~~T~~ECHNICAL MEMORANDUM ◦ ~~AUGUST~~ NOVEMBER 2021

Assessment of Groundwater Dependent Ecosystems for the Fillmore and Piru Basins Groundwater Sustainability Plan

PREPARED FOR

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Cover Photo: The East Grove GDE Unit in the Fillmore Basin (credit: Bruce Orr)

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1 BACKGROUND AND SETTING

This Technical Appendix to the Fillmore and Piru Basins Groundwater Sustainability Plan (GSP) addresses the extent and condition of groundwater dependent ecosystems (GDEs) in the Fillmore and Piru Valley Groundwater Basins of the Santa Clara River Valley Groundwater Basin. The Fillmore and Piru groundwater basins are managed by Fillmore and Piru Basins Groundwater Sustainability Agency (FPBGSA). As part of the California's Sustainable Groundwater Management Act (SGMA), Groundwater Sustainability Agencies (GSAs) are required to consider GDEs and other beneficial uses of groundwater when developing their GSPs. SGMA defines GDEs as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 351(m)). As described in The Nature Conservancy's guidance for GDE analysis (Rohde et al. 2018), a GDE's dependence on groundwater refers to reliance of GDE species and/or ecological communities on groundwater or interconnected surface water for all or a portion of their water needs. SGMA defines interconnected surface water as "surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer" where "the overlying surface water is not completely depleted". Interconnected surface water is also called areas of rising groundwater or a gaining stream. Mapping riparian or terrestrial GDEs requires mapping vegetation that can tap groundwater through their root systems, assessing the elevation of groundwater relative to the rooting depth of that vegetation, and mapping the extent of surface water that is interconnected with groundwater (Rohde et al. 2018). Mapping aquatic GDEs requires mapping the extent of interconnected surface water, which changes based on season and the water year type. Once the GDEs are mapped, the occurrence of special-status species can be used to assess the beneficial users of GDEs and the ecological value of GDEs in the basin, while remote sensing measurements can be used to track the health of groundwater dependent vegetation through time. This information will be used to inform sustainable management criteria for each management unit. This appendix relies on hydrologic and geologic data presented in the GSP and its technical appendices.

Plants can rely on water infiltrating into the soil via local rainfall, groundwater, or surface water. GDEs are ecosystems linked to groundwater through plant roots or direct users of interconnected surface water, and the plants typically have greater water requirements than found in the soil from local rainfall. Riparian plants, which are often present in GDEs, may instead be connected to surface water through their roots. Some species may be connected to groundwater when it is available, but not require groundwater for survival (e.g., mulefat [*Baccharis salicifolia*]), while other species (e.g., willows and cottonwoods) would not survive without additional water from groundwater or surface water. The presence of non-groundwater sources such as surface water and soil moisture within and near a GDE does not preclude the possibility that the GDE is supported by groundwater. A GDE is distinct from other riparian ecosystems in that it is either connected to a principal aquifer or is a beneficial user of a surface water or shallow/perched groundwater source that is connected to a principal aquifer.

1.1 Physiography

The Fillmore and Piru groundwater basins occupy the alluvial valley of the Santa Clara River from just west of the Los Angeles/Ventura County line to approximately 1 mile upstream of Santa Paula, California (Figure 1.1-1). The alluvial valley of the Santa Clara River serves as the floodplain of the Santa Clara River and the adjacent alluvial terraces and alluvial fans. The valley width ranges from approximately half a mile at the eastern boundary of the Piru subbasin, just west of the Los Angeles/Ventura County line, to over 4 miles at the confluence of Sespe Creek and the Santa Clara River. Together, the basins extend approximately 21 river miles along the valley axis and cover over 25,000 acres. Ground surface elevation ranges from 280 feet above sea level in the western Fillmore Groundwater Basin to about 1,000 feet above sea level in the eastern Piru Groundwater Basin and along the northern edge of the Fillmore Groundwater Basin (DWR 2016).

The basins are bounded to the north by Miocene to Pliocene marine deposits (the Pico Formation) of the Topatopa Mountains, uplifted by Tertiary thrusting along the San Cayetano Fault. The basins are bounded to the south by Oligocene continental deposits and Miocene to Pliocene marine deposits of the Oak Ridge and the Santa Susana mountains, uplifted by similar motion on the Oak Ridge Fault (Downs et al. 2020). The Santa Clara River occupies a valley between these ranges. Tectonic activity also influences drainage network patterns in the basins (Stillwater Sciences 2011).

Upstream of the Fillmore and Piru groundwater basins, the Santa Clara River is largely unregulated except for Castaic Dam on Castaic Creek and Bouquet Dam on Bouquet Creek. Castaic Dam regulates a large (154 square miles [mi^2]) watershed and forms Castaic Lake, which is operated with Pyramid Lake as a hydroelectric pumped storage project. Castaic Dam generally operates as a run-of-the river facility but may retain water for future release when inflows to Castaic Lake are high. Bouquet Dam regulates less than 1% of the Santa Clara River watershed area and is also unlikely to have a significant impact on watershed hydrology (Stillwater Sciences 2011). There is a strong rainfall gradient from the relatively wet Sespe and Piru drainages in the western part of the watershed to the drier upper Santa Clara watershed in Los Angeles County,

The largest tributary to the Piru Groundwater Basin is Piru Creek, which joins the Santa Clara River about 6 miles downstream of the Piru Groundwater Basin boundary near Buckhorn. Piru Creek has a drainage area of 438 square miles and is regulated by Santa Felicia Dam and Lake Piru 5.7 miles upstream of the confluence with the Santa Clara River. The Piru Groundwater Basin extends up Piru Creek from the Santa Clara River to Santa Felicia Dam. Santa Felicia Dam was constructed in 1955, and the subsequent peak flow was 28,800 cubic feet per second (cfs) in 1969. Releases are from the dam are rarely greater than 600 cfs (Dan Detmer, personal communication). Pyramid Dam was completed further upstream on Piru Creek in 1971 to impound water imported to the watershed via the California Water Project. Flows are released through Santa Felica Dam annually to recharge groundwater storage in the Fillmore and Piru groundwater basins and other downstream basins and to provide water for groundwater replenishment facilities further downstream. Hopper Canyon Creek joins the Santa Clara River approximately 3 miles downstream of the Piru Creek confluence.

The largest tributary in the Fillmore Groundwater Basin is Sespe Creek, which joins the Santa Clara River about 4.4 miles downstream of the boundary between the Fillmore and Piru groundwater basins just downstream of the town of Fillmore. Sespe Creek has a drainage area of 260 square miles and is undammed. The older portions of the City of Fillmore were situated on the alluvial fan built by sediments from Pole Creek, a smaller (10.7-square-mile) tributary between Sespe and Hopper Canyon creeks, which joins the Santa Clara River about 3 miles upstream of Sespe Creek. The drainage area of the Santa Clara River at the downstream end of the Fillmore Groundwater Basin is 1,476 square miles.

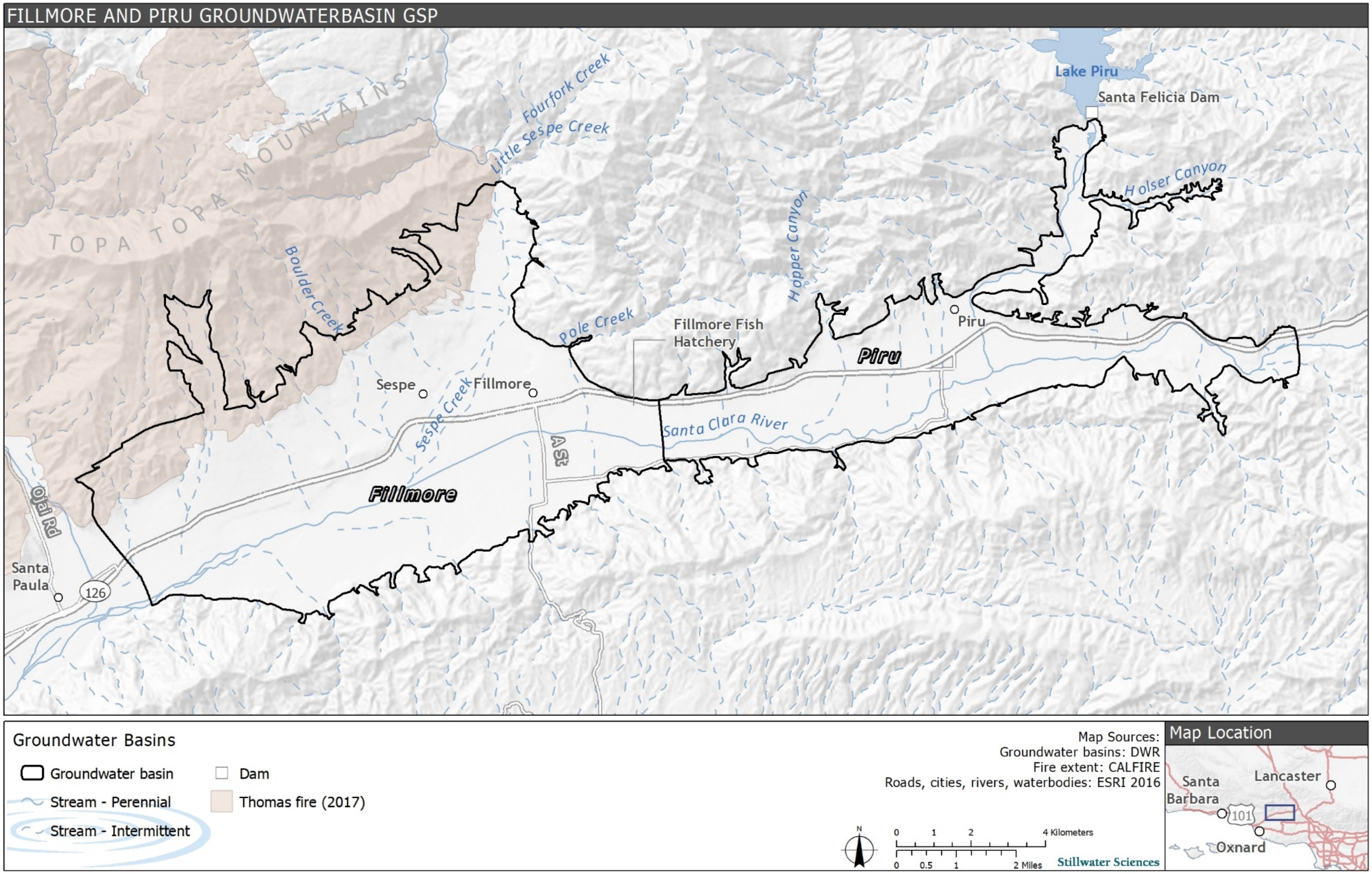


Figure 1-1~~1.1-1~~. Fillmore and Piru groundwater basins.

1.2 Aquifer and Soils

The Fillmore and Piru groundwater basins are in the distinctive geological province of the west-east trending Transverse Ranges. The Santa Clara River watershed has a drainage area of 1623 square miles (mi^2) that retains a relatively natural state compared with other large watersheds in coastal southern California. In general, both groundwater basins consist of an upper aquifer of sand and gravel Quaternary alluvium underlain by Pleistocene Saugus Formation, which consists of permeable sand and gravels folded into an east-west trending syncline.

The Piru Groundwater Basin's eastern boundary coincides with exposures of shale and thinning of the surface alluvium to about 20 feet. The basin extends westward to the Fillmore Fish Hatchery, approximately 1 mile upstream of the City of Fillmore, where bedrock constriction of the alluvial basin forces groundwater closer to the land surface, resulting in seepage from the aquifer to the Santa Clara River. Recent alluvium is typically 60–80 feet thick in the Piru Groundwater Basin and is underlain by older alluvium, which occurs as terrace deposits up to 80 feet thick. Beneath the alluvium, the Saugus Formation extends to depths of up to 8,800 feet. Discontinuous clay layers also occur in the basin (Mann 1959).

The Fillmore Groundwater Basin lies directly west of the Piru Narrows, a constriction in the valley width located at the boundary between the Fillmore and Piru basins (Figure 1.1-1). The Fillmore Groundwater Basin includes the Santa Clara River alluvial valley, the Pole Creek fan, and Sespe Creek floodplain. The western boundary of the basin is located approximately half a mile east of the City of Santa Paula and coincides with shallow groundwater and a gaining reach of the Santa Clara River. At the eastern boundary, recent alluvium is approximately 60 feet thick, deepening to 80 feet downstream. Older alluvium reaches depths of approximately 100 feet. Along the valley, the Saugus Formation reaches a depth of approximately 8,400 feet; at the western boundary, it shallows to 5,000–6,000 feet. The northern portion of the basin is characterized by recent Quaternary alluvium. The most extensive alluvial fan, Pole Creek, is located between Sespe Creek and the Santa Clara River and underlies much of the City of Fillmore (Figure 1.1-1). West of Fillmore, the recent Sespe Creek alluvium is approximately 80 feet thick (Mann 1959).

Soils in the basins are alluvial or eolian in origin and are derived from the upper Santa Clara River and surrounding mountains. Three soil associations occur in the basins (Edwards et al. 1970). The Santa Clara River floodplain is covered by Riverwash-Sandy Alluvial Land, an excessively drained, highly stratified complex of sediment ranging in size from sand to cobbles with minimal silt and clay. The Pico-Metz-Anacapa association occurs on alluvial terraces and extends into some of the westerly drainages in the Fillmore Groundwater Basin. This association is characterized by well- to excessively drained sandy loam and is 60 or more inches deep. Within this association, Anacapa soils are slightly alkaline. The Mocho-Sorrento-Garretson association occurs at higher elevations in tributaries at the mountain front, particularly on the north side of the basins. These well-drained loams to silty clay loams reach depths of over 60 inches and are some of the most agriculturally productive in Ventura County.

1.3 Hydrology

Natural surface flows in the Santa Clara River are supplemented by controlled releases from Lake Piru and, upstream of the Piru Groundwater Basin, releases from Castaic Lake. Major tributaries in the Fillmore and Piru groundwater basins include Piru, Hopper, and Sespe creeks. Apart from high flows associated with high-intensity rainfall events, flows in the Santa Clara River are generally low. At Montalvo (USGS gage 11114000) daily flows from 1927–2004 (the period of record) were less than 10 cfs for 50% of the year (Stillwater Sciences 2007d). Upstream of the Piru Groundwater Basin, at the county line (USGS gage 11108500), flow is typically 20–28 cfs (UWCD 2016). The low-flow hydrology of the Santa Clara River in the basin area has been characterized by alternating reaches of perennial and intermittent flow (Beller et al. 2016) based on bedrock constrictions and the resultant connection of the riverbed to the shallow aquifer. In the Fillmore and Piru groundwater basins, perennial flow commonly occurs at the basin boundaries, with the extent of the perennial reaches varying based on inflows to the basin.

In the Fillmore and Piru groundwater basins, the Santa Clara River is a dynamic semi-confined braided stream with perennial reaches at the basin boundaries with large intermittent reaches between. The Santa Clara River Basin has an extremely high sediment supply and is subject to extremely large floods (Stillwater Sciences 2011). Minor channel shifting occurs during most 5–10-year floods (frequently associated with El Niño years), but the largest changes in channel alignment occur during less frequent larger magnitude floods that exceed a 10-year recurrence interval (Stillwater Sciences 2007, Stillwater Sciences 2011).

Groundwater recharge primarily occurs though infiltration of surface waters into the bed of the Santa Clara River and its tributaries (UCWD 2016). The shallow aquifers in both the Fillmore and Piru groundwater basins are unconfined aquifers with deeper aquifers having varying degrees of confinement. In the Piru Groundwater Basin, groundwater generally flows from east to west, parallel to the river channel, in both the alluvium and the Saugus formation. At the bedrock constriction near the Fillmore Fish Hatchery, the narrower aquifer cross-section drives the water table upward locally, resulting in a perennial gaining reach of the Santa Clara River in all but the driest years. Downstream, in the Fillmore Groundwater Basin, the alluvium widens and depth to the water table increases. Near the boundary of the Fillmore Groundwater Basin and the Santa Paula Basin to the west, low-permeability bedrock constricts the alluvium, albeit less than near the fish hatchery (DBS&A 2020). Approaching the constriction, the narrower aquifer cross-section and southwest flow of recharged groundwater from the Sespe Creek alluvium drive the water table toward the surface. Downstream of the constriction, the water table deepens. This reach of the Santa Clara River experiences perennial gaining conditions even in dry years. Minimum depth to groundwater was less than 10 feet at both constrictions in 2015 during a period of drought (UWCD 2016)

The primary source of groundwater recharge is percolation from the Santa Clara River in the wider areas of the valley and alluvium and from Piru and Sespe creeks. Longitudinal Groundwater inflow from the Santa Clara River Valley East Groundwater Basin is a significant source of recharge to the Piru Groundwater Basin, as is inflow to the Fillmore Groundwater Basin from the Piru Groundwater Basin. In both basins, recharge also occurs from stream percolation into outcrops of the Saugus Formation to the north, from direct precipitation on the alluvium and northern alluvial fans, and from agricultural return flow.

Groundwater levels in both basins are sensitive to changes in surface flow. Annual conservation releases from Lake Piru by United Water resulted in approximately10-foot increases in groundwater levels in the Piru Groundwater Basin and approximately 5-foot increases in the Fillmore Groundwater Basin from 2009 to 2012 (UWCD 2016). Conversely, groundwater levels declined significantly during the 2012–2016 drought period, during which no conservation releases were made.

1.4 Historical Ecology

The strongest process control on the distribution of floodplain wetland and riparian vegetation in the Santa Clara River is the availability of groundwater. Areas of rising groundwater that result in perennial surface flow and dense riparian woodlands are interspersed with “losing reaches” with intermittent surface flow conditions and less dense vegetation (Stillwater Sciences 2007a, Beller et al. 2011, Orr et al. 2011, Beller et al. 2016, Stillwater Sciences 2016). Within the forested wetland areas, flood disturbances are an important secondary control, with large floods causing significant adjustment of the channel and floodplain topography that periodically resets the pattern of vegetation. Surface erosion of the floodplain and bank erosion associated with lateral migration of channel causes uprooting of established trees while, subsequently, processes of deposition as the flood recedes establish barren surfaces suitable for vegetation regeneration.

Together, surface water flows and fluvial geomorphic processes are the basis for vegetation recruitment and succession in GDEs, with surface water or shallow groundwater availability critical for vegetation growth. Such controls are common to GDEs, with previous studies of riparian vegetation in semi-arid river systems highlighting controls such as the magnitude and frequency of flood disturbance (Bendix 1994, 1997; Harris 1999; Bendix and Hupp 2000), depth to groundwater (as reflected in preference for gaining versus losing reaches; Stromberg et al. 1996, Shafroth et al. 1998), and a combination of the two (Hupp and Osterkamp 1996, Lite 2003, Bagstad et al. 2006, Leenhouts et al. 2006, Osterkamp and Hupp 2010).

Prior to Euro-American settlement in valley in the late 1700s, mature stands of riparian woodland or forest were focused on four locations in the Santa Clara River corridor. Evidence suggests that these locations had discrete patches of dense, persistent cottonwood-willow (*Populus* and *Salix* species) riparian forest, and that they corresponded to hydrologically gaining reaches of rising groundwater (Boughton et al. 2006, Stillwater Sciences 2007c, Beller et al. 2011, Orr et al. 2011, Beller et al. 2016). While the extent of these four riparian forests has reduced over time as population increased in the Santa Clara valley, their locations have been persistent, pointing to the fundamental role of hydrogeological control on forest existent (Beller et al., 2016). Three of the four locations—the East Grove, Cienega, and Del Valle—occur in the Fillmore and Piru groundwater basins (Figure 1.4-1), with the East Grove located at the downstream end of the Fillmore Groundwater Basin, Cienega at the boundary between the Fillmore and Piru groundwater basins, and Del Valle at the upstream end of the Piru Groundwater Basin (Figure 1.4-1). All are areas where groundwater occurs close to the floodplain surface.

Although the general locations suitable for forested wetlands are unchanged from historical conditions as a function of hydrogeology, surface water and shallow groundwater conditions are now influenced by surface water diversions, managed water releases, and treated wastewater releases. As a result, despite significant changes in general to the vegetation of the Santa Clara River valley and riparian corridor (see for example, descriptions presented in Beller et al. 2011 and Stillwater Sciences 2016), remnants of the three historically persistent riparian-forested wetlands in the Fillmore and Piru groundwater basins that were dominated by willows and cottonwoods are still supported, albeit in a more fragmented form (Orr et al. 2011, Beller et al. 2016). This decreasing extent mirrors changes in the Santa Clara valley in the Fillmore and Piru basins. Between the mid-nineteenth century and 2005, the extent of active riparian corridor decreased by nearly half, from an estimated 15,500 acres to 8,000 acres (Beller et al., 2016). Agricultural and urban development and subsequent levees and berms reduced the area of riparian forest relative to historical conditions, particularly in the Cienega and East Grove areas (Downs et al. 2013, Beller et al. 2016). .

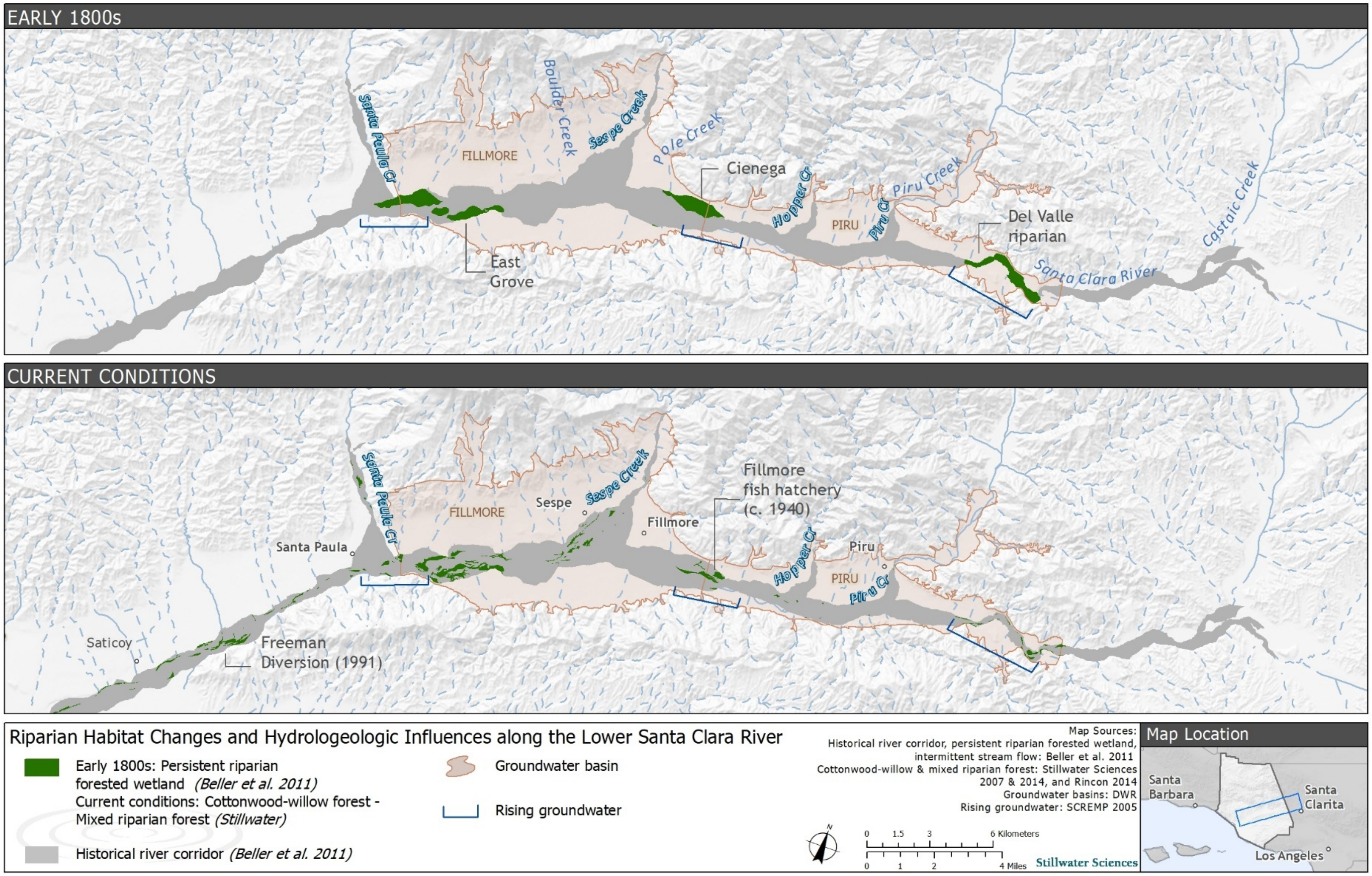


Figure 1-2~~1.4-1~~. Riparian wetland forest extent along the Santa Clara River under historical and current conditions. Note the persistence of the three main forested wetland patches identified from historical source from at least the early 1800s to the present. (Adapted from Beller et al. 2016 and Stillwater Sciences 2016).

2 Methods of GDE IDENTIFICATION And Special-Status Species Assessment

This section details the methods used to map potential GDEs (Section 2.1) and identify special-status species that are likely dependent on groundwater (Section 2.2).

2.1 Vegetation and Wetland Communities

Potential GDE units in the Fillmore and Piru groundwater basins were identified based on the vegetation present and the presence of interconnected surface water. Several studies have identified the extent of reaches of the Santa Clara River that are connected to groundwater (URS 2005, Stillwater Sciences 2008, Beller et al. 2011, Beller et al. 2016). Interconnected reaches were identified as part of the GDE units. California Department of Water Resources' (DWR) maintains an indicators of groundwater dependent ecosystems (iGDE) database. The database, which is published online and referred to as the Natural Communities Commonly Associated with Groundwater dataset (DWR 2020), includes vegetation and wetland natural communities. These data were reviewed and augmented with additional vegetation mapping datasets to produce a map of final GDE units; additional information on vegetation community composition, aerial imagery, depth to groundwater modeled from local wells (where available), plant and species distributions in the area, and plant species rooting depths were also reviewed to support this determination. Interconnected surface water was identified based on vegetation mapping (which identifies surface water), UWCD (2017), and field observations by Stillwater scientists. Maximum rooting depths from the literature are provided in Appendix C, Table C-1. Another way to explore the rooting depth of plants is to assess their elevation relative to the river channel surface (the relative elevation). Assuming that the groundwater elevation near the stream is similar to the stream elevation, we can assess the likely rooting depth of plants based on their relative elevation. Stillwater Sciences (2007a) assessed the relative elevation of various plant types in the Santa Clara River. Those results are provided in Appendix C, Table C-2.

2.1.1 Data sources

This section includes brief descriptions of the vegetation community data and other information sources used to identify and aggregate potential GDEs into final GDE units. The iGDE database (DWR 2020) was reviewed in a geographic information system (GIS) and used to generate a preliminary map to serve as the primary basis for initial identification of potential GDEs in the Fillmore and Piru groundwater basins. This dataset is a combination of the best available data obtained from the following publicly available sources:

- Vegetation Classification and Mapping Program (VegCAMP), California Department of Fish and Wildlife (CDFW)
    - Santa Clara River Parkway Vegetation Database (Stillwater Sciences 2007b). *Imagery date: 2005; Minimum mapping unit (MMU): 1-acre.*
- Classification and Assessment with Landsat of Visible Ecological Groupings (CalVeg) – United States Department of Agriculture - Forest Service (USDA 2014). *Imagery date: 2005; Minimum mapping unit (MMU): 2.5-acre.*
- National Wetlands Inventory - Version 2.0 (NWI v2.0), U.S. Fish and Wildlife Service (USFWS 2018). *Minimum mapping unit (MMU): 0.5-acre.*

A more recent vegetation mapping effort for the Santa Clara River was completed in 2018. This dataset was used in the final GDE identification in place of the Santa Clara River Parkway Vegetation Database (Stillwater Sciences 2007b) referenced above.

- Vegetation Mapping of the Santa Clara River, Ventura County and Los Angeles County, California. Prepared for the Western Foundation of Vertebrate Zoology (Stillwater Sciences 2019). *Imagery date: 2016; Minimum mapping unit (MMU): 0.5-acre.*

The extent of the integrated data sources is shown in Table 2.1-1 and Figure 2.1-1.

Table 2.1-1. Vegetation and wetland data sources for Fillmore and Piru groundwater basins.

Data source	Mapped area (acres)		
	Fillmore	**Piru**	**Total**
Vegetation			
CalVeg	17,997.0	6,489.6	24,486.6
Vegetation Mapping of the Santa Clara River	4,580.4	4,405.6	8,986.0
Wetland			
NWI	8.5	0.3	8.8
Total[1]	**22,585.9**	**10,895.4**	**33,481.4**

[1] Totals may not appear to sum exactly due to rounding error.

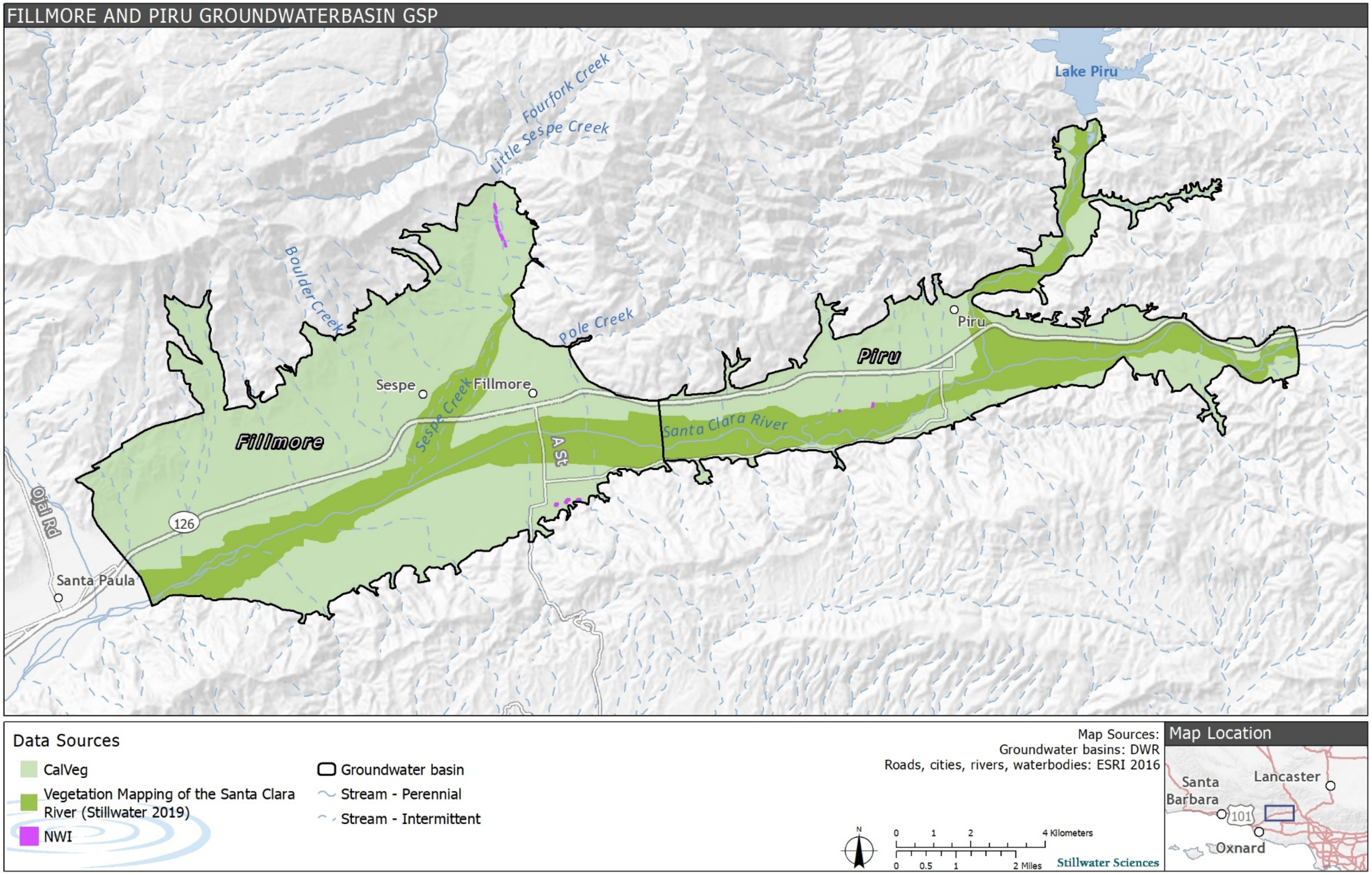


Figure 2-12.1-1. Vegetation and wetland data sources used for the final GDE map.

