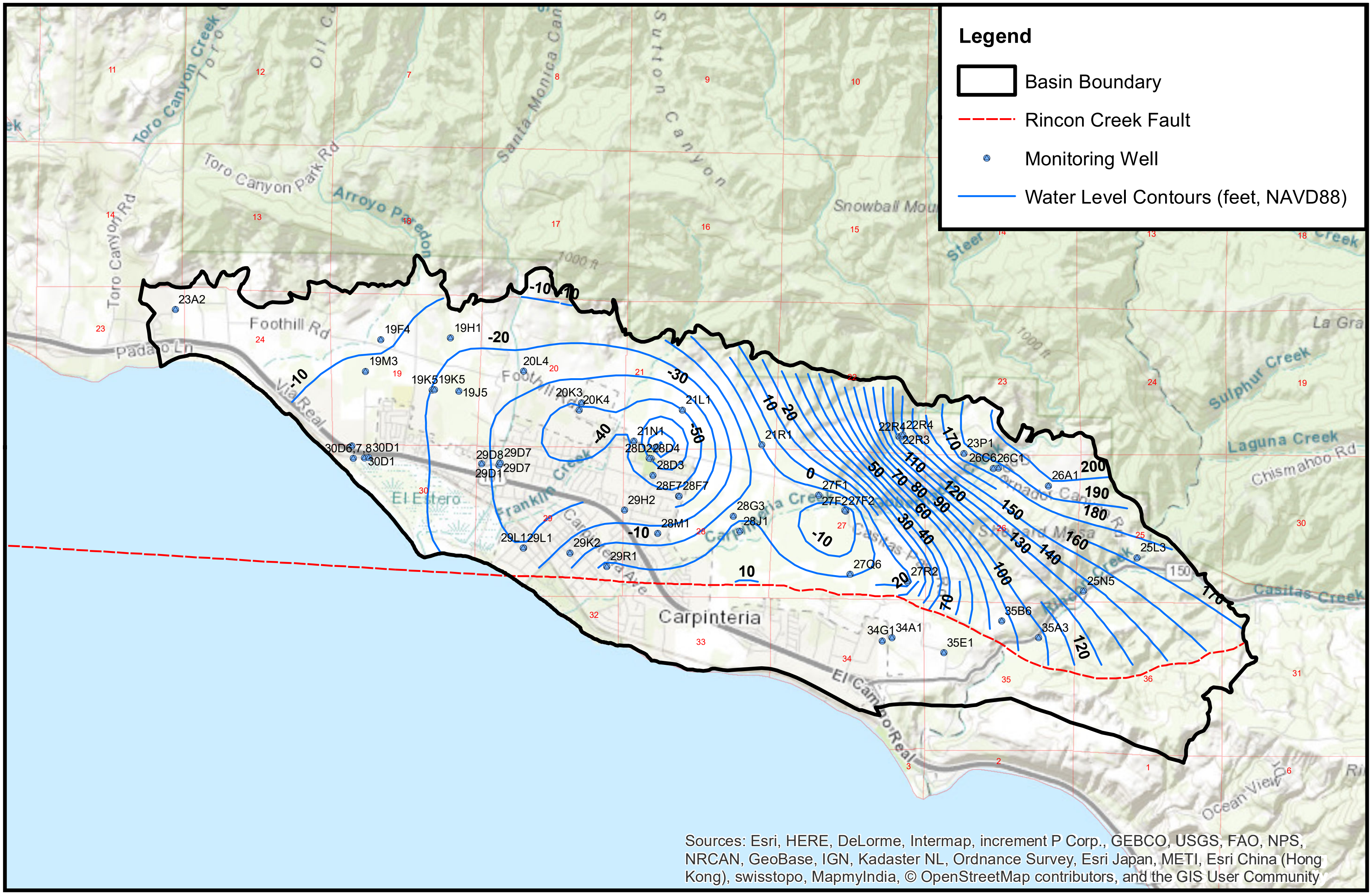



PUEBLO water resources

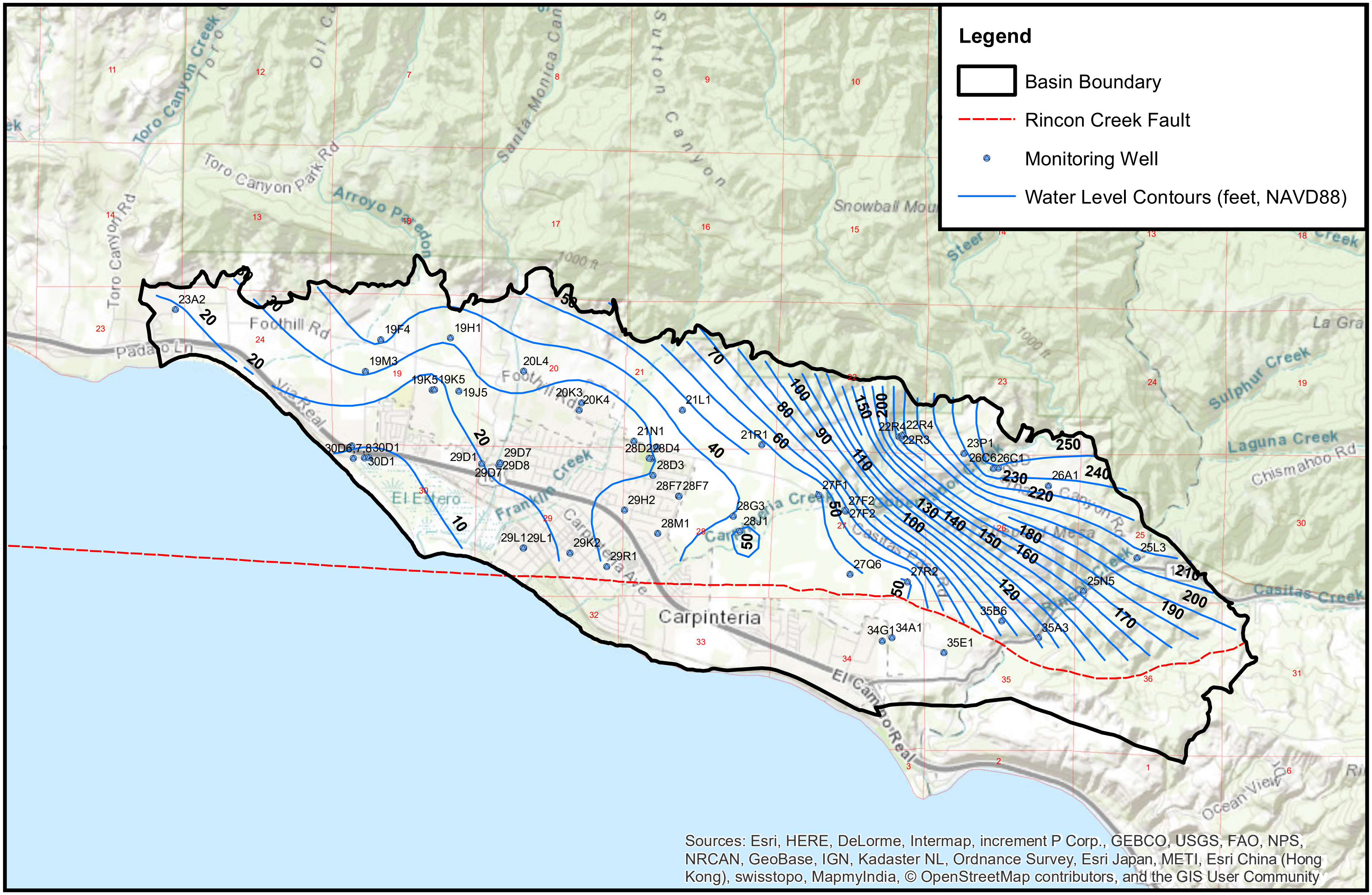
N
W
E
S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-18 Groundwater Elevation Contours - Fall 1991**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
DRAFT




PUEBLO water resources

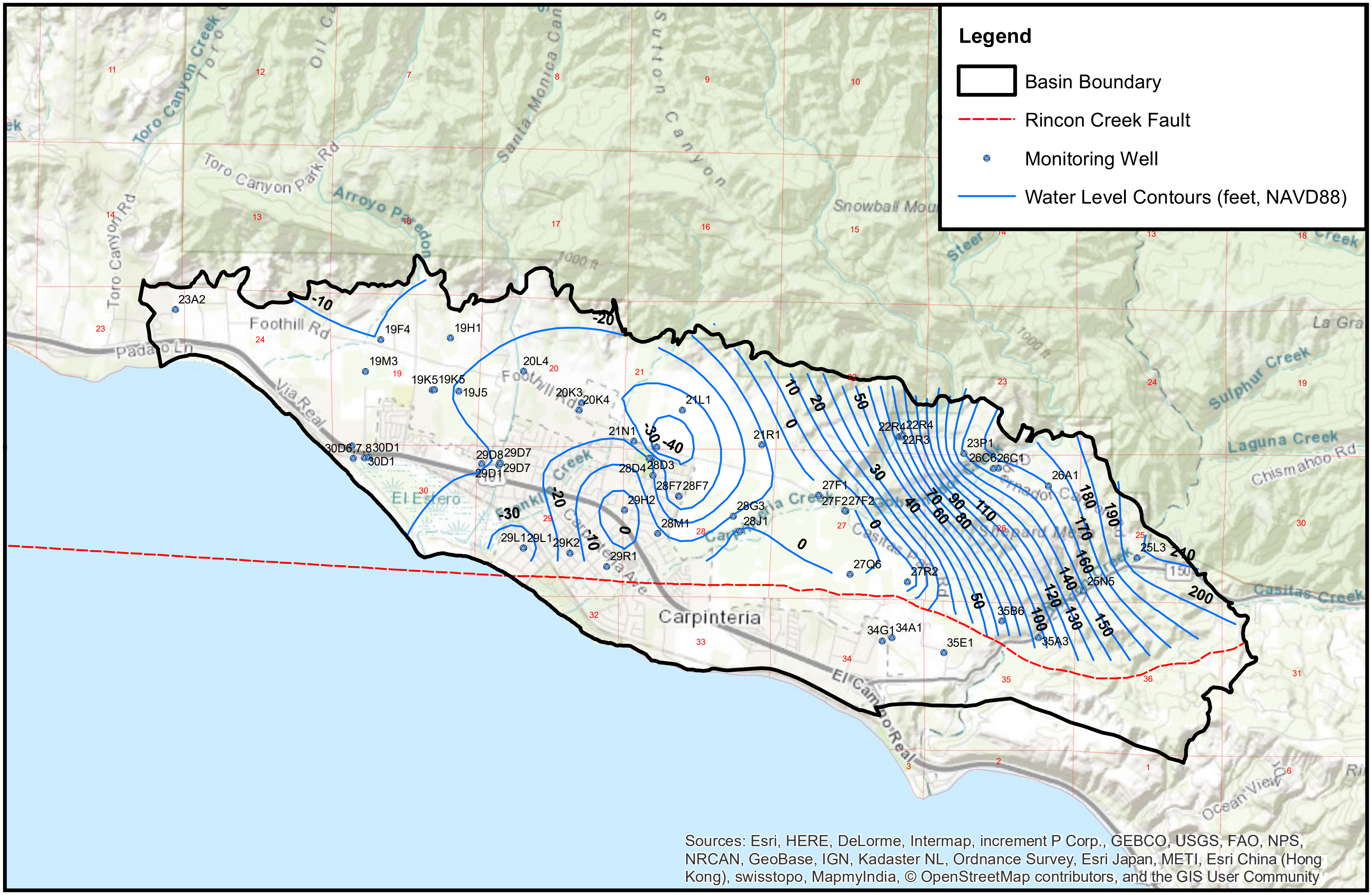
N
W E
S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-19 Groundwater Elevation Contours - Spring 1998**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
DRAFT



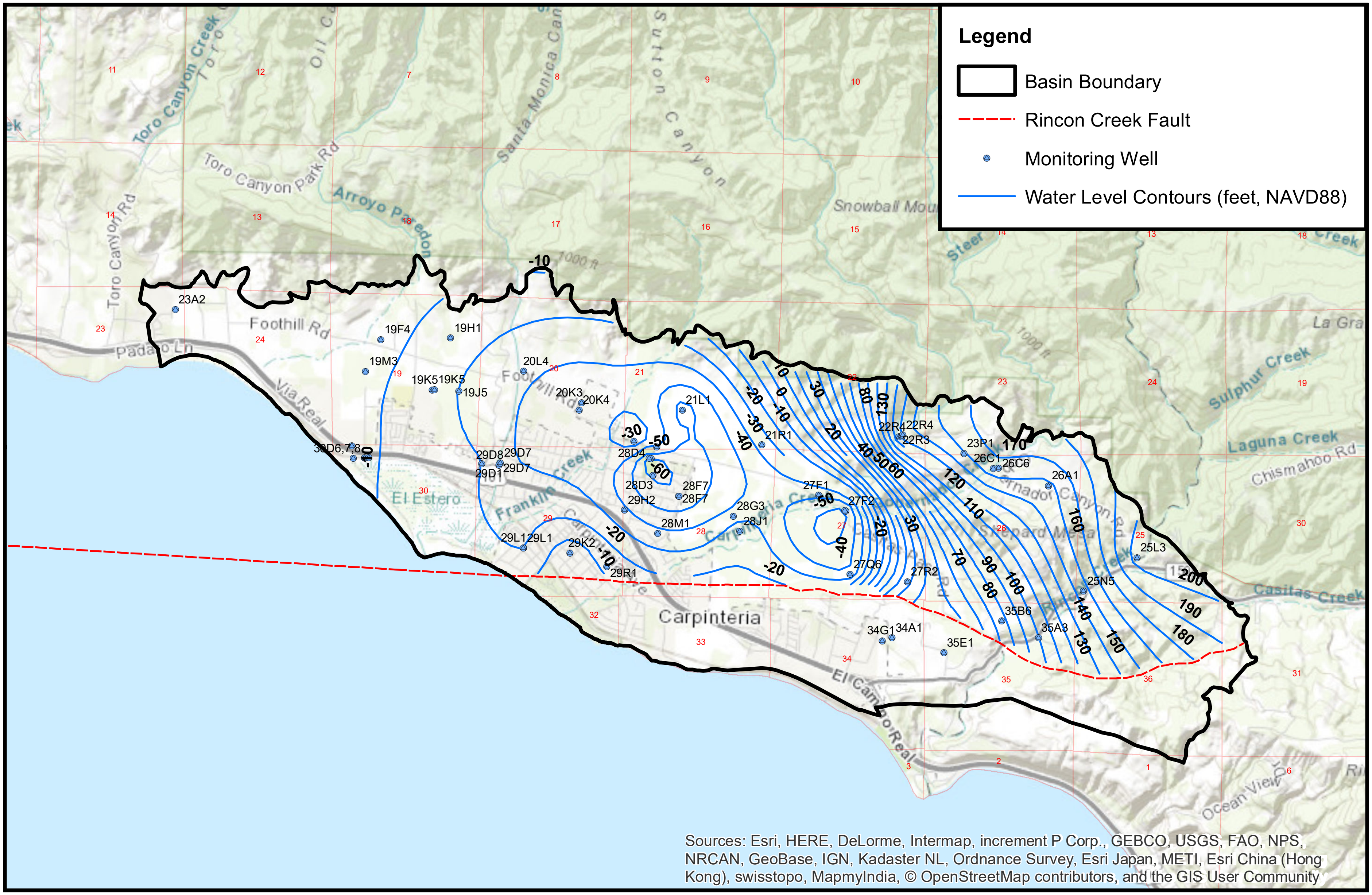

PUEBLO water resources

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-20 Groundwater Elevation Contours - January 2015**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

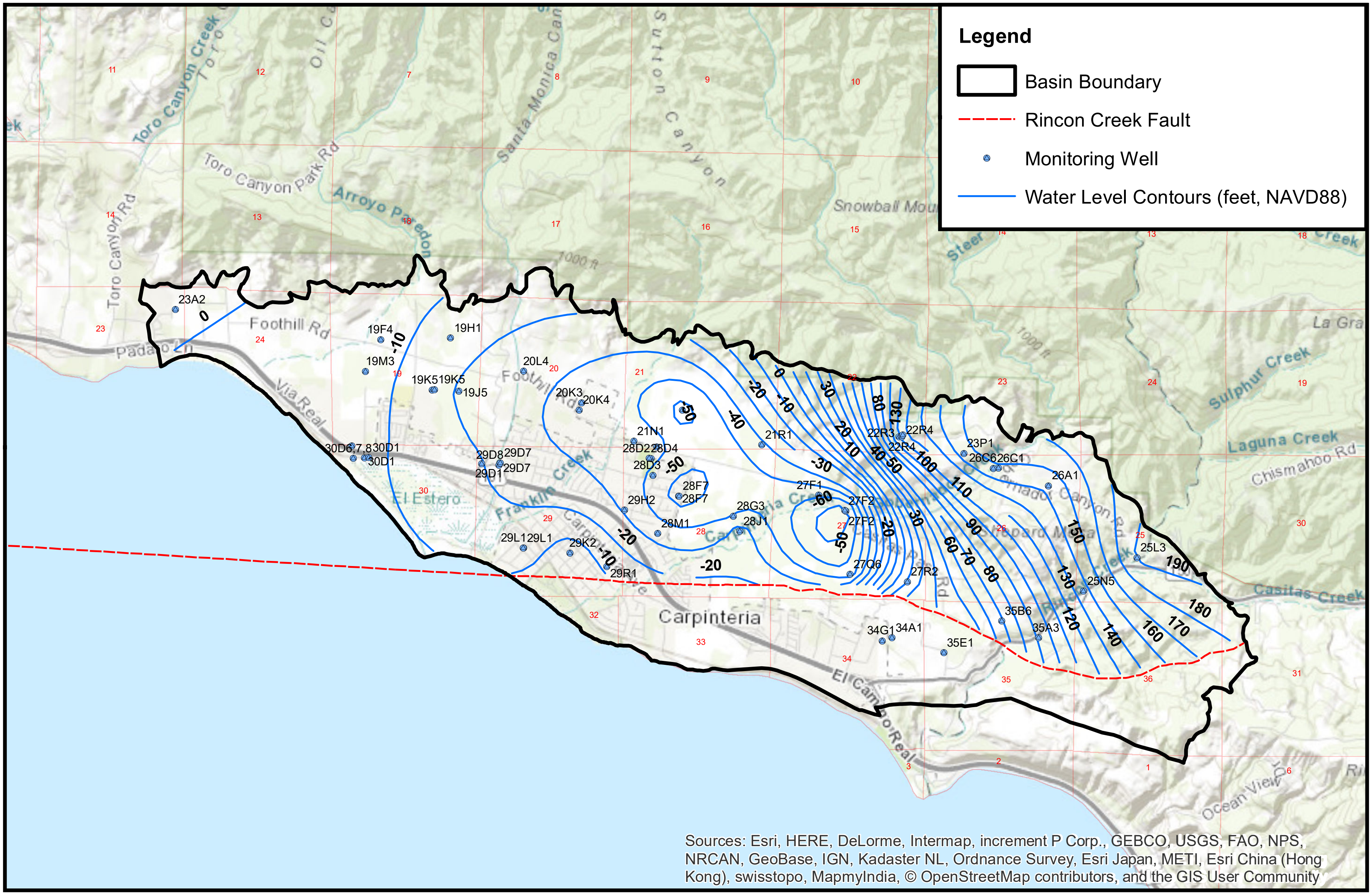
September 2022
DRAFT




PUEBLO water resources

**Figure 3-21 Groundwater Elevation Contours - Spring 2020**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
DRAFT




PUEBLO water resources

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-22 Groundwater Elevation Contours - Fall 2020**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