2.1.2 Procedure

The steps for defining and mapping GDEs outlined in Rohde et al. (2018) were used as a guideline for this process. A decision tree was applied to determine when species or biological communities were considered groundwater dependent based on definitions found in SGMA (State of California 2014) and Rohde et al. (2018). This decision tree, created to systematically and consistently address the range of conditions encountered, is summarized below; the term "unit" refers to an area with consistent vegetation and hydrology:

The unit is a GDE if groundwater is likely:

1. Interconnected with surface water OR
2. An important hydrologic input to the unit during some time of the year, AND
3. Important to survival and/or natural history of inhabiting species, AND
4. Associated with a principal aquifer used as a regionally important source of groundwater

The unit is not a GDE if its hydrologic regime is primarily controlled by:

1. Disconnected surface water and groundwater greater than 30 feet (ft) below the ground surface (to account for uncertainty in groundwater data and rooting depths). If groundwater is greater than 30 ft below the ground surface groundwater is unlikely a source of water for the plants that therefore must rely on surface water or rainfall.
1. Surface discharge or drainage from an upslope human-made structure(s) with no connection to a principal aquifer, such as an irrigation canal, irrigated fields, reservoir, cattle pond, or water treatment pond/facility.
2. Precipitation inputs directly to the unit surface. This excludes vernal pools from being GDEs where units are hydrologically supplied by direct precipitation and very local shallow subsurface flows from the immediately surrounding area.

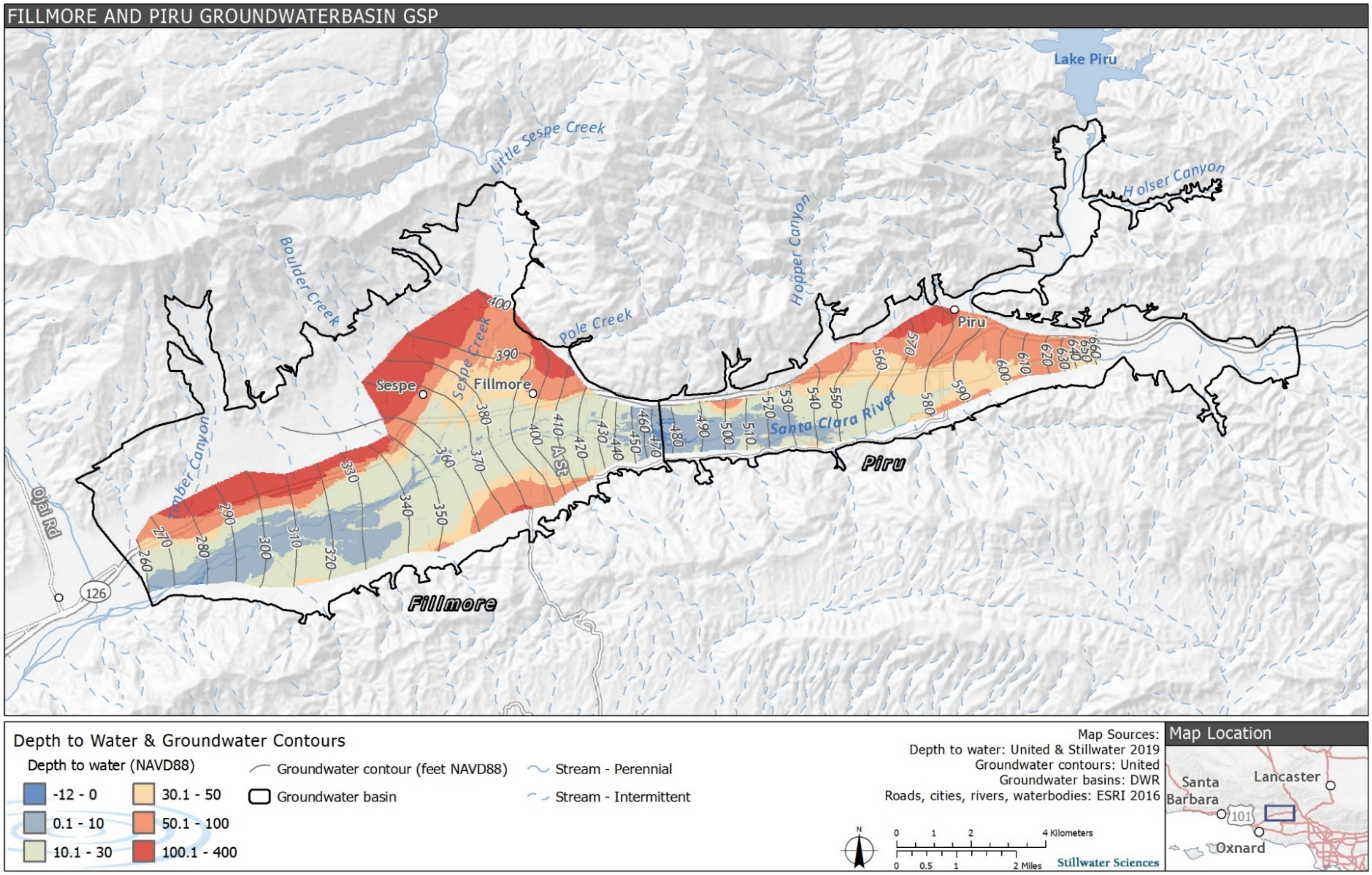
Interconnected surface water occurs at the three historical wetlands (Figure 1.4-1) along the Santa Clara River at the upstream end of the Piru Basin (Del Valle), at the boundary between the basins (Cienega), and at the downstream end of the Fillmore Basin (East Grove). Because vegetation communities tend to co-occur with areas of rising groundwater (Stillwater Science 2007b), vegetation and interconnected surface water GDEs were combined where they coincide.

The vegetation community mapping data sources identified in Section 2.1.1 were combined in GIS to create a groundwater basin-wide vegetation map. Consistent with Klausmeyer et al. (2018), the most recent and highest resolution mapping was prioritized over earlier and coarser scale datasets. The datasets were prioritized in the following order, with the highest priority data sources listed first: Vegetation Mapping of the Santa Clara River (Stillwater Sciences 2019) and CalVeg (USDA 2014). A crosswalk between the two mapping classification systems (i.e., Manual of California Vegetation [Vegetation Mapping of the Santa Clara River] and CalVeg) can be found in Appendix A (Table A-1).

Finally, additional wetland mapping was incorporated where vegetation data were coarse and did not accurately capture wetland features. These additional wetland data sources were incorporated unilaterally across the selected vegetation data source and were chosen to represent the best available data for the extent of each vegetation data source. CalVeg was supplemented with the iGDE wetland mapping (DWR 2020), which is derived from the National Wetlands Inventory (USFWS 2018). The Vegetation Mapping of the Santa Clara River dataset was mapped to a scale that did not require supplemental wetland data.

Depth to Groundwater

Rohde et al. (2018) recommend that maps of potential GDEs be compared with local groundwater elevations to determine where groundwater is within the rooting depth of potential GDEs. Given uncertainties in extrapolating well measurements to GDEs and differences in surface elevation of wells and GDEs, Rohde et al. (2018) recommend assigning GDE status to vegetation communities either within 30 feet of the ground surface or where interconnected surface waters are observed. To make this determination, we subtracted groundwater elevation contours for the ~~spring~~ fall of 2011~~9~~ (United Water 2020) from 2018 ground surface LiDAR (USGS 2018) in GIS. Figure 2.1-2 shows the 2019 groundwater elevation contours and resultant depth to water contours. The groundwater elevation in ~~spring~~ fall 2011~~9~~ was used because the groundwater elevation was higher (i.e., closer to the ground surface) in this pre-drought year than other available years. Use of the highest groundwater elevation period likely results in an overestimate of potential GDE area; the presence of shallow groundwater in a single year does not necessarily indicate that shallow groundwater is common in a particular area. The groundwater elevation contours focus on the Santa Clara River alluvial plain, where shallow groundwater data are more common than along Sespe and Piru creeks. Contours to groundwater data are uncertain, particularly in the intermittent reaches where shallow groundwater wells are rare or absent.


FILLMORE AND PIRU GROUNDWATERBASIN GSP
Lake Piru
Little Sespe Creek
Holser Canyon
Boulder Creek
Hopper Canyon
Pole Creek
Sespe Creek
Sespe
Fillmore
Piru
Santa Clara River
Timber Canyon
Ojai Rd
126
Depth to Water & Groundwater Contours
Depth to water (NAVD88)
-12 - 0
0.1 - 10
10.1 - 30
30.1 - 50
50.1 - 100
100.1 - 400
Groundwater contour (feet NAVD88)
Groundwater basin
Stream - Perennial
Stream - Intermittent
Map Sources:
Depth to water: United & Stillwater 2019
Groundwater contours: United
Groundwater basins: DWR
Roads, cities, rivers, waterbodies: ESRI 2016
Stillwater Sciences
Map Location
Santa Barbara
Lancaster
Oxnard
101

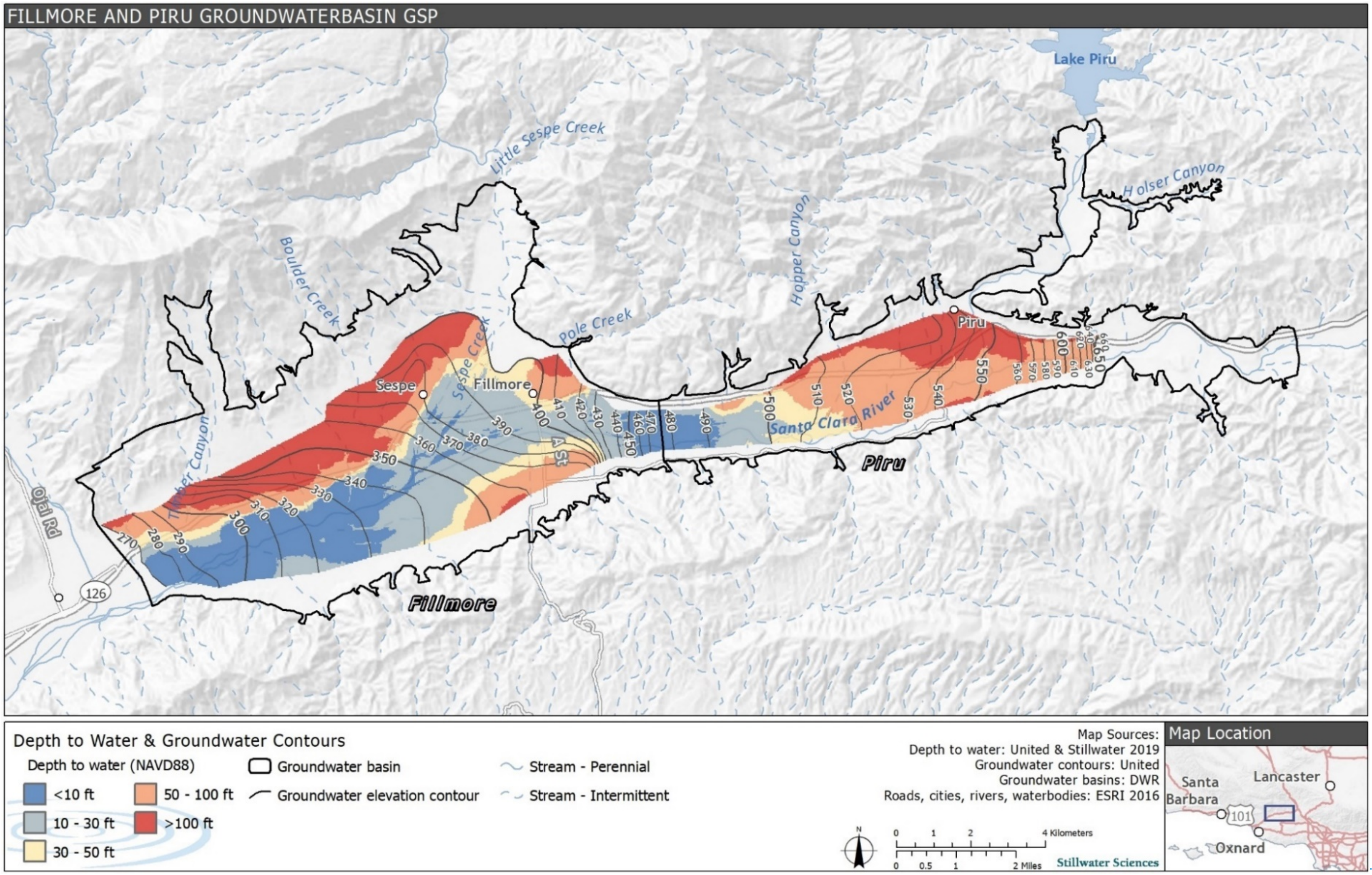
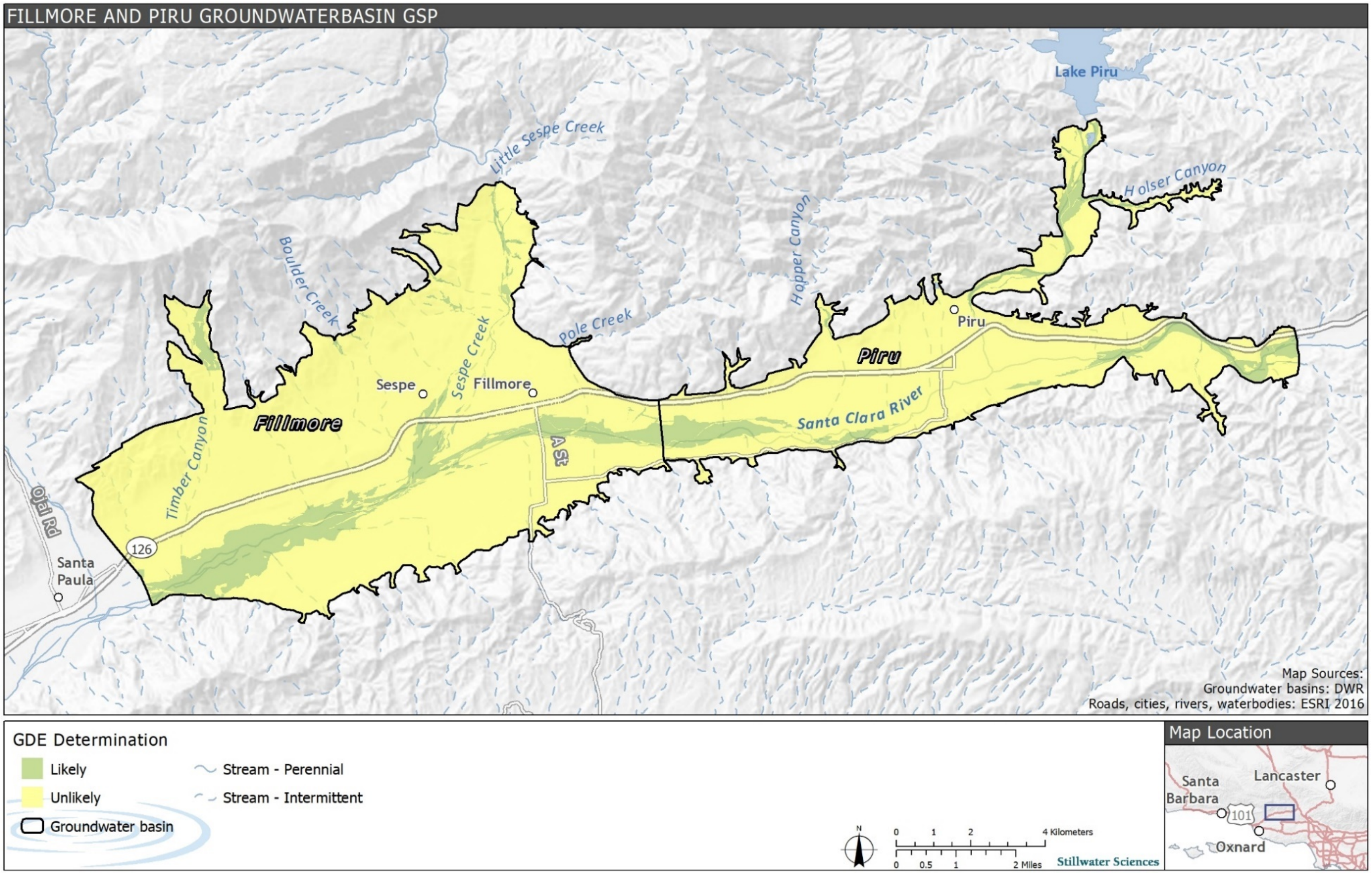


Figure 2-22.1-2. ~~Spring 2019~~Fall 2011 depth to water and groundwater elevation contours.

2.1.3 Refine potential GDE map

To inform the assessment of GDE condition and potential effects (Sections 4 and 5), the basin-wide vegetation and wetland map was reviewed, and each community was assigned a groundwater dependence category (i.e., unlikely or likely; Figure 2.1-3). This determination was based on species composition and the groundwater dependency of dominant species, whether they were considered groundwater dependent by the iGDE database (DWR 2020) and wetland indicator status (Lichvar et al. 2016). Although Klausmeyer et al. (2018) includes species with upland facultative wetland indicator status (Lichvar et al. 2016) in their list of groundwater dependent mapping units, these upland facultative species were classified as unlikely to be groundwater dependent based on their typical elevation relative to the low-flow channel in the Santa Clara River watershed. Figure 2.1-4 shows the differences between the iGDE database and the potential GDE map. Section 4.1 discusses the vegetation communities that were identified as likely to depend on groundwater.

These potential GDEs were overlaid with the depth to water dataset (as discussed in Section 2.1.2) in GIS and any communities occurring outside of 30-ft depth to groundwater were removed. The depth to water modeling data did not cover the entire extent of both the Fillmore and Piru groundwater basins; in these areas, a manual review of potential GDEs was performed using aerial imagery. Coast live oak (*Quercus agrifolia*) communities were included as potential GDEs when they occurred in riparian areas or drainages; any mapped stands growing on a clear slope were excluded based on landscape position and improbable connection to groundwater. These stands typically occur on the upland fringes of the basin, where the non-water bearing Pico Formation bedrock outcrops (Fillmore Basin GSP Figure 2.2-3 and Piru Basin GSP Figure 2.2-3) and average slopes exceed 20%. It is therefore extremely unlikely that oaks in these areas are connected to groundwater-bearing alluvial or fluvial sedimentary formations.


FILLMORE AND PIRU GROUNDWATERBASIN GSP
Lake Piru
Little Sespe Creek
Holser Canyon
Boulder Creek
Hopper Canyon
Pole Creek
Piru
Sespe Creek
Sespe
Fillmore
Santa Clara River
A St
Timber Canyon
Ojai Rd
Santa Paula
126
Map Sources:
Groundwater basins: DWR
Roads, cities, rivers, waterbodies: ESRI 2016
GDE Determination
Likely
Unlikely
Groundwater basin
Stream - Perennial
Stream - Intermittent
N
0 1 2 4 Kilometers
0 0.5 1 2 Miles
Stillwater Sciences
Map Location
Santa Barbara
Lancaster
101
Oxnard

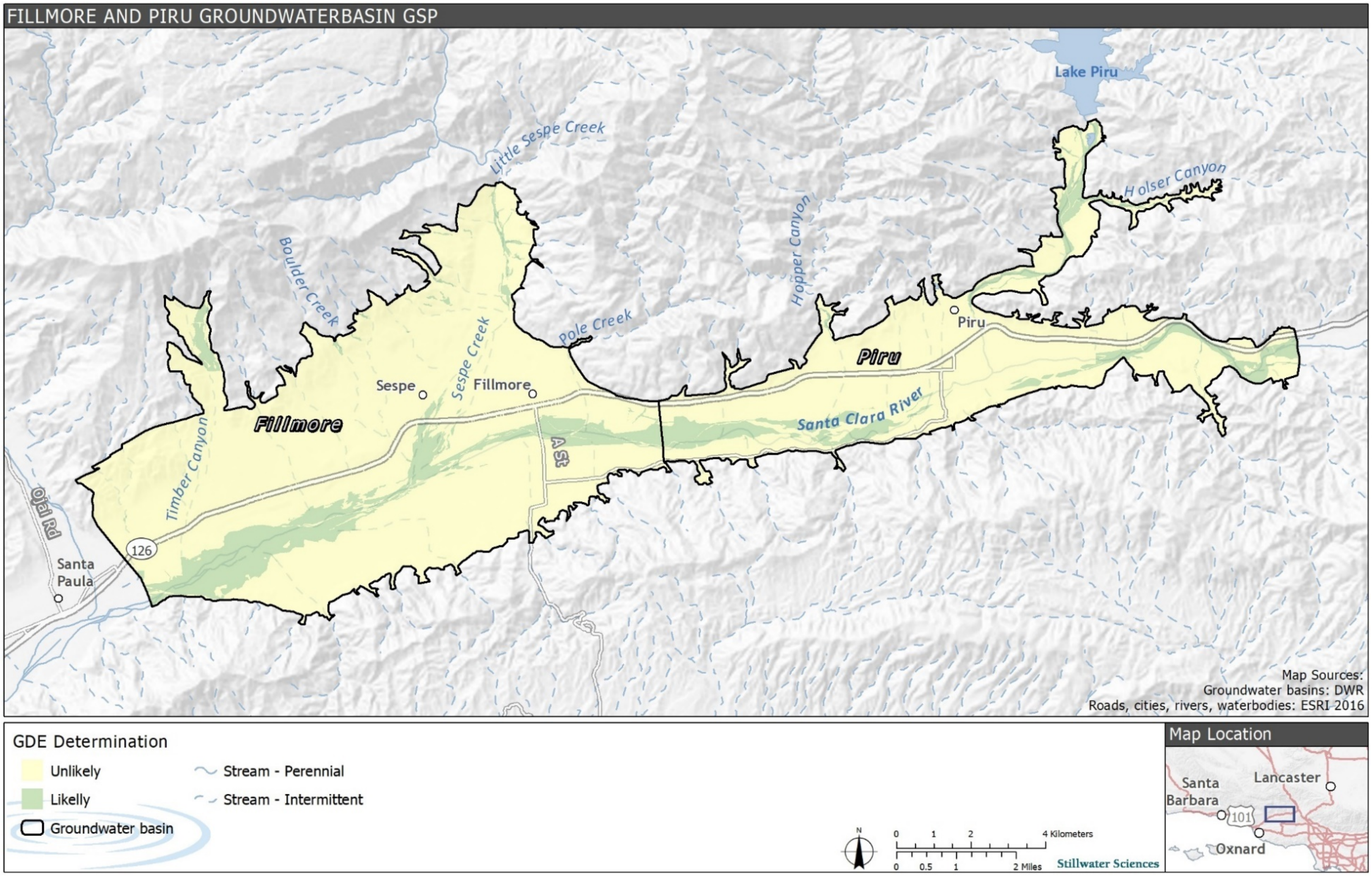
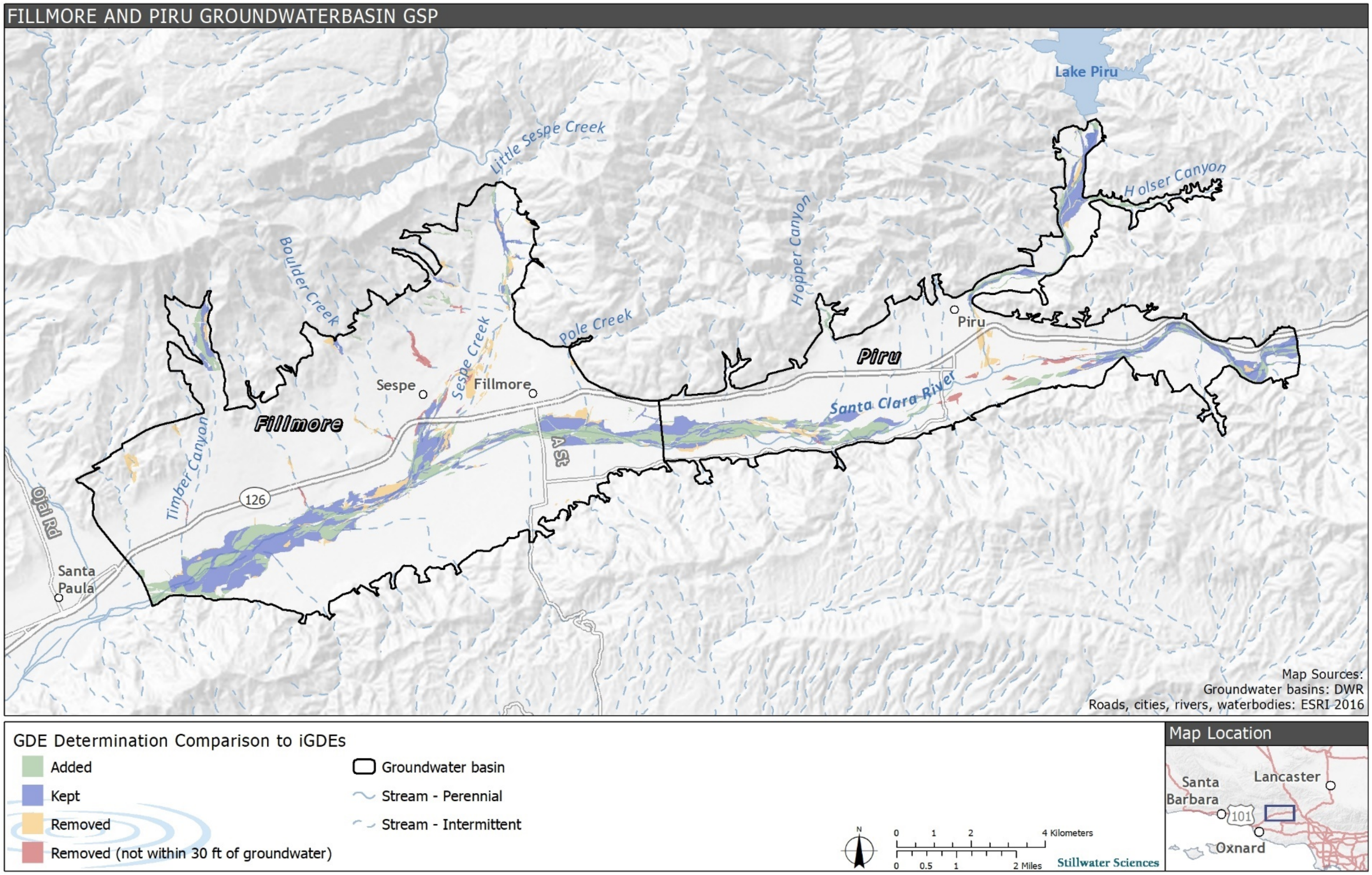


Figure 2-3~~2.1-3~~. Potential GDE determination based on the methods outlined in Section 2.1.


FILLMORE AND PIRU GROUNDWATERBASIN GSP
Lake Piru
Little Sespe Creek
Holser Canyon
Hopper Canyon
Boulder Creek
Pole Creek
Piru
Sespe Creek
Sespe
Fillmore
Santa Clara River
Timber Canyon
A St
126
Ojai Rd
Santa Paula
Map Sources:
Groundwater basins: DWR
Roads, cities, rivers, waterbodies: ESRI 2016
GDE Determination Comparison to iGDEs
Added
Kept
Removed
Removed (not within 30 ft of groundwater)
Groundwater basin
Stream - Perennial
Stream - Intermittent
N
0 1 2 4 Kilometers
0 0.5 1 2 Miles
Stillwater Sciences
Map Location
Santa Barbara
Lancaster
101
Oxnard

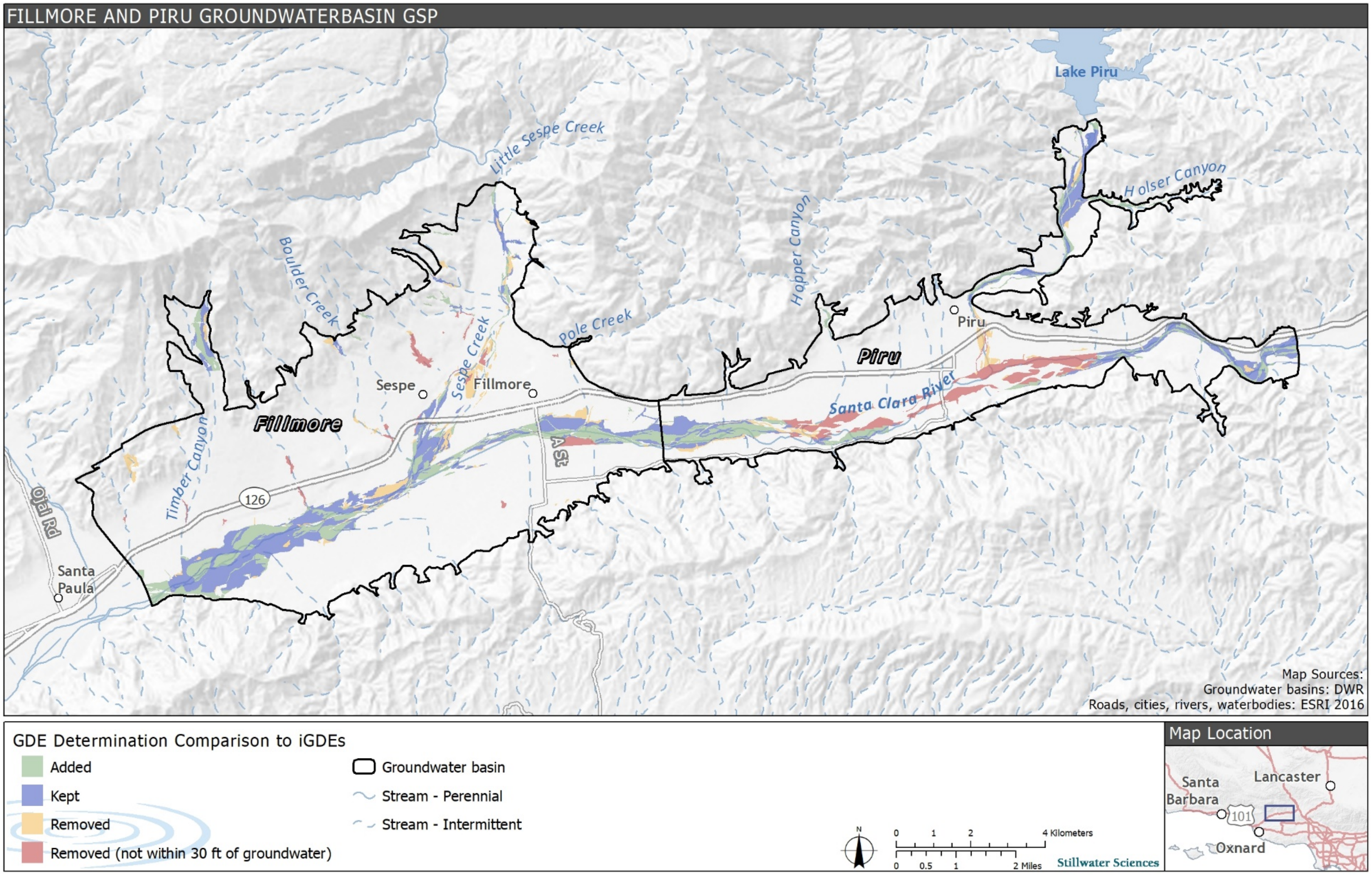


Figure 2-42.1-4. Potential GDE determination compared to iGDE mapping (Klausmeyer et al. 2018). The final GDEs are indicated by kept and added classes.