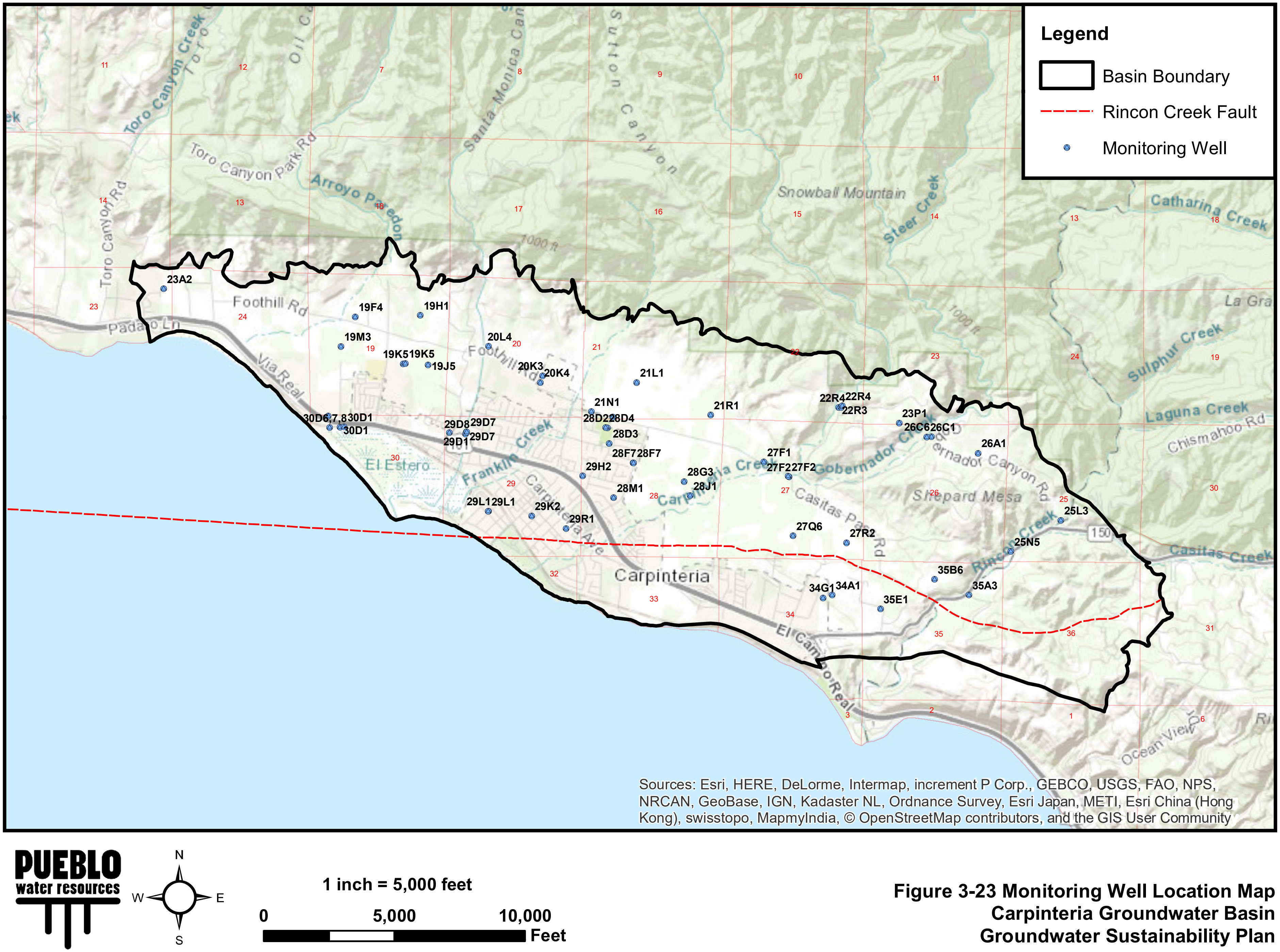



**Figure 3-23 Monitoring Well Location Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
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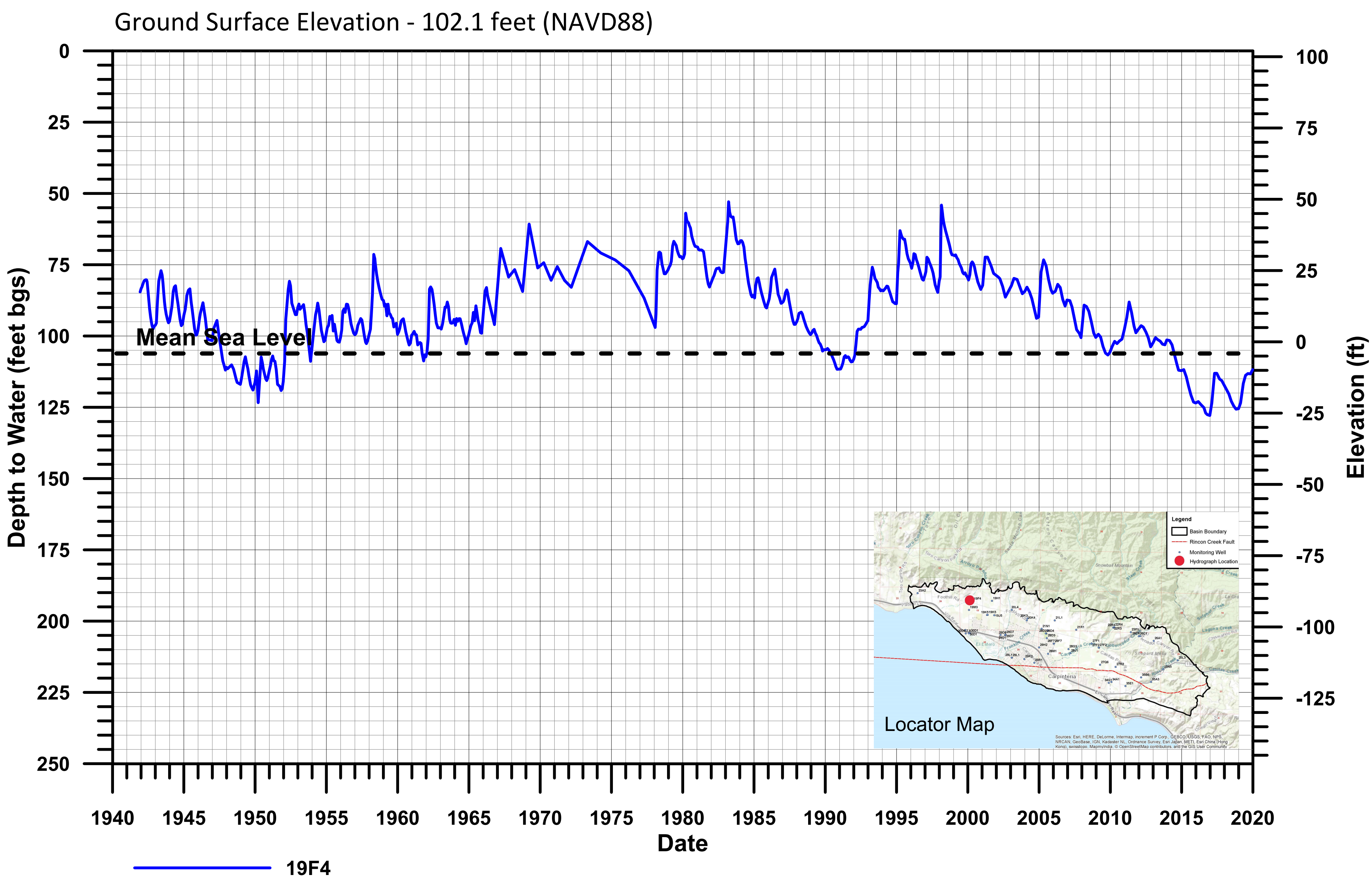
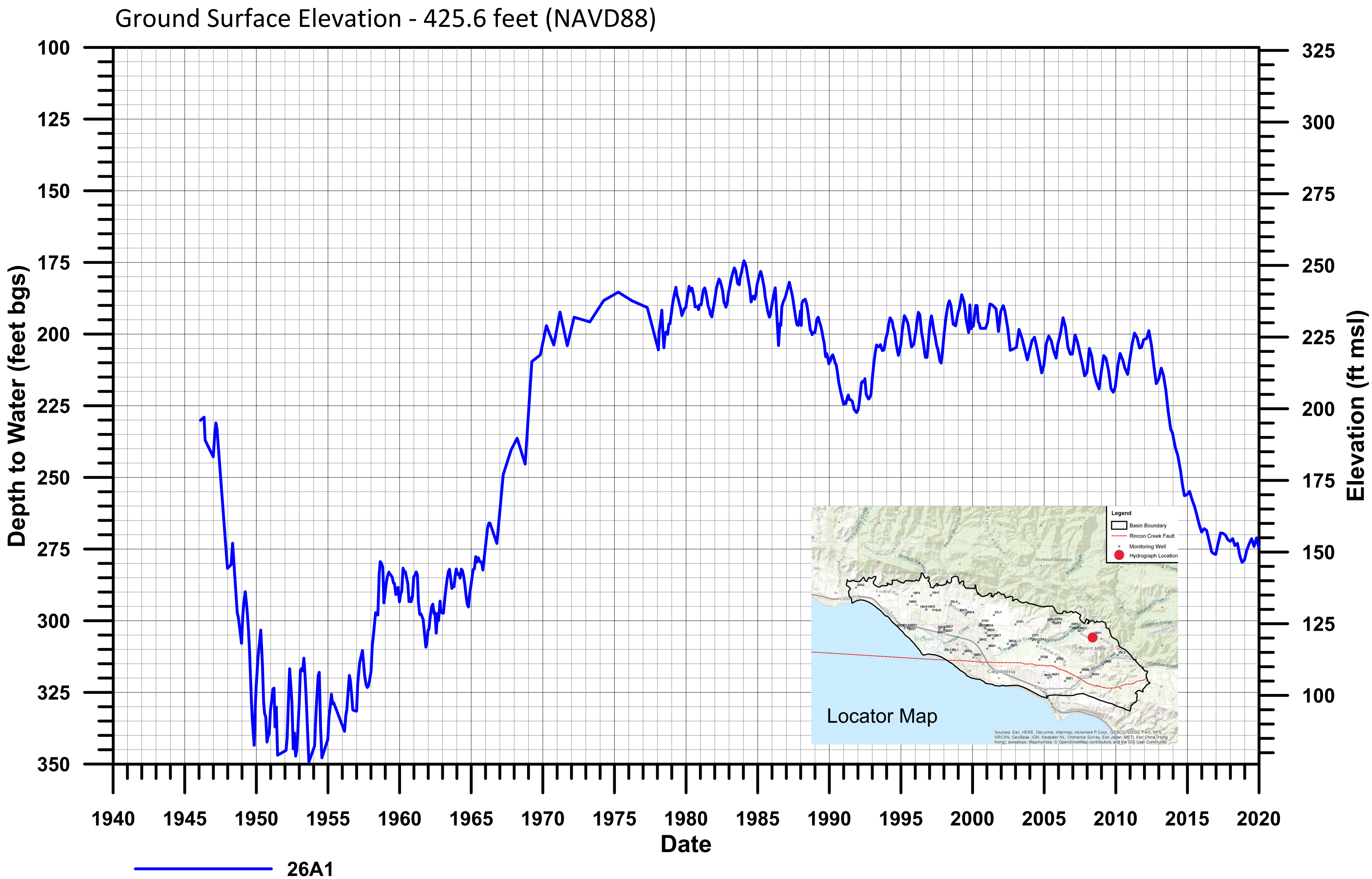



**PUEBLO** water resources

**Figure 3-24 Water Level Data - 4N/25W-19F4**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
DRAFT




PUEBLO water resources

**Figure 3-25 Water Level Data - 4N/25W-26A1**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

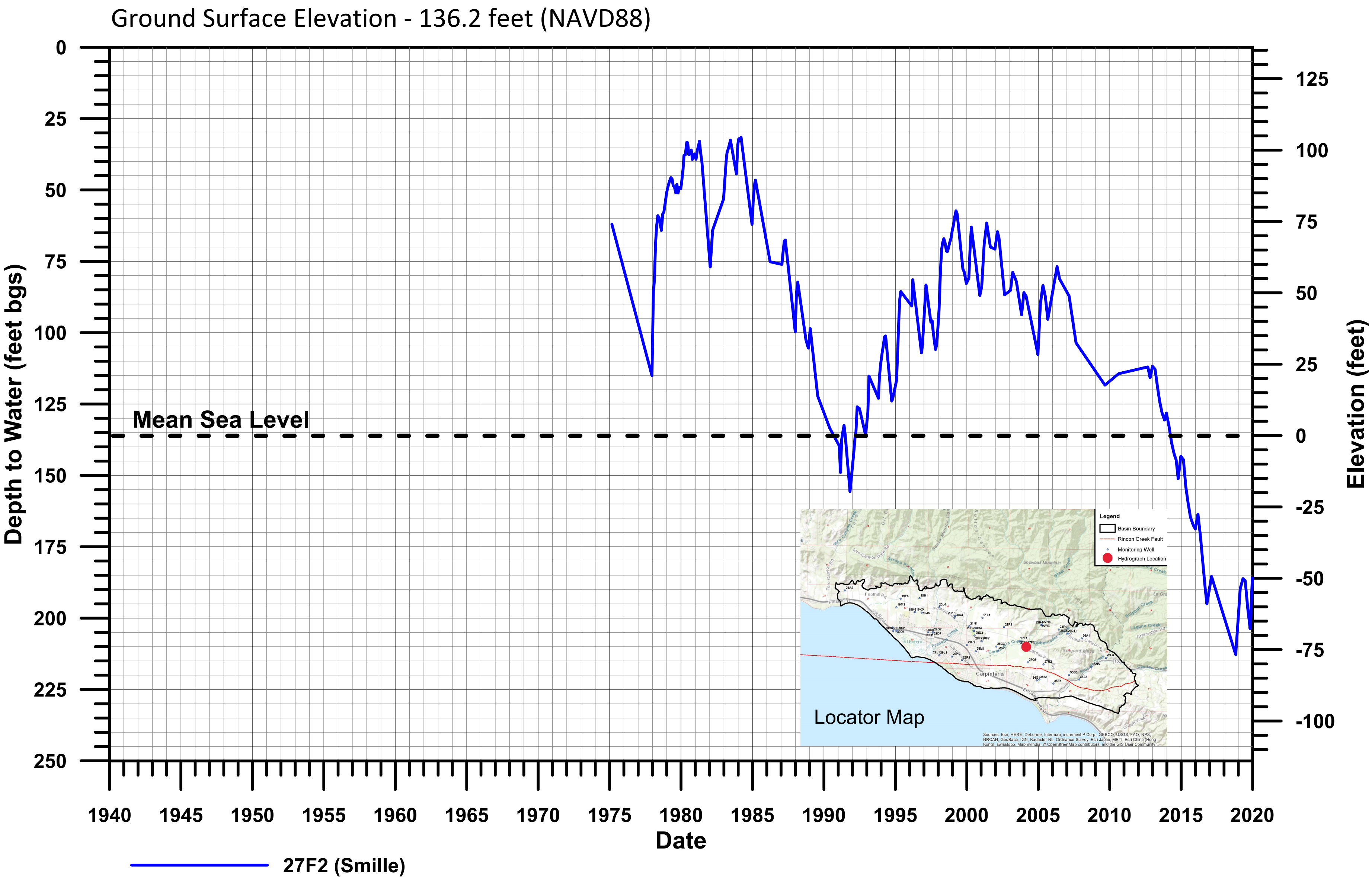
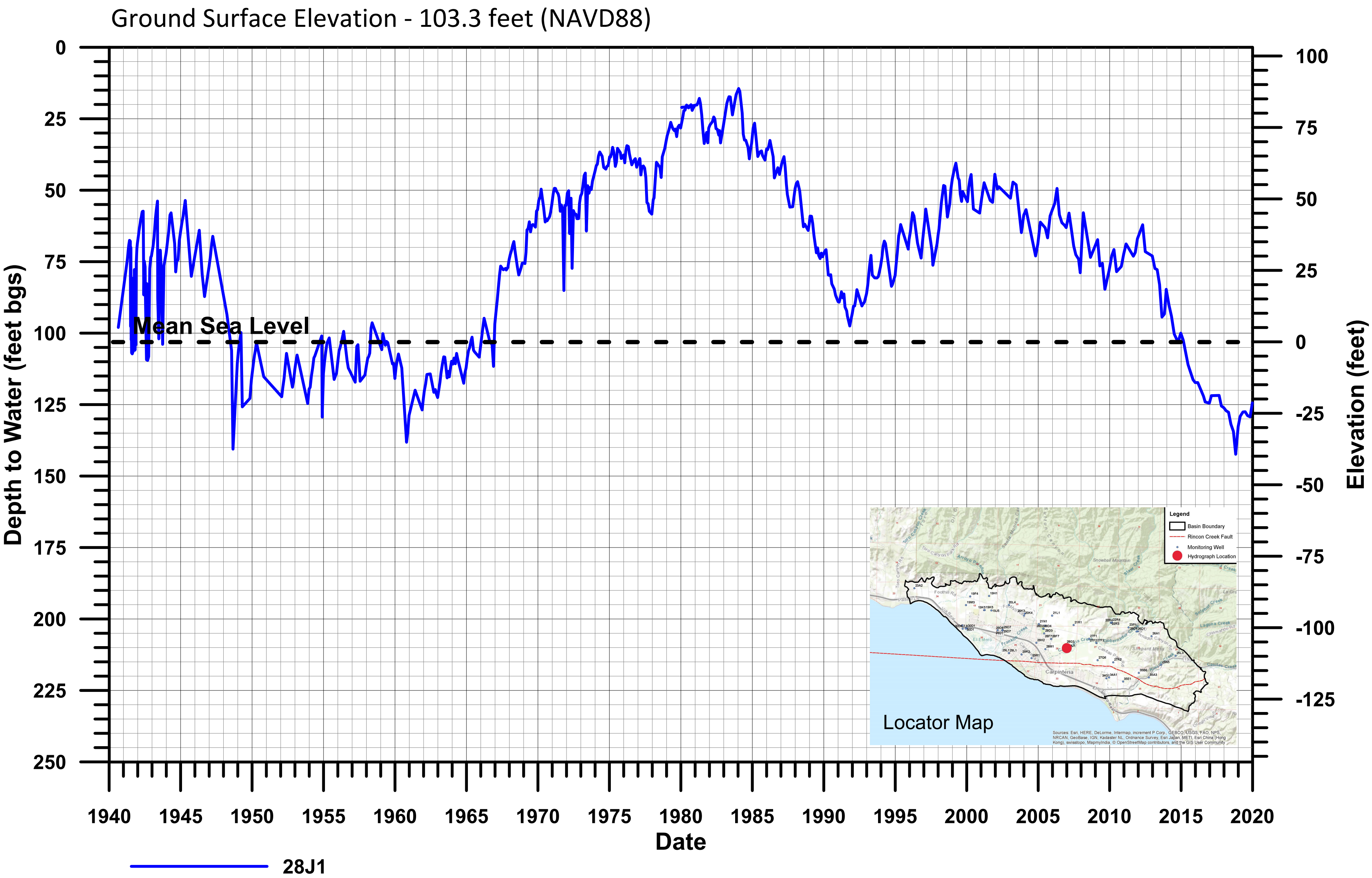