2.2 Special-status Species

As part of this analysis, special-status species and sensitive natural communities that are potentially associated with GDEs in the Fillmore and Piru groundwater basins were identified. Groundwater dependent special status species in the basin are beneficial users of groundwater. For the purposes of this document, special-status species are defined as those:

- listed, proposed, or under review as endangered or threatened under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA);
- designated by CDFW as a Species of Special Concern;
- designated by CDFW as Fully Protected under the California Fish and Game Code (Sections 3511, 4700, 5050, and 5515);
- designated as Forest Service Sensitive according to the Regional Forester's Sensitive Species Management Guidelines listed per USFS Memorandum 2670 (USFS 2011);
- designated as Bureau of Land Management (BLM) sensitive;
- designated as rare under the California Native Plant Protection Act (CNPPA); and/or
- included on CDFW's most recent Special Vascular Plants, Bryophytes, and Lichens List (CDFW 2020a) with a California Rare Plant Rank (CRPR) of 1, 2, 3, or 4.

Sensitive natural communities are defined as vegetation communities identified as critically imperiled (S1), imperiled (S2), or vulnerable (S3) on the most recent California Sensitive Natural Communities List (CDFW 2020b).

2.2.1 Data sources

Stillwater ecologists queried databases on regional and local occurrences and spatial distributions of special-status species within the Fillmore and Piru groundwater basins. Spatial database queries included potential GDEs plus a 1-mile buffer. Databases queried included:

- California Natural Diversity Database (CNDDB) (CDFW 2019);
- Vegetation Mapping of the Santa Clara River, Ventura County and Los Angeles County, California, prepared for the Western Foundation of Vertebrate Zoology (Stillwater Sciences 2019);
- California Native Plant Society (CNPS) Manual of California Vegetation (2020);
- eBird (2021); and
- The Nature Conservancy (TNC) freshwater species lists generated from the California Freshwater Species Database (CAFSD) (TNC 2020).

2.2.2 Procedure

Stillwater reviewed the database query results and identified special-status species and community types with the potential to occur within or be associated with the vegetation and aquatic communities in or immediately adjacent to the potential GDEs. Stillwater ecologists then consolidated these special-status species and sensitive community types into a list along with summaries of habitat preferences, potential groundwater dependence, and reports of any known occurrences (Section 4.2.2 and Appendix A).

Wildlife species were evaluated for potential groundwater dependence using determinations from the Critical Species Lookbook (Rohde et al. 2019) or by evaluating known habitat preferences, life histories, and diets. Species GDE associations were assigned one of three categories:

- Direct—species directly dependent on groundwater for some or all water needs (e.g., cottonwood with roots in groundwater, juvenile steelhead in dry season).
- Indirect—species dependent upon other species that rely on groundwater for some or all water needs (e.g., riparian birds).
- No known reliance on groundwater.

Sensitive natural communities were classified as either likely or unlikely to depend on groundwater based on species composition using the same methodology as vegetation communities (Section 2.1.3). Plant species were evaluated for potential groundwater dependence based on their habitat (Jepson Flora Project 2020) and association with vegetation communities classified as GDEs. Special-status plant GDE associations were assigned one of three categories: likely, possible, or unlikely. The "possible" category was included to classify plant species with limited habitat data or where a species may have an association with a vegetation community identified as a GDE (e.g., Coast live oak, California sagebrush [*Artemisia californica*]).

Database query results for local and regional special-status species occurrences were combined with their known habitat requirements to develop a list of groundwater dependent special-status species (Section 4.2.2) that satisfy the following criteria: (1) documented to occur within the GDE unit, or (2) known to occur in the region and suitable habitat present in the GDE unit.

3 POTENTIAL GDE UNITS

3.1 Potential GDE Units

Seven potential GDE units were identified based on hydrologic and ecological conditions of the GDEs identified using the methods outlined in Section 2.1.3 (Table 3.1-1 and Figure 3.1-1). Potential GDE units are units that may use groundwater but could also be using water from other sources (e.g., soil moisture, agricultural runoff, or surface flows). The likelihood of groundwater dependence for each potential GDE unit is explored in Section 6. The exterior boundaries of each unit were established using the extent vegetation communities. Adjacent GDE units were differentiated based on changes in the dominant vegetation community such as a transition from willows and cottonwoods to mulefat or the presence of interconnected surface water. Three of the units mostly coincide with areas of rising groundwater and thus contain interconnected surface water as part of the GDE.

Table 3.1-1. Potential GDE unit description.

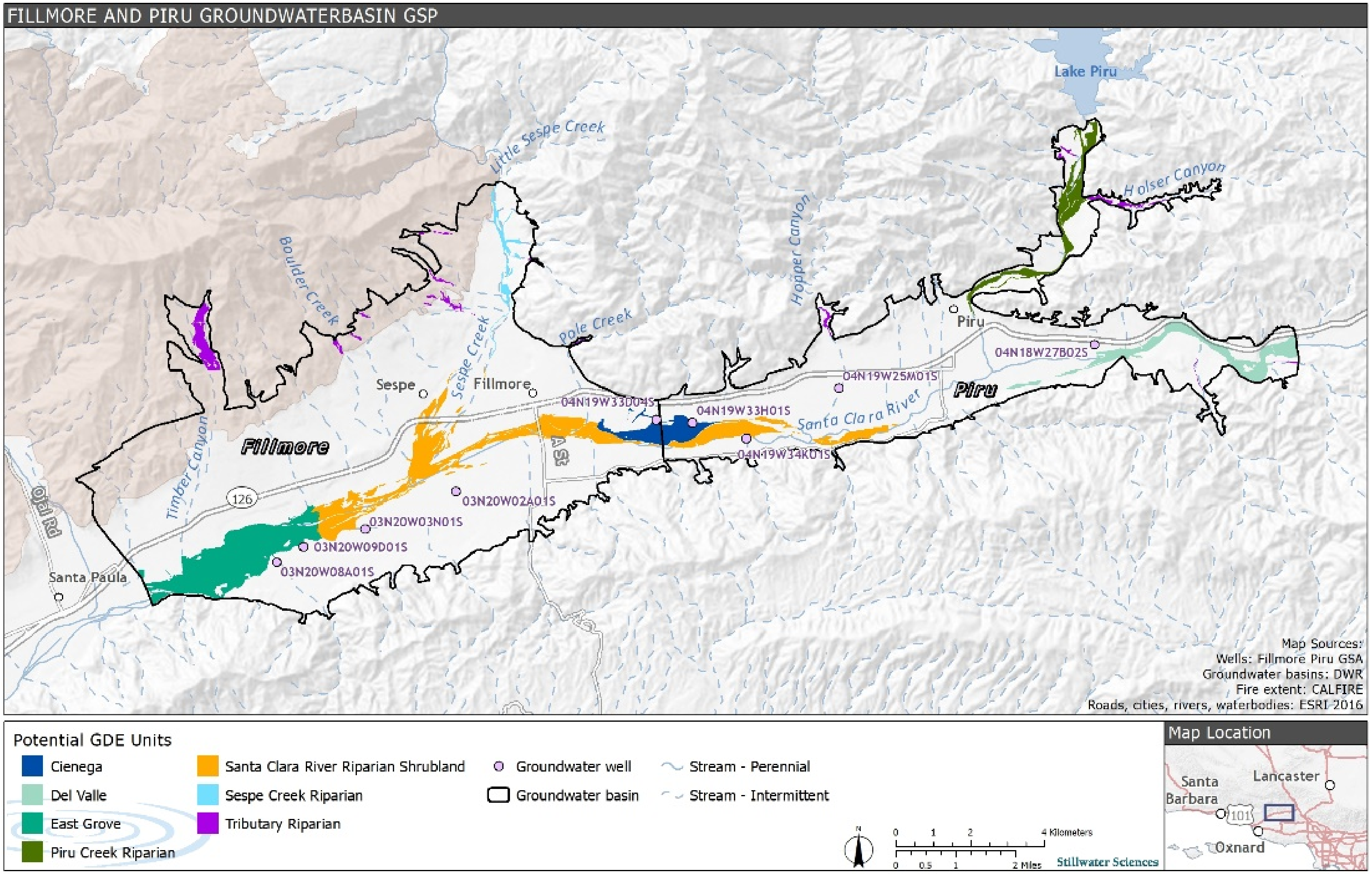
Potential GDE units	Description
Del Valle	Historical Del Valle complex located at the upstream end of the Piru Groundwater Basin. Unit is predominantly dense riparian forest, with established Freemont cottonwood and red willow. This unit includes the interconnected surface water portions of the Santa Clara River, which extends from the basin boundary downstream to approximately Las Brisas Bridge.
Santa Clara River Riparian Shrubland	Riparian zone along the Santa Clara River; dominated by facultative phreatophytes and riparian shrubland habitat. Unit occupies both Fillmore and Piru groundwater basins. Unit is characterized by lower density and low-stature shrubs and is dominated by mulefat.

Potential GDE units	Description
Cienega	Historical Cienega complex located near the Fillmore Fish Hatchery. Unit occurs in both Fillmore and Piru groundwater basins. Unit is dominated by mulefat and giant reed of variable density throughout. This unit includes interconnected surface water in the Santa Clara River.
East Grove	Historical East Grove complex located at the downstream end of the Fillmore Groundwater Basin. Unit is occupied by dense riparian forest dominated by mulefat, black cottonwood, and red willow. This unit includes interconnected surface water on the Santa Clara River.
Piru Creek Riparian	Riparian zone along Piru Creek from Santa Felicia Dam to Highway 126. Unit is characterized by a thin but dense riparian corridor, dominated by mulefat, Freemont cottonwood, and red willow.
Tributary Riparian	Riparian habitat within tributaries to both Fillmore and Piru groundwater basins. Predominantly located to the north of the Santa Clara River draining the Topa Topa mountain range. Unit is dominated by oaks and other hardwoods.
Sespe Creek Riparian	Riparian zone along Sespe Creek from the boundary of the Fillmore Groundwater Basin to Highway 126. Unit is dominated by mixed hardwood and low-stature willows.

Potential GDE units in the Fillmore and Piru groundwater basins contain 3,9554,214.1 acres of GDE habitats, with the majority (625%) occurring in the Fillmore Groundwater Basin (Table 3.1-2). The Santa Clara River Riparian Shrubland and East Grove are the largest potential GDE units and together account for 843% of the GDE units in the Fillmore Groundwater Basin.

Table 3.1-2. Extent of potential GDEs by GDE unit by Groundwater Basin (acres).

GDE unit	Fillmore	Piru	Total
Cienega	133.6	159.6	293.2
Del Valle	-	502.9466.1	502.9466.1
Santa Clara River Riparian Shrubland	1,046.01,073.1	342.1549.3	1,388.11622.4
East Grove	1,101.9101.0	-	1,101.0101.9
Piru Creek Riparian	-	336.9336.5	336.9336.5
Tributary Riparian	196.6195.1	68.968.9	265.5264.0
Sespe Creek Riparian	94.1103.4	-	103.494.1
Total	**2,596.981.5**	**1,373.6617.2**	**3,955.14,214.1**


FILLMORE AND PIRU GROUNDWATERBASIN GSP
Lake Piru
Little Sespe Creek
Holser Canyon
Hopper Canyon
Boulder Creek
Pole Creek
Sespe Creek
Piru
04N18W27B02S
04N19W25M01S
Piru
Sespe
Fillmore
04N19W33D04S
04N19W33H01S
Santa Clara River
04N19W34K01S
Fillmore
A St
Timber Canyon
126
03N20W02A01S
03N20W03N01S
03N20W09D01S
03N20W08A01S
Ojai Rd
Santa Paula
Map Sources:
Wells: Fillmore Piru GSA
Groundwater basins: DWR
Fire extent: CALFIRE
Roads, cities, rivers, waterbodies: ESRI 2016
Potential GDE Units
Cienega
Del Valle
East Grove
Piru Creek Riparian
Santa Clara River Riparian Shrubland
Sespe Creek Riparian
Tributary Riparian
Groundwater well
Groundwater basin
Stream - Perennial
Stream - Intermittent
Stillwater Sciences
Map Location
Santa Barbara
Lancaster
101
Oxnard

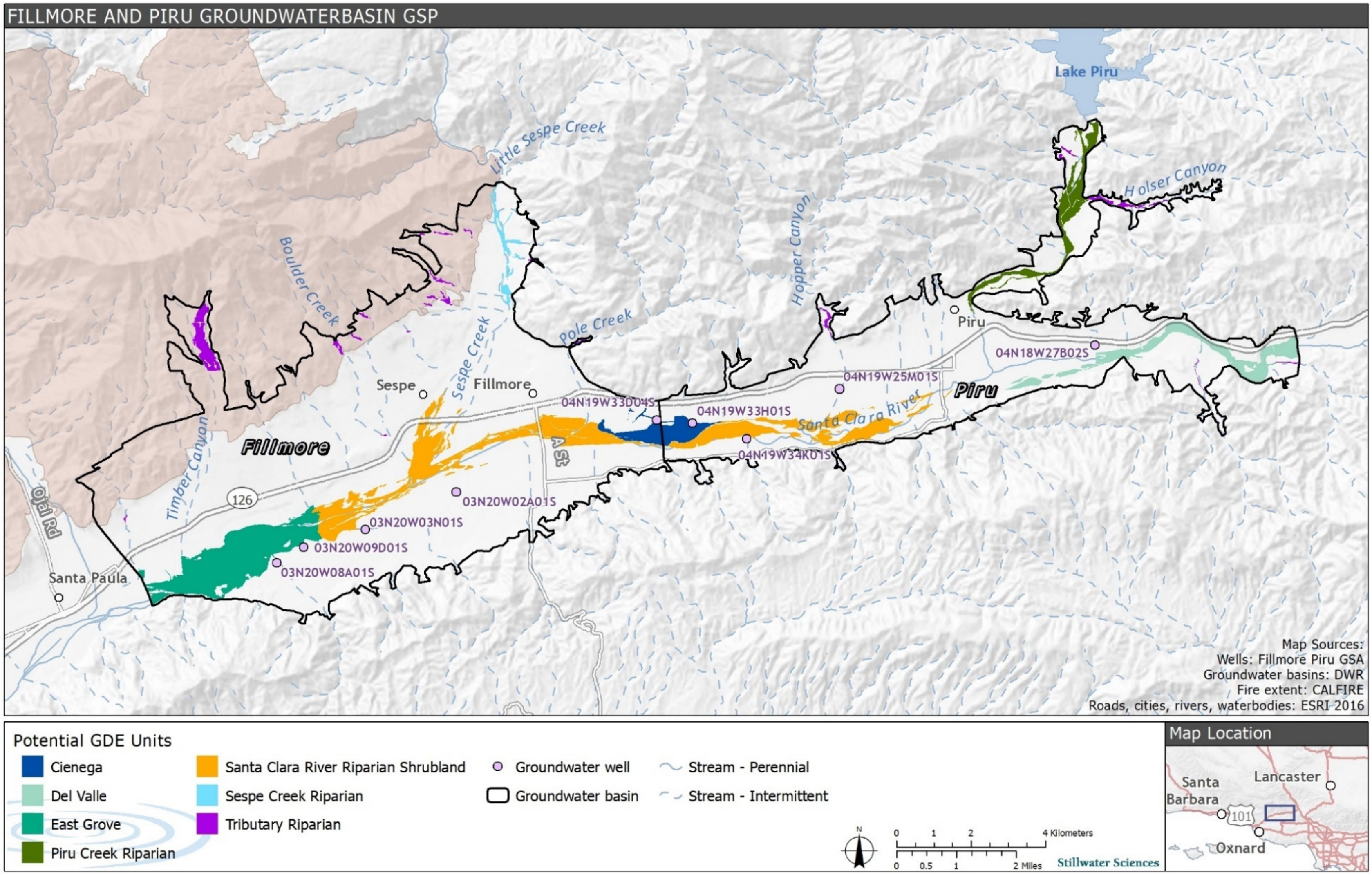


Figure ~~3.1~~ 3-11. Potential GDE units and groundwater wells for the Fillmore and Piru groundwater basins.

4 GROUNDWATER AND INTERCONNECTED SURFACE WATER HYDROLOGY

Changes to groundwater elevations and interconnected surface water flows through time can lead to changes in GDE health and extent. This section uses available groundwater level data to assess temporal trends in the groundwater elevations for potential GDE units with well data (Section 4.1). Section 4.2 explores groundwater quality and its potential effect on GDEs. Finally, Section 4.3 explores the extent of interconnected surface water and spatial trends in interconnected surface water that can later be used to assess potential impacts of groundwater management to GDEs. These changes in groundwater levels and interconnected surface water are linked with changes to GDE health in Section 6.

4.1 Groundwater Levels

Historical dry periods and droughts play a major influence on groundwater elevations across the Fillmore and Piru groundwater basins. Droughts in 1974–1977, 1986–1991, and 2012–2016 had significant signatures in the hydrographs of shallow wells located beside the identified GDEs. Most recently, basins were near to full capacity in 2011 (i.e., groundwater levels very close to the surface) ahead of the 2012–2016 drought, which generally caused water levels in wells to decline. The largest drops were seen in wells in the central part of Piru Groundwater Basin the higher elevation portions of the basin along Sespe Creek (the Sespe Upland) and Pole Creek Fan area of Fillmore Groundwater Basin. The greatest seasonal fluctuations are seen in the same areas (central Piru Groundwater Basin, Sespe Upland, and Pole Creek Fan), where hydraulic gradients are relatively steep. In general, ground surface elevation in the Sespe Upland areas increases steeply to the north, unlike the relatively flat topography near to the Santa Clara River channel. As such, depths to groundwater tend to be greatest along the Sespe Upland.

Long-term records of shallow groundwater are relatively rare in the Fillmore and Piru groundwater basins. Below we use well data presented in the Monitoring Plan and Data Gaps Analysis Appendix (DBS&A 2020) to explore shallow groundwater trends for the GDE units shown in Figure 3.3-1 from east to west. We were unable to examine the groundwater levels in the Tributary Riparian GDE unit because there are no representative wells located in or near the unit.

Many of the wells considered in the analysis below are screened below the shallow groundwater used by GDEs (Table 3.1-1) and may not accurately represent the actual shallow groundwater elevation. Additionally, land surface elevation, and therefore depth to water, at a monitoring well site may differ from that at the GDEs it represents, particularly with distance from the river channel. GDEs are typically located closer to channels and at lower elevations than their representative well sites. We used a DEM to extract land surface elevations at GDEs along cross-channel transects at each well. The range of ground elevation for the GDEs is represented by the green shaded area in figures 4.1-1 through 4.1-5. In addition to depth to water data at each well site, we present the range of elevation of potential GDEs along each transect to provide rough constraints on depth to water at the potential GDEs.

The following sections analyze groundwater elevation changes for some of the GDE units. In light of the limitations of the monitoring well data, the groundwater elevation data presented in this section are intended to illustrate general trends within GDE units. The spring 2019 depth to water surface (Section 2.1.2), as opposed to monitoring well data, is used to establish GDE connectivity with shallow groundwater.

4.1.1 Piru Basin

Del Valle

Well 04N18W27B02S is an active agricultural well installed in 1932, with a screen depth of 140–255 feet (**Error! Reference source not found.**~~Table 4.1-1~~). The well is approximately 1,500 ft north of the downstream end of the Del Valle unit. The depth of groundwater in this well varies from about 19–160 feet below ground surface (ft bgs) (Figure 4.1-1). The shaded green areas in this and subsequent figures represent the range of elevation of the GDE along a transect perpendicular to the valley axis. After a period of low water elevation levels in the 1960s, the water level between droughts was generally within 10–30 ft bgs. During droughts, the water level dropped to greater than 100 ft bgs before recovering. The low water levels prior to the 1970s occurred before the effluent releases from Los Angeles County increased. Groundwater elevation has increased since the 2012–2016 drought but by early 2020 had not yet reached the long-term average depth. GDE elevations in this unit are 7 to 15 ft below the well site elevation, so depth to water at GDEs is likely to be shallower than at the well. (Figure 4.1-1).

Table 4.1-1. Characteristics for wells used for the groundwater quality and groundwater level assessment. The location of the wells is shown on Figure 2.3-1.

Well	Basin	GDE Unit	Screen depth (ft bgs)	Data type[1]	Water quality data available	Water level data available
04N18W27B02S	Piru	Del Valle	140–255	WQ, WL	1960–2004	1932–2020
04N19W34K01S	Piru	Santa Clara River Riparian Shrubland	5–120	WQ, WL	1931–2016	1972–2019
04N19W33H01S	Piru	Cienega	237–362	WQ	1954–1958	2007–2011**
04N19W33D04S	Fillmore	Cienega	140–486	WQ, WL	1951–1985	1972–2020
03N20W03N01S	Fillmore	Santa Clara River Riparian Shrubland	120–172	WQ, WL	1981–1994	1959–2020
03N20W09D01S	Fillmore	East Grove	210–310	WQ, WL	1969–2019	1988–2019

[1] WQ=groundwater quality, WL= groundwater level

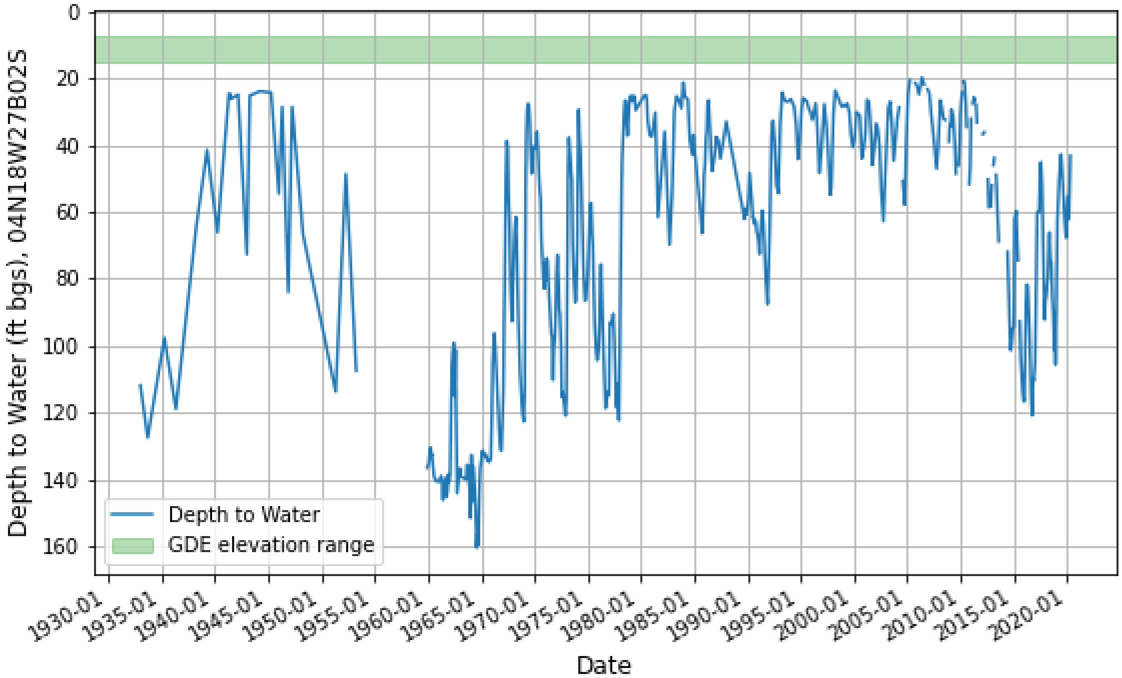


Figure 4-14.1-1. Depth to groundwater and potential GDE elevation range on well transect, Well 04N18W27B02S in the Del Valle GDE Unit. Well site elevation is assumed to be 0 ft bgs.

Santa Clara River Riparian Shrubland

Well 04N19W34K01S within the Santa Clara River Valley Riparian Shrubland GDE Unit in the Piru Basin and 0.45 miles east of the Cienega Riparian Complex boundary has a screen depth of 5–120 feet bgs and was installed in 1972. The average depth to groundwater over the period or record was 19.5 feet bgs. Groundwater levels in well declined sharply to 49–62 ft bgs during droughts (Figure 4.1-2), but quickly recovered to the long-term average values. Since 2016, water elevations have risen, but still had not fully recovered to a normal range of 15 feet bgs or less by fall 2019. GDE elevations in this unit range from 1.5 ft above to 12 ft below the well site elevation. In general, depth to water at GDEs is likely to be shallower than at the well (Figure 3.1-2).

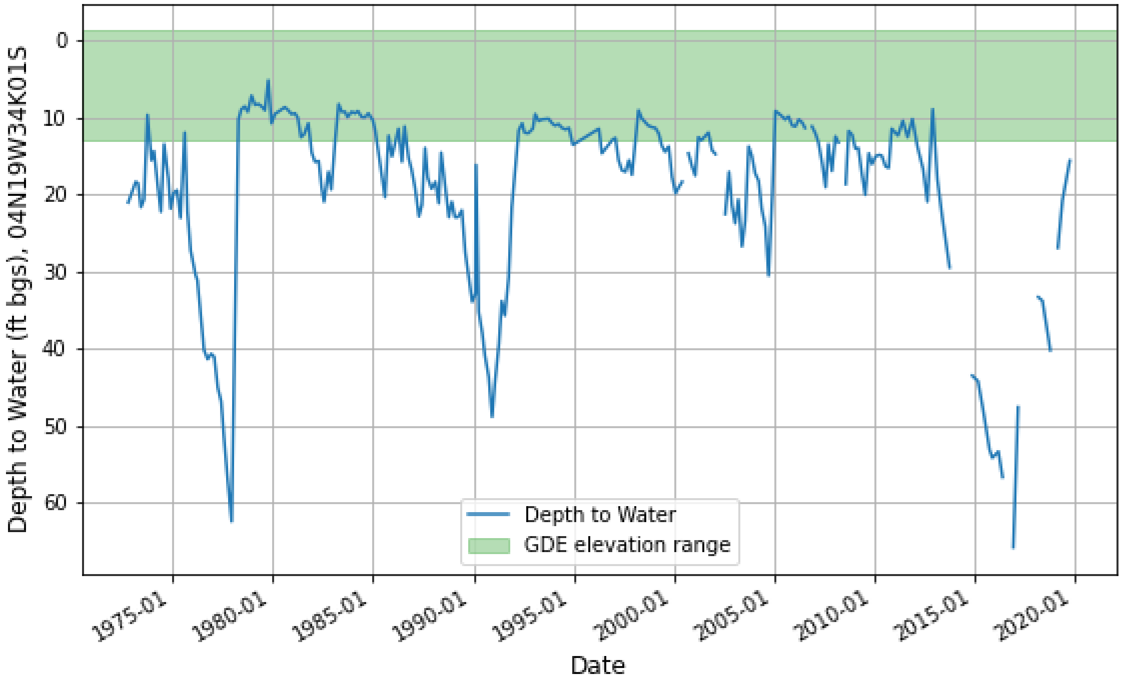


Figure 4-24.1-2. Depth to groundwater and potential GDE elevation range on well transect, Well 04N19W34K01S in the Santa Clara River Riparian Shrubland GDE Unit (Piru). Well site elevation is assumed to be 0 ft bgs.

4.1.2 Fillmore Basin

Cienega

Well 04N19W33D04S lies within the Cienega GDE Unit in the Fillmore Groundwater Basin and is screened at 140–486 feet (**Error! Reference source not found.**~~Table 4.1-1~~). It became operational in 1972 and the average depth to water from 1972–2019 was 5.4 feet bgs (Figure 4.1-3). The well data show significant declines during droughts, with groundwater level dropping to 25–33 feet during the droughts before returning to 5–10 ft bgs between the droughts. GDE elevations in this unit range from 2 feet above to 6 feet below the well site elevation (Figure 4.1-3).

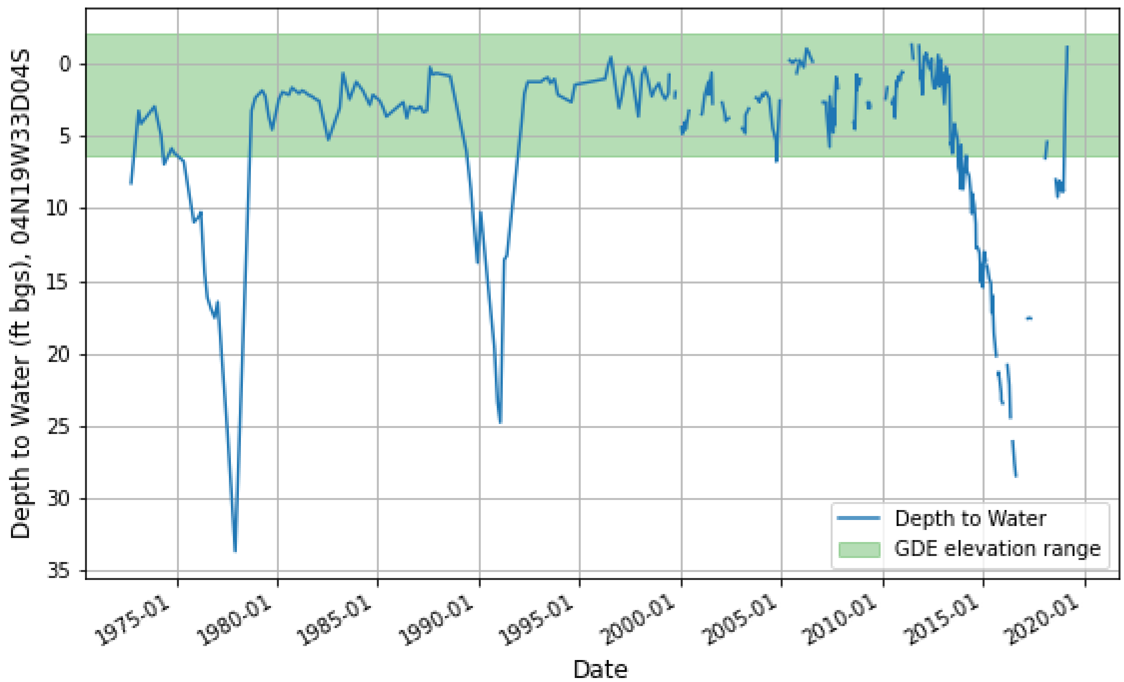


Figure 4-3~~4.1-3~~. Depth to groundwater and potential GDE elevation range in well cross-section, Well 04N19W33D04S in the Cienega GDE Unit. Well site elevation is assumed to be 0 ft bgs.

Santa Clara River Riparian Shrubland

Well 03N20W03N01S is in the Fillmore Groundwater Basin, 0.1 miles outside of the Santa Clara River Valley Riparian Shrubland boundary (0.75 miles east of the East Grove GDE Unit) and has been operational since 1959. This well has a screen depth of 120–172 feet bgs (**Error! Reference source not found.**~~Table 4.1-1~~). Over the 60 years of recorded depths to groundwater, this well averages 14.7 feet bgs (Figure 4.1-4). Similar to the other wells in the basin, the water elevation drops during droughts, with the largest drop occurring in 2016, when the water elevation was greater than 40 ft bgs. Following the droughts, the water elevation recovers to its average long-term value. GDE elevations in this unit range from 1 ft above to 12.5 ft below the well site elevation. In general, depth to water at GDEs is likely to be shallower than at the well because groundwater depths are increasing downstream toward the area of rising groundwater in the East Grove.

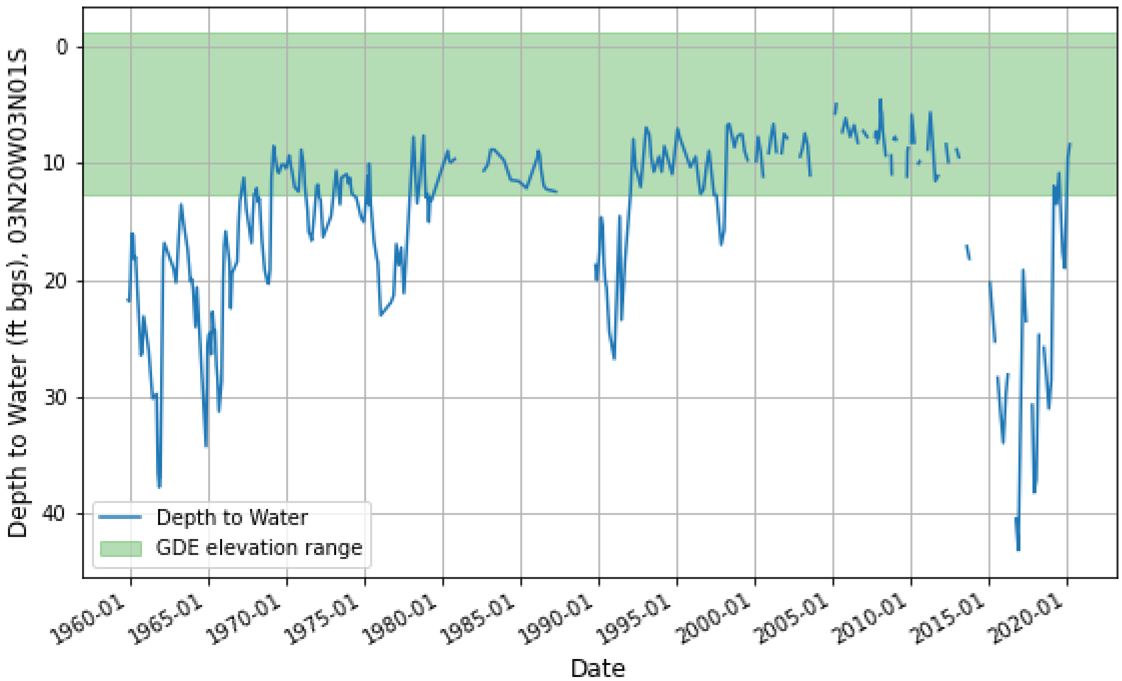


Figure 4-4~~4.1-4~~. Depth to groundwater and potential GDE elevation range in well cross-section, Well 03N20W03N01S in the Santa Clara River Riparian Shrubland GDE Unit (Fillmore). Well site elevation is assumed to be 0 ft bgs.

East Grove

Well 03N20W09D01S, in operation since 1988, is an agricultural well that has a screen depth of 210–310 feet bgs (**Error! Reference source not found.**~~Table 4.1-1~~). The average water level from 1988–2019 was 8.7 feet bgs (Figure 4.1-5). Groundwater data are relatively sparse in this well, particularly after 2010. This well shows a similar pattern to other wells described above, with declines in groundwater elevation during droughts followed by recovery. During the 2012–2016 drought, recorded groundwater depths decreased to almost 25 ft bgs. Adam Lambert (UCSB) has established numerous groundwater monitoring points (<12 ft) in the East Grove GDE Unit. These wells show similar results to Figure 4.2-5, but the magnitude of changes varies based on the location and relative elevation. GDE elevations in this unit are up to 11 feet below the well site elevation. In general, depth to water at GDEs is likely to be shallower than at the well (Figure 4.1-5).

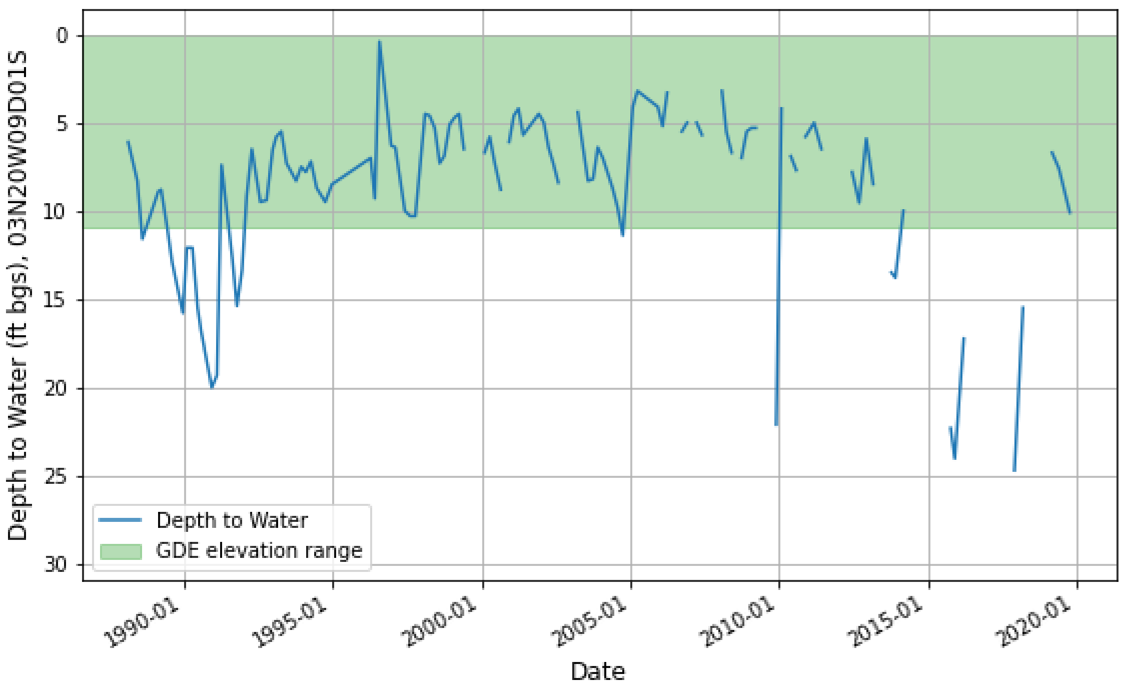


Figure 4-5~~4.1-5~~. Depth to groundwater and potential GDE elevation range in well cross-section, Well 03N20W09D01S in the East Grove GDE Unit. Well site elevation is assumed to be 0 ft bgs.

4.2 Groundwater Quality

In general, groundwater in the Fillmore and Piru groundwater basins is high-quality with a few exceptions (DBS&A 2020). Between 1951 and 1968, elevated concentrations of TDS, sulfate, chloride, and boron near the Ventura/Los Angeles County line were generally connected to loosely regulated oil fields in Los Angeles County. Some of these elevated concentrations persisted after the Clean Water Act reduced impacts from the oil fields (DBS&A 2020). High chloride concentrations in the Santa Clara River originating in Los Angeles County cause the largest concern for water quality, particularly for agricultural uses in the Piru Groundwater Basin. Historically, water quality chemicals of concern (COCs) in the basins include:

- Total dissolved solids (TDS)
- Sulfate
- Chloride
- Nitrate
- Boron

The inter-quartile range of concentration for the five contaminants of concern and the EPA maximum contaminant level (MCL) in drinking water are shown in Table 4.2-1. In general, while concentrations for the contaminants of concern exceeded MCLs at times, they were not sufficiently high to impact GDEs. Moreover, shallow groundwater (used by GDEs) is usually younger and recharged by the surface waters of the Santa Clara watershed and has less legacy contamination than deeper groundwater (VCWPD 2016).

Table 4.2-1. Inter-quartile range and peak concentration (in square brackets) for selected contaminants observed in wells in the GDE units.

Well number	Basin	GDE unit	TDS (mg/l)	Chloride (mg/l)	Sulfate (mg/l)	Nitrate (mg/l)	Boron (mg/l)
04N18W27B02S	Piru	Del Valle	2413–2696 [3123]	150–151 [159]	365– 1412 [1536]	14–44 [66]	0.7–0.73 [1]
04N19W34K01S	Piru	Santa Clara River Riparian Shrubland	1366–1520 [1520]	41–55 [67]	616–339 [710]	9.2–13.6 [28]	0.6–0.8 [1.0]
04N19W33D04S	Piru	Cienega	966–1180 [1221]	31 to 47 [49]	458-522 [1332]	9.8–16 [32]	1–1.1 [1.1]
04N19W33H01S	Fillmore	Cienega	980 [n/a]	33–54 [54]	487–720 [720]	8.5–42 [42]	0.86–0.89 [0.89]
03N20W03N01S	Fillmore	Santa Clara River Riparian Shrubland	1048–1300 [1400]	41–62 [70]	476–580 [580]	17–41 [48]	0.8–0.9 [0.9]
03N20W09D01S	Fillmore	East Grove	1290–1516 [1516]	74–79 [81]	587–616 [650]	39.5–73 [73]	0.5–0.8 [0.9]
MCL (mg/l)			500[a]	250[a]	250[a]	45[b]	1[c]

[a] EPA secondary Maximum Contaminant Level
[b] EPA Maximum Contaminant Level
[c] California State Notification Level

4.3 Interconnected Surface Waters

Surface waters within the Piru and Fillmore groundwater basins have varying degrees of connection to groundwater. Three reaches of the Santa Clara River are connected to groundwater, as are the upper reaches of Piru and Sespe creeks (Figure 4.6). It is uncertain whether the lower reaches of Piru and Sespe creeks are connected to groundwater. It is unlikely that surface flows in the other intermittent tributaries tot the Santa Clara River are connected to groundwater (Figure 4.6).

Generally, surface waters can be categorized into three major surface water types: perennial reaches, intermittent reaches, and ephemeral reaches. For this discussion we define perennial reaches as those that have surface flow except during prolonged and severe droughts. For the Santa Clara River, perennial reaches are generally supported by rising groundwater and are areas of interconnected surface water (UCWD 2017). Surface flows occur for prolonged periods in intermittent reaches, but the reaches tend to go dry during most years. Ephemeral reaches occur in smaller tributaries within the basin and only support surface flow immediately after storm events.

As discussed in Section 1.4, the Santa Clara River has alternating perennial and intermittent reaches with perennial reaches occurring where rising interconnected groundwater contributes the vast majority of the surface water (except during storm events with significant runoff) and the intermittent reaches are losing reaches that are disconnected from groundwater during most of the year (Figure 4.6). Perennial reaches include the Del Valle, Cienega, and East Grove GDE units (Figure 1.4 12). . Continuous surface water flow across the Fillmore and Piru basins can also occur due to effluent from Los Angeles County or dam releases, such as in the reach immediately downstream of Piru Dam.

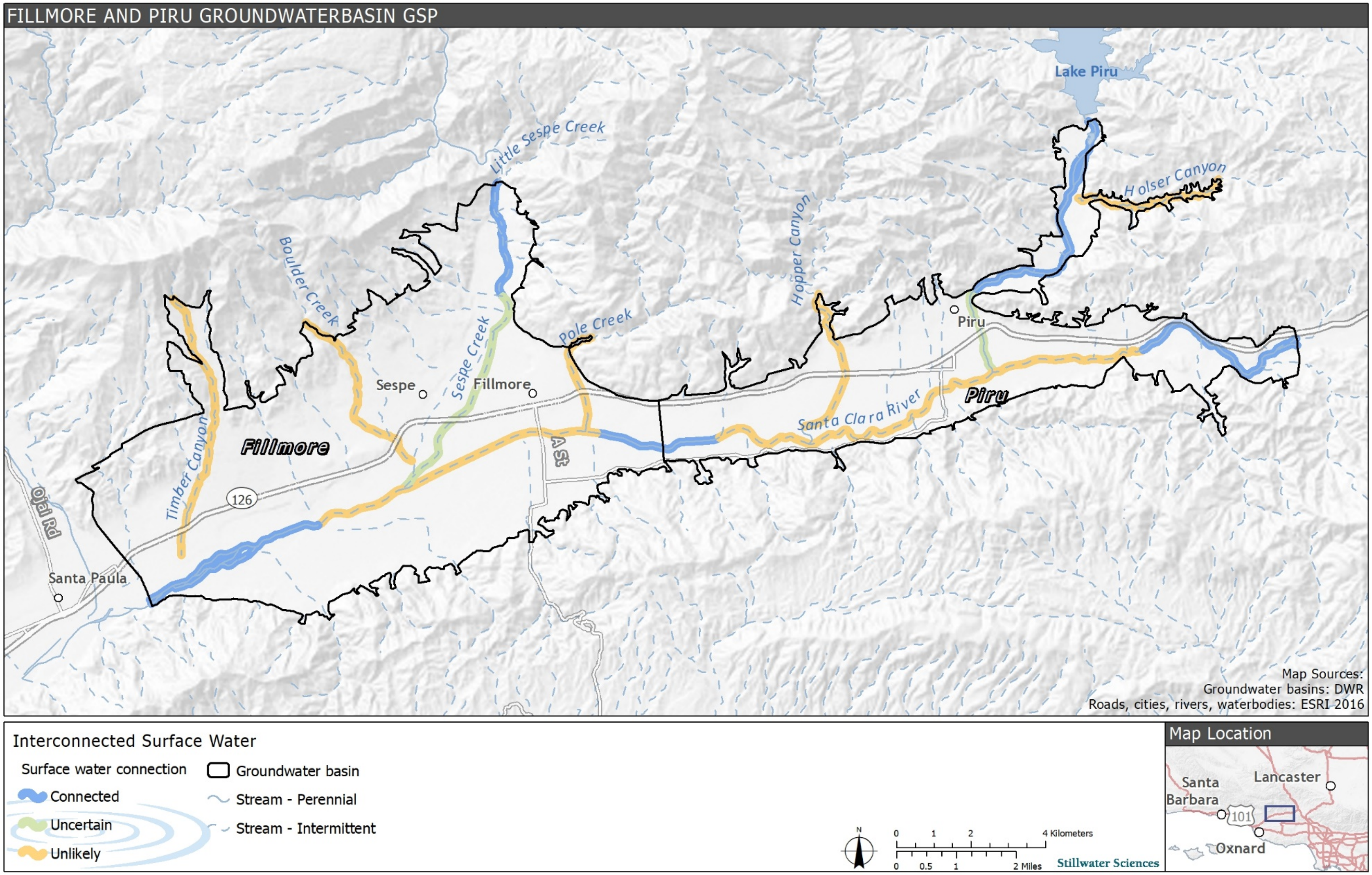


Figure 4-6: Interconnected surface water and perennial and intermittent stream reaches.

4.3.1 Piru Groundwater Basin

The Piru Groundwater Basin has three perennial reaches that generally co-occur with the Del Valle GDE Unit, the Cienega Riparian Complex GDE unit, and Piru Creek from Santa Felicia Dam to the confluence with the Santa Clara River. The Del Valle Reach occurs at the upstream end of the Piru Groundwater Basin where the valley width is still narrow, and the alluvial basin is shallow relative to downstream reaches. The Del Valle Reach was historically perennial (Beller et al. 2016) and flows are currently augmented by effluent releases in Los Angeles County. The extent of dry season surface flow in the Cienega Reach was mapped from 2011–2018 by United Water and is discussed below. Groundwater depths along Hopper Canyon Creek increase from about 10 ft bgs during wet years near the Santa Clara River to >30 ft bgs north of Highway 125. ~~The degree to which~~ Hopper Canyon Creek is therefore unlikely to be ~~currently~~ connected to groundwater within the Piru Basin ~~is unknown~~boundary. Several small ephemeral tributaries to the Santa Clara River and Piru Creek occur in the reach and are disconnected from groundwater (Figure 4-6). To our knowledge, there has not been a systematic exploration of the extent of surface water in lower Piru Creek or lower Hopper Canyon Creek.

Flows in the Del Valle Reach were monitored at the Santa Clara River near Piru gage (USGS Gage Number 11109000) from 1928–1932 and since water year 1997 at the Las Brisas Bridge, and at the USGS gage at the Ventura County line (also known as Blue Cut, USGS Gage Number 11108500) from 1953–1996. These gage records show that this reach is perennial, but shallow groundwater levels are not monitored in this reach. Rising groundwater is thought to occur upstream of this reach, in the adjacent Santa Clara River Valley East groundwater basin. USGS Gage 111085000 is located on a bedrock high; from the gage downstream to the Las Brisas Bridge, surface flow is thought to be stable and sustained by rising groundwater upstream and effluent releases from Los Angeles County (Dan Detmer personal communication). Near the Las Brisas Bridge, the river transitions to a losing reach. Shallow groundwater commonly occurs in this area and~~,~~ is sustained by surface flow from upstream areas (Figure 4-6). The occurrence of shallow groundwater in this reach is not influenced by any known groundwater pumping in the Piru Basin (UWCD 2021).

A 6.5-mile-long intermittent, losing reach occurs between Del Valle and the Cienega Reach of the Santa Clara River in the Piru Groundwater Basin. The groundwater is relatively deep in this reach and when the Santa Clara River flows, the surface flow is disconnected from groundwater (Figure 4-6). During very wet years (e.g., 1998 and 2005), prolonged surface water releases from Santa Felicia Dam or Castaic Lake in combination with high recharge rates during storms cause high stream bed infiltration rates that replenish the groundwater beneath and near the river and can cause groundwater levels to reach the stream bed. This condition abates when the surface water flows cease (or decrease dramatically) and the mounded groundwater beneath the river declines and the surface water flow returns to a disconnected state with the aquifer.

Flow in lower Piru Creek is maintained by releases from Santa Felicia Dam, which likely also raises the groundwater level in this area. This reach of Piru Creek was historically intermittent (Beller et al. 2016) but there is currently perennial flow at least in the upper portion of the reach.

4.3.2 Fillmore Groundwater Basin

The Santa Clara River in the Fillmore Groundwater Basin has two reaches with rising groundwater (i.e., interconnected surface water) that correspond to the Cienega and the East

Grove GDE units (Figure 4-6). Surface flows in ~~both of these~~both reaches are typically dominated by rising groundwater except during storm flows. The rising groundwater flows can be supplemented by man-made releases from Santa Felicia Dam or Castaic Lake. The extent of rising groundwater (the source of the perennial flow) varies based on water year type (see section 4.3.3 for a discussion). Between these two reaches the Santa Clara River is an intermittent, losing reach for approximately 5 miles.

Sespe Creek is perennial at the USGS gage near the Fillmore Groundwater Basin boundary (where the creek exits the mountains) but the downstream extent of perennial flow is not known, although the lower portion of Sespe Creek is intermittent (Figure 4-6). Other tributaries within the Fillmore Groundwater Basin, including Pole Creek, Boulder Creek, and Timber Creek, are typically ephemeral or intermittent (i.e., disconnected from groundwater). United Water mapped the extent of surface water from 2011–2017 and that is explored below.

4.3.3 Variations in the extent of surface water 2011-2017 in the western Piru and Fillmore basins

United Water used field observations and photographs to map the extent of dry-season surface water in the Santa Clara River from 2011–2017 (UCWD 2017, Figure 4.3-1). This period includes relatively wet 2011 and the 2012–2016 drought and subsequent recovery in 2017. The wetted area was mapped as extending downstream to the Freeman Diversion (red triangles on the west end of the images in Figure 4.3-1) if a diversion occurred according to the diversion rate operations log. Santa Clara River flow rates were measured at the Fillmore Fish Hatchery (eastern circle in Figure 4.3-1, downstream end of Piru Groundwater Basin) and Willard Road (the western circle in Figure 4.3-1, downstream end of Fillmore Groundwater Basin). Sespe Creek flow was measured at the USGS gage (northernmost circle in August 2011 and June 2012). Castaic Lake and Santa Felicia Dam releases were absent for six months prior to the measurements shown on Figure 3.3-1 and the flows are therefore assumed to be entirely groundwater dependent.

Figure 4.3-1 shows that the extent of surface water and the magnitude of surface flows both decreased during the drought. The total length of the wetted stream channel in the Ventura County portion of the Santa Clara River decreased from approximately 17 miles in Fall 2012 to less than 5 miles in Fall 2016 (Figure 4.3-1). Streamflow at the Fillmore Fish Hatchery declined from 25 cfs in 2011 to 6 cfs in fall 2013. Surface flows were absent near the fish hatchery from 2014 to 2016 before returning in 2017. Streamflow at the downstream end of the Fillmore Groundwater Basin declined from 42 cfs in August 2011 to 1 cfs in October 2016. Subsequent dry-season flow measurements at Willard Road in 2018 and 2019 (not shown) ranged up to 16 cfs. Lower Sespe Creek remained dry from spring 2013 through November 2017. Surface flows at both the fish hatchery and Willard Road are linked with groundwater elevation (UCWD 2017, UCWD 2021a).

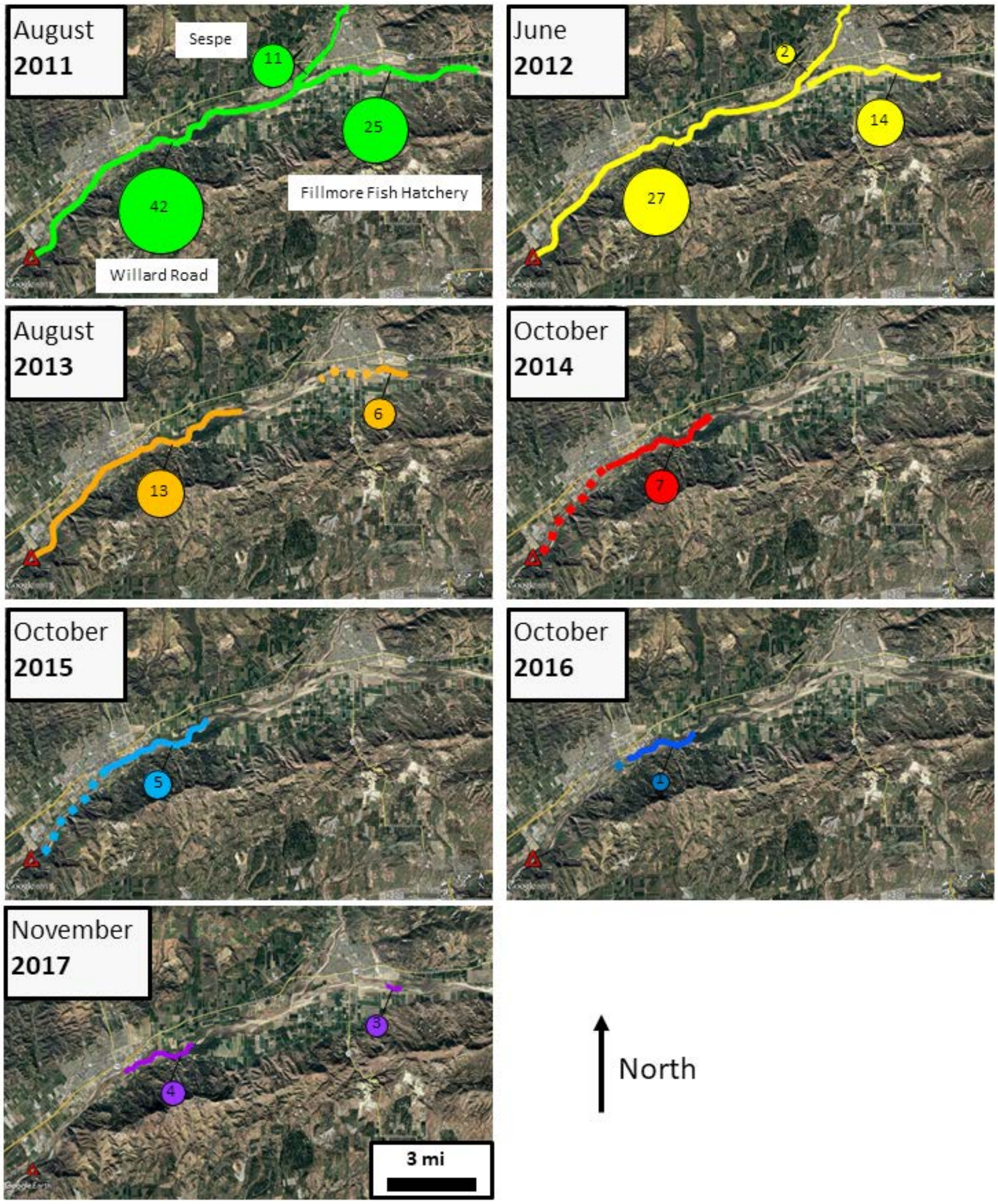


Figure 4-7~~4.3-1~~. Dry season surface flow extent measured in the Fillmore Groundwater Basin and the downstream portion of the Piru Groundwater Basin. The solid-colored lines correspond to the extent of surface flow with the flow in cfs indicated in bubbles. The red triangle is the Freeman Diversion Dam, downstream of the Fillmore and Piru groundwater basins. Reaches where the downstream extent of surface water flow is inferred based on diversion at Freeman Dam are indicated by dotted lines. Figure from UWCD (2017).

5 GDE CONDITION

This section characterizes the potential GDE units based on their hydrologic and ecological conditions and assigns a relative ecological value to each unit by evaluating its ecological assets and its vulnerability to changes in groundwater (Rohde et al. 2018).

5.1 Ecological Conditions

GDEs include terrestrial and aquatic habitat and other open-water aquatic habitats. There are few shallow groundwater wells (wells screened within the rooting zone of GDEs) in the Fillmore and Piru groundwater basins. In the absence of shallow wells, deeper wells, which may or may not reflect shallow groundwater conditions, coupled with observations of surface flow and ecological observations can be used to assess the extent of shallow groundwater. These data suggest that there continues to be shallow groundwater and interconnected surface water at the basin boundaries at the historical Del Valle, Cienega, and East Grove riparian woodlands (compare Figure 1.4-1 with Figure 3.1-1). The Cienega and East Grove riparian woodlands are located at sites of rising groundwater due to constrictions in the valley width. The beneficial uses of interconnected surface waters are discussed in Section 5.2.1. The role of shallow groundwater elsewhere in the basin is less certain and will be assessed based on interpolated groundwater elevation and vegetation.

The GDE determination (i.e., likely or unlikely) is shown in Figure 3.1-2.

5.1.1 Vegetation communities and GDE habitats

Piru

The Piru Groundwater Basin contains 1,617373 acres of mapped GDEs, which compose 153% of the total area of the basin. The Del Valle GDE Unit contains the largest area of GDEs within the Piru Groundwater Basin along with the Santa Clara River Riparian Shrubland and Piru Creek Riparian GDE units. GDEs within the basin are predominately riparian communities. The most prevalent vegetation community across all GDE units is mulefat thickets, which makes up 41% of all mapped area of GDEs in the basin. Red willow riparian woodland and forest (*Salix laevigata* Woodland Alliance) and Freemont cottonwood woodland and forest (*Populus fremontii* Forest Alliance) are present in 169% and 147% of the GDE extent across the Piru Basin, respectively.

The Del Valle GDE Unit contains 315% (502.9458.1 acres) of the mapped extent of GDE within the Piru Basin and is predominantly riparian habitat. Freemont cottonwood woodland and forest (127.7 acres) and red willow riparian woodland and forest (120.8 acres) are the dominant vegetation types within this unit, with mulefat thickets (73.790.3 acres) also present throughout (Figure 5.1-1). These dominant vegetation communities are associated with the riparian zone on the mainstem Santa Clara River The maximum rooting depth reported in the literature for the cottonwood and willows is 6.9 ft, while mulefat has maximum reported rooting depths of about 2 ft (Appendix C). The shallowest depth to groundwater at monitoring well 04N18W27B02S is just less than 30 ft, but this well is located downstream of the Del Valle GDE Unit and likely records deeper groundwater than what occurs under the GDE.

As discussed in Section 4.3.1, the Del Valle GDE Unit has perennial flow from the basin boundary downstream to Blue Cut (Las Brisas Bridge). This flow is supported by upstream releases and rising groundwater and therefore supports aquatic GDEs. Groundwater dependent special-status aquatic species discussed in Section 5.2.

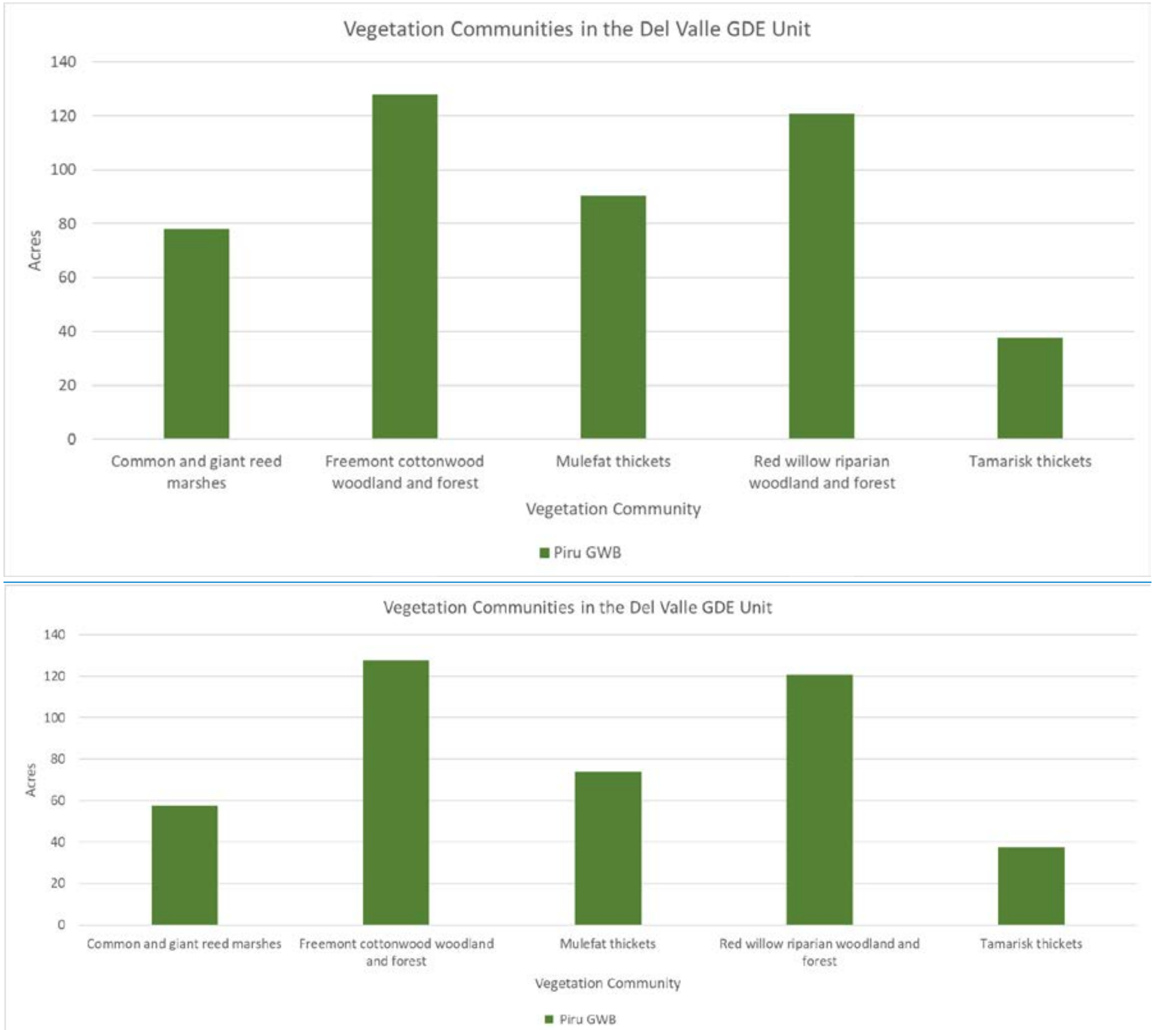


Figure 5-1~~5.1-1~~. Five most common vegetation ~~types OR~~ communities in the Del Valle GDE Unit, by acreage.