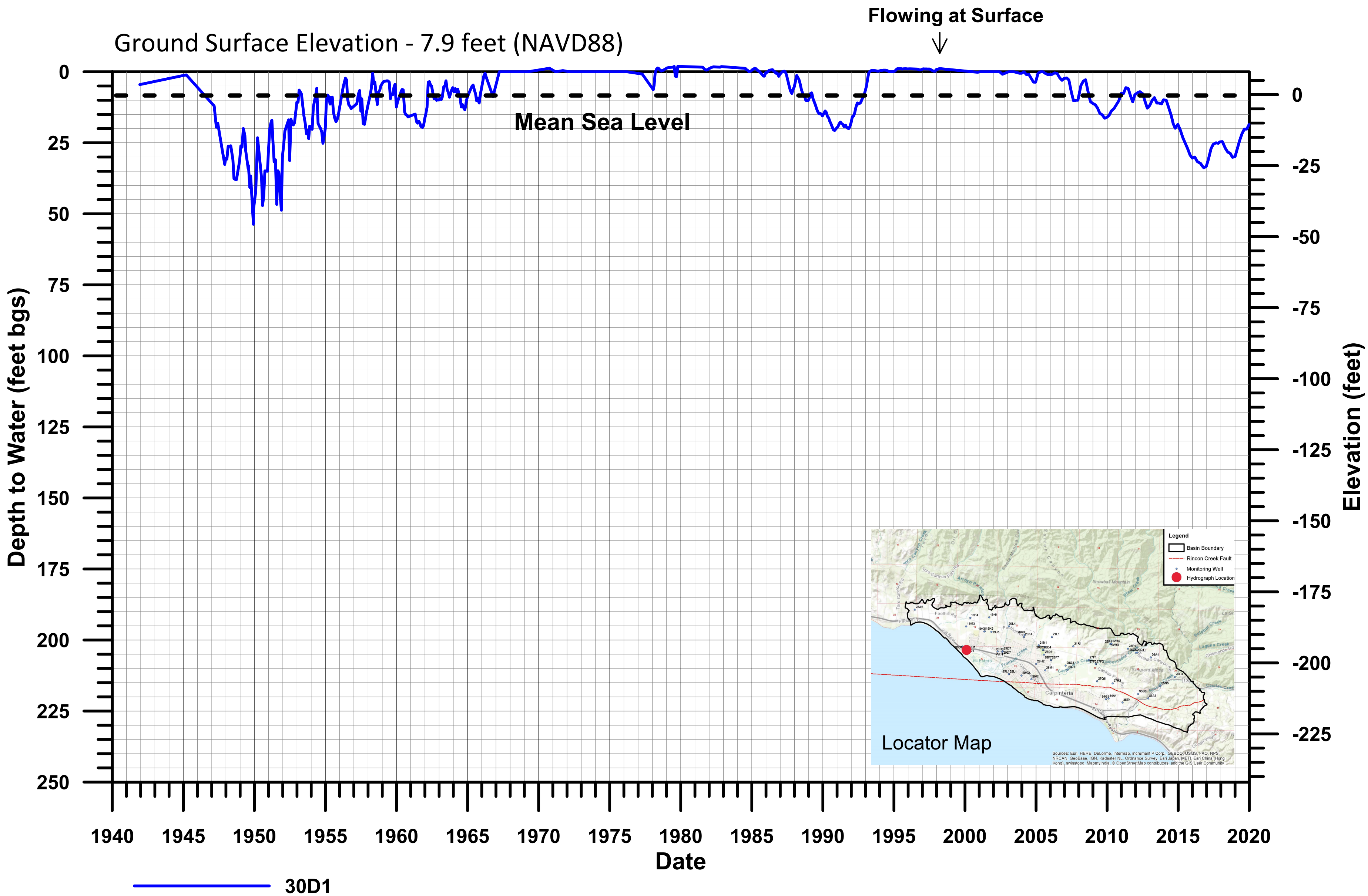



**Figure 3-26 Water Level Data - 4N/25W-27F2 (SMILLE)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**



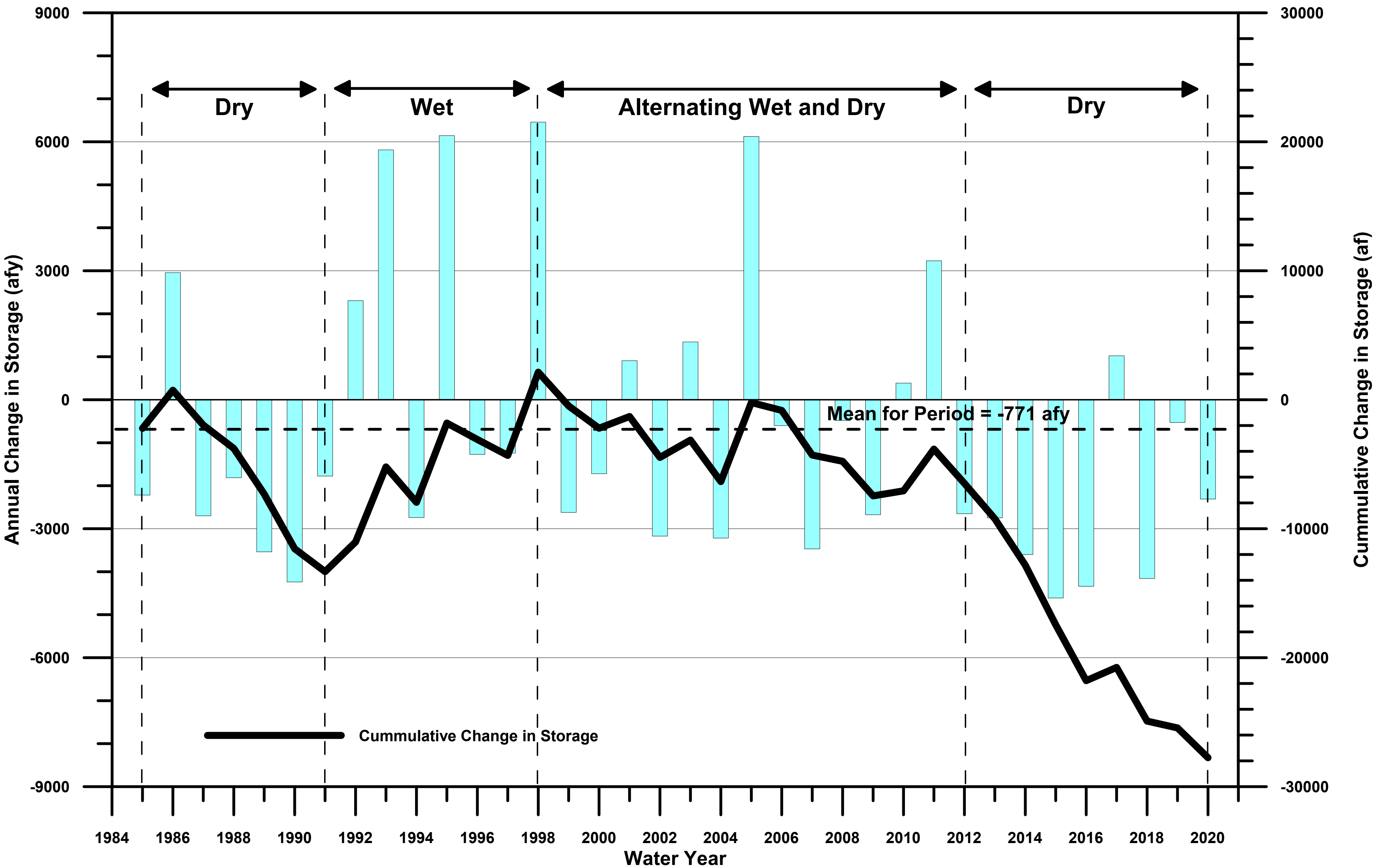

PUEBLO water resources

**Figure 3-27 Water Level Data - 4N/25W-28J1**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

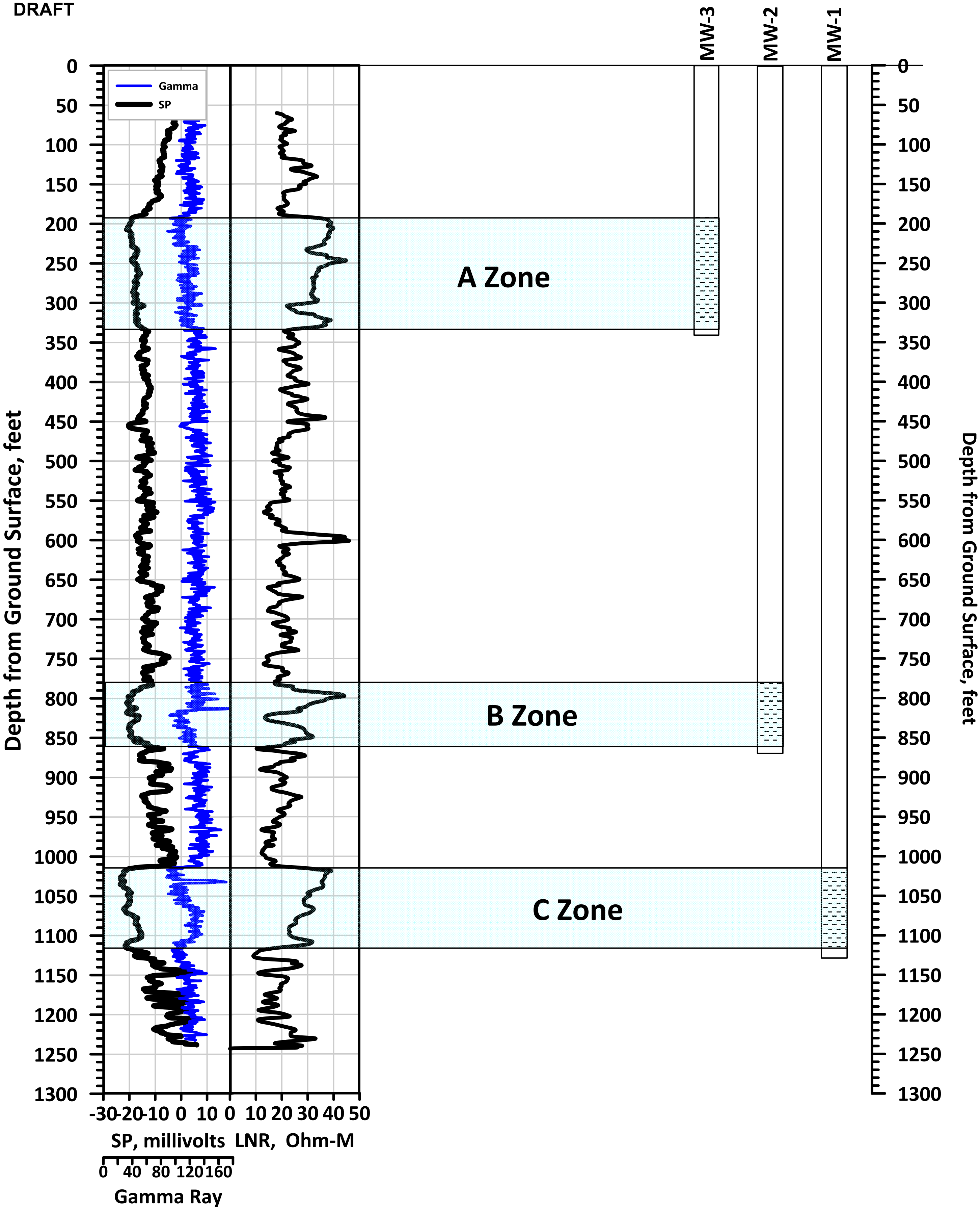
**Figure 3-28 Water Level Data - 4N/25W-30D1**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

**Figure 3-29 Change in Groundwater in Storage (WY 1985 - 2020)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

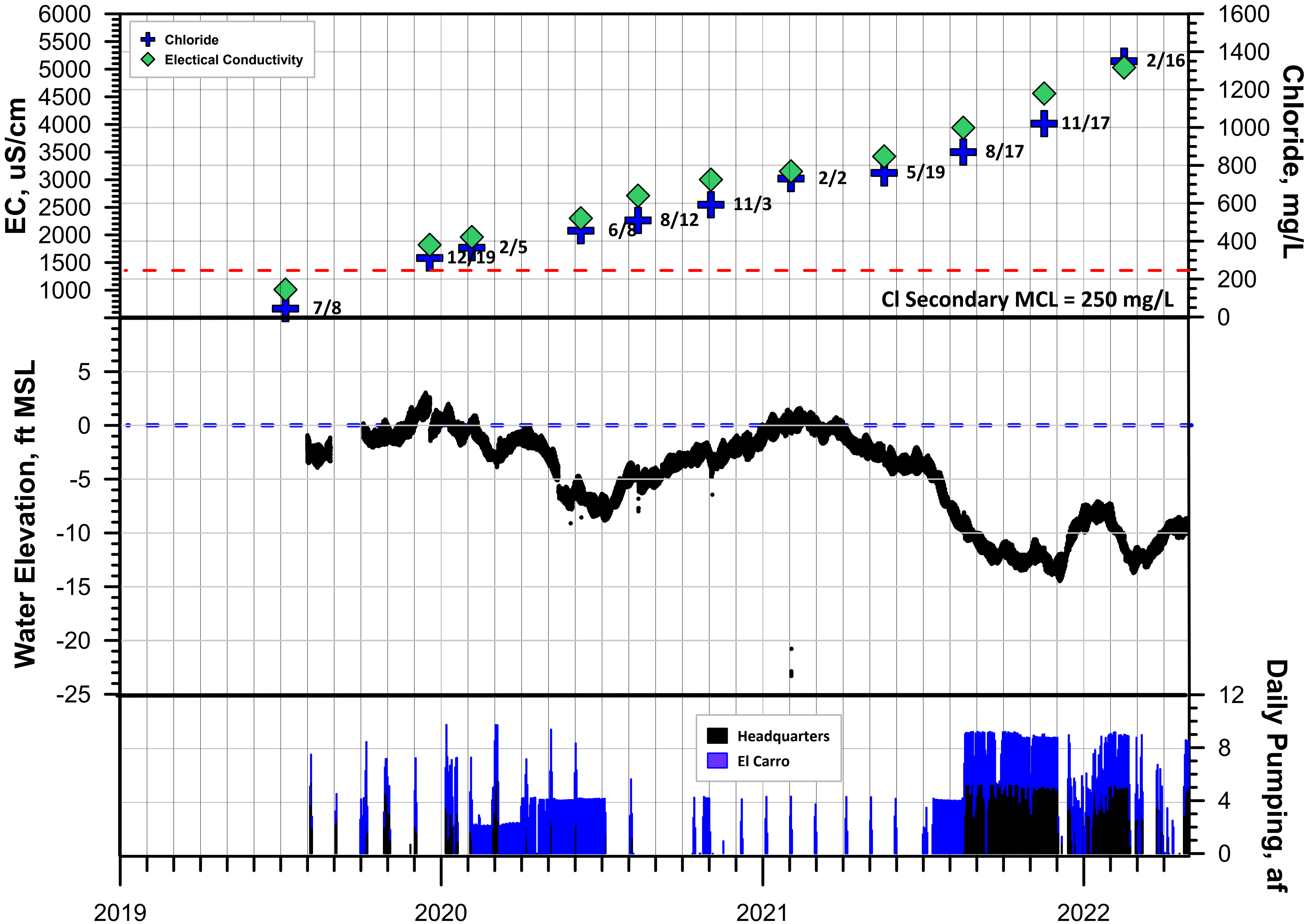
September 2022
DRAFT




PUEBLO
water resources

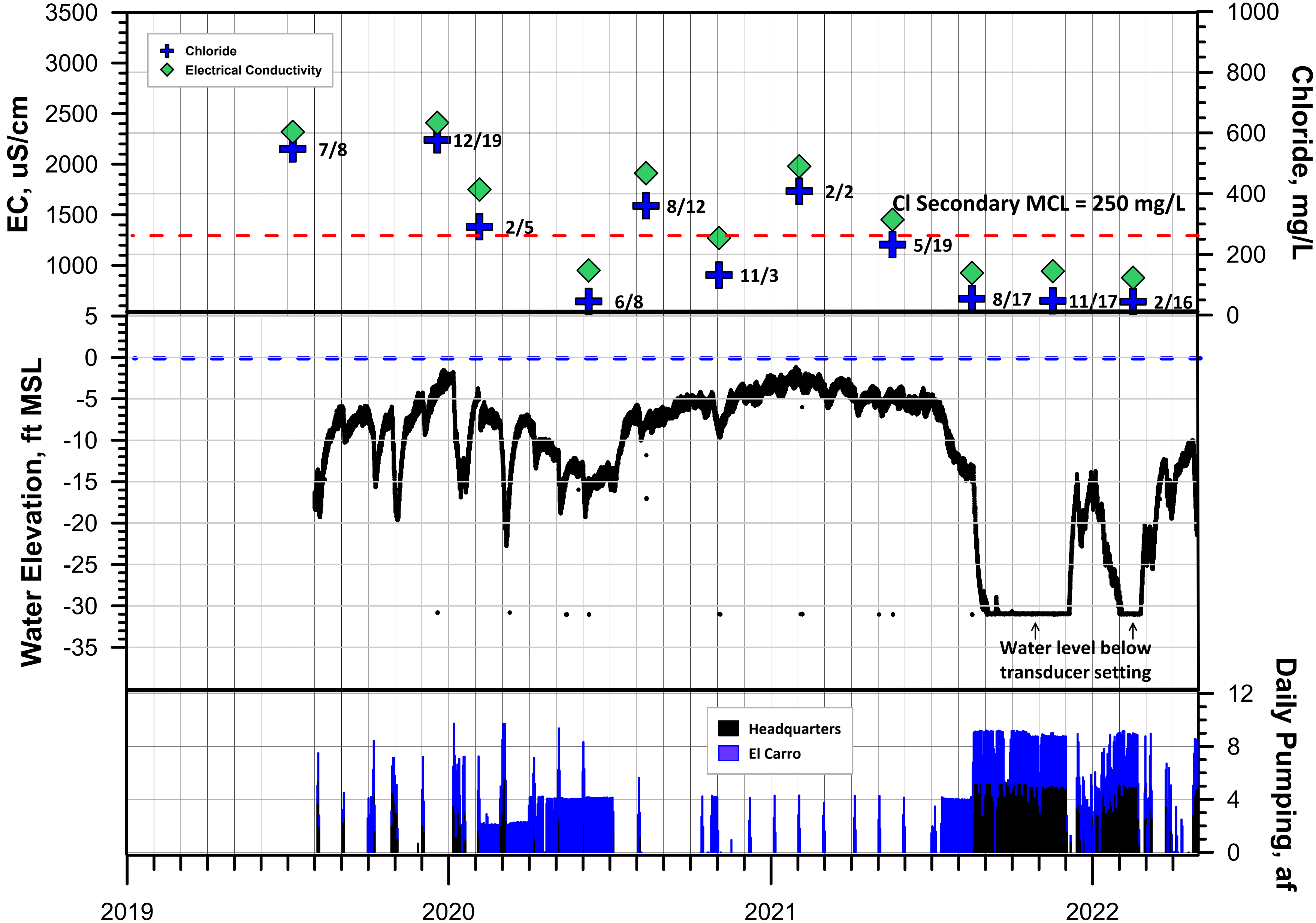
**Figure 3-30 Sentinel Well Completions Schematic**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

September 2022
DRAFT




PUEBLO water resources

**Figure 3-31 Sentinel Well Data - MW-1 (C Zone)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**




PUEBLO water resources

Figure 3-32 Sentinel Well Data - MW-2 (B Zone)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan

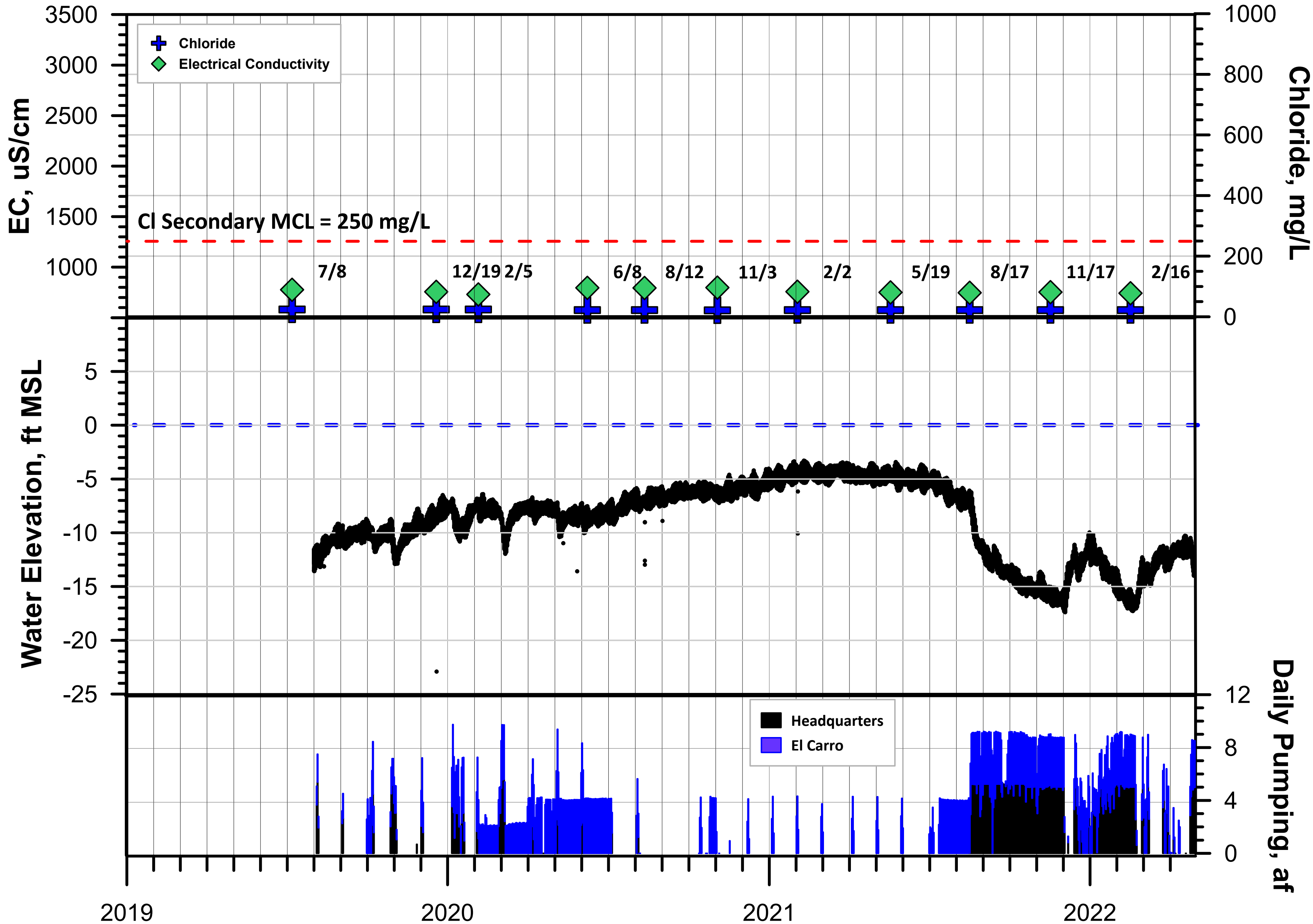
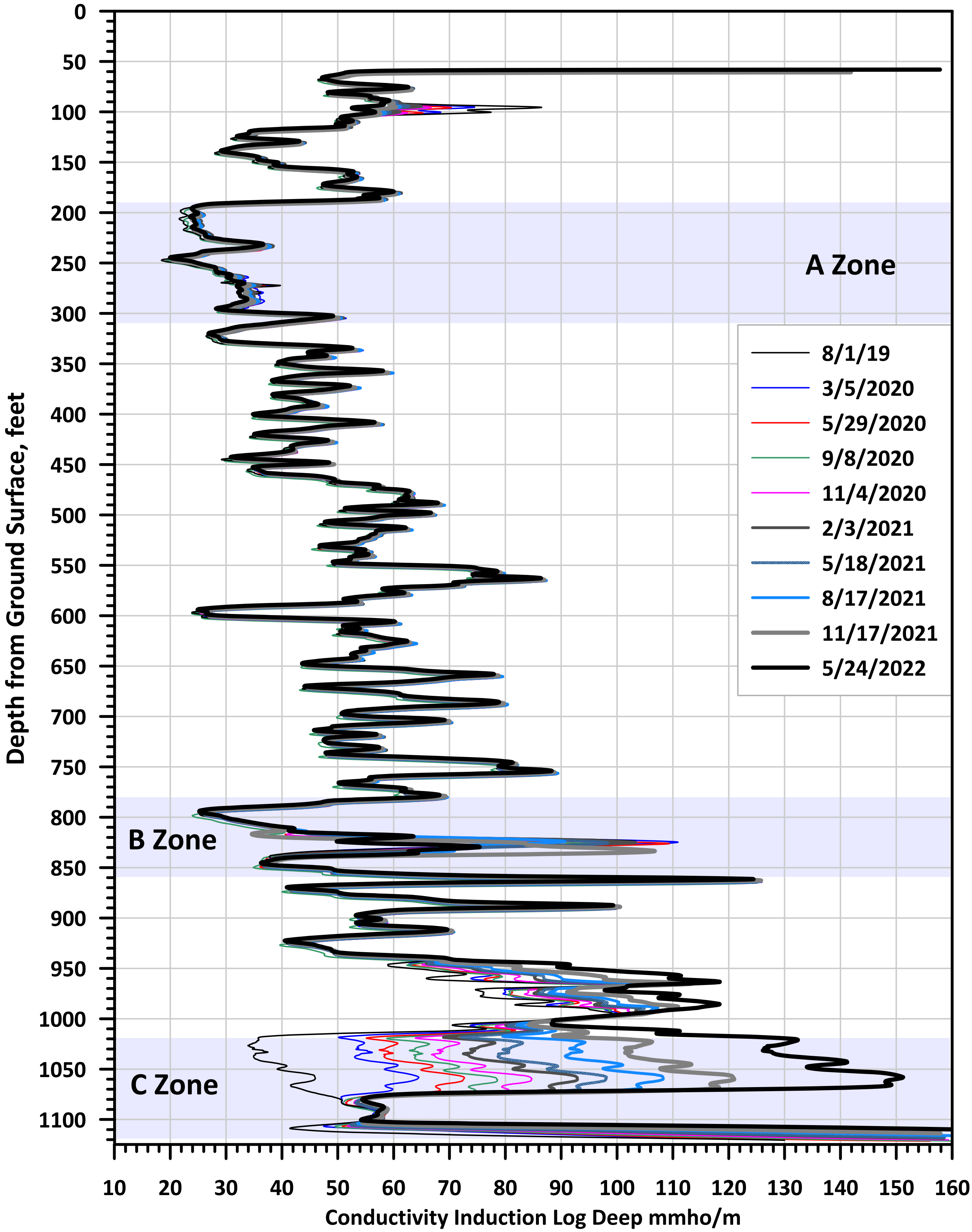