The Santa Clara River Riparian Shrubland GDE Unit represents ~~25~~34% (~~329.8~~549.2 acres) of mapped GDE extent within the Piru basin and is predominantly riparian habitat. Mulefat thickets (~~267.~~3714.9 acres) are the dominant GDE type within this unit, with common and giant reed marshes (~~50.3~~51.0 acres) and big sagebrush (50.4 acres) also present throughout (Figure 5.1-2). These herbaceous and shrub communities, which are associated with the riparian zone of the mainstem Santa Clara River, are more tolerant of the drier conditions in this unit.

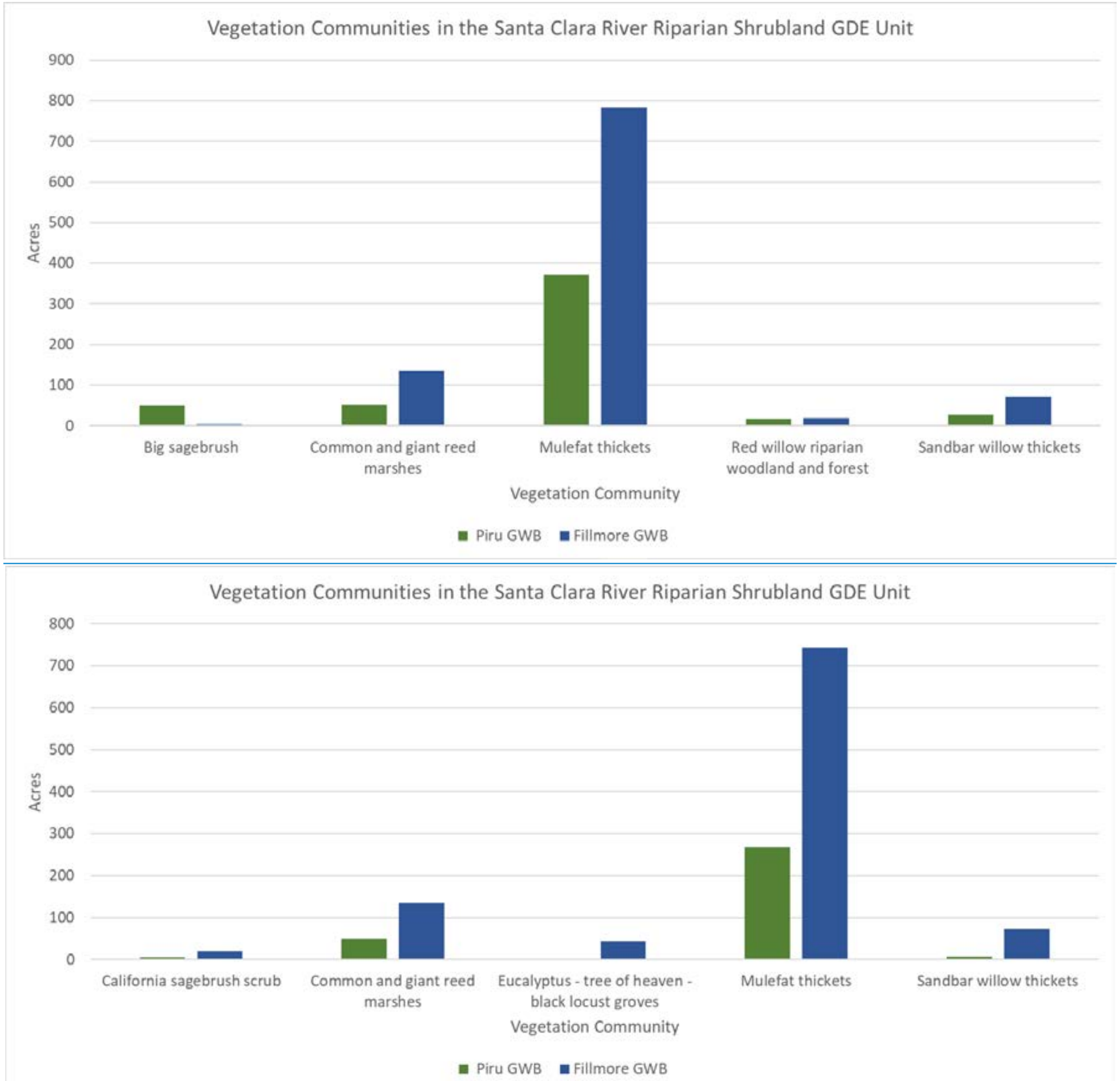


Figure 5-2~~5.1-2~~. Five most common vegetation communities in the Santa Clara River Riparian Shrubland GDE Unit, by acreage.

During parts of wetter years, interconnected surface waters may occur in the downstream end of Santa Clara River Riparian Shrubland in both the Fillmore and Piru basins, where groundwater levels are shallower than upstream portions of the unit. The extent of interconnected surface water relative to surface water derived from upstream is not known. Because interconnected surface waters likely only cover a portion of the Santa Clara River in this unit, and are likely short-lived, this unit may provide short-term habitat for aquatic species. Additional details for aquatic species are discussed in Section 4.2.

The Cienega GDE Unit contains 10~~2~~% (159.6 acres) of the mapped GDE units within the basin and is predominantly riparian habitat. Mulefat thickets (84.7 acres) and red willow riparian woodland and forest (44.0 acres) and are the dominant GDE types within this unit (Figure 5.1-3). These dominant vegetation communities are associated with the riparian zone and the historical Cienega wetland complex on the mainstem Santa Clara River. Prior to the 2012–2016 drought, cottonwoods and willows were much more common in this unit. Similar to the East Grove GDE Unit, the maximum rooting depths range from 2 ft for mulefat to 6.9 ft for the cottonwood and willow forests.

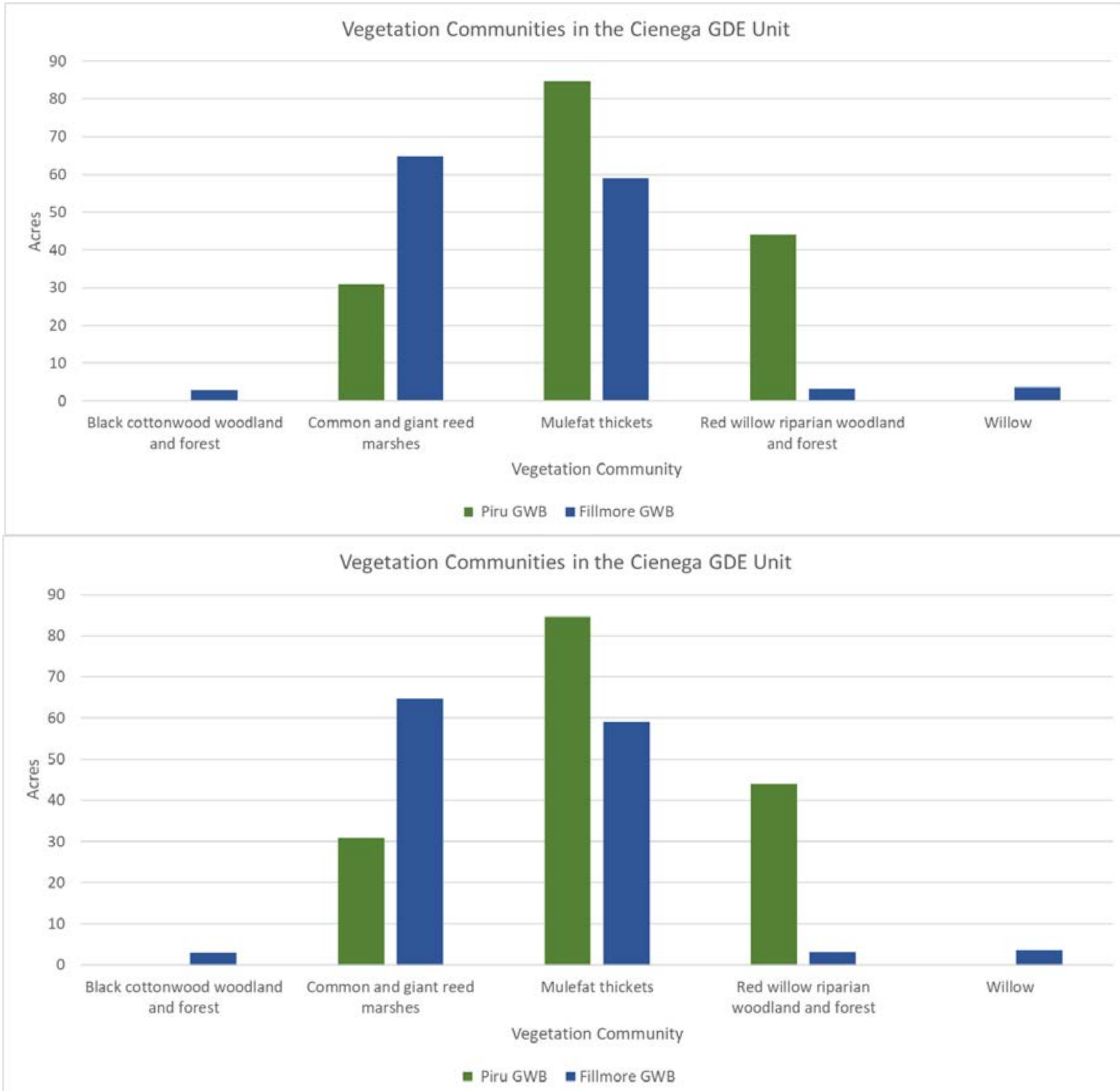


Figure 5-35.1-3. Five most common vegetation communities in the Cienega GDE Unit, by acreage.

The Cienega GDE unit supports interconnected surface water except for drought periods. Outside of drought periods, aquatic species use this reach of the Fillmore and Piru basins. Aquatic special-status species in the Cienega GDE unit are discussed in Section 4.2.

The Piru Creek Riparian GDE Unit contains 214% (314.9336.5 acres) of the mapped GDE units within the basin and is predominantly riparian habitat. Mulefat thickets (118.9 acres), Freemont cottonwood woodland and forest (92.8 acres), and red willow riparian woodland and forest (81.8 acres) are the dominant GDE types within this unit (Figure 5.1-4). These dominant vegetation communities are associated with the riparian zone of Piru Creek, which is a tributary to the Santa

Clara River. Similar to the East Grove Riparian Complex, the maximum rooting depths range from 2 ft for mulefat to 6.9 ft for the cottonwood and willow forests. Perennial flow in Piru Creek may sustain some of the plants.

Piru Creek is typically a losing reach downstream of Santa Felicia Dam. The presence and extent of interconnected surface water in Piru Creek is not known. Aquatic special-status species in the Piru Creek Riparian GDE unit are discussed in Section 4.2.

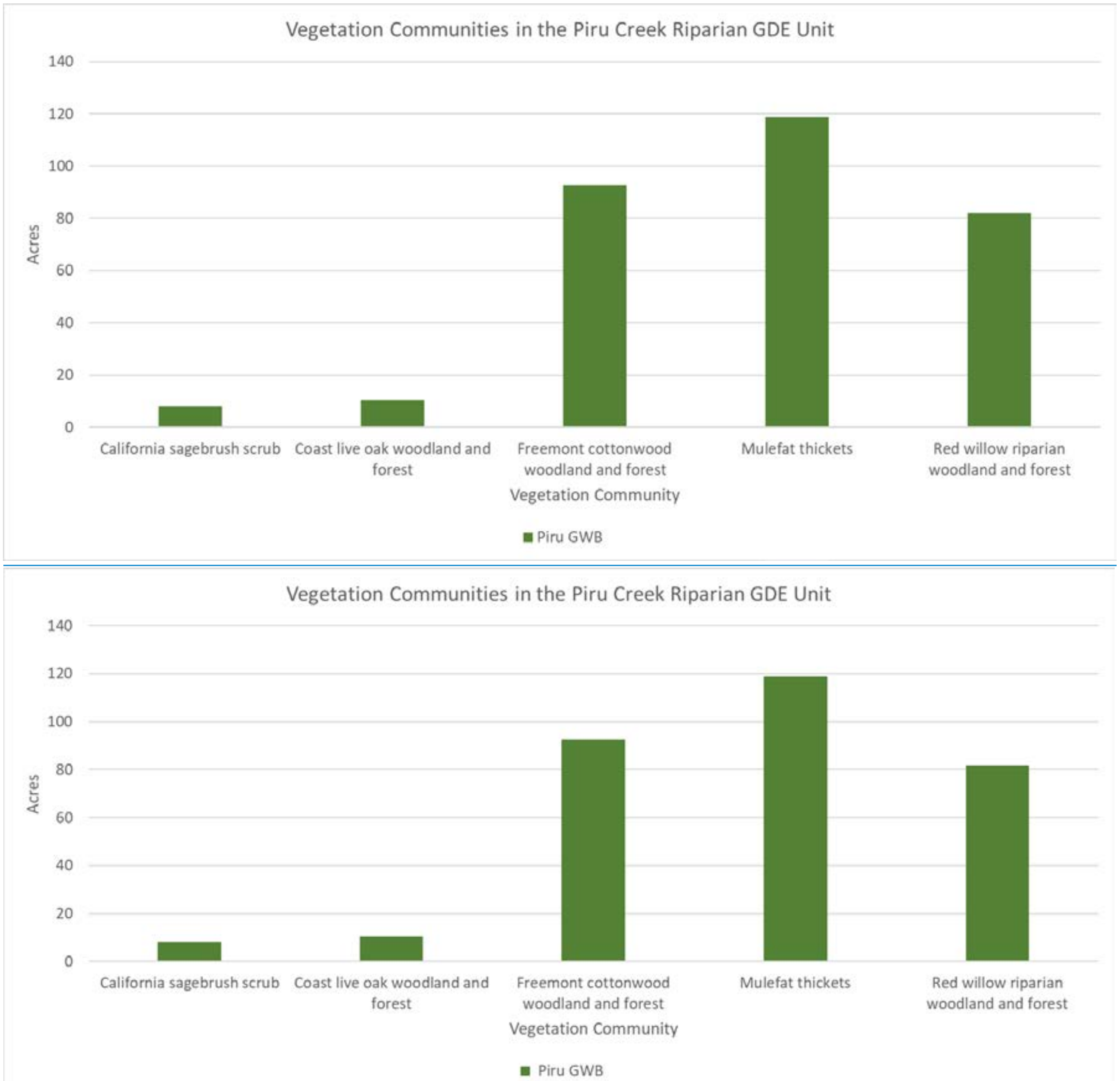
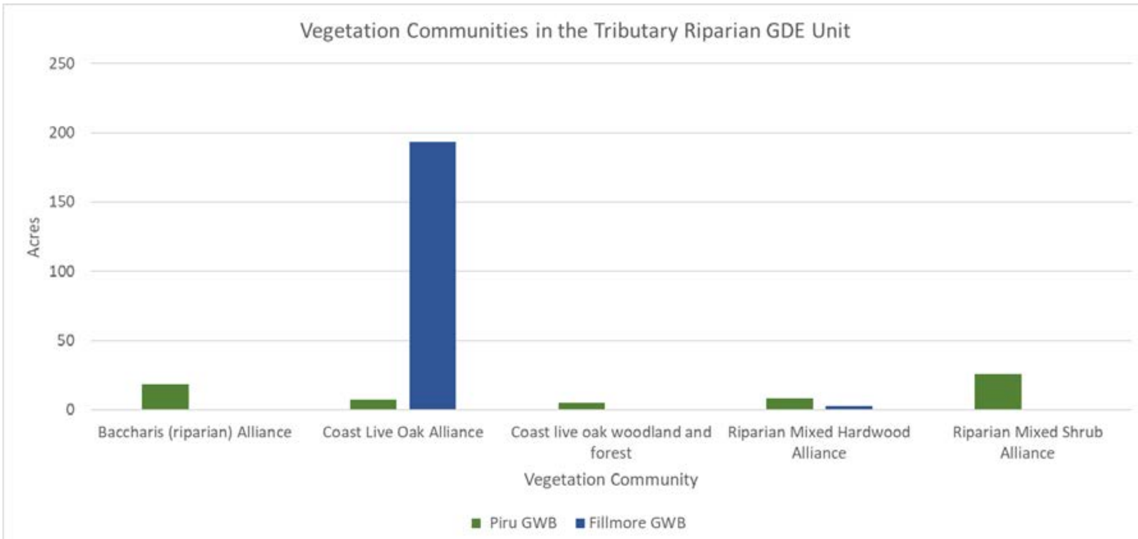


Figure 5-45.1-4. Five most common vegetation communities in the Piru Creek GDE Unit, by acreage.

The Tributary Riparian GDE Unit contains 4% (68.958.3 acres) of the mapped GDE units within the basin and is predominantly composed of Riparian Mixed Shrub Alliance (26.0 acres) and Baccharis (Riparian) Alliance (18.5 acres) (Figure 5.1-5). These vegetation communities are associated with drainages to Piru Creek and the Santa Clara River, including Holser and Hopper canyons. Vegetation along Holser Canyon is primarily comprised of Riparian Mixed Shrub

Alliance, while the vegetation along Hopper Canyon is a mixture of Riparian Mixed Shrub Alliance and Riparian Mixed Hardwood. Maximum rooting depths for these vegetation types are not well documented but likely range from 2.0 ft for *Baccharis* species (i.e., Riparian Mixed Scrub Alliance) to 6.9 ft or deeper for the cottonwood and willow species present in Riparian Mixed Hardwood Alliance. This GDE unit contains no shallow groundwater data to assess groundwater linkages, but the vegetation is likely not tied to the aquifer.



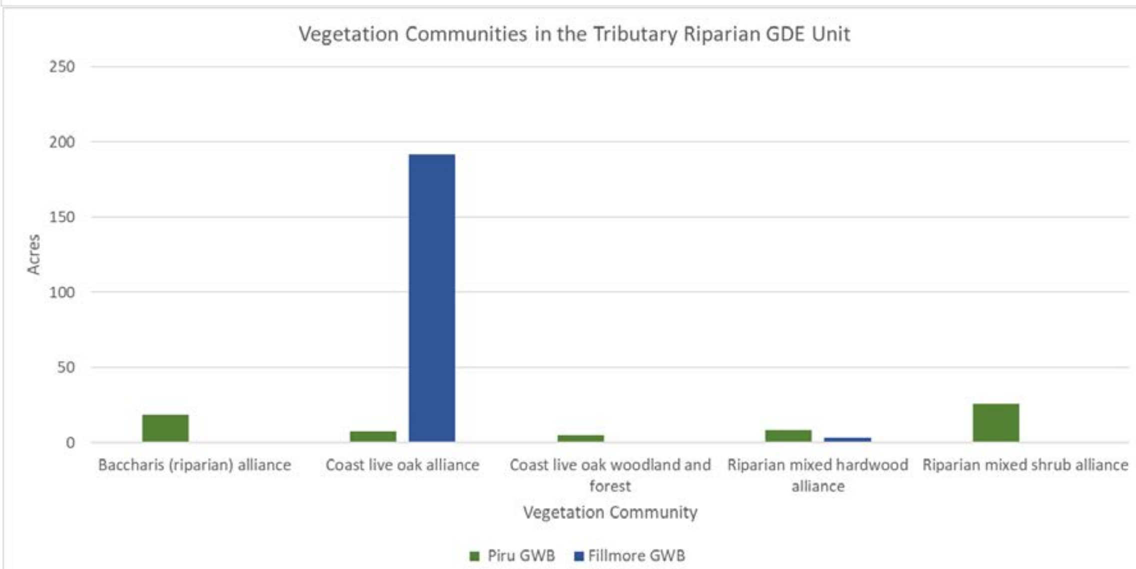


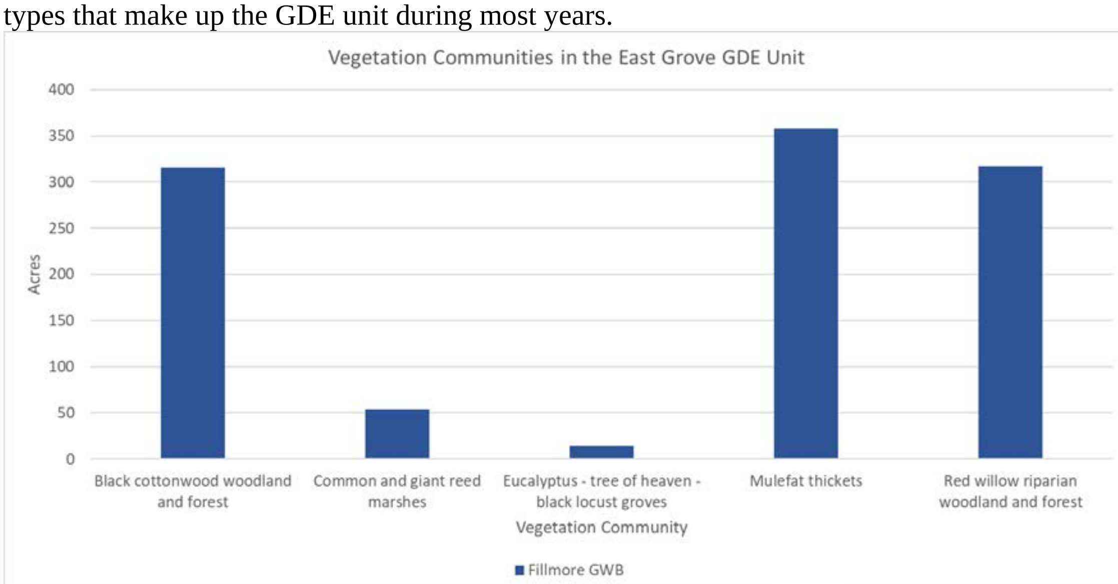
Figure 5-55.1-5. Five most common vegetation communities in the Tributary Riparian GDE Unit, by acreage.

Most of the streams within the Tributary Riparian unit are ephemeral or intermittent. Hopper Canyon Creek is intermittent at its downstream end, but the degree to which it is connected to groundwater in the upstream reaches within the Piru Basin is unknown. Pole Creek may sustain perennial flows in its uppermost reaches within the Fillmore Basin, but is intermittent downstream and disconnected from groundwater. The degree to which either of these tributaries were historically connected to groundwater in within the basin is unknown.

Fillmore

The Fillmore Groundwater Basin contains 2,~~582~~ 597 acres of mapped GDEs, comprising 11% of the total area of the basin. The East Grove and Santa Clara River Riparian Shrubland GDE are the largest units within the Fillmore Groundwater Basin, and vegetation types within the basin are predominately riparian communities. The most prevalent vegetation community across all GDE units is mulefat thickets (*Baccharis salicifolia* Shrubland Alliance), which makes up 47% of the mapped extent of GDEs in the basin. Red willow riparian woodland and forest (*Salix laevigata* Woodland Alliance) and black cottonwood woodland and forest (*Populus trichocarpa* Forest Alliance) are present in ~~14~~13% and ~~13~~12% of the GDE, respectively.

The East Grove GDE Unit contains 42~~3~~% (1,101.0~~9~~ acres) of mapped GDE units within the basin and is predominantly riparian habitat. Mulefat thickets (357.5 acres), red willow riparian woodland and forest (317.0 acres), and black cottonwood woodland and forest (31~~5.5~~7.0 acres) are the dominant GDE types within this unit (Figure 5.1-6). These dominant vegetation communities are associated with the riparian zone and the historical East Grove wetland complex on the mainstem Santa Clara River. Similar to the Del Valle GDE Unit, the maximum rooting depths range from 2 ft for mulefat to 6.9 ft for the cottonwood and willow forests. The groundwater elevation in the East Grove GDE Unit is within the rooting depth of the vegetation types that make up the GDE unit during most years.



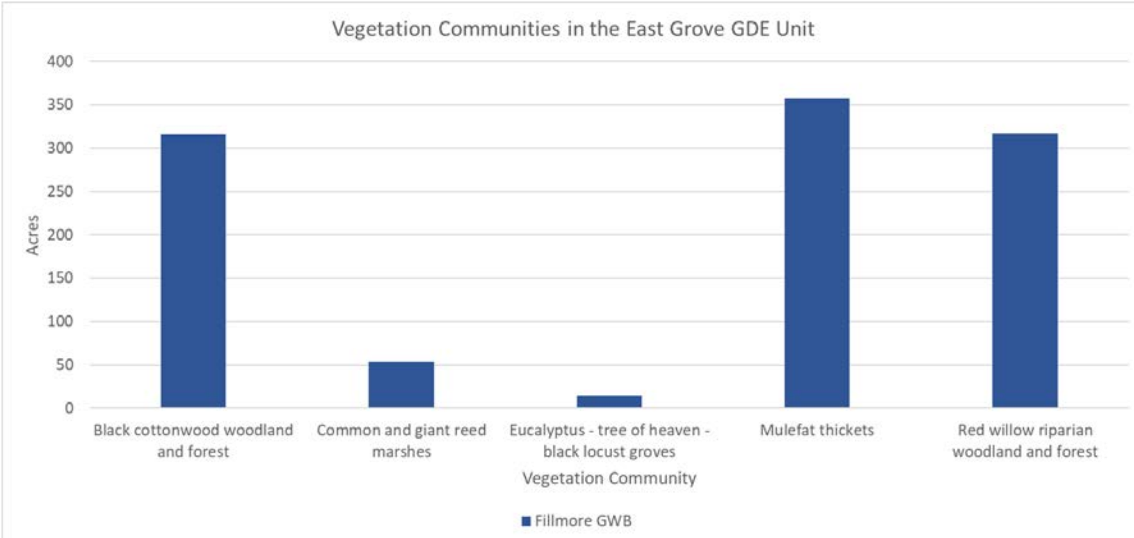


Figure 5-65.1-6. Five most common vegetation communities in the East Grove GDE Unit, by acreage.

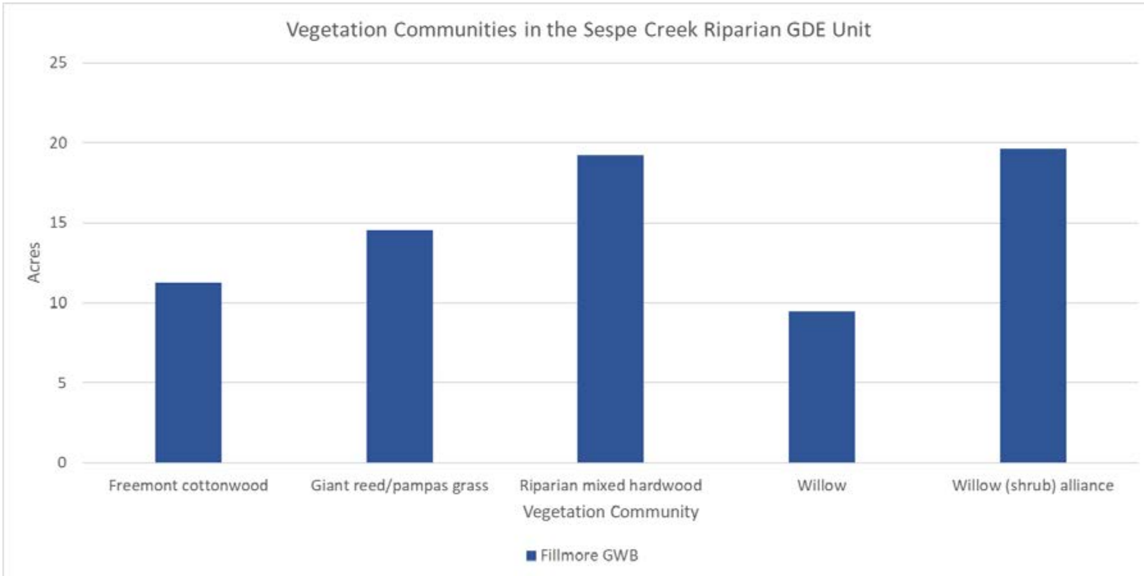
Due to rising groundwater, the East Grove GDE unit supports interconnected surface water. As shown in Section 3.3, the discharge and extent of interconnected surface water decreased during the drought form 2012–2016 in this unit. Because rising groundwater allowed surface discharge to persist over at least part of this reach during the drought, this GDE likely acted as a refuge for aquatic species during this period. Aquatic special-status species in the East Grove GDE unit are discussed in Section 4.2.

The Santa Clara River Riparian Shrubland GDE Unit contains 4041% (1,07346 acres) of mapped GDE units within the basin and is also predominantly riparian habitat. Mulefat thickets (743.6783.7 acres) and the common and giant reed marshes association (*Phragmites australis - Arundo donax* Herbaceous Semi-Natural Alliance; 134.3135.2 acres) are the dominant GDE types within this unit (Figure 5.1-2). These herbaceous and shrub communities, which are associated with the riparian zone of the mainstem Santa Clara River, are more tolerant of the drier conditions in this unit. Mulefat has maximum reported rooting depths of about 2 ft and Arundo (*Arundo donax*), the dominant plant species of the common and giant reed marshes Herbaceous Semi Natural Alliance, has rooting depths up to 16 ft (Appendix C). Comparing the rooting depths to the range of groundwater depths in Figure 3.2-2 shows that groundwater elevations are often within the maximum root depth of arundo and may be within the rooting depth of mulefat at lower relative elevations during particularly wet years, although such years were not common.

The Cienega GDE Unit contains 5% (133.6 acres) of the mapped GDE units within the basin and is predominantly riparian habitat. Common and giant reed marshes (64.8 acres) and mulefat thickets (59.0 acres) are the dominant GDE types within this unit (Figure 5.1-3). These dominant vegetation communities are associated with the riparian zone and the historical Cienega wetland complex on the mainstem Santa Clara River. The rooting depth ranges from 2 ft for mulefat to 16 ft for arundo (Appendix C). Mulefat thickets typically occur at higher relative elevation in the Santa Clara River despite their shallow rooting depth, suggesting that they are often disconnected from groundwater. Prior to the 2012–2016 drought, Fremont cottonwoods and willows (both with maximum rooting depths of 6.9 ft) were common. Kibler et al. (2019) have shown that much of the cottonwood and willow species died out during the drought where the drop in groundwater was 16.4 ft or greater. The mean relative elevation of willows in the Santa Clara River ranges from 4.8 to 12.4 ft, while Fremont cottonwoods have a mean relative elevation of 9.7 ft (Appendix C, Table C–2). Common and giant reed (arundo) have a maximum reported rooting depth of 16 ft and occur at a mean relative elevation of 7.6 ft (Appendix C).

The Tributary Riparian GDE Unit contains 8% (~~196.6~~195.1 acres) of the mapped GDE units within the basin and is predominantly composed of Coast Live Oak Alliance (19~~3.~~1.~~4~~9 acres), with Riparian Mixed Hardwood Alliance also present (3.2 acres) (Figure 5.1-5). These vegetation communities are associated with drainages from the mountain range to the north of the basin (i.e., Santa Paula Ridge and San Cayetano Mountain). Coast Live Oak has a rooting depth up to 35.1 ft, while the Riparian Mixed Hardwood Alliance has rooting depths up to 6.9 ft (Appendix C). Neither the groundwater depth nor the source of water for vegetation in this GDE is known. The tributaries are not perennial, which suggests that a combination of surface water and groundwater may support the riparian hardwood. The Coast Live Oak Alliance may tap other water sources.