Figure 3.33 Sentinel Well Data - MW-3 (A Zone)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan




PUEBLO water resources

Figure 3-34 MW-1 Induction Surveys
Carpinteria Groundwater Basin
Groundwater Sustainability Plan


100 0 100 200 300 400 500 600

(US SURVEY FEET)

1 2 3 4 5 6 7 8 9

DIGITAL ELEVATION MODEL (FEET)

**LEGEND:**

0 500 — ERT PROFILE LOCATION AND CHAINAGE (IN FEET)

SENTINEL WELLS: MW-1 (SHALLOW), MW-2 (MEDIUM), AND MW-3 (DEEP)

Notes:

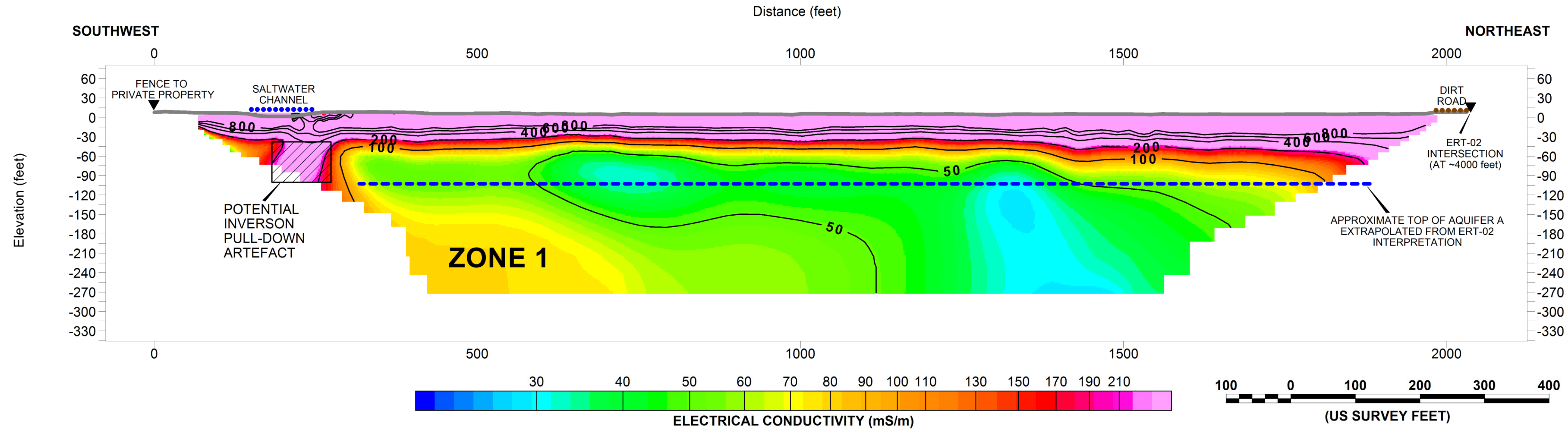
1. This Figure should be read in conjunction with BGC's report titled "Electrical resistivity tomography (ERT) investigation to map saltwater intrusion in Carpinteria, California", and dated October, 2021.
2. The ERT surveys were collected as part of a saltwater intrusion study at Carpinteria, California between April 20 and 23, 2021.
3. ERT Field Parameters - Minimum Electrode Spacings: 22.5 m (73.8 feet) and 5 m (16.4 feet); Electrode Arrays: Gradient-Plus and Dipole-Dipole.
4. Coordinate system is NAD83 California State Plane Zone V (SPCS83; US Survey Feet). Vertical datum is CGVD2013.
5. Inset map imagery source: Bing Imagery (May 2018).
6. The Carpinteria Salt Marsh Reserve (i.e., saltmarsh) is comprised of an approximately 20 m (65.6 feet) thick estuarine deposit of locally organic-rich fine-grained materials and subordinate sand deposits (Minor et al., 2009).

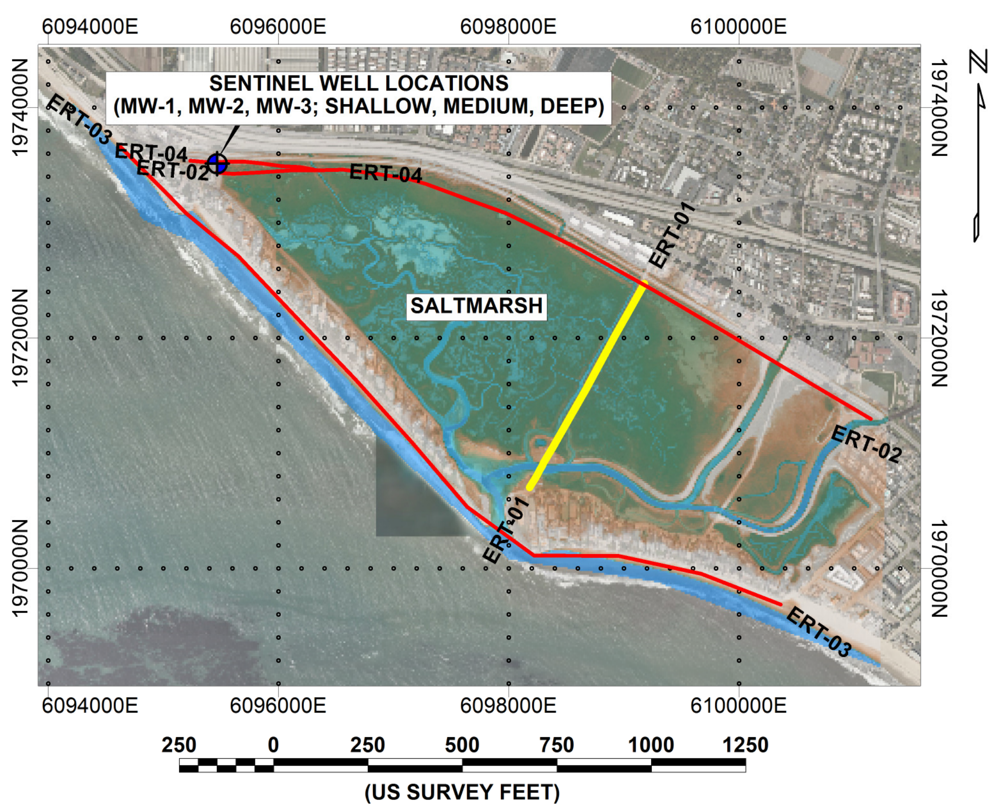
| PREPARED BY: | FIGURE TITLE: | | |
|---|---|---|---|
| LGW | CARPINTERIA ERT SURVEY BASEMAP | | |
| CHECKED BY: | CLIENT: | | |
| AFM | CARPINTERIA VALLEY WATER DISTRICT (CVWD) | | |
| APPROVED BY: | SCALE: | PROJECT NO: | FIGURE NO: |
| LGW | AS SHOWN | 2252001 | 1 |

File Path: BGC Engineering Inc\Geophysics - Files\2.0 Current BGC Projects\2252001 - Carpinteria\3.0 Data Processing\4.0 Oasis\Maps\2252001-Pueblo-Carpinteria BaseMap-A.map



**Figure 3-35 ERT Survey Line Location Map**




| Zone | Maximum Thickness (feet) | Interpretation |
|---|---|---|
| 1 | ≥ 138 | Possible saltwater intrusion into Aquifer A. |

**LEGEND:**

CROSS-SECTION
- ELECTRICAL CONDUCTIVITY CONTOUR (mS/m)
- SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)
- NOTABLE WATER CROSSING (> 15 m)
- NOTABLE OBSERVED SURFACE FEATURE

INSET
- DISPLAYED 2021 ERT PROFILE LOCATION
- OTHER 2021 ERT PROFILE LOCATIONS
- SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)

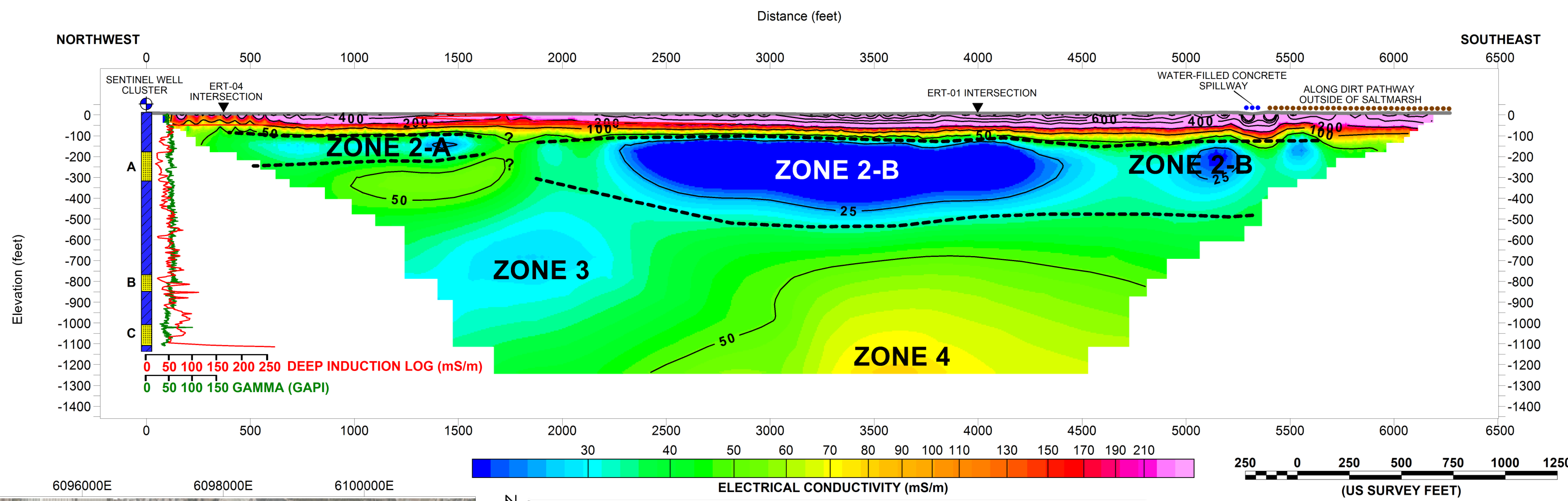
Notes:
1. This Figure should be read in conjunction with BGC's report titled "Electrical resistivity tomography (ERT) investigation to map saltwater intrusion in Carpinteria, California", and dated October, 2021.
2. The ERT surveys were collected as part of a saltwater intrusion study at Carpinteria, California between April 20 and 23, 2021.
3. ERT-01 Field Parameters - Minimum Electrode Spacing 5 m (16.4 feet); Electrode Arrays: Gradient-Plus and Dipole-Dipole.
4. The ERT-01 section is modelled results of a combined array (i.e., gradient and dipole-dipole) inversion and is displayed as electrical conductivity (mS/m) on a log scale from 20 - 250 mS/m.
5. Coordinate system is NAD83 California State Plane Zone V (SPCS83; US Survey Feet). Vertical datum is CGVD2013.
6. Inset map imagery source: Bing Imagery (May 2018).

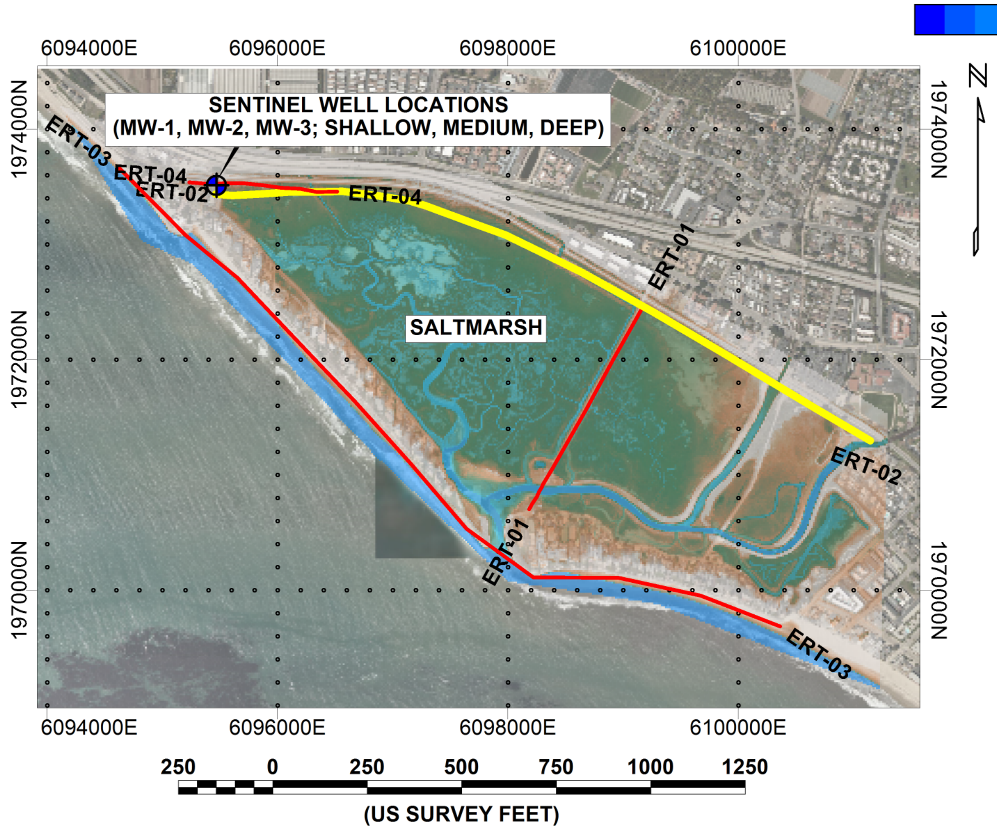
| | | | | |
|---|---|---|---|---|
| PREPARED BY: LGW | FIGURE TITLE: CARPINTERIA SALTWATER INTRUSION: ERT-01 | | | |
| CHECKED BY: PDB | CLIENT: CARPINTERIA VALLEY WATER DISTRICT (CVWD) | | | |
| APPROVED BY: LGW | SCALE: AS SHOWN | PROJECT NO: 2252001 | FIGURE NO: 2 | |

File Path: BGC Engineering Inc\Geophysics - Files\2.0 Current BGC Projects\2252001 - Carpinteria\3.0 Data Processing\4.0 Oasis\Maps\2252001-Pueblo-Carpinteria_ERT01-A.map



Figure 3-36 ERT Profile 01




| Zone | Maximum Thickness (feet) | Interpretation |
|---|---|---|
| 2-A | 115 | Aquifer A. No saltwater intrusion. |
| 2-B | 400 | A thicker zone of Aquifer A. No saltwater intrusion. |
| 3 | 400 | Potential coarse-grained material (i.e., sands/gravels). Possibly Aquifer B. |
| 4 | ≥ 250 | At the bottom of the ERT section and the limits of the ERT profile's spatial resolution. Not considered to be notable or significant. |

**GENERAL HYDROSTRATIGRAPHIC UNITS:**
- PREDOMINANTLY FINE-GRAINED CONFINING LAYERS
- AQUIFER UNITS (ZONE A, B, & C)

**LEGEND:**
CROSS-SECTION
- ELECTRICAL CONDUCTIVITY CONTOUR (mS/m)
- FEBRUARY 2021 DEEP CONDUCTIVITY LOG IN mS/m (PACIFIC SURVEYS)
- FEBRUARY 2021 GAMMA LOG IN GAPI (PACIFIC SURVEYS)
- SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)
- INTERPRETED AQUIFER A BOUNDS
- NOTABLE WATER CROSSING (> 15 m)
- NOTABLE OBSERVED SURFACE FEATURE

INSET
- DISPLAYED 2021 ERT PROFILE LOCATION
- OTHER 2021 ERT PROFILE LOCATIONS
- SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)

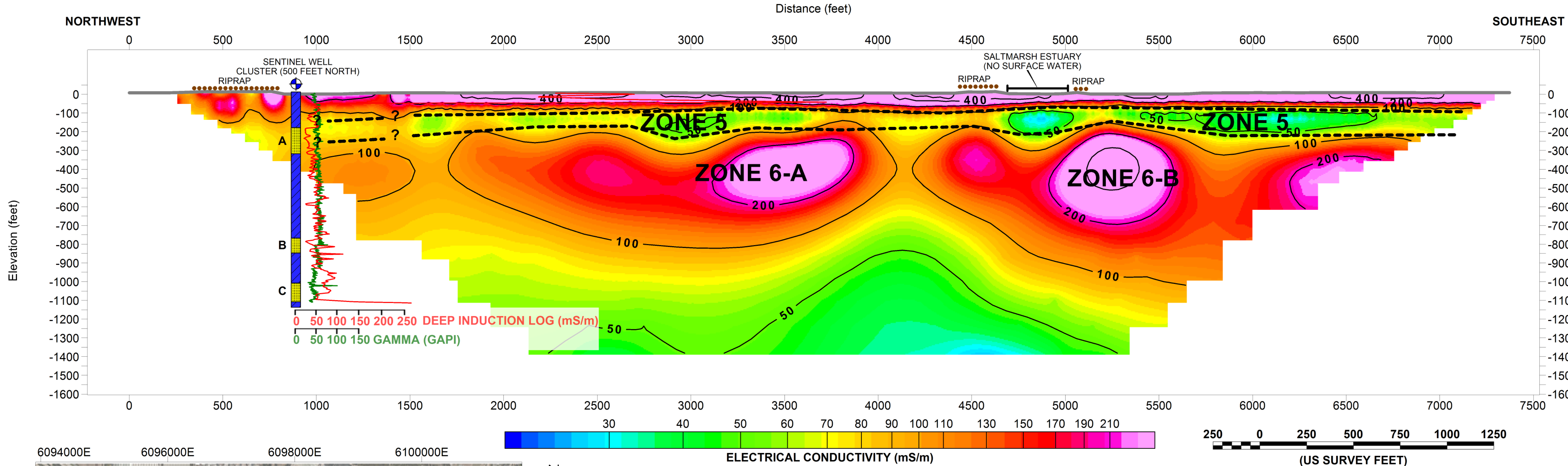
Notes:
1. This Figure should be read in conjunction with BGC's report titled "Electrical resistivity tomography (ERT) investigation to map saltwater intrusion in Carpinteria, California", and dated October, 2021.
2. The ERT surveys were collected as part of a saltwater intrusion study at Carpinteria, California between April 20 and 23, 2021.
3. ERT-02 Field Parameters - Minimum Electrode Spacing 22.5 m (73.8 feet); Electrode Arrays: Gradient-Plus and Dipole-Dipole.
4. The ERT-02 section is modelled results of a combined array (i.e., gradient and dipole-dipole) inversion and is displayed as electrical conductivity (mS/m) on a log scale from 20 - 250 mS/m.
5. Coordinate system is NAD83 California State Plane Zone V (SPCS83; US Survey Feet). Vertical datum is CGVD2013.
6. Inset map imagery source: Bing Imagery (May 2018).

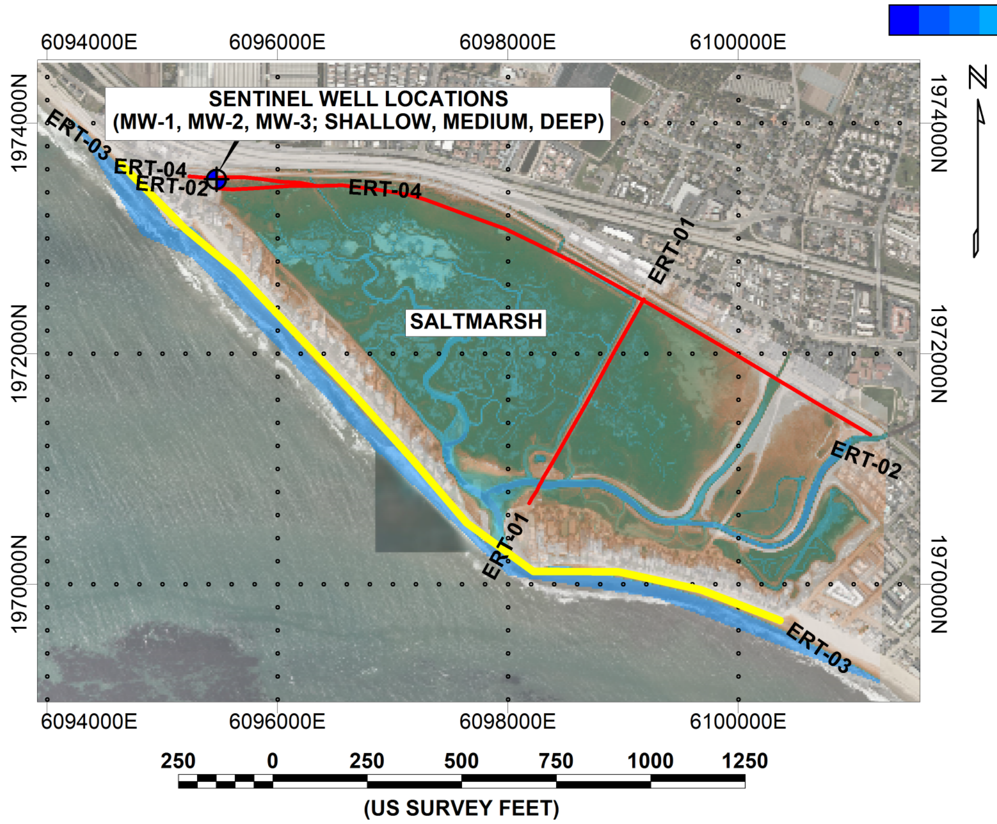
| PREPARED BY: | FIGURE TITLE: | | |
|---|---|---|---|
| LGW | CARPINTERIA SALTWATER INTRUSION: ERT-02 | | |
| CHECKED BY: | CLIENT: | | |
| PDB | CARPINTERIA VALLEY WATER DISTRICT (CVWD) | | |
| APPROVED BY: | SCALE: | PROJECT NO: | FIGURE NO: |
| LGW | AS SHOWN | 2252001 | 3 |

File Path: BGC Engineering Inc\Geophysics - Files\2.0 Current BGC Projects\2252001 - Carpinteria\3.0 Data Processing\4.0 Oasis\Maps\2252001-Pueblo-Carpinteria_ERT02-A.map



Figure 3-37 ERT Profile 02




| Zone | Maximum Thickness (feet) | Interpretation |
|---|---|---|
| 5 | 130 | Aquifer A. Zones of possible saltwater intrusion (i.e., electrical conductivities exceeding 70 mS/m). |
| 6-A | 600 | 1. Possible saltwater intrusion into the thickest portion of Aquifer A (as interpreted from ERT-02; Zone 2-B). 2. Possible saltwater-saturated fine-grained materials (i.e., clays) and relatively thin coarse-grained deposits (e.g., sand lenses and stringers) associated with confining layer between Aquifer A and B. |
| 6-B | 600 | 1. Possible saltwater intrusion into the thickest portion of Aquifer A (as interpreted from ERT-02; Zone 2-B). 2. Possible saltwater-saturated fine-grained materials (i.e., clays) and relatively thin coarse-grained deposits (e.g., sand lenses and stringers) associated with confining layer between Aquifer A and B. |

**GENERAL HYDROSTRATIGRAPHIC UNITS:**
PREDOMINANTLY FINE-GRAINED CONFINING LAYERS
AQUIFER UNITS (ZONE A, B, & C)

**LEGEND:**
CROSS-SECTION
ELECTRICAL CONDUCTIVITY CONTOUR (mS/m)
FEBRUARY 2021 DEEP CONDUCTIVITY LOG IN mS/m (PACIFIC SURVEYS)
FEBRUARY 2021 GAMMA LOG IN GAPI (PACIFIC SURVEYS)
SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)
INTERPRETED AQUIFER A BOUNDS
NOTABLE WATER CROSSING (> 15 m)
NOTABLE OBSERVED SURFACE FEATURE
INSET
DISPLAYED 2021 ERT PROFILE LOCATION
OTHER 2021 ERT PROFILE LOCATIONS
SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)

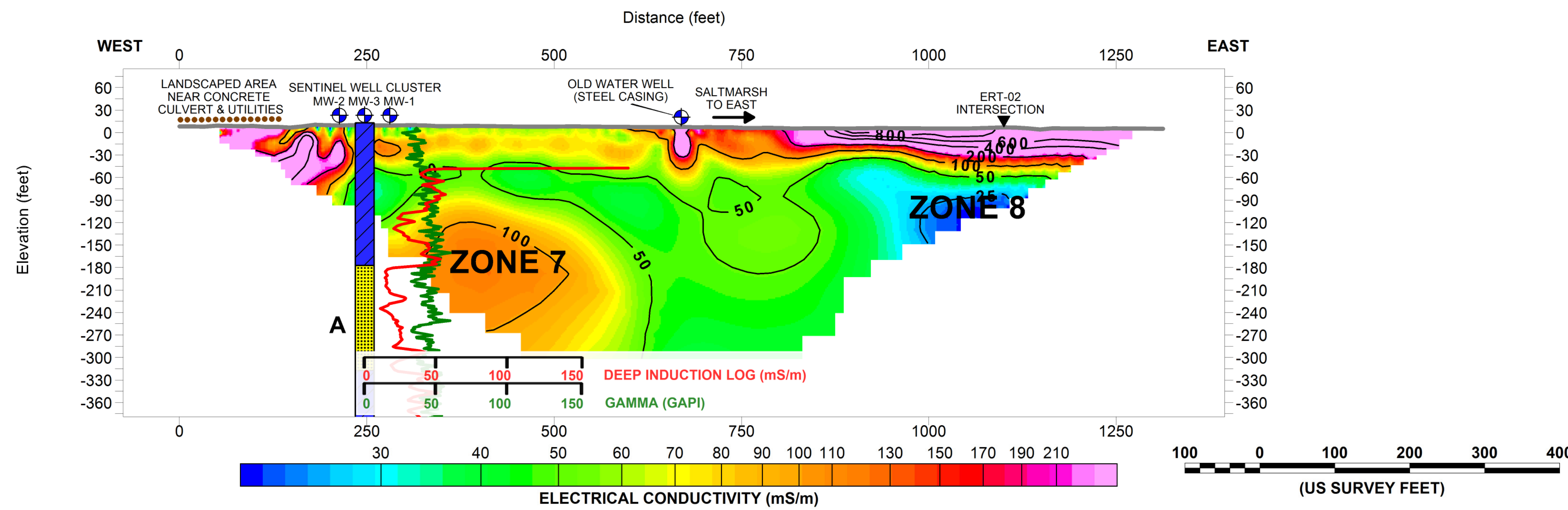
Notes:
1. This Figure should be read in conjunction with BGC's report titled "Electrical resistivity tomography (ERT) investigation to map saltwater intrusion in Carpinteria, California", and dated October, 2021.
2. The ERT surveys were collected as part of a saltwater intrusion study at Carpinteria, California between April 20 and 23, 2021.
3. ERT-03 Field Parameters - Minimum Electrode Spacing 22.5 m (73.8 feet); Electrode Arrays: Gradient-Plus and Dipole-Dipole.
4. The ERT-01 section is modelled results of a combined array (i.e., gradient and dipole-dipole) inversion and is displayed as electrical conductivity (mS/m) on a log scale from 20 - 250 mS/m.
5. Coordinate system is NAD83 California State Plane Zone V (SPCS83; US Survey Feet). Vertical datum is CGVD2013.
6. Inset map imagery source: Bing Imagery (May 2018).

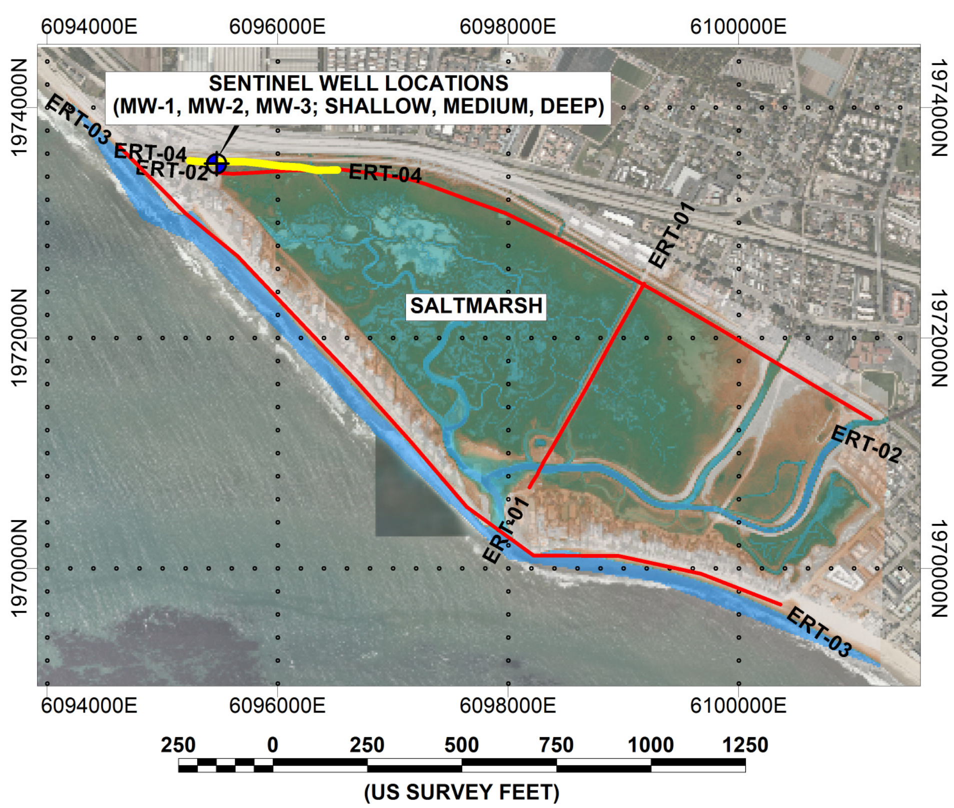
| | | | |
|---|---|---|---|
| PREPARED BY: LGW | FIGURE TITLE: CARPINTERIA SALTWATER INTRUSION: ERT-03 | | |
| CHECKED BY: PDB | CLIENT: CARPINTERIA VALLEY WATER DISTRICT (CVWD) | | |
| APPROVED BY: LGW | SCALE: AS SHOWN | PROJECT NO: 2252001 | FIGURE NO: 4 |

File Path: BGC Engineering Inc\Geophysics - Files\2.0 Current BGC Projects\2252001 - Carpinteria\3.0 Data Processing\4.0 Oasis\Maps\2252001-Pueblo-Carpinteria_ERT03-A.map



Figure 3-38 ERT Profile 03




| Zone | Maximum Thickness (feet) | Interpretation |
|---|---|---|
| 7 | 30? | Likely artificially thickened (the true thickness is unknown). The deep induction log indicates that Zone 7 could be approximately 30 feet thick and associated with a more clay-rich lithology within the confining layer overlying Aquifer A. No saltwater intrusion. |
| 8 | ≥ 60 | Likely associated with Zone 2-A on ERT-02, and therefore Aquifer A. No saltwater intrusion. |

**GENERAL HYDROSTRATIGRAPHIC UNITS:**
- PREDOMINANTLY FINE-GRAINED CONFINING LAYERS
- AQUIFER UNITS (ZONE A, B, & C)

**LEGEND:**

CROSS-SECTION
- ELECTRICAL CONDUCTIVITY CONTOUR (mS/m)
- FEBRUARY 2021 DEEP CONDUCTIVITY LOG IN mS/m (PACIFIC SURVEYS)
- FEBRUARY 2021 GAMMA LOG IN GAPI (PACIFIC SURVEYS)
- SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)
- INTERPRETED AQUIFER A BOUNDS
- NOTABLE WATER CROSSING (> 15 m)
- NOTABLE OBSERVED SURFACE FEATURE

INSET
- DISPLAYED 2021 ERT PROFILE LOCATION
- OTHER 2021 ERT PROFILE LOCATIONS
- SENTINEL WELL LOCATION (PUEBLO WATER RESOURCES)

Notes:
1. This Figure should be read in conjunction with BGC's report titled "Electrical resistivity tomography (ERT) investigation to map saltwater intrusion in Carpinteria, California", and dated October, 2021.
2. The ERT surveys were collected as part of a saltwater intrusion study at Carpinteria, California between April 20 and 23, 2021.
3. ERT-04 Field Parameters - Minimum Electrode Spacing 5 m (16.4 feet); Electrode Arrays: Gradient-Plus and Dipole-Dipole.
4. The ERT-01 section is modelled results of a combined array (i.e., gradient and dipole-dipole) inversion and is displayed as electrical conductivity (mS/m) on a log scale from 20 - 250 mS/m.
5. Coordinate system is NAD83 California State Plane Zone V (SPCS83; US Survey Feet). Vertical datum is CGVD2013.
6. Inset map imagery source: Bing Imagery (May 2018).

| PREPARED BY: | FIGURE TITLE: | | |
|---|---|---|---|
| LGW | CARPINTERIA SALTWATER INTRUSION: ERT-04 | | |
| CHECKED BY: | CLIENT: | | |
| PDB | CARPINTERIA VALLEY WATER DISTRICT (CVWD) | | |
| APPROVED BY: | SCALE: | PROJECT NO: | FIGURE NO: |
| LGW | AS SHOWN | 2252001 | 5 |

File Path: BGC Engineering Inc\Geophysics - Files\2.0 Current BGC Projects\2252001 - Carpinteria\3.0 Data Processing\4.0 Oasis\Maps\2252001-Pueblo-Carpinteria ERT04-A.map



**Figure 3-39 ERT Profile 04**

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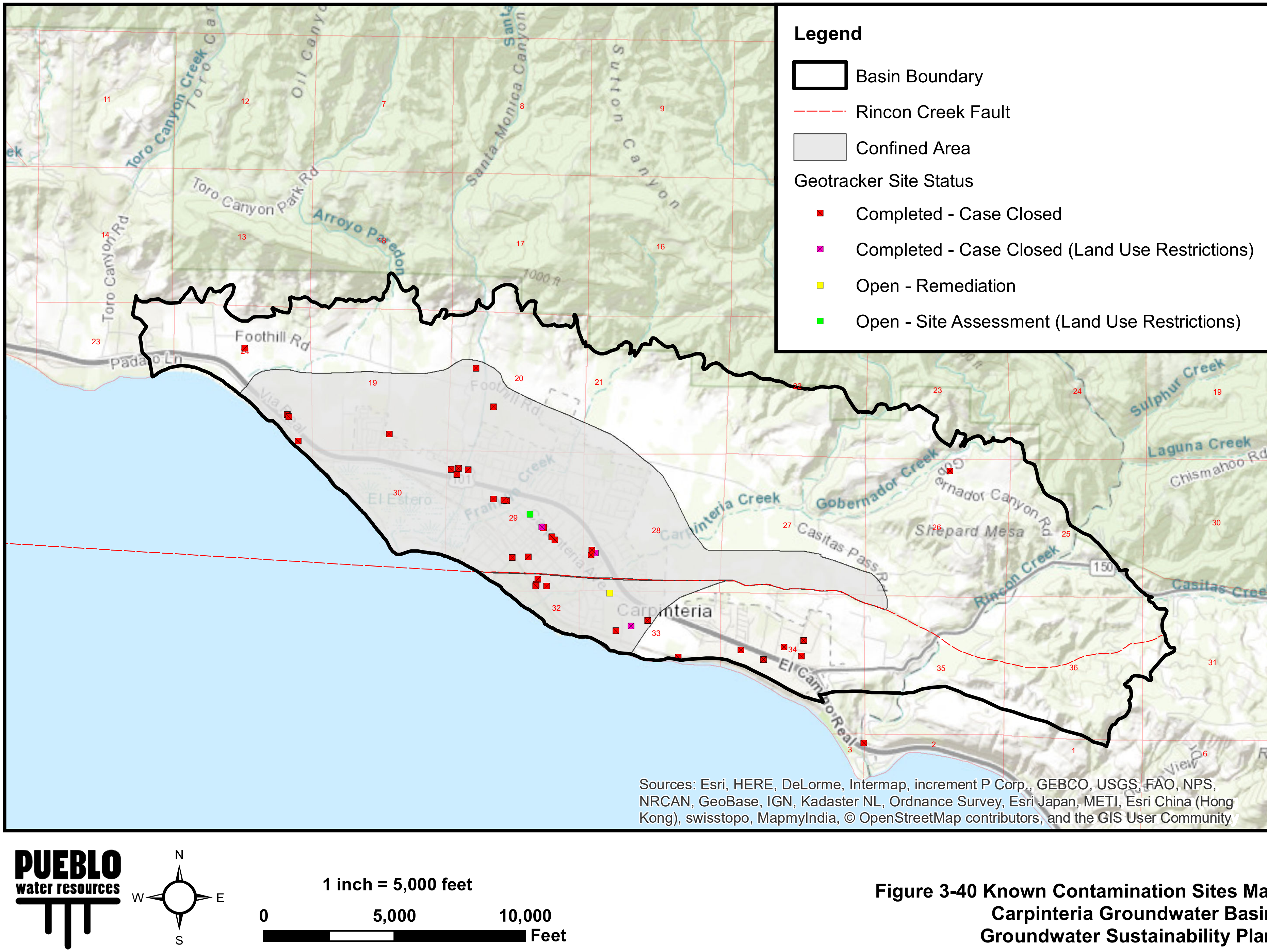


PUEBLO water resources

**Figure 3-40 Known Contamination Sites Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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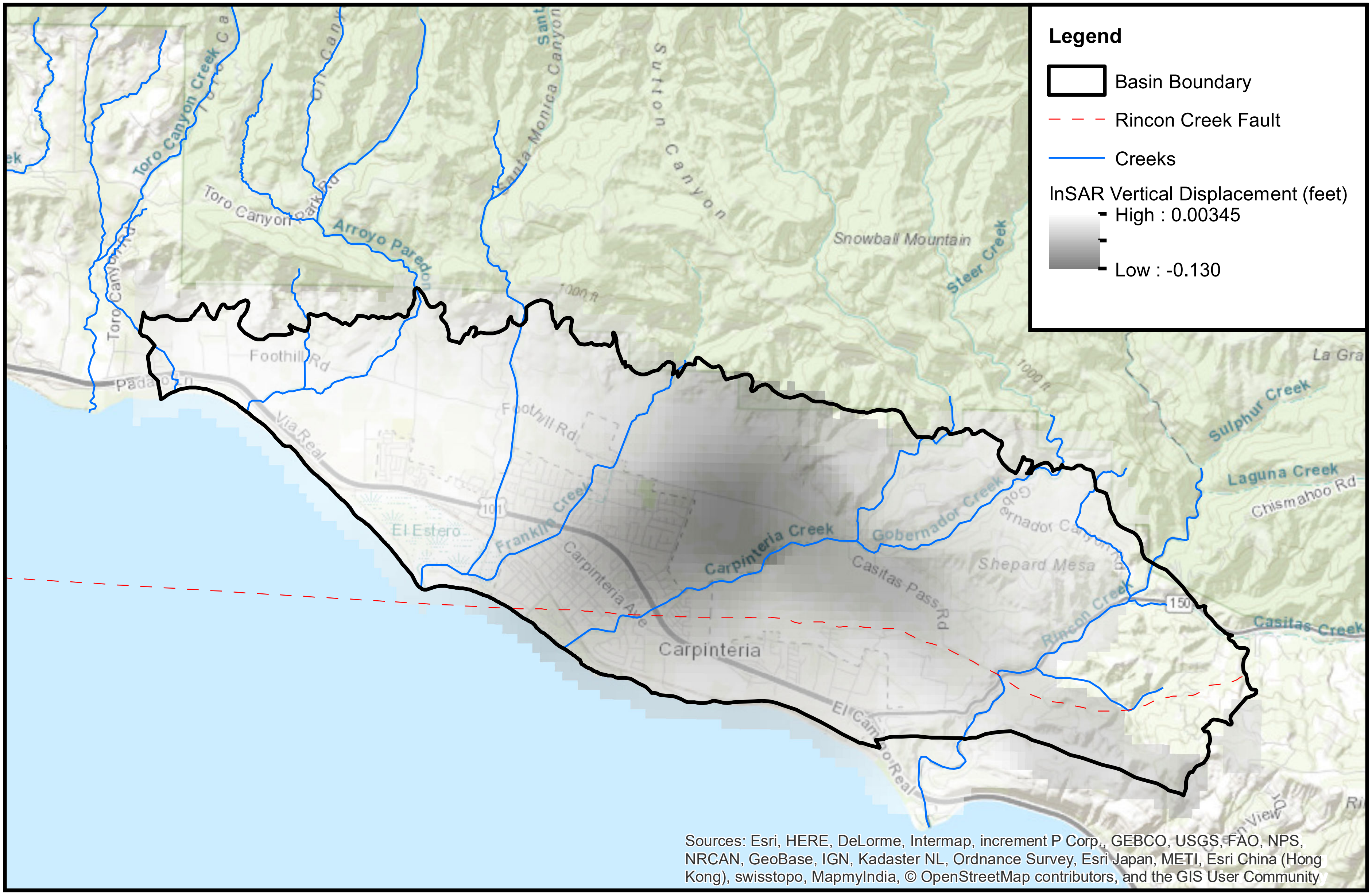