The Sespe Creek Riparian GDE Unit contains 4% (~~103.4~~94.1 acres) of the mapped GDE units within the basin and is predominantly riparian habitat. Willow (shrub) Alliance (19.6 acres) and Riparian Mixed Hardwood Alliance (19.2 acres) are the dominant GDE types within this unit (Figure 5.1-7). These dominant vegetation communities are associated with the riparian zone of Sespe Creek, which is a tributary to the Santa Clara River. Maximum rooting depths for both willows and cottonwoods in the literature is 6.9 ft (Appendix C, Table C–2). The mean relative elevation of willows ranges from 4.8 to 12.4 ft in the Santa Clara River, while Fremont cottonwoods have a mean relative elevation of 9.7 ft (Appendix C, Table C–2). Data on the depth to groundwater are sparse but can exceed 30 ft in places.



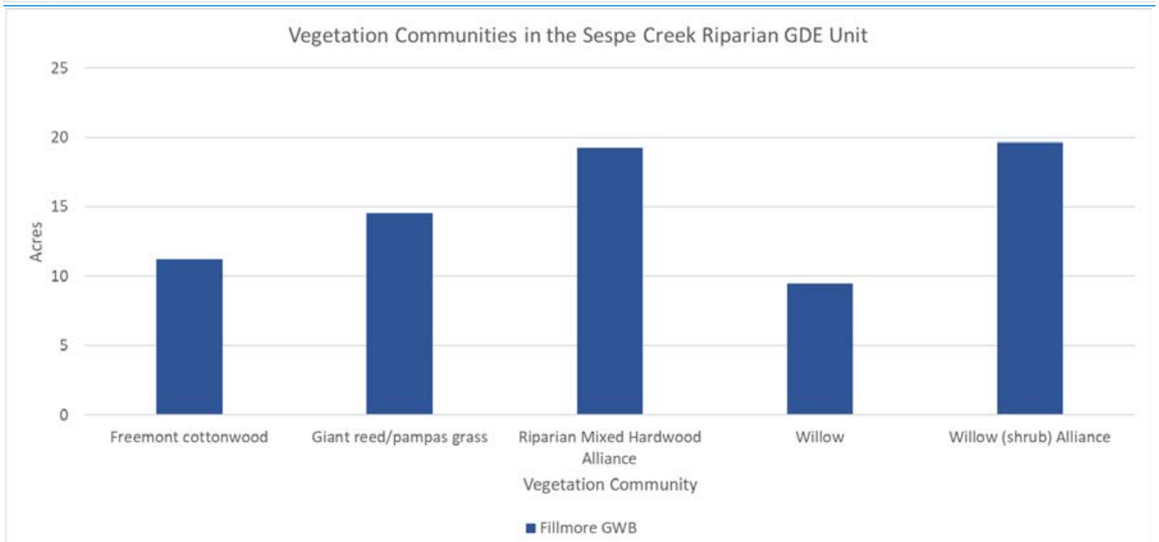


Figure 5-75.1-7. Five most common vegetation communities in the Sespe Creek Riparian GDE Unit, by acreage.

As discussed above, Sespe Creek is a losing reach in its downstream section and has perennial flow in its upstream section. The degree of interconnected surface water is not known in this reach. Aquatic special-status species in this unit are discussed in Section 5.2.

5.2 Beneficial Uses and Groundwater Dependent Special-status Species

5.2.1 Beneficial uses

The Water Quality Control Plan (Basin Plan) for the Los Angeles Region (LARWQCB 2014) identifies the surface waters in the GDE units as having a variety of beneficial uses pertaining to fish, wildlife, and GDEs. These beneficial uses apply to aquatic features that are fed by groundwater within the Fillmore and Piru groundwater basins. The beneficial uses for aquatic features and groundwater vary between aquatic features and include:

- Groundwater recharge (GWR);
- Freshwater replenishment (FRSH);
- Warm freshwater habitat (WARM);
- Cold freshwater habitat (COLD);
- Wildlife habitat (WILD);
- Preservation of biological habitats of special significance (BIOL);
- Support of habitat for rare, threatened, or endangered species (RARE);
- Warm and cold migration habitat (MIGR);
- Warmwater spawning habitat (SPWN); and
- Wetland habitat (WET).
- Aquaculture (AQUA).

Beneficial uses include those that directly benefit groundwater conditions (e.g., groundwater recharge [GWR]), those supported directly by groundwater via interconnected surface waters (e.g., freshwater replenishment [FRSH]; support of rare, threatened, or endangered species [e.g., Southern California steelhead, California condor] [RARE]), and those that apply to groundwater beneficial uses (i.e., aquaculture [AQUA]).

5.2.2 Special-status species

The Fillmore and Piru groundwater basins are ecologically important and provide habitat for numerous wildlife species that are groundwater dependent. Within the two groundwater basins, five plants, 11 natural communities, 10 wildlife, and four fish species were identified as indirectly or directly groundwater dependent and may occur within the Fillmore and Piru groundwater basins. Appendix B provides information for special-status terrestrial and aquatic wildlife species from the database queries that are not groundwater dependent and/or unlikely to occur in the GDE units, including each species' regulatory status, habitat associations, and documented occurrences in the groundwater basins.

The Fillmore and Piru groundwater basins include designated critical habitat for four federally listed species: California condor (*Gymnogyps californianus*), least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*), and southern California steelhead (*Oncorhynchus mykiss*) (USFWS 1976, USFWS 1977, USFWS 1994, USFWS 2013, NMFS 2005). The amount of critical habitat for each species within the Fillmore and Piru groundwater basins is shown in Table 5.2-1 and locations are shown in Figure 5.2-1. Critical habitat for the California condor occupies a 2-acre patch on the upland edge of the Fillmore Basin, and is not associated with any GDEs.

Table 5.2-1. U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) designated critical habitat[1] within the Fillmore and Piru groundwater basins.

Common name *Scientific name*	USFWS critical habitat (acres)			NMFS critical habitat (miles)		
	Fillmore	Piru	Total	Fillmore	Piru	Total
California condor *Gymnogyps californianus*	2	-	2	-	-	-
Least Bell's vireo *Vireo bellii pusillus*	-	1,443	1,443	-	-	-
Southwestern willow flycatcher	2,472	2,612	5,083	-	-	-

Empidonax traillii extimus						
Southern California steelhead *Oncorhynchus mykiss*	-	-	-	15.4	15.3	30.7
All species	**2,474**	**4,055**	**6,528**	**15.4**	**15.3**	**30.7**

[1] Data sources: USFWS 1976, USFWS 1977, USFWS 1994, USFWS 2013, NMFS 2005

Habitat management and special-status species recovery plans have been implemented in the Fillmore and Piru groundwater basins and include protections for special-status species and associated habitats. These plans include *United Water Conservation District Multiple Species Habitat Conservation Plan* (UWCD 2018), *Southern California Gas Company Multi-Species Habitat Conservation Plan* (SoCalGas 2020), *Santa Clara River Upper Watershed Conservation Plan* (TNC 2006), *Conservation Plan for the Lower Santa Clara River Watersheds and Surrounding Areas* (TNC 2008), and *Santa Clara River Enhancement and Management Plan* (VCWPD and LADPW 2005).

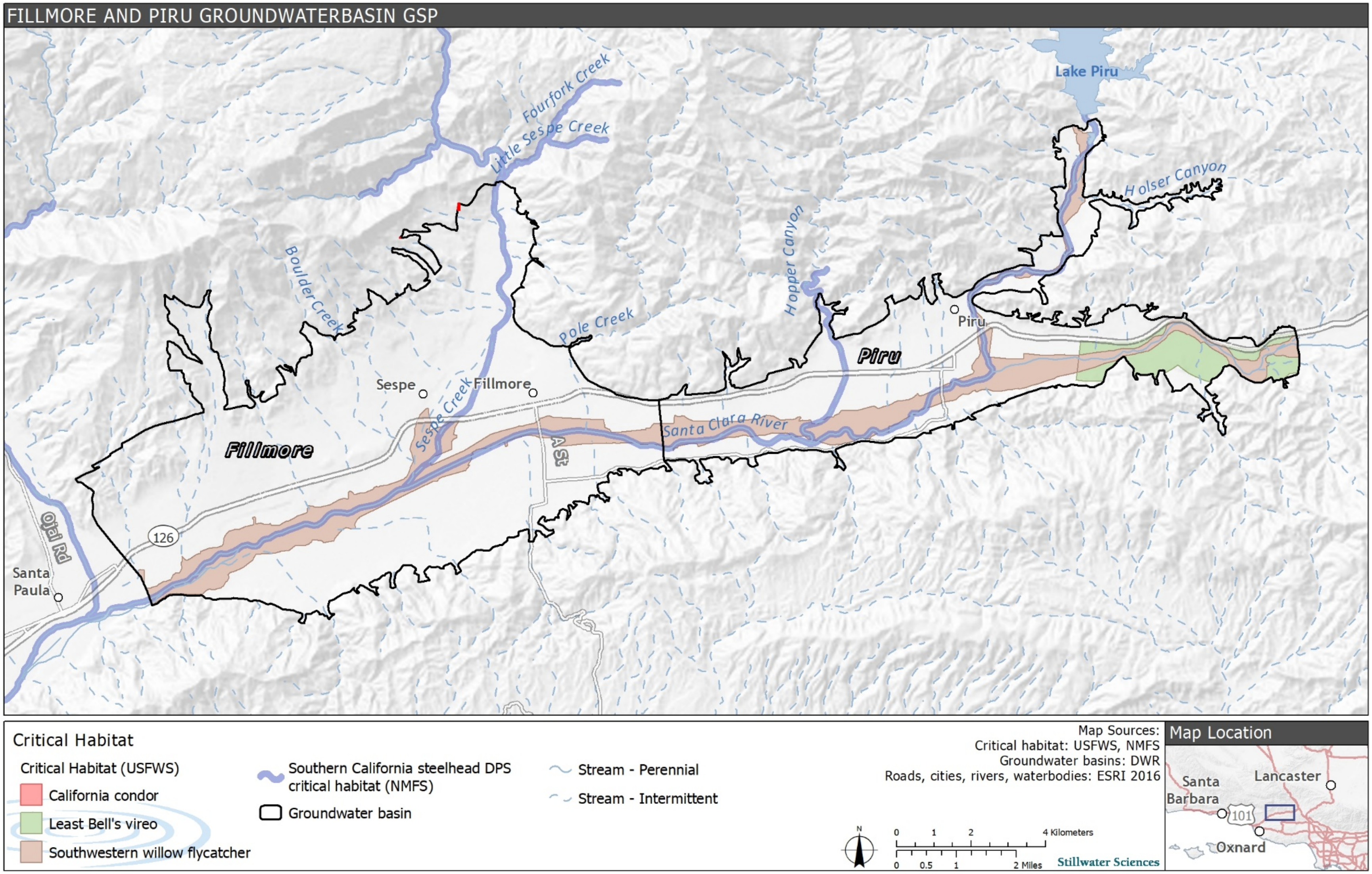


Figure 5-8~~5.2-1~~. Critical habitat within the Fillmore and Piru groundwater basins.

Piru

Plants and natural communities

Four potentially groundwater dependent special-status plant species were documented in the Piru Groundwater Basin (Table 5.2-2). One species, white rabbit-tobacco, was identified as likely to depend on groundwater and has been observed in the open rock and sand wash bed of the Santa Clara River within the Del Valle and Cienega GDE units. Three species were identified as possibly dependent on groundwater and are predominantly associated with the Tributary Riparian GDE Unit. Slender mariposa lily (*Calochortus clavatus* var. g*racilis*) and Greata's aster are both associated with Foothill Canyon habitats, and San Fernando Valley spineflower (*Chorizanthe parryi* var. *fernandina*), which has been observed directly upstream of the Piru Groundwater Basin, is associated with coastal sage scrub habitat.

Ten potentially groundwater dependent sensitive natural communities were documented with the potential to occur in the Piru Groundwater Basin (Table 5.2-2). Seven of these communities are identified as likely to depend on groundwater; these GDEs are predominantly riparian habitats (e.g., southern cottonwood willow riparian forest, southern willow scrub, and California sycamore woodlands [*Platanus racemosa – Quercus agrifolia* Woodland Alliance]) and occur throughout the basin in all of the GDE units present within the Piru Groundwater Basin (i.e., Del Valle, Santa Clara River Riparian Shrubland, Cienega, Piru Creek Riparian, and Tributary Riparian). Additional potentially groundwater dependent sensitive natural communities include arrow weed thickets [*Pluchea sericea* Shrubland Alliance], which is a shrubland community associated with intermittent or seasonally flooded washes and is documented in the Del Valle GDE Unit.

Table 5.2-2. Special-status plant species and sensitive natural communities with known occurrence within the Piru Groundwater Basin.

Common name ***Scientific name***	**Status**[1]	**Association with GDE**	**Occurrence location**	**Source**[2]	**Habitat and occurrence**
Plants					
Slender mariposa lily *Calochortus clavatus* var. *gracilis*	1B.2, S2S3, G4T2T3, not state or federally listed	Possible	Del Valle, Piru Creek Riparian, Tributary Riparian	CNDDB	Shaded foothill canyons, chaparral; eight regional CNDDB observations, primarily in sagebrush on north-facing slopes and ridges of Newhall Ranch area.
San Fernando Valley spineflower *Chorizanthe parryi* var. *fernandina*	1B.1, S1, G2T1, SE, FPT	Possible	Tributary Riparian	CNDDB	Sandy coastal scrub, valley and foothill grassland; single CNDDB record from 2011 in Potrero Canyon near its confluence with the Santa Clara River.
Payne's bush lupine *Lupinus paynei*	1B.1, S1, G1Q, not state or federally listed	Unlikely	Piru Creek Riparian	CNDDB	Coastal and riparian scrub, valley and foothill grassland, generally on sandy soils; single CNDDB record from 2008 in Rancho Temescal.
Ojai navarretia *Navarretia ojaiensis*	1B.1, S2, G2, not state or federally listed	Unlikely	Del Valle, Tributary Riparian	CNDDB	Openings in chaparral or coastal scrub, valley and foothill grassland, generally on clay soils; four CNDDB records on clay soil in grasslands of Ventura Homestead and Newhall Ranch areas.
White rabbit-tobacco *Pseudognaphalium leucocephalum*	2B.2, S2, G4, not state or federally listed	Likely	Cienega, Del Valle	CNDDB	Sandy or gravelly benches, dry stream or canyon bottoms; CNDDB records in sandy, rocky washes.
Greata's aster *Symphyotrichum greatae*	1B.3, S2, G2, not state or federally listed	Possible	Tributary Riparian	CNDDB	Mesic areas in broadleafed upland forest, chaparral, cismontane and riparian woodland; CNDDB records in Hopper and Pine canyons.

Common name ***Scientific name***	**Status**[1]	**Association with GDE**	**Occurrence location**	**Source**[2]	**Habitat and occurrence**
Sensitive Natural Communities					
Arrow weed thickets *Pluchea sericea* shrubland alliance	S3, G4	Likely	Del Valle	VMSCR	Around springs, seeps, irrigation ditches, canyon bottoms, stream borders, and seasonally flooded washes; occur in the Central Valley and desert areas of southern California.
California sycamore woodlands *Platanus racemosa – Quercus agrifolia* woodland alliance	S3, G3	Likely	Piru Creek Riparian	VMSCR	Riparian woodlands along intermittent streams, springs, seeps, riverbanks, and floodplain terraces; occur in scattered stands along California's central and southern Coast Ranges, the Sierra Nevada foothills, the Peninsular and Transverse ranges, and the western Mojave and Colorado deserts.
California walnut groves *Juglans californica* forest and woodland alliance	S3, G3	Unlikely	Piru Creek Riparian, Tributary Riparian	CalVeg, CNDDB, VMSCR	Riparian corridors, but most stands cover all hillslopes; occur along southern California coast and in Peninsular and Transverse ranges.
Fremont cottonwood forest and woodland *Populus fremontii – Fraxinus velutina – Salix gooddingii* forest and woodland alliance	S3, G4	Likely	Del Valle, Piru Creek Riparian, Santa Clara River Riparian Shrubland	CalVeg, VMSCR	On floodplains, along low-gradient rivers and streams, and in alluvial fans and valleys with a dependable subsurface water supply; occur throughout much of California except the Sierra Nevada and Modoc Plateau.
Scale broom scrub *Lepidospartum squamatum* shrubland alliance	S3, G3	Unlikely	Piru Creek Riparian, Santa Clara River Riparian Shrubland	CalVeg, VMSCR	Intermittently or rarely flooded, low-gradient alluvial deposits along streams, washes, and fans; occur in southern California in the inner central Coast Ranges, Transverse and Peninsular ranges, and the Mojave Desert.
Southern cottonwood willow riparian forest	S3.2, G3	Likely	Piru Creek Riparian	CNDDB	Frequently flooded lands along rivers and streams; occur in the Transverse and Peninsular ranges from Santa Barbara County south and east to the edge of the deserts.
Southern mixed riparian forest	S2.1, G2	Likely	Tributary Riparian	CNDDB	Frequently flooded lands along rivers and streams; sand and gravel bars close to river channels; occur along and at the mouths of perennial and intermittent streams of the southern Coast Ranges.
Southern riparian scrub	S3.2, G3	Likely	Santa Clara River Riparian Shrubland	CNDDB	Sand and gravel bars close to river channels; occur along and at the mouths of perennial and intermittent streams of the southern Coast Ranges.

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Occurrence location**	**Source[2]**	**Habitat and occurrence**
Southern willow scrub	S2.1, G3	Likely	Del Valle, Piru Creek Riparian, Santa Clara River Riparian Shrubland	CNDDB	Generally on alluvium deposited near stream channels during floods; occur along major rivers of coastal southern California.
Valley oak riparian	S2.1, G3	Unlikely	Tributary Riparian	CNDDB	Valley bottoms and gentle slopes that are intermittently flooded; occur in the Coast Ranges, Central Valley, and foothills of the Sierra Nevada, Cascade, and Klamath ranges.

[1] Status codes:

G = Global
T = Subspecies or variety

Federal
FT = Listed as threatened under the federal Endangered Species Act
FPT = Proposed as threatened under the federal Endangered Species Act
FD = Federally delisted

State
S = Sensitive
SE = Listed as Endangered under the California Endangered Species Act
ST = Listed as Threatened under the California Endangered Species Act
SSC = CDFW species of special concern
SFP = CDFW fully protected species

Rank
1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
3 Vulnerable—At moderate risk of extinction or elimination due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
4 Apparently Secure—Uncommon but not rare; some cause for long-term concern due to declines or other factors.
5 Demonstrably Secure—Common; widespread and abundant.
Q Taxonomic questions associated with this name
Ranks such as S2S3 indicate a ranking between S2 and S3

California Rare Plant Rank (CRPR)
1B Plants rare, threatened, or endangered in California and elsewhere
2B Plants rare, threatened, or endangered in California, but more common elsewhere
4 More information needed about this plant, a review list
4 Plants of limited distribution, a watch list

CRPR Threat Ranks:
0.1 Seriously threatened in California (high degree/immediacy of threat)
0.2 Fairly threatened in California (moderate degree/immediacy of threat)
0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known)

[2] Sources: CNDDB (CDFW 2019), CalVeg (USDA 2014), VMSCR (Vegetation Map of the Santa Clara River; Stillwater Sciences 2019).

Terrestrial and aquatic wildlife

Ten potentially groundwater dependent special-status terrestrial and aquatic wildlife species were identified as having the potential to occur within the Piru Groundwater Basin: one amphibian species, six bird species, and two reptile species (Table 5.2-3). Additional information on these species, including regulatory status, habitat associations, and documented occurrences in the groundwater basin, is provided in Table 5.2-3.

Southwestern pond turtle and two-striped gartersnake are the only wildlife species likely present (i.e., documented occurrences) in the Piru Groundwater Basin classified as directly groundwater dependent due to their association with riverine and lentic habitats. Southwestern pond turtles likely use habitat within the Del Valle, Cienega, and Piru Creek GDE units for foraging (e.g., open water), nesting (e.g., grasses and forbs alliance), and/or overwintering (e.g., mixed riparian and willow scrub and cottonwood or willow alliance). Two-striped gartersnake likely use freshwater (e.g., perennial riverine) and riparian (e.g., riparian mixed hardwood and/or shrub) habitats within the Del Valle, Cienega, and Piru Creek Riparian GDE units for capturing prey. One special-status species, arroyo toad (*Anaxyrus californicus*), was not documented in the Piru Groundwater Basin but is an included species that could possibly occur along the Santa Clara River and within the Del Valle, Cienega, and Piru Creek Riparian GDE units (VCWPD and LADPW 2005, Stillwater Sciences 2007c).

Indirectly groundwater dependent bird species use riparian habitat (e.g., willow/willow shrub, cottonwood, mixed riparian alliances) within the Del Valle GDE Unit, Santa Clara River Riparian Shrubland, Cienega GDE Unit, and Piru Creek Riparian GDE units for foraging, nesting, and migratory habitat. These GDE units include designated critical habitat for southwestern willow flycatcher (Del Valle [433 acres], Santa Clara River Riparian Shrubland [316 acres], Cienega [154 acres], and Piru Creek Riparian [246 acres]), and least Bell's vireo (Del Valle [436 acres] and Tributary Riparian [6 acres]). In general, least Bell's vireo requires smaller vegetation patches than southwestern willow flycatcher and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) (see Table 5.2-3).

Table 5.2-3. Groundwater dependent special-status terrestrial and aquatic wildlife species with known occurrence or suitable habit in the Piru Groundwater Basin.

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to occur in Piru Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Piru Groundwater Basin**
Amphibian						
Arroyo toad *Anaxyrus californicus*	FE/SSC	Possible (suitable habitat)	No documented occurrences	CAFSD	Direct	Washes, arroyos, sandy riverbanks, riparian areas with willows, sycamores, oaks, cottonwoods; needs exposed sandy streamsides with stable terraces for burrowing, with scattered vegetation for shelter, and areas of quiet water or pools free of predatory fishes with sandy or gravel bottoms without silt for breeding. Arroyo toads depend on groundwater for breeding in shallow still pools and riparian vegetation that provides foraging habitat (Rohde et al. 2019). Historically found in the upper and lower Santa Clara River basin and currently persists in Middle/Upper Piru Creek upstream of Lake Piru (Santa Clara River Trustee Council 2008). A habitat assessment conducted by Stillwater Sciences (2007c) estimated that there were 893 acres of potential habitat along Piru Creek below Santa Felicia Dam and the Santa Clara River upstream of the confluence with Piru Creek.
Reptile						
Two-striped gartersnake *Thamnophis hammondii*	BLMS, FSS/SSC	Likely	Cienega, Del Valle, Piru Creek Riparian	CNDDB, CAFSD	Direct	Highly aquatic snake species. Found in or near permanent fresh water, often along streams with rocky beds and riparian vegetation. Prey includes fish, fish eggs, tadpoles, newt larvae, small frogs and toads, leeches, and earthworms. Commonly found in the Santa Clara River watershed (UWCD 2018). Occurrences on Santa Clara River between Salt Creek and Summer Four Crossing in 2000; in spillway ponds downstream of Lake Piru in 2016, along Piru Creek near Piru Canyon Road in 2009 (CDFW 2019).

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in Piru Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Piru Groundwater Basin**
Southwestern pond turtle *Actinemys pallida*[5]	BLMS, FSS/SSC	Likely	Cienega, Del Valle, Piru Creek Riparian	CNDDB, CAFSD	Direct	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Feeds on aquatic plants, invertebrates, worms, frog and salamander eggs and larvae, crayfish, and occasionally frogs and fish. Relies on surface water that may be supported by groundwater (Rhode et al. 2019). Documented throughout the Santa Clara River and in parts of the Piru Creek watersheds. Occurrences include Santa Clara River upstream of Piru in 2000, spillway ponds and downstream of Lake Piru in 2016 (CDFW 2019).
Bird						
Least Bell's vireo *Vireo bellii pusillus*	FE/SE	Likely	Cienega, Del Valle, East Grove, Piru Creek Riparian, Sespe Creek Riparian	CNDDB, CAFSD	Indirect	Nests in dense vegetative cover of riparian areas; often nests in willow or mulefat; forages in dense, stratified canopy. This species relies on groundwater dependent vegetation in riparian areas, particularly during breeding periods (Rohde et al. 2019). Eats insects, fruits, and berries. Documented throughout the Santa Clara River and Piru Creek in the Piru Groundwater Basin (CDFW 2019, eBird 2021, WFVZ 2020c). Documented breeding occurs on the TNC Sespe Cienega property (WFVZ 2020c, eBird 2021). Critical habitat located along the Santa Clara River in the Del Valle Riparian Complex GDE Unit (USFWS 1994).
Southwestern willow flycatcher *Empidonax traillii extimus*	FE/SE	Likely	Del Valle	CNDDB, CAFSD	Indirect	Dense brushy thickets within riparian woodland often dominated by willows and/or alder, near permanent standing water. Reliant on groundwater dependent riparian vegetation, including for nest sites that are typically located near slow-moving streams, or side channels and marshes with standing water and/or wet soils (Rohde et al. 2019). Feeds on insects, fruits, and berries. Occurrences throughout the Santa Clara River (CDFW 2019, eBird 2021). Critical habitat located along the Santa Clara River in the Del Valle Riparian Complex and Piru Creek GDE units between the

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to occur in Piru Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Piru Groundwater Basin**
						confluence with Santa Clara River and Lake Piru (USFWS 2013).
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	BLMS, FSS, FT/SE	Likely	Del Valle	CNDDB	Indirect	Summer resident of valley foothill and desert riparian habitats; nests in open woodland with clearings and low, dense, scrubby vegetation. Reliant on groundwater dependent riparian vegetation for habitat (Rhode et al. 2019). Historical populations documented along the Santa Clara River 3.5 miles east of Piru in 1979 are possibly extirpated (CDFW 2019).

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in Piru Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Piru Groundwater Basin**
White-tailed kite *Elanus leucurus*	BLMS/SFP	Likely	Cienega, Del Valle, Piru Creek Riparian, Santa Clara River Riparian Shrubland	CNDDB	Indirect	Lowland grasslands and wetlands with open areas; nests in trees near open foraging area. Predominately preys on small mammals, but its diet also includes birds, and lizards. Occurrences along Santa Clara River and Piru Creek (CDFW 2019, eBird 2021, WFVZ 2020c).
Yellow warbler *Setophaga petechia*	–/SSC	Likely	Cienega, Del Valle, Piru Creek Riparian, Santa Clara River Riparian Shrubland	CNDDB	Indirect	Open canopy, deciduous riparian woodland close to water, along streams or wet meadows. Reliant on groundwater dependent riparian vegetation for breeding habitat (e.g., willows, alders, and cottonwoods). Typically eats insects. Occurrences along Santa Clara River and Piru Creek (CDFW 2019, eBird 2021, WFVZ 2020c).
Yellow-breasted chat *Icteria virens*	–/SSC	Likely	Cienega, Del Valle, Piru Creek Riparian	CNDDB, CAFSD	Indirect	Early successional riparian habitats with a dense shrub layer and an open canopy. Occurrences along Santa Clara River (CNDDB 2019, eBird 2021, WFVZ 2020c). Occurrences along Santa Clara River and Piru Creek (CDFW 2019, eBird 2021).

[1] Status codes:

Federal
FE = Listed as endangered under the federal Endangered Species Act
FT = Listed as threatened under the federal Endangered Species Act
FSS = Forest Service Sensitive Species
BLMS = Bureau of Land Management Sensitive Species

StateSE = Listed as Endangered under the California Endangered Species Act
SSC = CDFW species of special concern
SFP = CDFW fully protected species

[2] Potential to Occur:
Likely: the species *has* documented occurrences and the habitat is high quality or quantity
Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity
Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity
None: no potential to occur due to lack of habitat and/or the population is assumed extirpated

[3] Query source:
CAFSD: California Freshwater Species Database (TNC 2020)
CNDDB: California Natural Diversity Database (CDFW 2019)
eBird: (eBird 2021)

[4] Groundwater Dependent Ecosystem (GDE) association:
Direct: Species directly dependent on groundwater for some or all water needs
Indirect: Species dependent upon other species that rely on groundwater for some or all water needs

[5] Formerly *Emys marmorata marmorata*

Fish

The Santa Clara River in the Piru Groundwater Basin likely supports limited native fish populations because of the presence of sub-optimal water quality conditions (e.g., high temperature, low summer flows, low dissolved oxygen), poor habitat quality (e.g., low amounts of cover that provides refuge from predators and high flows), insufficient surface water connectivity (e.g., the watershed is 'flashy' during and following storm events [NMFS 2012] and this reach loses surface flowwater quickly following storms or drought conditions), and the presence of non-native fish (Stoecker and Kelley 2005), although there is limited peer-reviewed literature minimal literature regarding fish populations within these reaches (Kelley 2004). Piru Creek supports more diverse native and non-native fish species assemblages than the Santa Clara River because it has more instream shelter cover and more riparian vegetation than the Santa Clara River (Stoecker and Kelley 2005). Instream cover supports suitable spawning, feeding, and rearing habitat for fish. Disconnected ephemeral tributaries in the Piru Groundwater Basin can be used by fish species seasonally, but do not contain surface water year-round and are not connected to groundwater. Under its FERC license, United Water currently releases water downstream of Santa Felicia Dam from Lake Piru to support southern California steelhead passage through this reach when criteria for instream flows are triggered.

Four special-status fish species have the potential to occur in the interconnected reaches of the Piru Groundwater Basin (Table 5.2-4). The interconnected reaches include the Santa Clara River from the upstream boundary of the Piru Basin to near Las Brisas Bridge, within the Del Valle GDE Unit, and the downstream boundary of the Piru Basin near the Cienega GDE Unit. The extent of interconnected surface water near the Cienega GDE Unit varies seasonally and based on the water year type. An additional species, the Santa Ana sucker, occurs in the Piru Groundwater Basin and is listed as threatened under the federal Endangered Species Act, but those occurring in the Santa Clara River and tributaries have no special status due to uncertainties at the time of its listing regarding whether it is native to the Santa Clara River watershed. In the Piru Groundwater Basin, designated critical habitat for southern California steelhead includes the mainstem Santa Clara River upstream to the Piru Creek confluence, the lower 3 miles of Hopper Canyon Creek, and Piru Creek upstream to Santa Felicia Dam (Figure 5.2-1). Due to the life history complexities, steelhead is the term used to describe the anadromous life history type and *O. mykiss* is generally used when life history types are indistinguishable, such as juveniles that have not yet exhibited a life history strategy. Southern California steelhead (steelhead) are listed as endangered under the federal Endangered Species Act, but resident *O. mykiss* or "rainbow trout" are not. Steelhead For the purposes of this analysis, it is assumed steelhead use the mainstem Santa Clara River from the boundary with the Fillmore Basin upstream to Piru Creek primarily as a migration corridor for passage to and from suitable spawning areas in tributaries potentially including Hopper and Piru creeks because of a lack of Primary Constituent Elements for freshwater rearing sites present in the mainstem Santa Clara River for *O. mykiss* (NMFS 2008, Kelley 2004, NMFS 2012, Stoecker and Kelley 2005). As described previously, the Santa Clara River contains sub-optimal water quality and q, quantity and abundant non-native fish species, which limits rearing opportunities for native fish (NMFS 2012, Kelley 2004, Stoecker and Kelley 2005). Hopper Canyon Creek is intermittent within the Piru Basin and *O. mykiss* habitat on Hopper Canyon Creek is primarily upstream of the basin boundary (Francis 2010). Rainbow trout may also use these creeks and may travel between them.