PUEBLO water resources

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-41 InSAR Vertical Displacement Map (6/13/15 - 7/1/22)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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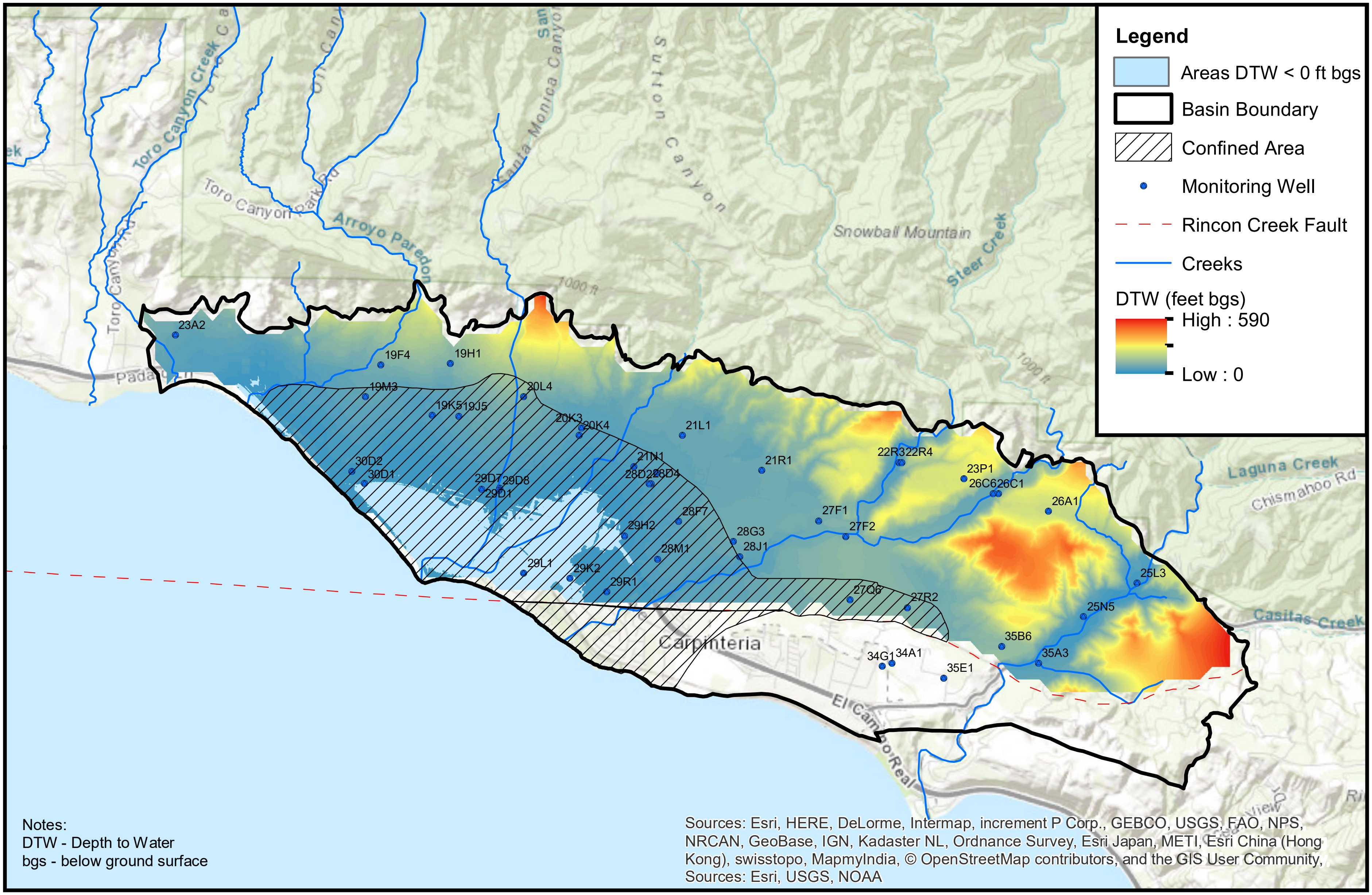


PUEBLO water resources

N
W E
S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-42 Depth to Water Map (SPRING 2005)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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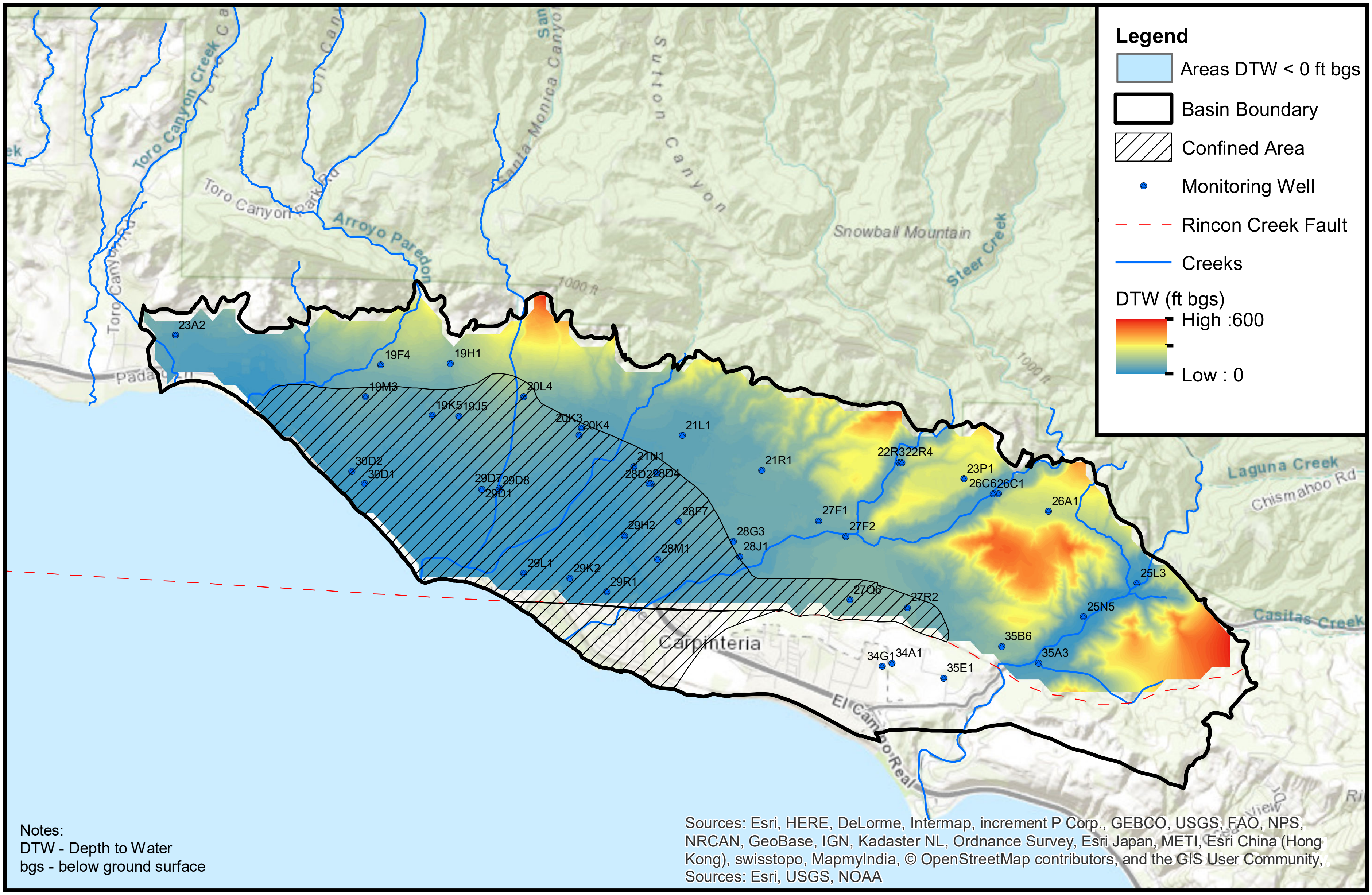


PUEBLO water resources

N
W E
S

**1 inch = 5,000 feet**

**0 5,000 10,000 Feet**

**Figure 3.43 Depth to Water Map (Spring 2010)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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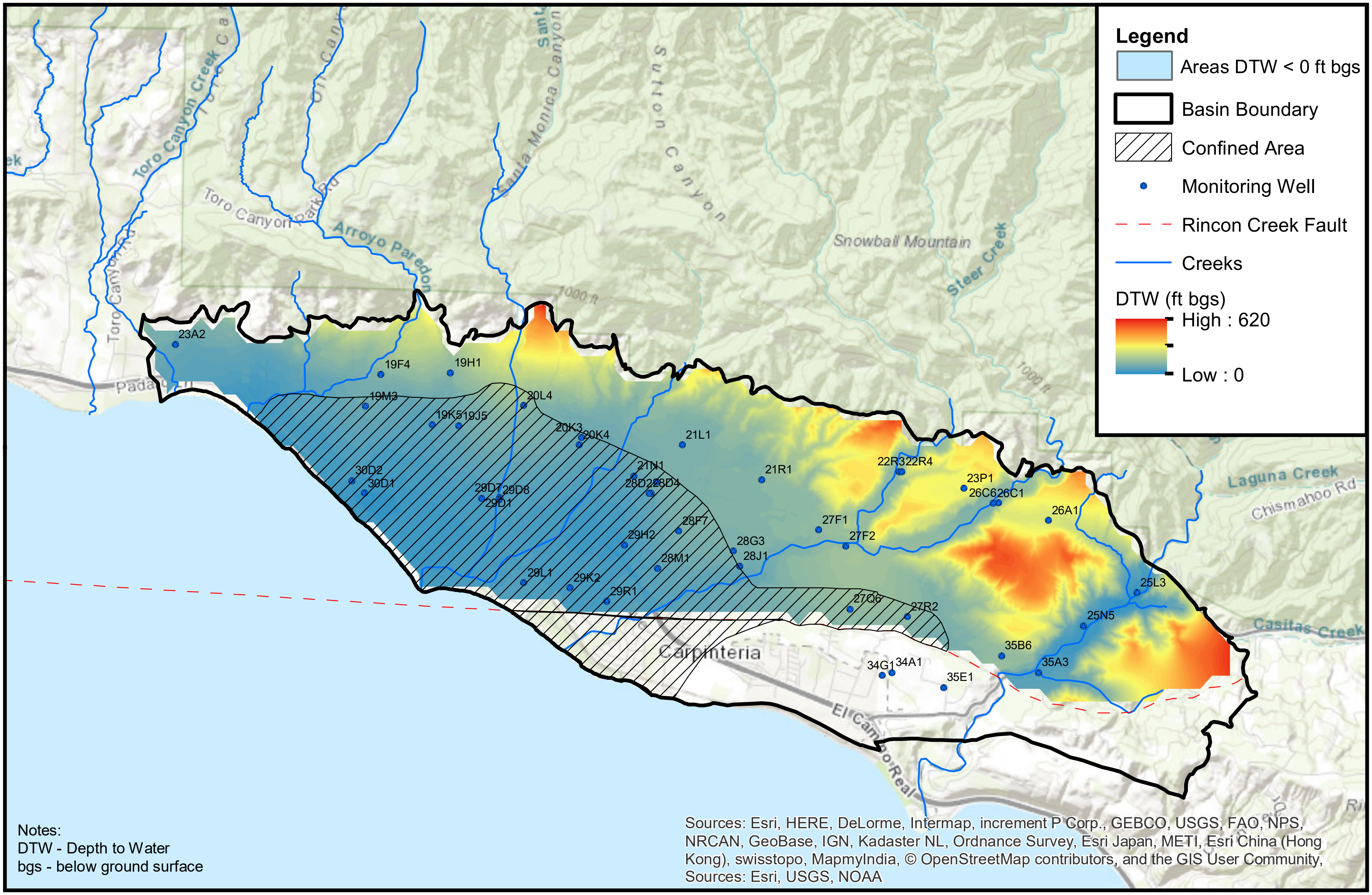


PUEBLO water resources

N W E S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-44 Depth to Water Map (Spring 2015)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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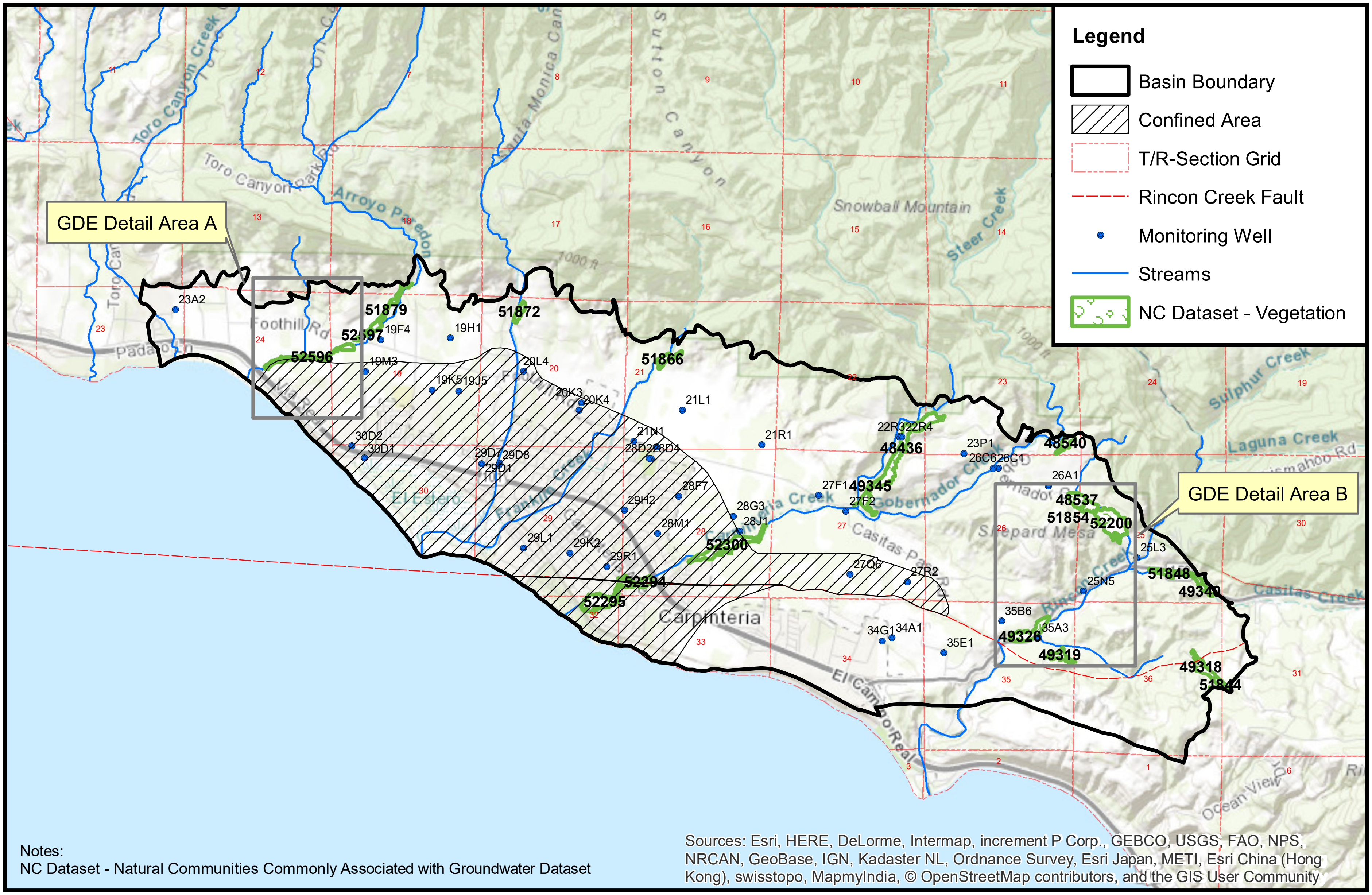
**DRAFT**




PUEBLO water resources

N
W E
S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-45 Potential GDE Location Map - Vegetation**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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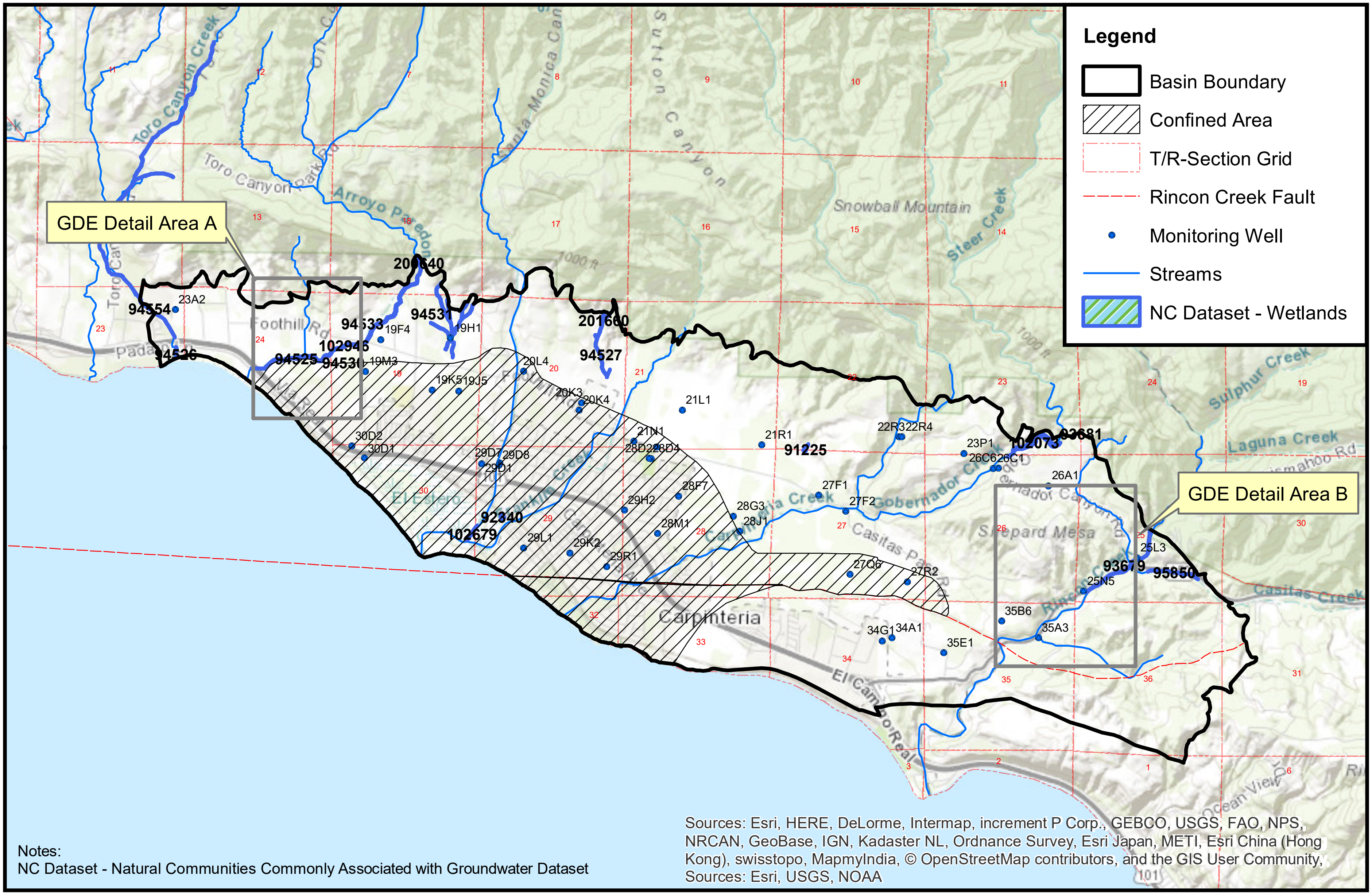


PUEBLO water resources

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3-46 Potential GDE Location Map - Wetlands**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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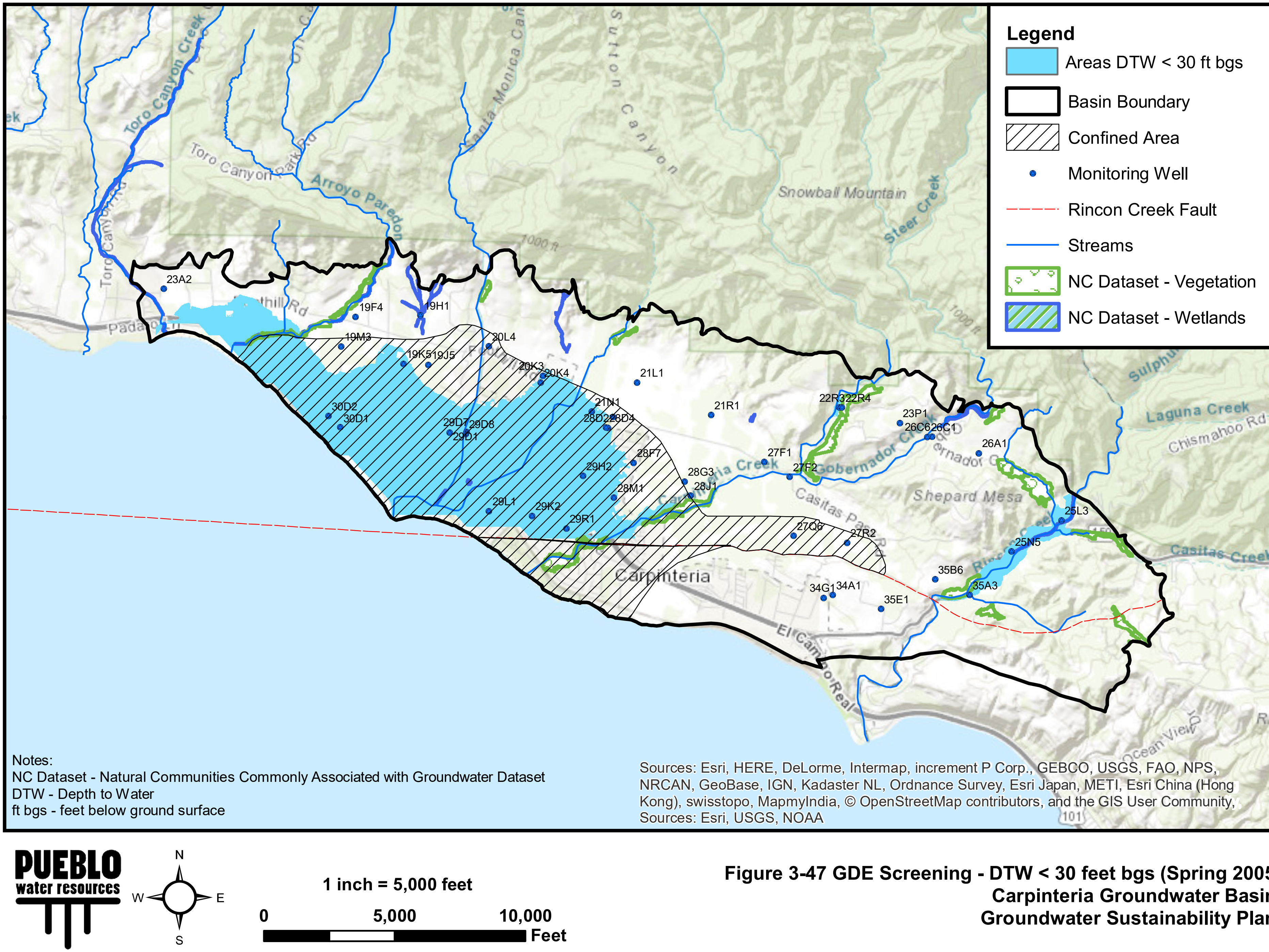


**Figure 3-47 GDE Screening - DTW < 30 feet bgs (Spring 2005)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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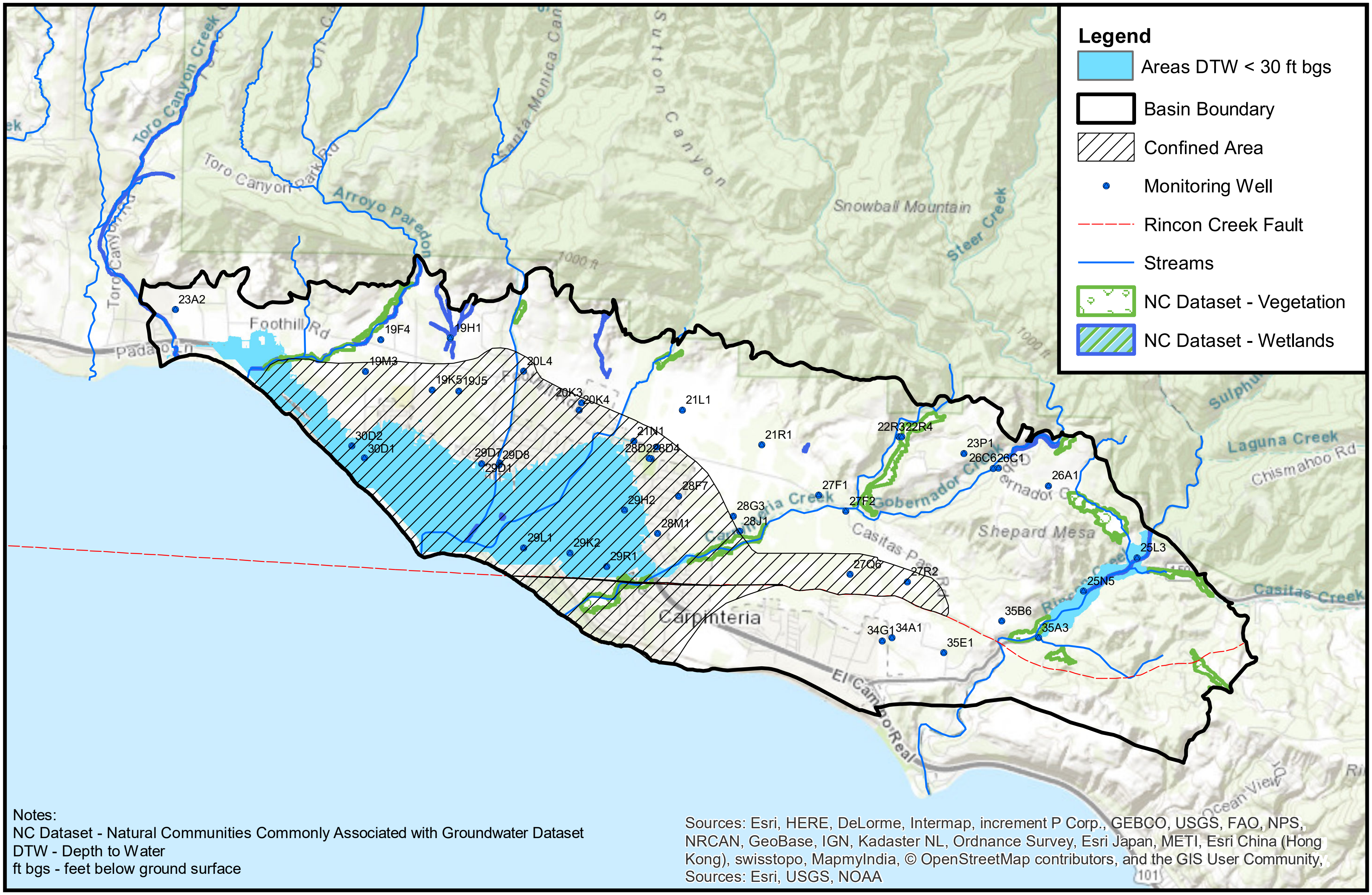


PUEBLO water resources

N W E S

1 inch = 5,000 feet

0 5,000 10,000 Feet

**Figure 3.48 GDE Screening - DTW < 30 feet bgs (Spring 2010)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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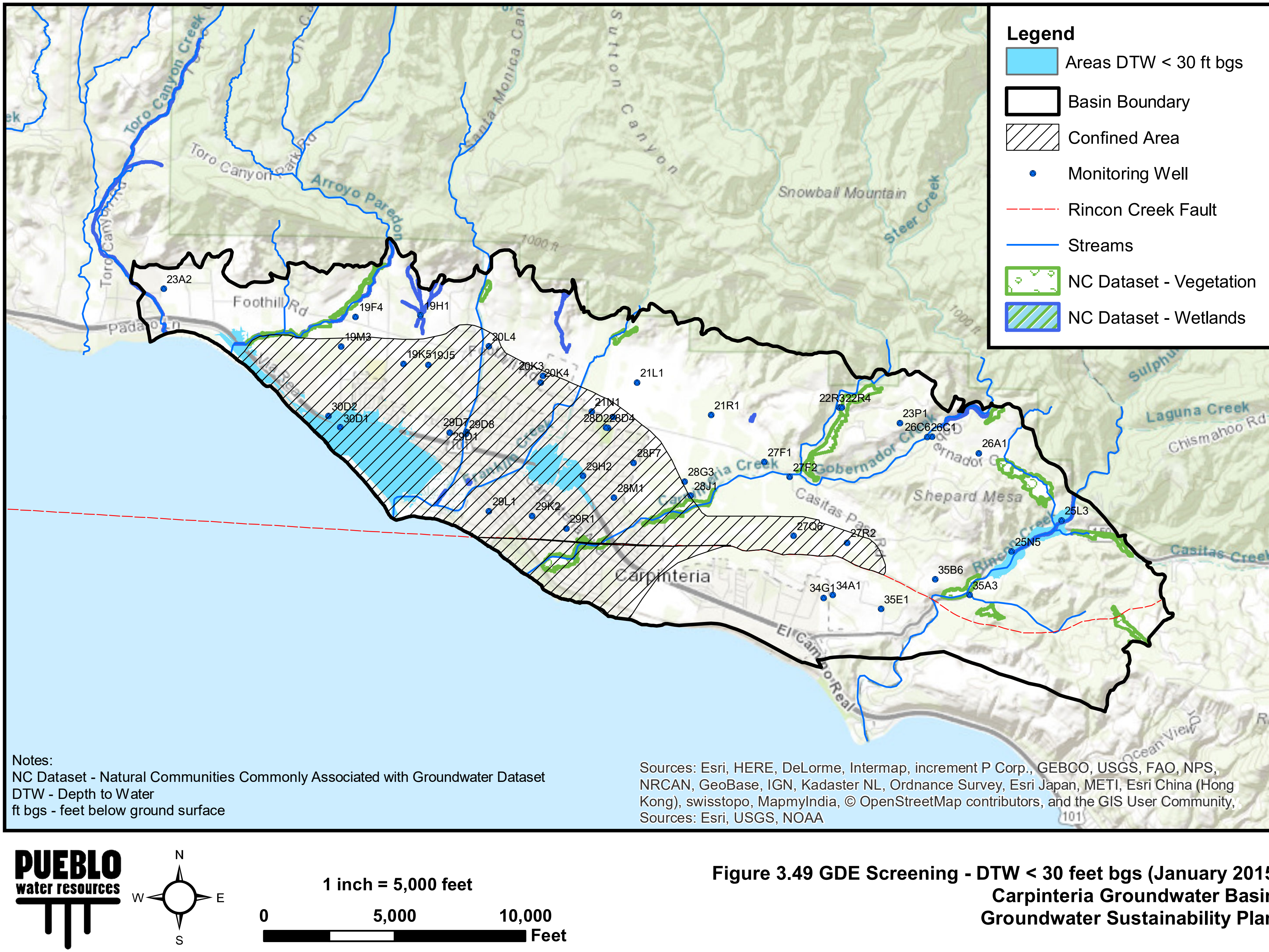


PUEBLO water resources

**Figure 3.49 GDE Screening - DTW < 30 feet bgs (January 2015)**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**


**Figure 3-50 GDE Screening - Detail Area A Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**


**Figure 3-51 GDE Screening - Detail Area B Map**
**Carpinteria Groundwater Basin**
**Groundwater Sustainability Plan**

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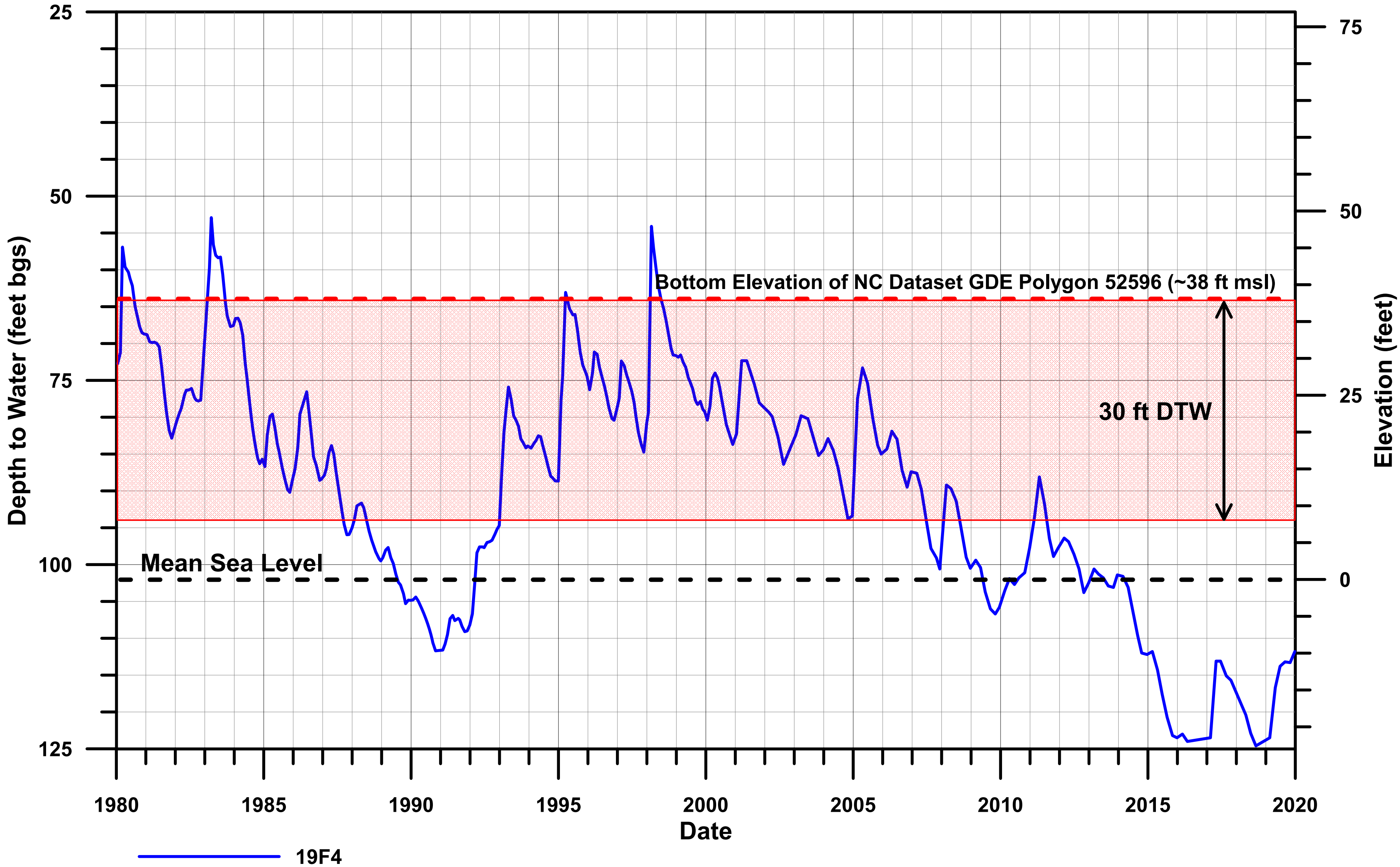



PUEBLO water resources

Figure 3-52 GDE Screening Water Level Data - 4N/25W-19F4 (relative to GDE Polygon 52596)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan

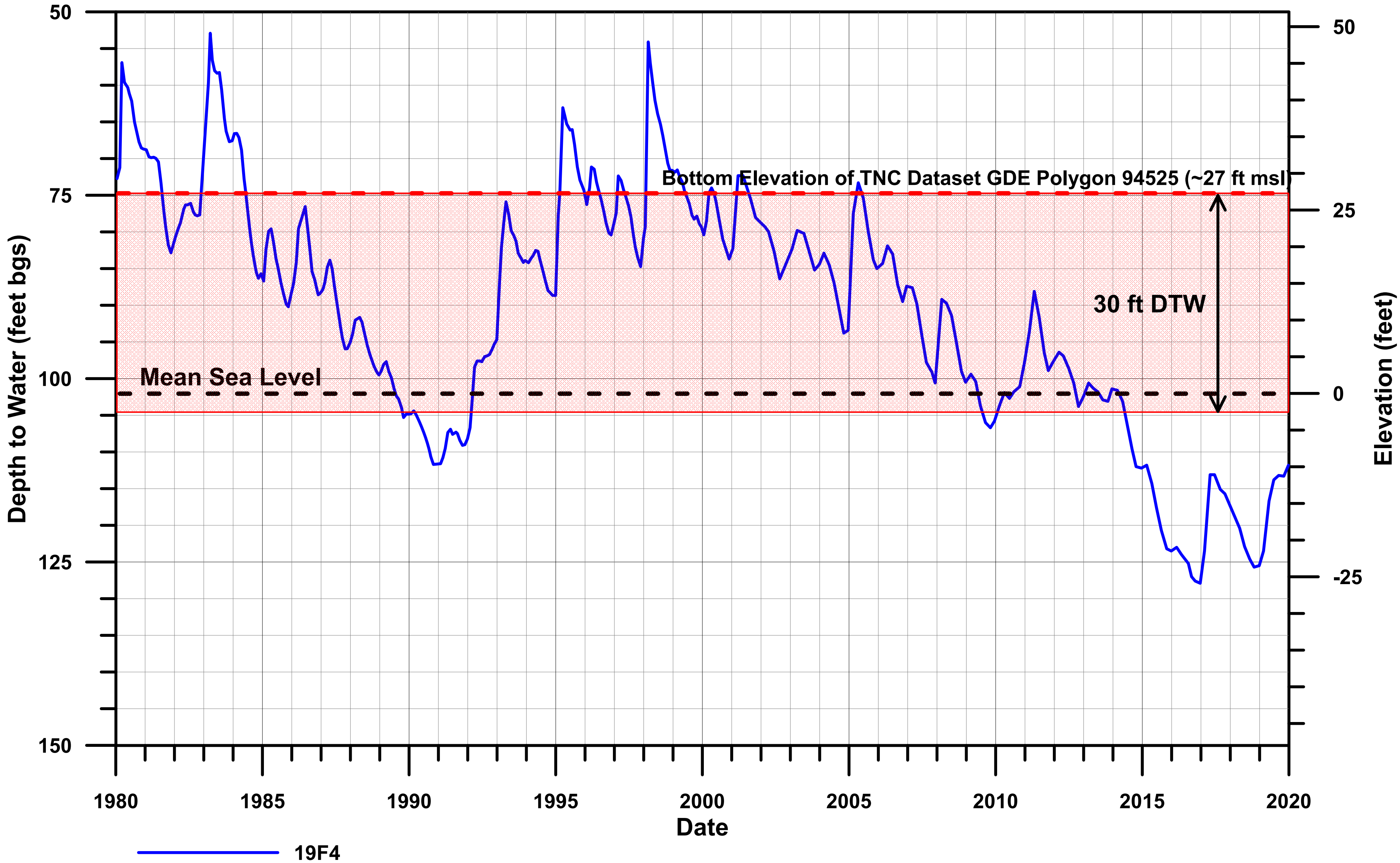
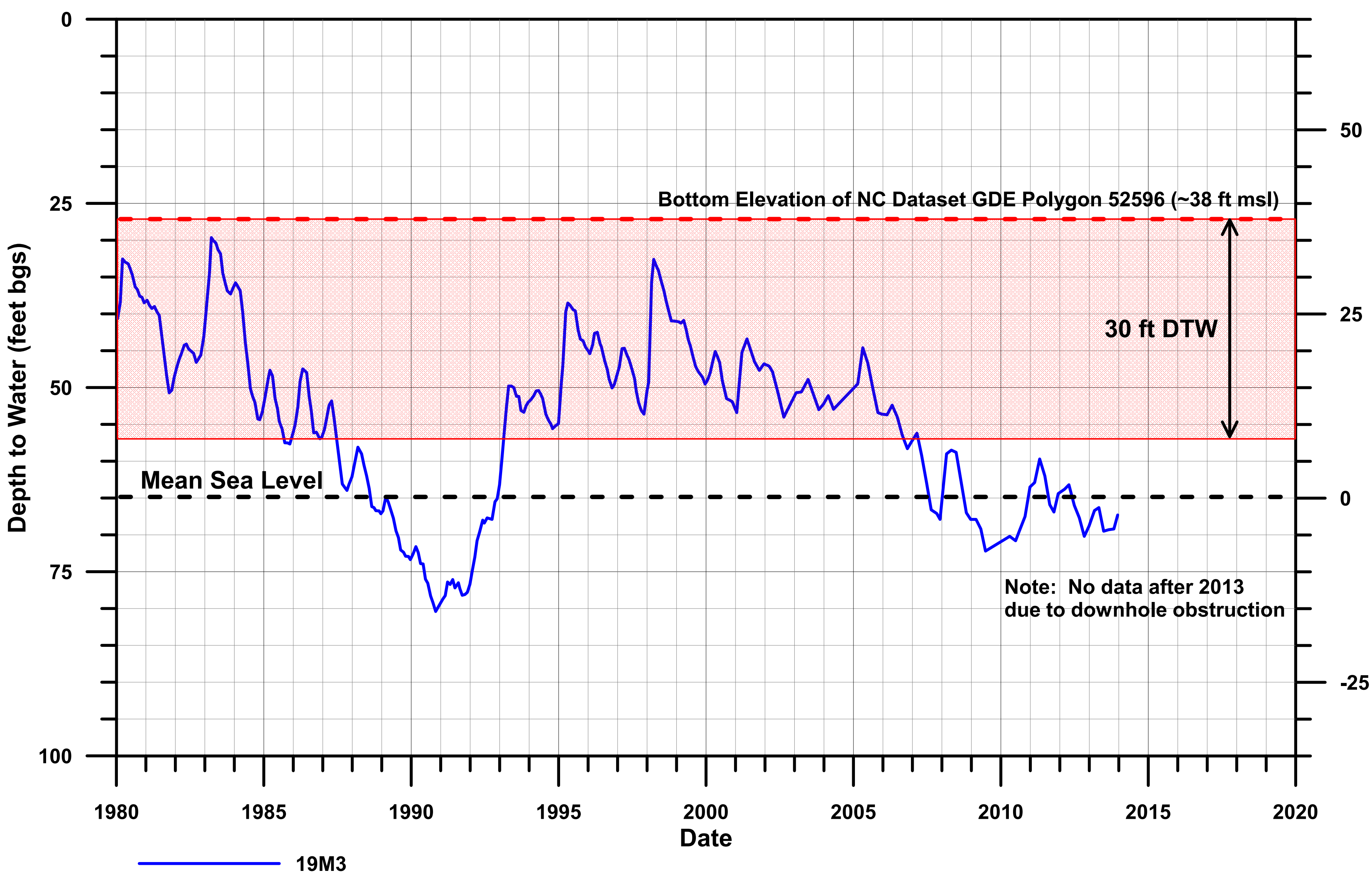
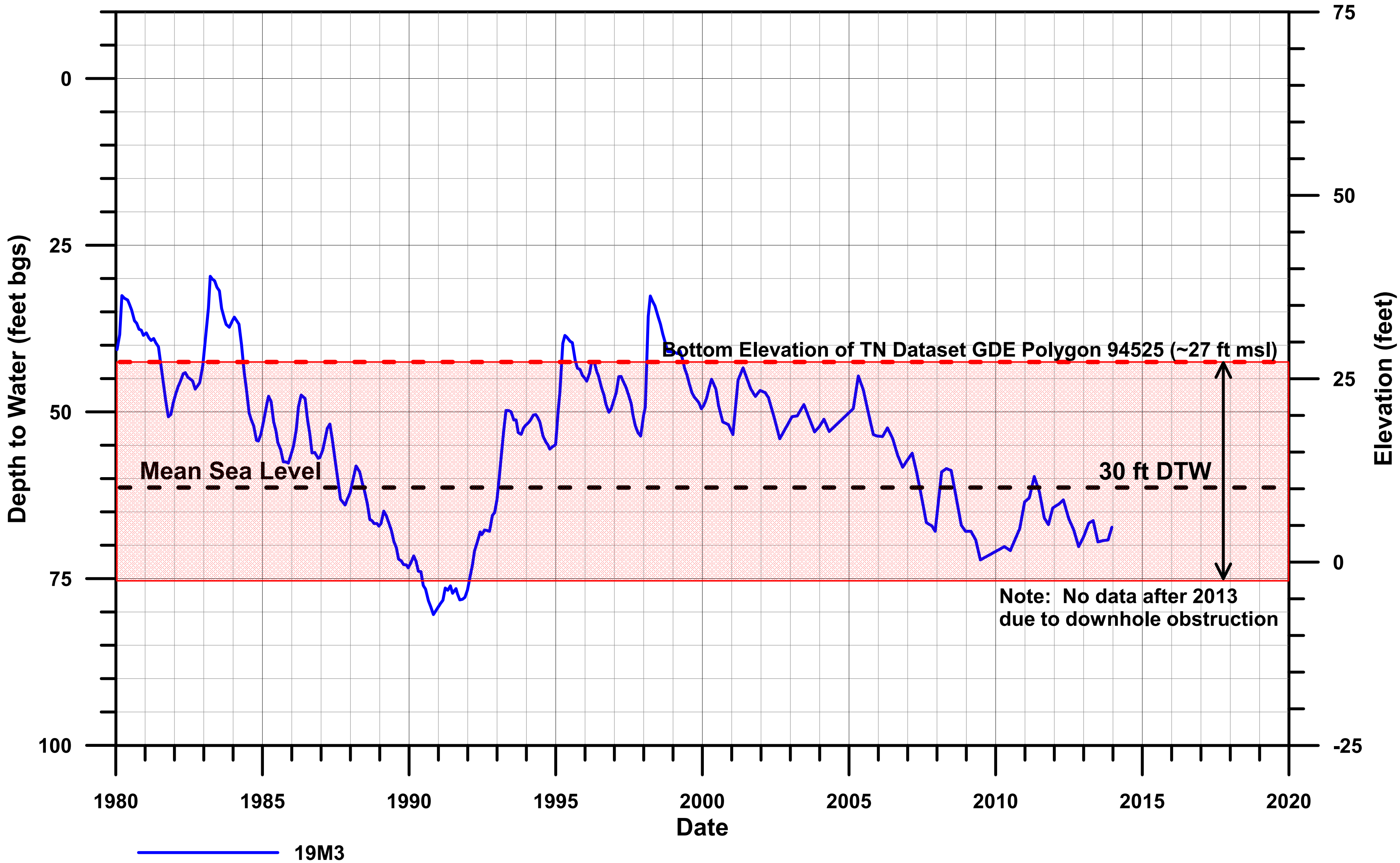