Anadromous adult and juvenile steelhead passage in Santa Clara River within Piru Basin requires an appropriate magnitude and duration of flows for steelhead to safely pass upstream or downstream through the channels. Anadromous steelhead passage along the mainstem Santa Clara River between the confluences with Sespe Creek and Piru Creek (which includes the reaches of the Santa Clara River in the Piru Groundwater Basin) can occur at flows above approximately 700 cfs (Harrison et al. 2006). Flows of this magnitude occur for a few days per year during average and above average water year types (Harrison et al. 2006). Anadromous steelhead passage in Santa Clara River within Piru Basin requires an appropriate magnitude and duration of flows for steelhead to safely pass upstream or downstream through the channels. Only a small portion of the reach used for anadromous upstream and downstream steelhead passage (near the Cienega GDE Unit) has interconnected surface water. When adult passage occurs during high flows, rising groundwater is <5% of the total discharge (compare rising groundwater flow from Figure 3.3-1 with flows required for passage). The modeling results are discussed in Section 2.2.2.7 of the GSP. Moreover, rising groundwater only occurs over a limited extent of the reach between Fillmore and Piru creeks and is downstream of the main passage barrier near Santa Clara River confluence with Hopper Canyon Creek observed by Harrison et al. (2006). Rising groundwater is therefore likely not an important component of anadromous steelhead upstream passage. Generally, connected surface water and 0.4 feet of water depth is necessary for smolts to migrate downstream (CDFW 2017). However, the flow required to support 0.4 ft depth in the Piru Basin has not been studied and is unknown. Juvenile downstream emigration may occur between January and June (Booth 2020), although the majority of smolts captured downstream of Piru Groundwater Basin at the Freeman Diversion occurred between mid-March and late May in the Santa Clara River (Booth 2020). Smolt emigration requires spatially continuous surface flow including reaches outside of the zones of rising groundwater. Given the lack of information on both the flow requirement for emigrating smolts and the effect of rising groundwater on flows during emigration, the reliance on groundwater for smolt emigration within this reach is unknown.

There is no evidence of current summer juvenile rearing within the Santa Clara River in the Piru Basin, although summer fish surveys in the reach are sparse. Juvenile rearing conditions in the Santa Clara River in the Piru Basin are thought to be poor mainly due to high water temperatures, shallow water depths, low flows, and limited instream cover. Some limited juvenile rearing habitat for *O. mykiss* is possible where rising groundwater occurs near the Cienega GDE Unit or downstream of the water releases from Lake Piru in Piru Creek, possibly supporting cooler stream temperatures, but rearing juvenile *O. mykiss* have not been observed in this locationthe Santa Clara River in the Piru Basin.

Most of the fish species listed in Table 5.2-4 are likely to occur in perennial reaches within the basin. The anadromous species (i.e., steelhead and Pacific lamprey), non-migratory species, and other native aquatic species may occur in the intermittent reaches seasonally.

Table 5.2-4. Groundwater dependent special-status fish with known occurrence or suitable habit in the Piru Groundwater Basin.

Common name ***Scientific name***	**Native or introduced**	**Status[1] Federal/ State**	**Occurrence in interconnected reaches**	**Source(s)**	**Habitat and occurrence within the Piru Groundwater Basin**
Southern California steelhead *Oncorhynchus mykiss irideus*	Native	FE	Santa Clara River upstream to Piru Creek (likely migration, unlikely spawning and rearing), Piru Creek (possible migration, spawning, and rearing)	Howard et al. 2015, Howard and Booth 2016, ACS 2002, Stoecker and Kelley 2005	Occur in freshwater systems and require adequate water conditions suitable for migration (i.e., flow, dissolved oxygen levels within the surface water, and water temperature suitable for passage) and suitable substrate (i.e., gravels) for spawning. Juvenile *O. mykiss* require suitable cover, flow, foraging conditions, and cool temperatures for rearing. Juvenile emigration (i.e., outmigration to the ocean) requires water conditions suitable for migration. *O. mykiss* migration (both upstream and downstream) can occur in all surface water reaches of the Piru Groundwater Basin when flows are sufficiently high (Stoecker and Kelley 2005). *O. mykiss* spawning and rearing likely occurs in Piru Creek. Rearing could occur in the Santa Clara River, but is unlikely due to poor habitat and temperature conditions (Stoecker and Kelley 2005).

Common name ***Scientific name***	**Native or introduced**	**Status[1] Federal/ State**	**Occurrence in interconnected reaches**	**Source(s)**	**Habitat and occurrence within the Piru Groundwater Basin**
Pacific lamprey *Entosphenus tridentatus*	Native	SSC	Santa Clara River (possiblelikely migration, pre-spawning holding, rearing), Piru Creek (possibleunlikely migration, pre-spawning holding, spawning, rearing)	Chase 2001, United 2009, Reid 2015,, Stoecker and Kelley 2005 United 2018	Occurs in freshwater systems and requires adequate flows for migration, suitable substrate (i.e., gravels) for spawning, and adequate cover for pre-spawning holding. Juveniles (called ammocoetes) spend an extended period of time (between four and 10 years) rearing while burrowed in sediments filter feeding on organic material and require suitable cover, flow, foraging conditions, and cool temperatures. Juvenile migrant (called macropthalmia) emigration (i.e., outmigration to the ocean) requires water conditions suitable for migration (i.e., water velocity and water depth, dissolved oxygen levels within the surface water, and water temperature suitable for passage). No Pacific lamprey have been observed in the main stem Santa Clara River upstream of Freeman Diversion or in Piru Creek, however Pacific lamprey anywhere with perennial habitat can be considered potential habitat for Pacific lamprey with actual distribution and use subject to the constraints of suitable habitat and barriers to passagemigration (both upstream and downstream) is likely in all surface water reaches of the Piru Groundwater Basin when flows are sufficiently high (Reid 2015; United 2018Reid 2015).
Unarmored threespine stickleback *Gasterosteus aculeatus williamsoni*	Native	SE, FE, SFP	Likely in the Santa Clara River and possible in Piru Creek	ACS 2002, Swift et al. 1993, CDFW 2019	Occurs in freshwater rivers and streams. Unarmored threespine stickleback populations have been documented within the interconnected mainstem Santa Clara River (CDFW 2019), could occur within Piru Creek year-round, and likely use the disconnected tributary reaches when conditions are conducive to passage. Migration is largely localized and opportunistic; this species does not exhibit defined migration.

Common name ***Scientific name***	**Native or introduced**	**Status[1] Federal/ State**	**Occurrence in interconnected reaches**	**Source(s)**	**Habitat and occurrence within the Piru Groundwater Basin**
Santa Ana sucker *Catostomus santaanae*	Native	FT (not in Santa Clara River watershed)[3]	Likely in the Santa Clara River and Piru Creek	Howard and Booth 2016, United 2018, ACS 2002, Swift et al. 1993, CDFW 2019	Occurs in freshwater rivers and streams. The species has been observed within all surface water reaches (i.e., perennial tributaries, perennial mainstem, and ephemeral reaches) in the Piru Groundwater Basin (CDFW 2019, United 2018, Howard and Booth 2016). Recent genetics studies documented Santa Ana and Owens sucker hybrids (*Catostomus santaanae* x *fumeiventris*) within the Piru Groundwater Basin.
Arroyo chub *Gila orcutti*	Introduced (but native to other nearby watersheds)	SSC	Likely in Santa Clara River, likely in Piru Creek	Howard et al. 2015, United 2018, ACS 2002, CDFW 2019	Occurs in freshwater rivers and streams. Although arroyo chub, a CDFW SSC, is not native to the Santa Clara River watershed, CDFW protects the species within the watershed. Arroyo chub has been observed in the Del Valle ISW reach within the Piru Groundwater Basin and is likely to occur in the perennial tributary reaches and ephemeral reaches when conditions are conducive to passage (CDFW 2019, Howard et al. 2015, United 2018). Arroyo chub does not exhibit defined migration and the species' movement is largely localized and opportunistic.

[1] Federal
FE = Listed as endangered under the federal Endangered Species Act
FT = Listed as threatened under the federal Endangered Species Act
FSS = Forest Service Sensitive Species
BLMS = Bureau of Land Management Sensitive Species

State
SE = Listed as Endangered under the California Endangered Species Act
SSC = CDFW species of special concern
SFP = CDFW fully protected species

[2] Potential to Occur:
Likely: the species *has* documented occurrences and the habitat is high quality or quantity
Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity
Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity
None: no potential to occur due to lack of habitat and/or the population is assumed extirpated

[3] The Santa Ana sucker is federally threatened; however, because of previous uncertainty regarding whether it is native to the SCR watershed, United States Fish and Wildlife Service (USFWS) does not currently consider the species federally threatened within the SCR watershed (USFWS 2017).

Fillmore

Plants and natural communities

Four potentially groundwater dependent special-status plant species have been documented in the Fillmore Groundwater Basin (Table 5.2-5). One species, white rabbit-tobacco (*Pseudognaphalium leucocephalum*), was identified as likely to depend on groundwater. Multiple populations of white rabbit-tobacco have been observed in the open rock and sand wash bed of the Santa Clara River (East Grove GDE Unit), and at least one population has been documented within more densely wooded areas. Two species were identified as possibly dependent on groundwater, umbrella larkspur (*Delphinium umbraculorum*) and Greata's aster (*Symphyotrichum greatae*), both of which were observed in the mountain range to the north of the basin and are associated with moist oak forests and cismontane and riparian woodland, respectively. The fourth species, late-flowered mariposa lily (*Calochortus fimbriatus*) is unlikely to depend on groundwater.

Ten potentially groundwater dependent sensitive natural communities were documented with the potential to occur in the Fillmore Groundwater Basin (Table 5.2-5). Eight of these communities are identified as likely to depend on groundwater; these GDEs are predominantly within riparian habitats (e.g., black cottonwood woodland and forest, southern mixed riparian forest, southern riparian scrub) and occur in the East Grove and Sespe Creek Riparian GDE units. Additional potentially groundwater dependent sensitive natural communities include herbaceous communities associated with wetlands and marsh margins (e.g., hardstem and California bulrush marshes [*Schoenoplectus* (*acutus*, *californicus*) Herbaceous Alliance] and ashy ryegrass – creeping ryegrass turfs [*Leymus cinereus – Leymus triticoides* Herbaceous Alliance]), which were documented in the East Grove GDE Unit.

Table 5.2-5. Special-status plant species and natural communities with known occurrence within the Fillmore Groundwater Basin.

Common name ***Scientific name***	**Status**[1]	**Association with GDE**	**Documented Occurrences in GDE units**	**Source**[2]	**Habitat and occurrence**
Plants					
Late-flowered mariposa lily *Calochortus fimbriatus*	1B.3, S3, G3, not state or federally listed	Unlikely	Santa Clara River Riparian Shrubland, Tributary Riparian	CNDDB	Dry, open coastal and foothill woodland, chaparral; two CNDDB occurrences in the vicinity of Santa Paula Peak and Sespe Creek.
Umbrella larkspur *Delphinium umbraculorum*	1B.3, S3, G3, not state or federally listed	Possible	Tributary Riparian	CNDDB	Moist oak forest, foothill woodland; single CNDDB record from 1999 on the north side of Santa Paula Peak.
White rabbit-tobacco *Pseudognaphalium leucocephalum*	2B.2, S2, G4, not state or federally listed	Likely	Cienega, East Grove	CNDDB	Sandy or gravelly benches, dry stream or canyon bottoms; CNDDB records in sandy, rocky washes.
Greata's aster *Symphyotrichum greatae*	1B.3, S2, G2, not state or federally listed	Possible	Tributary Riparian	CNDDB	Mesic areas in broadleafed upland forest, chaparral, cismontane and riparian woodland; CNDDB records in Hopper and Pine canyons.
Sensitive Natural Communities					
Ashy ryegrass – creeping ryegrass turfs *Leymus cinereus – Leymus triticoides* herbaceous alliance	S3, G3	Likely	East Grove	VMSCR	Poorly drained floodplains, playas, drainage and valley bottoms, and marsh margins; occur throughout much of California at elevations below 10,000 ft.
Black cottonwood forest and woodland *Populus trichocarpa* forest and woodland alliance	S3, G5	Likely	Cienega, East Grove, Santa Clara River Riparian Shrubland, Sespe Creek Riparian	VMSCR	Seasonally flooded and permanently saturated soils on stream banks and alluvial terraces; occur throughout much of California except the Central Valley, Sacramento-San Joaquin Delta, and Mojave and Sonoran deserts.

Common name ***Scientific name***	**Status[1]**	**Association with GDE**	**Documented Occurrences in GDE units**	**Source[2]**	**Habitat and occurrence**
California walnut groves *Juglans californica* forest and woodland alliance	S3, G3	Unlikely	Sespe Creek Riparian, Tributary Riparian, Santa Clara River Riparian Shrubland	CalVeg, CNDDB, VMSCR	Riparian corridors, but most stands cover all hillslopes; occur along southern California coast and in Peninsular and Transverse ranges.
Fremont cottonwood forest and woodland *Populus fremontii – Fraxinus velutina – Salix gooddingii* forest and woodland alliance	S3, G4	Likely	Santa Clara River Riparian Shrubland	CalVeg, VMSCR	On floodplains, along low-gradient rivers and streams, and in alluvial fans and valleys with a dependable subsurface water supply; occur throughout much of California except the Sierra Nevada and Modoc Plateau.
Hardstem and California bulrush marshes *Schoenoplectus* (*acutus*, *californicus*) herbaceous alliance	S3S4, not globally ranked	Likely	East Grove	VMSCR	Brackish to freshwater marshes, stream banks and bars of river mouth estuaries, ponds and lake shores, sloughs, and roadside ditches; occur throughout most of California at elevations below 8,200 ft.
Scale broom scrub *Lepidospartum squamatum* shrubland alliance	S3, G3	Unlikely	Santa Clara River Riparian Shrubland, Sespe Creek Riparian	CalVeg, VMSCR	Intermittently or rarely flooded, low-gradient alluvial deposits along streams, washes, and fans; occur in southern California in the inner central Coast Ranges, Transverse and Peninsular ranges, and the Mojave Desert.
Southern cottonwood willow riparian forest	S3.2, G3	Likely	Sespe Creek Riparian	CNDDB	Frequently flooded lands along rivers and streams; occur in the Transverse and Peninsular ranges from Santa Barbara County south and east to the edge of the deserts.
Southern mixed riparian forest	S2.1, G2	Likely	Tributary Riparian	CNDDB	Typically, a younger successional stage of riparian forest due to disturbance or more frequent flooding.

Common name *Scientific name*	Status[1]	Association with GDE	Documented Occurrences in GDE units	Source[2]	Habitat and occurrence
Southern riparian scrub	S3.2, G3	Likely	East Grove, Santa Clara River Riparian Shrubland	CNDDB	Sand and gravel bars close to river channels; occur along and at the mouths of perennial and intermittent streams of the southern Coast Ranges.
Southern willow scrub	S2.1, G3	Likely	Santa Clara River Riparian Shrubland	CNDDB	Generally, on alluvium deposited near stream channels during floods; occur along major rivers of coastal southern California

[1] Status codes:

G = Global
T = Subspecies or variety

Federal
FT = Listed as threatened under the federal Endangered Species Act
FD = Federally delisted

State
S = Sensitive
SE = Listed as Endangered under the California Endangered Species Act
ST = Listed as Threatened under the California Endangered Species Act
SSC = CDFW species of special concern
SFP = CDFW fully protected species

Rank
1 Critically Imperiled—At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors.
2 Imperiled—At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
3 Vulnerable — At moderate risk of extinction or elimination due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
4 Apparently Secure — Uncommon but not rare; some cause for long-term concern due to declines or other factors.
5 Demonstrably Secure — Common; widespread and abundant.
Q Taxonomic questions associated with this name
Ranks such as S2S3 indicate a ranking between S2 and S3

California Rare Plant Rank (CRPR)
1B Plants rare, threatened, or endangered in California and elsewhere
2B Plants rare, threatened, or endangered in California, but more common elsewhere
4 More information needed about this plant, a review list
4 Plants of limited distribution, a watch list

CRPR Threat Ranks:
0.1 Seriously threatened in California (high degree/immediacy of threat)
0.2 Fairly threatened in California (moderate degree/immediacy of threat)
0.3 Not very threatened in California (low degree/immediacy of threats or no current threats known)

[2] Sources: CNDDB (CDFW 2019), CalVeg (USDA 2014), VMSCR (Vegetation Map of the Santa Clara River; Stillwater Sciences 2019).

Terrestrial and aquatic wildlife

Ten potentially groundwater dependent special-status terrestrial and aquatic wildlife species were identified as having the potential to occur within the Fillmore Groundwater Basin: one amphibian species, seven bird species, and two reptile species (Table 5.2-6). Additional information on these species, including regulatory status, occurrences in GDE units, habitat associations, and documented occurrences in the groundwater basin, is provided in Table 5.2-6.

Southwestern pond turtle (*Actinemys pallida*) and two-striped gartersnake (*Thamnophis hammondii*) are the only wildlife species likely present (i.e., documented occurrences) in the Fillmore Groundwater Basin classified as directly groundwater dependent due to their association with riverine and lentic habitats. Southwestern pond turtles likely use habitat within the Santa Clara River GDE units (i.e., Santa Clara River Riparian Shrubland, Cienega, and East Grove) and Sespe Creek Riparian GDE for foraging (e.g., open water), nesting (e.g., grasses and forbs alliance), and/or overwintering (e.g., mixed riparian and willow scrub and cottonwood or willow alliance). Two-striped gartersnake likely use freshwater (e.g., perennial riverine) and riparian (e.g., riparian mixed hardwood and/or shrub) habitats within the Santa Clara Riparian Shrubland, Sespe Creek Riparian GDEs for capturing prey. The arroyo toad was not documented within the Fillmore Groundwater Basin; however, suitable habitat within the East Grove and Sespe Creek Riparian GDE units (e.g., freshwater wetland; riverwash; and cottonwood, willow, or mixed riparian alliances) could potentially support all the toad's life history stages (breeding, larval juvenile rearing, juvenile and adult foraging).

Indirectly groundwater dependent bird species (i.e., least Bell's vireo, southwestern willow flycatcher, western yellow-billed cuckoo, white-tailed kite [*Elanus leucurus*], yellow warbler [*Setophaga petechia*], and yellow-breasted chat [*Icteria virens*]) use riparian habitat (e.g., willow/willow shrub, cottonwood, mixed riparian alliances) within the Santa Clara River GDE units (i.e., Santa Clara River Riparian Shrubland, Cienega, and East Grove) for foraging, nesting, and migrating. These GDE units include designated critical habitat for the southwestern willow flycatcher (Santa Clara River Riparian Shrubland [952 acres], Cienega Riparian Complex [116 acres], and East Grove [923 acres]). The California condor's designated critical habitat is not located within a GDE unit; habitat use in the Fillmore Basin GDE Units (e.g., Sespe Creek Riparian) may be limited to foraging.

Table 5.2-6. Groundwater dependent special-status terrestrial and aquatic wildlife species with known occurrence or suitable habit in the Fillmore Groundwater Basin.

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to** occur in **Fillmore Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Fillmore Groundwater Basin**
Amphibian						
Arroyo toad *Anaxyrus californicus*	FE/SSC	Possible	No documented occurrences	CAFSD	Direct	Washes, arroyos, sandy riverbanks, riparian areas with willows, sycamores, oaks, cottonwoods; needs exposed sandy streamsides with stable terraces for burrowing, with scattered vegetation for shelter, and areas of quiet water or pools free of predatory fishes with sandy or gravel bottoms without silt for breeding. The arroyo toad depends on groundwater for breeding in shallow still pools and riparian vegetation that provides foraging habitat (Rohde et al. 2019). It was historically found in the upper and lower Santa Clara River basin and currently persists in along Sespe Creek from Hot Springs Canyon upstream to the mouth of Tule Creek (Sweet 1992 as cited in USFWS 1999). Low potential to occur along the Santa Clara River (VCWPD and LADPW 2005).
Reptile						
Two-striped gartersnake *Thamnophis hammondii*	BLMS, FSS/SSC	Likely	Santa Clara Riparian Shrubland, Sespe Creek Riparian	CNDDB, CAFSD	Direct	Highly aquatic snake species. Found in or near permanent fresh water, often along streams with rocky beds and riparian vegetation. Prey includes fish, fish eggs, tadpoles, newt larvae, small frogs and toads, leeches, and earthworms. Commonly found in the Santa Clara River watershed (UWCD 2018). Occurrences along Santa Clara River bank on the south edge of Fillmore and on Sespe Creek (<1 mile upstream of the Sespe Creek Riparian GDE) unit in 2011 (CDFW 2019).

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to** occur in **Fillmore Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Fillmore Groundwater Basin**
Southwestern pond turtle *Actinemys pallida*[5]	BLMS, FSS/SSC	Likely	East Grove, Sespe Creek Riparian	CNDDB, CAFSD	Direct	Ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Feeds on aquatic plants, invertebrates, worms, frog and salamander eggs and larvae, crayfish, and occasionally frogs and fish. Relies on surface water that may be supported by groundwater (Rhode et al. 2019). Documented throughout the Santa Clara Rivera and Sespe Creek watersheds. Occurrences include Santa Clara River approximately 3 miles downstream of the confluence with Sespe Creek in 2016 and Sespe Creek between 2 and 4 miles north of Fillmore (CDFW 2019).

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to** occur in **Fillmore Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Fillmore Groundwater Basin**
Bird						
Least Bell's vireo *Vireo bellii pusillus*	FE/SE	Likely	Cienega, East Grove, Santa Clara River Riparian Shrubland	CNDDB, CAFSD	Indirect	Nests in dense vegetative cover of riparian areas; often nests in willow or mulefat; forages in dense, stratified canopy. This species relies on groundwater dependent vegetation in riparian areas, particularly during breeding periods (Rohde et al. 2019). Eats insects, fruits, and berries. Documented throughout the Santa Clara River and Sespe Creek in the Fillmore Groundwater Basin (CDFW 2019, eBird 2021, WFVZ 2020c). Documented breeding occurrences in the TNC properties listed: Sespe Cienega (Cienega) (eBird 2021), the Taylor property, and the Hedrick Ranch Nature Area (East Grove Riparian Complex); CDFW's Cienaga Springs Ecological Preserve (Cienega and Santa Clara River Riparian Shrubland) (WFVZ 2020a, WFVZ 2020b).
Southwestern willow flycatcher *Empidonax traillii extimus*	FE/SE	Likely	Cienega, East Grove, Santa Clara River Riparian Shrubland	CNDDB, CAFSD	Indirect	Dense brushy thickets within riparian woodland often dominated by willows and/or alder, near permanent standing water. Reliant on groundwater dependent riparian vegetation, including for nest sites that are typically located near slow-moving streams, or side channels and marshes with standing water and/or wet soils (Rohde et al. 2019). Feeds on insects, fruits, and berries. Occurrences throughout the Santa Clara River (CDFW 2019, eBird 2021). Critical habitat located along the Santa Clara River in the East Grove, Santa Clara River, and Cienega GDE units (USFWS 2013).

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to** occur in **Fillmore Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Fillmore Groundwater Basin**
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	BLMS, FSS, FT/SE	Likely	East Grove, Santa Clara River Riparian Shrubland	CNDDB	Indirect	Summer resident of valley foothill and desert riparian habitats; nests in open woodland with clearings and low, dense, scrubby vegetation. Reliant on groundwater dependent riparian vegetation for habitat (Rhode et al. 2019). Occurrences along Santa Clara River in the East Grove GDE (CDFW 2019, eBird 2021), and in TNC's Hedrick Ranch Nature Area (East Grove) (WFVZ 2020b). Historical populations documented along Sespe Creek west of Fillmore in 1924 are presumed extant (CDFW 2019).
White-tailed kite *Elanus leucurus*	BLMS/SFP	Likely	Cienega, East Grove, Santa Clara River Riparian Shrubland	CNDDB	Indirect	Lowland grasslands and wetlands with open areas; nests in trees near open foraging area. Predominately preys on small mammals, but its diet also includes birds and lizards. Occurrences along Santa Clara River (CDFW 2019, eBird 2021, WFVZ 2020c). Breeding documented in CDFW's Cienaga Springs Ecological Preserve (Cienega and Santa Clara River Riparian Shrubland) (WFVZ 2020a).
Yellow warbler *Setophaga petechia*	–/SSC	Likely	Cienega, East Grove, Santa Clara River Riparian Shrubland, Sespe Creek Riparian,	CNDDB	Indirect	Open canopy, deciduous riparian woodland close to water, along streams or wet meadows. Reliant on groundwater dependent riparian vegetation for breeding habitat (e.g., willows, alders, and cottonwoods). Typically eats insects. Occurrences along Santa Clara River (CNDDB 2019, eBird 2021, WFVZ 2020c) and near Sespe Creek at Grand Avenue terminus (CNDDB 2019, eBird 2021). Breeding documented in CDFW's Cienaga Springs Ecological Preserve (Cienega) (WFVZ 2020a), and TNC's Taylor property and the Hedrick Ranch Nature Area (East Grove) (WFVZ 2020b).

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to** occur in **Fillmore Groundwater Basin[2]**	**Documented occurrences in GDE units**	**Query source[3]**	**GDE association[4]**	**Habitat and documented occurrences in Fillmore Groundwater Basin**
Yellow-breasted chat *Icteria virens*	–/SSC	Likely	Cienega, East Grove, Santa Clara River Riparian Shrubland	CNDDB, CAFSD	Indirect	Early successional riparian habitats with a dense shrub layer and an open canopy. Occurrences along Santa Clara River (CDFW 2019, eBird 2021, WFVZ 2020c). Breeding documented in CDFW's Cienaga Springs Ecological Preserve (Cienega) (WFVZ 2020a), and suspected breeding in TNC's Hedrick Ranch Nature Area (East Grove) (WFVZ 2020b).

[1] Status codes:

Federal
- FE = Listed as endangered under the federal Endangered Species Act
- FT = Listed as threatened under the federal Endangered Species Act
- FSS = Forest Service Sensitive Species
- BLMS = Bureau of Land Management Sensitive Species

State
- SE = Listed as Endangered under the California Endangered Species Act
- SSC = CDFW species of special concern
- SFP = CDFW fully protected species

[2] Potential to Occur:
- *Likely:* the species *has* documented occurrences and the habitat is high quality or quantity
- *Possible:* no documented occurrences and the species' required habitat is moderate to high quality or quantity
- *Unlikely:* no documented occurrences and the species' required habitat is of low to moderate quality or quantity
- *None:* no potential to occur due to lack of habitat and/or the population is assumed extirpated

[3] Query source:
- CAFSD: California Freshwater Species Database (TNC 2020)
- CNDDB: California Natural Diversity Database (CDFW 2019)
- eBird: (eBird 2021)

[4] Groundwater Dependent Ecosystem (GDE) association:
- Direct: Species directly dependent on groundwater for some or all water needs
- Indirect: Species dependent upon other species that rely on groundwater for some or all water needs

[5] Formerly *Emys marmorata marmorata*

Fish

Fish are dependent on groundwater if they use interconnected surface water as part of their life cycle, including spawning, rearing, and migration. As discussed in Section 3.3, interconnected surface waters in the Fillmore Groundwater Basin occur in along the East Grove and Cienega GDE units of the Santa Clara River and likely in portions of Sespe Creek.

The mainstem Santa Clara River likely supports limited native fish populations because of the presence of sub-optimal water conditions (e.g., high temperature, low dissolved oxygen), poor habitat quality (e.g., low amounts of cover that provides refuge from predators and high flows), insufficient surface water connectivity (e.g., the watershed is ‘flashy’ during and following storm events [NMFS 2012] and large portions of this reach lose surface flows~~s water~~ quickly following storms or drought conditions), and the presence of non-native fish (Stoecker and Kelley 2005), although there is minimal literature regarding fish populations within these reaches (Kelley 2004). Sespe Creek supports diverse native and non-native fish species assemblages as it has more instream shelter cover and more riparian vegetation than the Santa Clara River (Stoecker and Kelley 2005). Instream cover supports suitable spawning, feeding, and rearing habitat for fish. Disconnected ephemeral tributaries in the Fillmore Groundwater Basin can be used by fish species seasonally, but do not contain surface water year-round and are not connected to groundwater and thus not considered here.

Four special-status fish species have the potential to occur in the interconnected reaches of the Fillmore Groundwater Basin (Table 5.2-7). An additional species, the Santa Ana sucker, occurs in the Fillmore Groundwater Basin and is listed as threatened under the federal Endangered Species Act, but those occurring in the Santa Clara River and tributaries have no special status due to uncertainties at the time of its listing regarding whether it is native to the Santa Clara River watershed. In the Fillmore Groundwater Basin, the National Marine Fisheries Service (NMFS) designated critical habitat for southern California steelhead in the mainstem Santa Clara River and Sespe Creek (Figure 5.2-1).

Similar to the Piru Basin, it is assumed the Santa Clara River in the Fillmore Groundwater Basin is primarily a migration corridor for adult and juvenile *O. mykiss* (Kelley 2004, Stoecker and Kelley 2005). *O. mykiss* utilize the mainstem Santa Clara River for passage to suitable spawning areas in Sespe Creek and further upstream to Piru Creek and to emigrate from the Santa Clara River to the estuary and/or Pacific Ocean as smolts. A small population of *O. mykiss* may utilize Pole Creek, but access issues within the Fillmore and Piru Basin may limit migration (Stoecker and Kelley 2005, Kajtaniak 2008). Rising groundwater supplies only a small portion of the flows required for anadromous steelhead passage to upstream spawning grounds, calculated by comparing the measured rising groundwater flows shown in Figure 3.3-1 with minimum passage requirements determined by Harrison et al. (2006). Harrison et al. (2006) found the minimum depth for anadromous steelhead passage in the mainstem Santa Clara River in the Fillmore Basin occurred at discharges of 500 cfs downstream of the confluence with Sespe Creek (Harrison et al. 2006). The groundwater models suggest that decreasing groundwater pumping by half reduces the flow of interconnected surface water by an average of 4.7 cfs, and ranges from 0.7–10 cfs at Willard Road at the downstream end of the East Grove GDE (see section 2.2.2.7 of the GSP for a discussion of these modeling results). Reducing groundwater pumping by half would therefore supply approximately <1–2% of the discharge required for anadromous steelhead passage. Moreover, the critical riffles (riffles which are a barrier to passage at some flows) identified by Harrison et al. (2006) do not correspond to areas of rising groundwater, further reducing the effects of groundwater management on passage flows. As discussed in the Piru Basin connected surface water and 0.4 feet of water depth is generally necessary for smolts to migrate downstream (CDFW 2017). However, necessary flows for downstream migrants within the Fillmore

Groundwater Basin has not been studied and is unknown. Juvenile downstream emigration may occur between January and June (Booth 2020), although the majority of smolts captured downstream of Fillmore Groundwater Basin occurred between mid-March and late May in the Santa Clara River (Booth 2020). Because the minimum surface water flows required for downstream passage are unknown for emigrating smolts, the influence of groundwater management on downstream passage is not clear for the Fillmore Groundwater Basin. Additional data on emigrating passage requirements is necessary to assess the influence of groundwater management on surface flows during downstream passage.