Figure 3-53 GDE Screening Water Level Data - 4N/25W-19F4 (relative to GDE Polygon 94525)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan



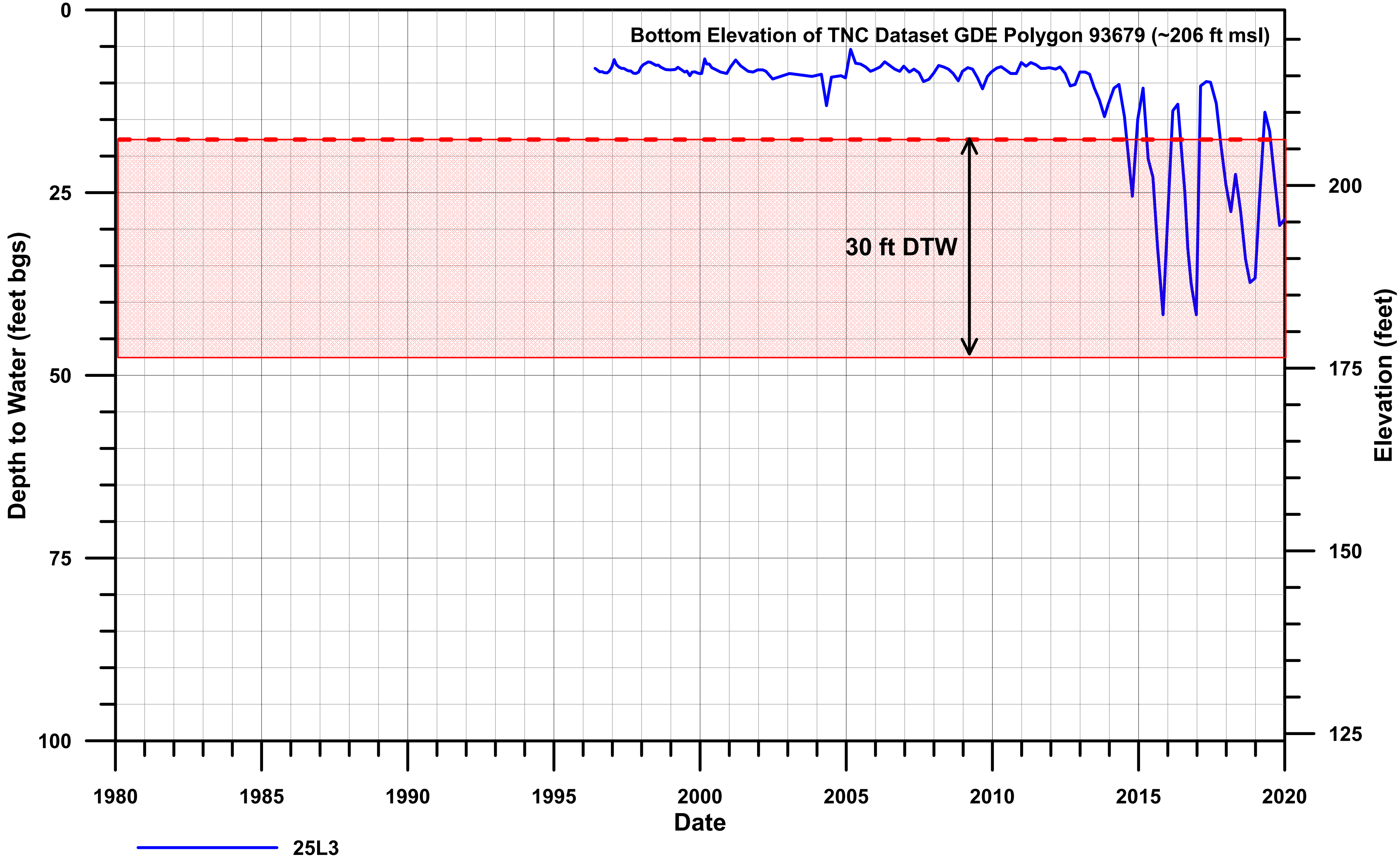

PUEBLO water resources

Figure 3.54 GDE Screening Water Level Data - 4N/25W-19M3 (relative to GDE Polygon 52596)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan



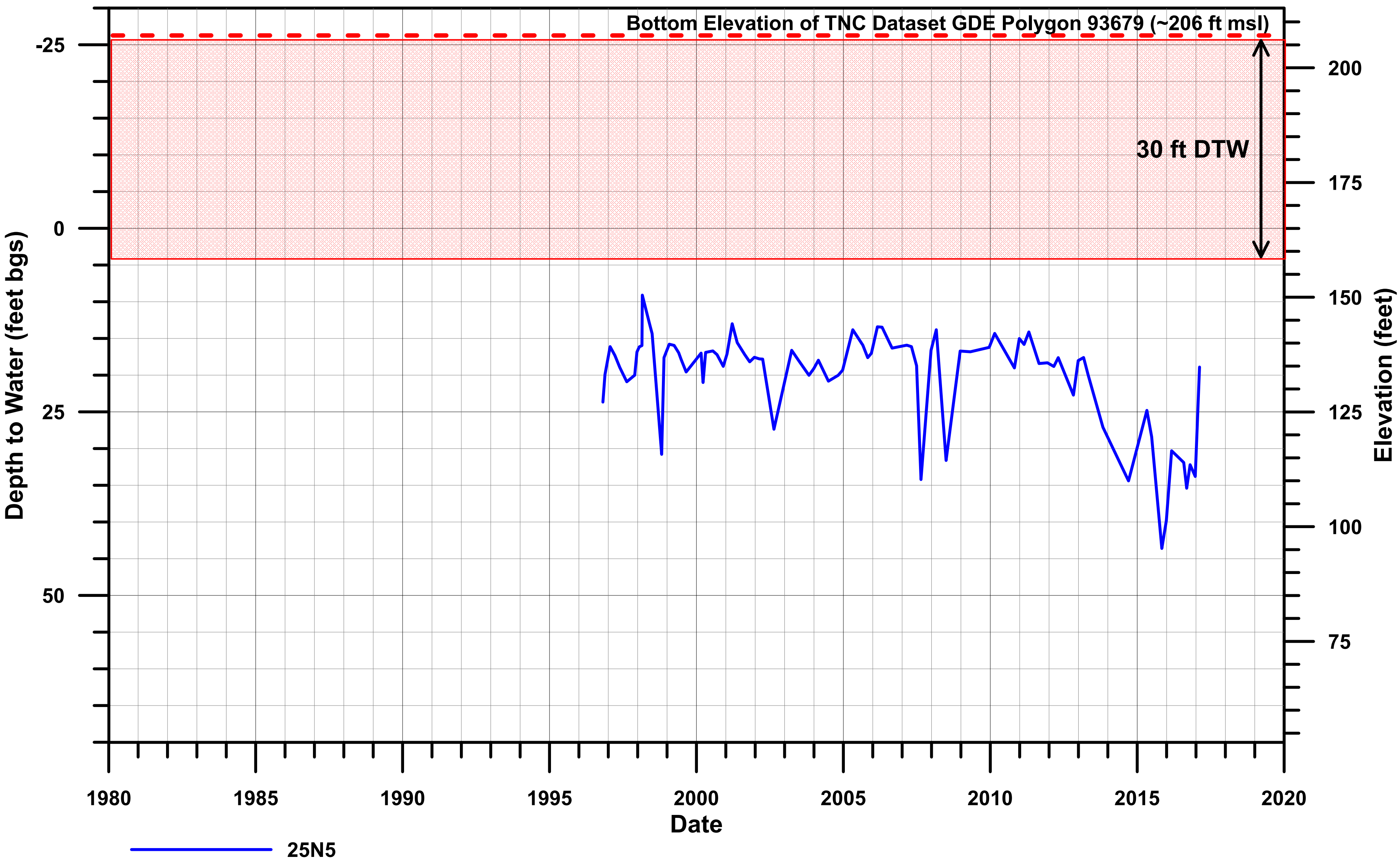

PUEBLO water resources

Figure 3-55 GDE Screening Water Level Data - 4N/25W-19M3 (relative to GDE Polygon 94525)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan



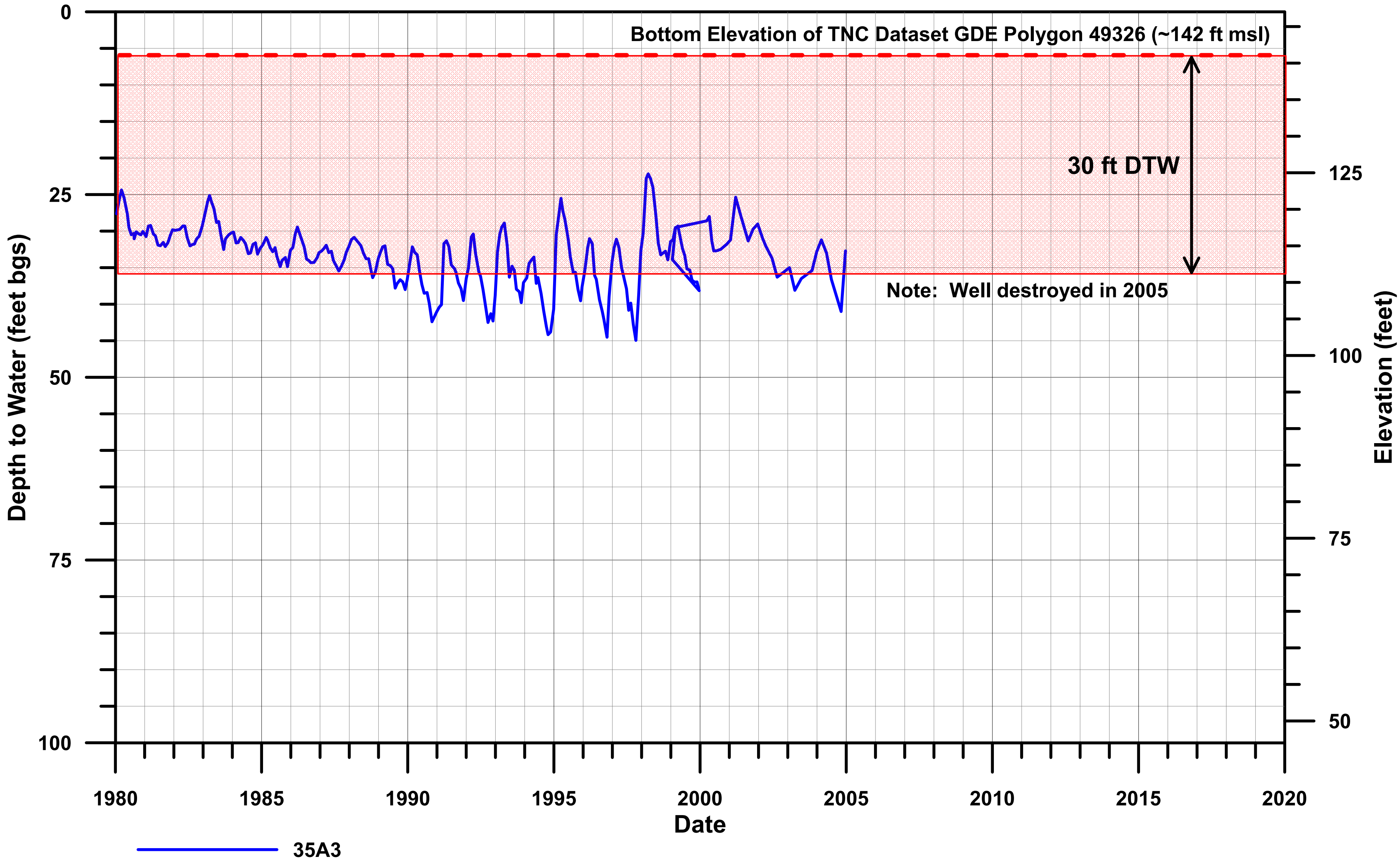

PUEBLO water resources

Figure 3-56 GDE Screening Water Level Data - 4N/25W-25L3 (relative to GDE Polygon 93679)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan




PUEBLO water resources

Figure 3-57 GDE Screening Water Level Data - 4N/25W-25N5 (relative to GDE Polygon 93679)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan




PUEBLO water resources

Figure 3-58 GDE Screening Water Level Data - 4N/25W-35A3 (relative to GDE Polygon 49326)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan

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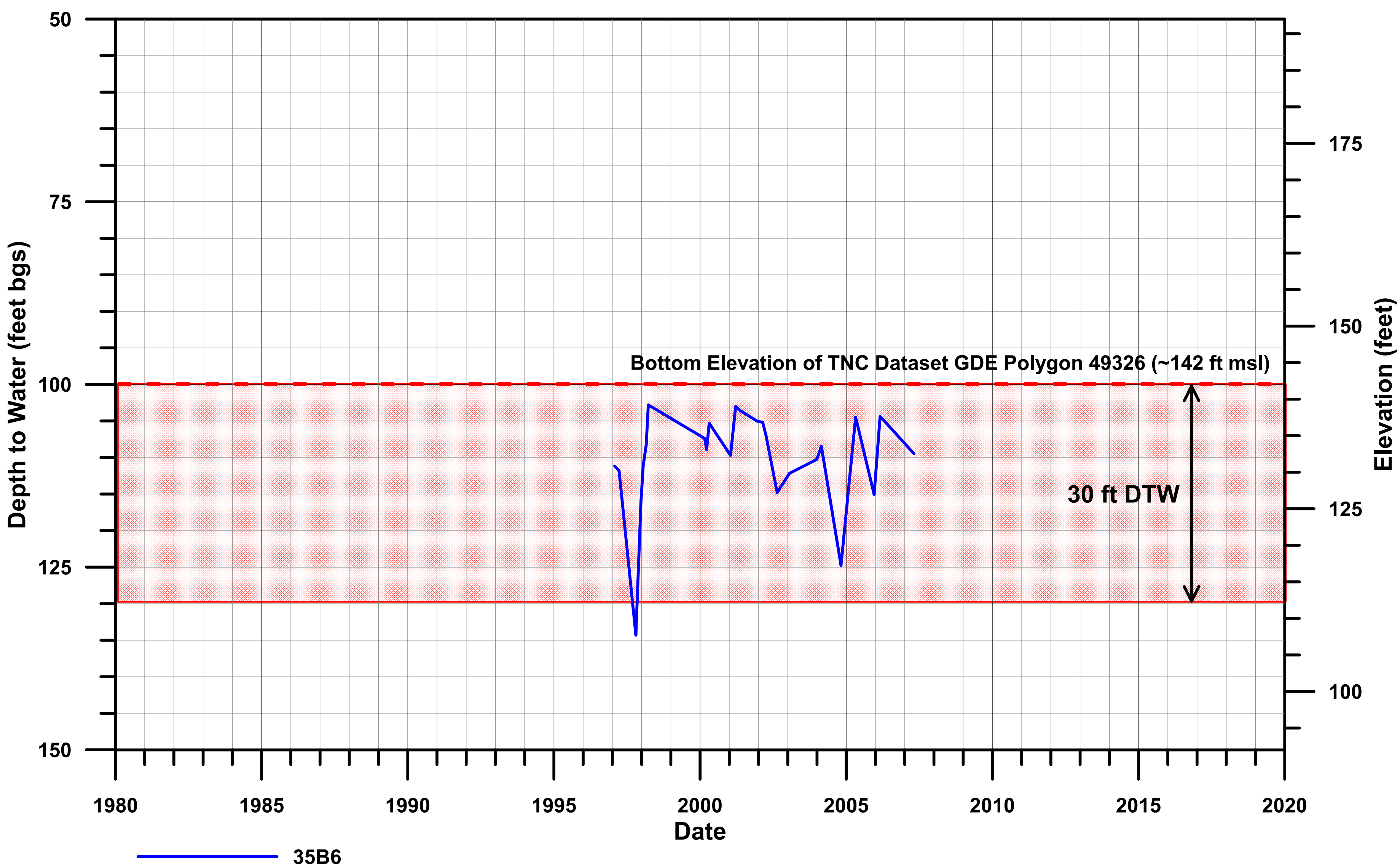


Figure 3-59 GDE Screening Water Level Data - 4N/25W-35B6 (relative to GDE Polygon 49326)
Carpinteria Groundwater Basin
Groundwater Sustainability Plan