Native fish, including *O. mykiss*, Pacific lamprey, unarmored threespine stickleback, and Santa Ana sucker, and the non-native, protected (i.e., CDFW species of special concerns species) arroyo chub could utilize perennial reaches of the Santa Clara River for movement, spawning, and rearing along the East Grove and Cienega GDE units and the upper portions of Sespe Creek year-round and intermittent reaches when water is present. However, there are few studies of fish occurrence in these reaches. *O. mykiss* utilizing the mainstem Santa Clara River for spawning and rearing in the Fillmore and Piru basin is thought to be unlikely (Stoecker and Kelley 2005) but has not been widely investigated.

Table 5.2-7. Groundwater dependent special-status fish with known occurrence or suitable habit in the Fillmore Groundwater Basin.

Common name ***Scientific name***	**Native or introduced**	**Status[1] Federal/ State**	**Occurrence in interconnected reaches**	**Source(s)**	**Habitat and occurrence within the Fillmore Groundwater Basin**
Southern California steelhead *Oncorhynchus mykiss irideus*	Native	FE	Santa Clara River (migration likely, spawning and rearing unlikely), Sespe Creek (likely migration, spawning, and rearing)	Howard et al. 2015, Howard and Booth 2016, United 2018, ACS 2002, Stoecker and Kelley 20005	Occurs in freshwater systems and requires adequate water conditions suitable for migration (i.e., flow, dissolved oxygen levels within the surface water, and water temperature suitable for passage) and suitable substrate (i.e., gravels) for spawning. Juvenile *O. mykiss* require suitable cover, flow, foraging conditions, and cool temperatures for rearing. Juvenile emigration (i.e., outmigration to the ocean) requires water conditions suitable for migration. *O. mykiss* migration (both upstream and downstream) can occur in all surface water reaches of the Fillmore Groundwater Basin when flows are sufficiently high (Stoecker and Kelley 2005). *O. mykiss* spawning and rearing occurs in Sespe Creek. Rearing is unlikely in the Santa Clara River due to poor habitat and temperature conditions (Stoecker and Kelley 2005).

Common name ***Scientific name***	**Native or introduced**	**Status[1] Federal/ State**	**Occurrence in interconnected reaches**	**Source(s)**	**Habitat and occurrence within the Fillmore Groundwater Basin**
Pacific lamprey *Entosphenus tridentatus*	Native	SSC	Santa Clara River (likely migration, pre-spawning holding, rearing), Sespe Creek (likely migration, pre-spawning holding, spawning, rearing)	Chase 2001, ~~United 2009 Reid 2015,~~ Stoecker and Kelley 2005, Reid 2015, United 2018	Occurs in freshwater systems and requires adequate flows for migration, suitable substrate (i.e., gravels) for spawning, and adequate cover for pre-spawning holding. Juveniles (called ammocoetes) spend an extended period of time (between four and 10 years) rearing while burrowed in sediments filter feeding on organic material and require suitable cover, flow, foraging conditions, and cool temperatures. Juvenile migrant (called macropthalmia) emigration (i.e., outmigration to the ocean) requires water conditions suitable for migration (i.e., water velocity and water depth, dissolved oxygen levels within the surface water, and water temperature suitable for passage). ~~Pacific lamprey migration (both upstream and downstream) is likely in all surface water reaches of the Fillmore Groundwater Basin when flows are sufficiently high (Stoecker and Kelley 2005).~~ Pacific lamprey have not been observed upstream of the Freeman Diversion in the mainstem Santa Clara River, however Pacific lamprey spawning and rearing ~~occurs~~ is documented in Sespe Creek (Reid 2015); therefore, logically, Pacific lamprey must migrate through the mainstem Santa Clara River portion of the Fillmore Groundwater Basin to get to Sespe Creek.
Unarmored threespine stickleback *Gasterosteus aculeatus williamsoni*	Native	SE, FE, SFP	Likely in the Santa Clara River, possible in Sespe Creek	ACS 2002, Swift et al. 1993, CDFW 2019	Occurs in freshwater rivers and streams. Unarmored threespine stickleback populations have been documented within the interconnected mainstem Santa Clara River (CDFW 2019), could occur within Sespe Creek year-round, and likely use the disconnected tributary reaches

Common name *Scientific name*	Native or introduced	Status[1] Federal/ State	Occurrence in interconnected reaches	Source(s)	Habitat and occurrence within the Fillmore Groundwater Basin
					when conditions are conducive to passage. Migration is largely localized and opportunistic; this species does not exhibit defined migration.

Common name ***Scientific name***	**Native or introduced**	**Status[1] Federal/ State**	**Occurrence in interconnected reaches**	**Source(s)**	**Habitat and occurrence within the Fillmore Groundwater Basin**
Santa Ana sucker *Catostomus santaanae*	Native	FT (not in Santa Clara River watershed)[3]	Likely in the Santa Clara River and Sespe Creek	Howard and Booth 2016, United 2018, ACS 2002, Swift et al. 1993, CDFW 2019	Occurs in freshwater rivers and streams. The species occurs within all surface water reaches in the Fillmore Groundwater Basin (CDFW 2019, United 2018, Howard and Booth 2016). Recent genetics studies reveal the presence of the Santa Ana and Owens sucker hybrid (*Catostomus santaanae* x *fumeiventris*) within Fillmore Groundwater Basin.
Arroyo chub *Gila orcutti*	Introduced (but native to other nearby watersheds)	SSC	Likely in the Santa Clara River, possible in Sespe Creek	Howard et al. 2015, United 2018, ACS 2002, CDFW 2019	Occurs in freshwater rivers and streams. Although arroyo chub, a CDFW SSC, is not native to the Santa Clara River watershed, CDFW protects the species within the watershed. Arroyo chub occurs in the perennial mainstem within Fillmore and is likely to occur in the perennial tributary reaches and ephemeral reaches when conditions are conducive to passage (CDFW 2019, Howard et al. 2015, United 2018). Arroyo chub does not exhibit defined migration and the species' movement is largely localized and opportunistic.

[1] Status codes:

Federal		State	
FE	= Listed as endangered under the federal Endangered Species Act	SE	= Listed as Endangered under the California Endangered Species Act
FT	= Listed as threatened under the federal Endangered Species Act	SSC	= CDFW species of special concern
FSS	= Forest Service Sensitive Species	SFP	= CDFW fully protected species
BLMS	= Bureau of Land Management Sensitive Species		

[2] Potential to Occur:

Likely: the species *has* documented occurrences and the habitat is high quality or quantity
Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity
Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity
None: no potential to occur due to lack of habitat and/or the population is assumed extirpated

[3] The Santa Ana sucker is federally threatened; however, because of previous uncertainty regarding whether it is native to the SCR watershed, United States Fish and Wildlife Service (USFWS) does not currently consider the species federally threatened within the SCR watershed (USFWS 2017)

5.3 Invasive Species

Non-native and invasive species are distributed throughout the Santa Clara River watershed, including the Fillmore and Piru groundwater basins. Invasive species have a negative impact on the riparian corridor and threaten native species populations. Two invasive plant species, arundo (giant reed; *Arundo donax*) and saltcedar (*Tamarix* spp.), are widely distributed within the Fillmore and Piru groundwater basins. Arundo and tamarisk were included as vegetation community types (see Section 4.1.1). The extent of mapped arundo and saltcedar is shown in Figure 5.3.-1 and acreages of the communities are presented in Appendix A.

Arundo is a highly aggressive, naturalized landscape plant that invades riparian zones by establishing dense, monospecific clonal stands (DiTomaso and Healy 2007). It spreads quickly and severely impacts the ecology of the riparian corridor (Stillwater Sciences and URS 2007) and uses a large amount of water to fuel its growth (Bell 1997, Geissow et al. 2011). In California, giant reed is known to increase the risk of flooding, create fire hazards, outcompete indigenous plant species for scarce water resources, and reduce the value of riparian habitat for wildlife (Bell 1994, Bell 1997, DiTomaso 1998). The least Bell's vireo and other riparian birds require structural diversity provided by riparian scrub and mature forest communities for breeding (Zembal 1990, Bell 1994, Bell 1997). When natural riparian vegetation types are replaced by thick stands of giant reed, bird species' abundance and other native wildlife have been found to decline (Bell 1994, Bell 1997, Herrera and Dudley 2003, Kisner 2004, Labinger and Greaves 2001).

In general, invading tamarisk significantly lowers wildlife habitat value in riparian ecosystems by decreasing available food sources and altering structural characteristics (Shafroth et al. 2005). Monotypic stands provide limited cover for large mammals and fewer nesting sites for birds and herpetofauna in more southern latitudes due to lack of shading in mid- to late summer (Hunter et al. 1988, Lovich and DeGouvenain 1998, Shafroth et al. 2005). Both the endangered southwestern willow flycatcher and the candidate for federal endangered species list western yellow-billed cuckoo prefer native forests in some cases, but incorporate some habitat with tamarisk into their breeding territory (Shafroth et al. 2005).

Invasive amphibian species, American bullfrog (*Lithobates catesbeianus*) and African clawed frog (*Xenopus laevis*), are documented on the Santa Clara River, including near the confluence with lower Sespe Creek and Piru Creek (Santa Clara River Trustee Council 2008). These amphibian species are found within or adjacent to aquatic habitat, including ponds, streams, reservoirs, and lakes. Both species likely prey on native species and have negative impacts on native amphibian species (e.g., arroyo toad).

Many non-native fish species, including black bullhead (*Ameiurus melas*), various sunfish species (*Lepomis* sp.) (e.g., green sunfish [*Lepomis cyanellus*] and bluegill [*Lepomis macrochirus*]), and bass species (*Micropterus* sp.) (e.g., largemouth bass [*Micropterus salmoides*]), have been documented within the Piru and Fillmore perennial tributaries year-round or within the other reaches within the SCR watershed (Stoecker and Kelley 2005). The distribution of invasive species within the mainstem and tributaries is not fully known; however, these species are either likely to occur or have the potential to occur within the perennial mainstem and ephemeral reaches due to observation of the species throughout the SCR watershed. Non-native predatory fish may have a large impact on native fish populations (e.g., salmonids), reducing the size of already diminished populations and limiting their ability to recover in response to habitat restoration efforts. In the NMFS (2012) southern California steelhead recovery plan, non-native species were designated a “very high threat” to the steelhead population in the Santa Clara River.

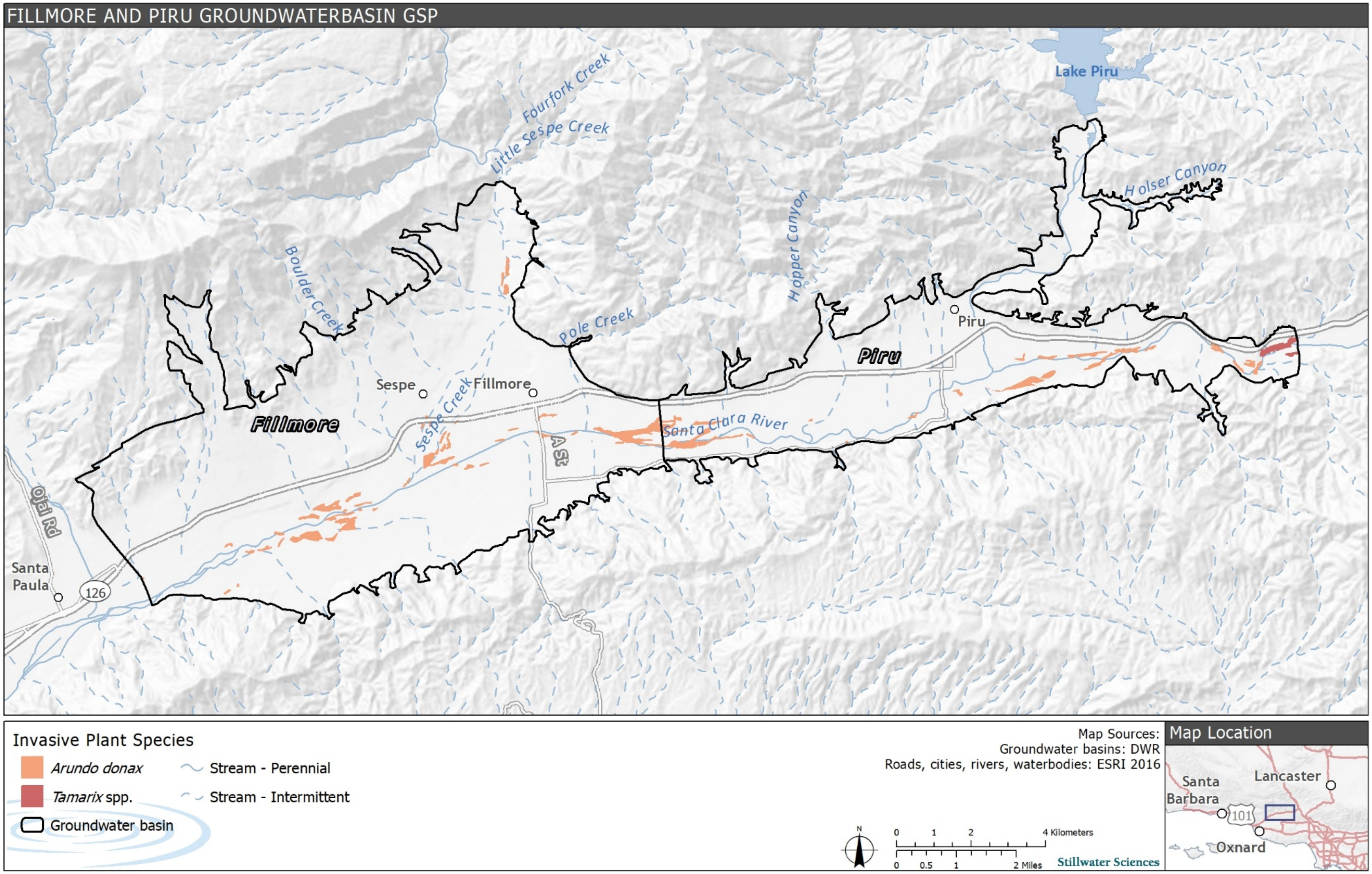


Figure 5-9~~5.3-1~~. Invasive species mapped within the Fillmore and Piru groundwater basins.

5.4 Ecological Value

The ecological value of each GDE unit was characterized by evaluating the presence and groundwater-dependence of special-status species and ecological communities and the vulnerability of these species and their habitat to changes in groundwater levels (Rohde et al. 2018). Following Rohde et al. (2018) ecological value is divided into three categories (Table 6.1-1).

Table 5.4-1. Ecological value of GDE units (Rohde et al. 2018).

Ecological Value classifications	
High Ecological Value	• GDE unit has been designated as important habitat (e.g., designated critical habitat). • Contains species that are dependent upon groundwater for their survival or are rare and unique. • Contains species that are vulnerable to slight-moderate changes in groundwater elevation that would result in substantial spatial redistribution
Moderate Ecological Value	• GDE unit contains species that are not legally protected but may be designated as a beneficial use. • Contains species that are partially dependent on groundwater. • Contains species that are somewhat vulnerable to slight-moderate changes in groundwater elevation that would result in some spatial redistribution.
Low Ecological Value	• GDE unit does not contain legally protected species. • Contains only species that are partially dependent on groundwater. • Contains species that are not vulnerable to slight-moderate changes in groundwater elevation.

In addition, the presence of natural or near-natural conditions and ecosystem function was also considered.

5.4.1 Piru

Del Valle GDE Unit

The Del Valle GDE Unit was determined to have **high ecological value** because: (1) it supports a relatively large number of special-status species and ecological communities (Tables 5.2-2, 5.2-3, and 5.2-4), (2) contains 433 acres of designated critical habitat for southwestern willow flycatcher and 436 acres of designated critical habitat for least Bell's vireo (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (two plants, three natural communities, two reptiles, and one fish; Tables 5.2-2, 5.2-3, and 5.2-4), and (4) includes species and ecological communities that are highly or moderately vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The reach of the Santa Clara River in the Del Valle GDE Unit is considered perennial and is typically connected to groundwater. The degree to which interconnected surface waters in this reach are maintained by releases from upstream effluent sources is unknown, but is believed to be significant. It provides important habitat for special-status aquatic and semi-aquatic species, potentially including southwestern pond turtle, two-striped gartersnake, unarmored threespine stickleback, and arroyo chub, and this habitat is vulnerable to groundwater uses that reduce the amount and quality of riverine habitat. Southern California steelhead and Pacific lamprey are not known to occur in or upstream of this reach. The Del Valle GDE Unit contains 34% of the total GDE acreage in the Piru Groundwater Basin (Table 3.1-2).

Santa Clara River Riparian Shrubland GDE Unit

The Santa Clara River Riparian Shrubland GDE Unit was determined to have **moderate ecological value** because: (1) it supports a moderate number of special-status species and ecological communities (Tables 5.2-2, 5.2-3, and 5.2-4), (2) contains 317 acres of designated critical habitat for southwestern willow flycatcher and approximately 3.8 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (three natural communities and three fish; Tables 5.2-2, 5.2-3, and 5.2-4), and (4) includes species and ecological communities that are somewhat vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The Santa Clara River in this GDE unit is considered intermittent and is not connected to groundwater. It may provide migration habitat for anadromous species (i.e., southern California steelhead), but this habitat has low vulnerability to groundwater reduction because most migration occurs during seasonal high flow periods. The unit contains 25% of the total GDE acreage in the Piru Groundwater Basin (Table 3.1-2).

Cienega GDE Unit

The Cienega GDE Unit was determined to have **high ecological value** because: (1) it supports a moderate number of special-status species and ecological communities (Tables 5.2-2, 5.2-3, and 5.2-4), (2) contains 154 acres of designated critical habitat for southwestern willow flycatcher and approximately 0.2 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (one plant, two reptiles, and four fish; Tables 5.2-2, 5.2-3, and 5.2-4), and (4) includes species and ecological communities that are highly or moderately vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The reach of the Santa Clara River in the Cienega GDE Unit is considered perennial and is connected to groundwater except during droughts. It provides important habitat for special-status aquatic and semi-aquatic species, potentially including southwestern pond turtle, two-striped gartersnake, southern California steelhead, unarmored threespine stickleback, and arroyo chub, and this habitat is vulnerable to groundwater uses that reduce the amount and quality of riverine habitat. The unit contains 12% of the total GDE acreage in the Piru Groundwater Basin (Table 3.1-2).

Piru Creek Riparian GDE Unit

The Piru Creek Riparian GDE Unit was determined to have **high ecological value** because: (1) it supports a relatively high number of special-status species and ecological communities (Tables 5.2-2, 5.2-3, and 5.2-4), (2) contains 246 acres of designated critical habitat for southwestern willow flycatcher and approximately 4.9 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (one plant, five natural communities, two reptiles, and five fish; Tables 5.2-2, 5.2-3, and 5.2-4), and (4) includes species and ecological communities that are highly or moderately vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). Piru Creek in this GDE unit is considered perennial, though baseflows are maintained by releases from Santa Felicia Dam, which likely also raises the groundwater level in this area. The lower portion of Piru Creek near the confluence with the Santa Clara River periodically lacks surface flow. Piru Creek provides important habitat for special-status aquatic and semi-aquatic species, potentially including southwestern pond turtle, two-striped gartersnake, southern California steelhead, unarmored threespine stickleback, and arroyo chub. Because surface flows in Piru Creek are mostly controlled by upstream releases rather than interconnected groundwater, this habitat is not vulnerable to groundwater uses that reduce the amount and quality of stream habitat. The unit contains 25% of the total GDE acreage in the Piru Groundwater Basin (Table 3.1-2).

Tributary Riparian GDE Unit

The Tributary Riparian GDE Unit was determined to have **moderate ecological value** because: (1) it supports a relatively low number of special-status species and ecological communities (Tables 5.2-2 and 5.2-3), (2) contains 5.6 acres of designated critical habitat for least Bell's vireo (Figure 5.2-1), (3) supports few native special-status species and natural communities with a likely or possible groundwater dependence (three plants and one natural community; Tables 5.2-2 and 5.2-3), and (4) primarily includes species and ecological communities with little vulnerability to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). They do, however, support valuable riparian habitat and likely movement corridors for a variety of native wildlife species. The tributary streams in this GDE unit are considered ephemeral and are not interconnected with groundwater. Typically, these streams only support surface flow immediately after storm events and thus provide little habitat value for fish and other aquatic species. Hopper Canyon Creek may have perennial flow at its upstream end within the basin and may have historically supported aquatic species. The connection to groundwater in Hopper Canyon Creek is unknown. The unit contains 5% of the total GDE acreage in the Piru Groundwater Basin (Table 3.1-2).

5.4.2 Fillmore

Santa Clara River Riparian Shrubland GDE Unit

The Santa Clara River Riparian Shrubland GDE Unit was determined to have **moderate ecological value** because: (1) it supports a relatively high number of special-status species and ecological communities (Tables 5.2-5, 5.2-6, and 5.2-7), (2) contains 952 acres of designated critical habitat for southwestern willow flycatcher and approximately 7.6 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (four natural communities, one reptile, and two fish; Tables 5.2-5, 5.2-6, and 5.2-7), and (4) includes species and ecological communities that are somewhat vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The Santa Clara River in this GDE unit is considered intermittent and is not connected to groundwater or to upstream and downstream perennial reaches in most years (Figure 4.1-1). It provides migration habitat for special-status anadromous species (i.e., southern California steelhead, Pacific lamprey) but this habitat has low vulnerability to groundwater reduction because most migration occurs during seasonal high flow periods. The unit contains a relatively large amount of GDE area (1,046 acres), accounting for 40% of the total GDE acreage in the Fillmore Groundwater Basin (Table 3.1-2).

Cienega GDE Unit

The Cienega GDE Unit was determined to have **high ecological value** because: (1) it supports a relatively large number of special-status species and ecological communities (Tables 5.2-5, 5.2-6, and 5.2-7), (2) contains 116 acres of designated critical habitat for southwestern willow flycatcher and approximately 1.1 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (one plant, one natural community, and four fish; Tables 5.2-5, 5.2-6, and 5.2-7), and (4) includes species and ecological communities that are highly or moderately vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The reach of the Santa Clara River in the Cienega GDE Unit is considered perennial and is connected to groundwater except during droughts. It provides important habitat for special-status aquatic and semi-aquatic species, potentially including southwestern pond turtle, southern California steelhead, unarmored threespine stickleback, and arroyo chub, and this habitat is vulnerable to groundwater uses that reduce the amount and quality of riverine habitat. The unit contains 5% of the total GDE acreage in the Fillmore Groundwater Basin (Table 3.1-2).

East Grove GDE Unit

The East Grove GDE Unit was determined to have **high ecological value** because: (1) it supports a relatively large number of special-status species and ecological communities (Tables 5.2-5, 5.2-6, and 5.2-7), (2) contains 923 acres of designated critical habitat for southwestern willow flycatcher and approximately 3.2 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (one plant, four natural communities, one reptile, and three fish; Tables 5.2-5, 5.2-6, and 5.2-7), and (4) includes species and ecological communities that are highly or moderately vulnerable to changes in groundwater discharge or groundwater levels that could substantially alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The reach of the Santa Clara River in the East Grove GDE Unit is considered perennial and is typically connected to groundwater. It provides important habitat for special-status aquatic and semi-aquatic species, potentially including southwestern pond turtle, southern California steelhead, Pacific lamprey, unarmored threespine stickleback, and arroyo chub, and this habitat is vulnerable to groundwater uses that reduce the amount and quality of riverine habitat. The unit contains a relatively large amount of GDE area (1,101.9 acres), accounting for 43% of the total GDE acreage in the Fillmore Groundwater Basin (Table 3.3-2).

Tributary Riparian GDE Unit

The Tributary Riparian GDE Unit was determined to have **moderate ecological value** because: (1) it supports a relatively low number of special-status species and ecological communities (Tables 5.2-5, 5.2-6, and 5.2-7), (2) contains no designated critical habitat (Figure 5.2-1), (3) supports few native special-status species and natural communities with a likely or possible dependence on groundwater (two plants and one natural community; Table 5.2-5), and (4) primarily includes species and ecological communities with little vulnerability to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). They do, however, support valuable riparian habitat and likely movement corridors for a variety of native wildlife species. The tributary streams in this GDE unit are considered ephemeral and are not connected to groundwater. Typically, these streams only support surface flow immediately after storm events and thus provide little habitat value for fish and other aquatic species. Pole Creek may have perennial flow at its upstream end within the basin and may have historically supported aquatic species. The connection to groundwater in Pole Creek is unknown. The Tributary Riparian GDE Unit contains 8% of the total GDE acreage in the Fillmore Groundwater Basin (Table 3.3-2).

Sespe Creek Riparian GDE Unit

The Sespe Creek Riparian GDE Unit was determined to have **moderately high ecological value** because: (1) it supports a moderate number of special-status species and ecological communities (Tables 5.2-5, 5.2-6, and 5.2-7), (2) contains approximately 3.2 miles of designated critical habitat for southern California steelhead (Figure 5.2-1), (3) supports native special-status species and natural communities with a known or high likelihood of direct groundwater dependence (two natural communities, two reptiles, and three fish; Tables 5.2-5, 5.2-6, and 5.2-7), and (4) includes species and ecological communities that are highly or moderately vulnerable to changes in groundwater discharge or groundwater levels that could alter their distribution, species composition, and/or health (Rohde et al. 2018, 2019). The upper 2 miles of Sespe Creek in this GDE unit are considered perennial, while the lower portion of Sespe Creek is likely intermittent (Figure 3.1-1). Sespe Creek's connection to groundwater is undetermined. Sespe Creek provides important habitat for special-status aquatic and semi-aquatic species, likely including southwestern pond turtle, two-striped gartersnake, southern California steelhead, Pacific lamprey, unarmored threespine stickleback, and arroyo chub, and this habitat is vulnerable to groundwater uses that reduce the amount and quality of stream habitat. The unit contains 4% of the total GDE acreage in the Fillmore Groundwater Basin (Table 3.3-2).

6 POTENTIAL EFFECTS OF GROUNDWATER MANAGEMENT ON GDES

This section presents the methods and results of our analysis to identify how groundwater management could affect GDEs in the Fillmore and Piru groundwater basins. Adverse effects (impacts) on GDEs are considered undesirable results under SGMA (State of California 2014). The analysis is based on the hydrologic conditions affecting GDEs and their susceptibility to changing groundwater conditions, trends in biological condition of the GDEs, and climate change projections and other anticipated conditions or management actions likely to affect GDEs in the future.

6.1 Approach

SGMA describes six groundwater conditions that could cause undesirable results, including adverse impacts on GDEs. These are (1) chronic lowering of groundwater levels, (2) reduction of groundwater storage, (3) seawater intrusion, (4) degraded groundwater quality, (5) land subsidence, and (6) depletion of interconnected surface waters. Rohde et al. (2018) identify chronic lowering of groundwater levels, degraded water quality, and depletions of interconnected surface water as the most likely conditions to have direct effects on GDEs, potentially leading to an undesirable result. Following this guidance and based on available information for the Fillmore and Piru groundwater basins, we have eliminated reduction of groundwater storage, seawater intrusion (the subbasins are not located in close proximity to the ocean), and land subsidence from consideration because they are not relevant to GDEs in the Fillmore and Piru groundwater basins.

We evaluated the potential for chronic lowering of groundwater levels, degraded groundwater quality, and depletion of interconnected surface waters to cause direct effects on GDEs compared to baseline conditions, with a focus on effects related to groundwater levels. First, we identified baseline hydrologic conditions for the GDE units using available information (Section 1.2 and Section 4). Next, we determined each GDE unit's susceptibility to changing groundwater conditions using available hydrologic data, climate change projections, and the GDE susceptibility classifications (Rohde et al. 2018), summarized in Table 6.1-1~~Table 6.1-1~~.

Table 6.1-1. Susceptibility classifications developed for evaluation of a GDE's susceptibility to changing groundwater conditions (Rohde et al. 2018).

Susceptibility classifications	
High Susceptibility	Current groundwater conditions for the selected hydrologic data fall outside the baseline range.[1]
Moderate Susceptibility	Current groundwater conditions for the selected hydrologic data fall within the baseline range but future changes in groundwater conditions are likely to cause it to fall outside the baseline range. The future conditions could be due to planned or anticipated activities that increase or shift groundwater production, causing a potential effect on a GDE.
Low Susceptibility	Current groundwater conditions for the selected hydrologic data fall within the baseline range and no future changes in groundwater conditions are likely to cause the hydrologic data to fall outside the baseline range.

[1] For purposes of this analysis, the baseline range is defined as the range of variability of the shallow groundwater depth for the period of record through 2015, with a minimum of 10 years (2005–2015).

We used these susceptibility classifications to trigger further evaluation of potential effects on GDEs. The elevation of groundwater relative to the rooting depth is crucial to assessing the impact of groundwater level change on groundwater dependent vegetation, with mortality of groundwater dependent vegetation occurring at groundwater depths (Kibler et al. 2021). Moreover, a rapid rate of declining groundwater can add additional stress to trees, even if the groundwater elevation is above the maximum rooting depth (Stella et al., 2021). If we determined a GDE unit to have moderate or high susceptibility to changing groundwater conditions, we used biological information to assess whether evidence exists of a biological response to changing groundwater levels or degraded groundwater quality. The biological response analysis was based on changes in Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) data for individual vegetation polygons within the GDE units (Klausmeyer et al. 2019). The polygons correspond to different GDE mapping units (i.e., different species compositions), and the size of the GDE polygons varied.

NDVI, which estimates vegetation greenness, and NDMI, which estimates vegetation moisture, were generated from surface reflectance corrected multispectral Landsat imagery corresponding to the period of July 9 to September 7 of each year, which represents the summer period when GDE species are most likely to use groundwater (see Klausmeyer et al. 2019 for further description of methods). Vegetation polygons with higher NDVI values indicate increased density of chlorophyll and photosynthetic capacity in the canopy, an indicator of vigorous, growing vegetation. Similarly, high NDMI values indicate that the vegetation canopy has high water content and is therefore not drought stressed. These indices are both commonly used proxies for vegetation health in analyses of temporal trends in health of groundwater dependent vegetation (Rouse et al. 1974 and Jiang et al. 2006 as cited in Klausmeyer et al. 2019).

Based on the NDVI and NDMI data, groundwater quality data from wells in or near GDE units in the Fillmore and Piru groundwater basins, and the likely susceptibility of the terrestrial and aquatic species and natural communities in each GDE unit to reported groundwater quality constituents, we found no evidence of a biological response associated with groundwater quality in any of the GDE units. Groundwater quality is therefore not addressed further in the analysis of potential effects.

Discharge of interconnected surface water in areas of rising groundwater is generally a function of groundwater elevation (see GSP Section 2.2.2.7), which is tied to water year type, groundwater management, and surface water releases from upstream reservoirs and water treatment plants. There is not sufficient data on the population of aquatic species that rely on interconnected surface water in the Fillmore and Piru Basins to track the health of these GDEs through time. Evidence suggests that aquatic species such as steelhead were more widespread prior to development of the Santa Clara River Valley since the mid 1900s, and the decline in populations is likely due to many factors, including dams within the Santa Clara River watershed, declining habitat quality outside of the groundwater basins, ocean conditions, and non-native species among many factors. Moreover, the degree to which *O. mykiss* spawn or rear in the basin is poorly understood. Because of these factors, use of the Santa Clara River and its tributaries is an existing data gap, and this analysis does not explore changes in aquatic ecosystem health.

6.2 Biological Data

Tracking the health of all components of groundwater dependent ecosystems through time would involve systematic tracking of populations through time and accounting for changes in driving variables such as floods, climate, and other stressors on populations. This section focuses on changes in vegetation through time using remote sensing data. While increases or decreases in vegetation health do not provide a definitive indication that other components of the ecosystem are thriving or under stress, it provides a reasonable first-order check on the clear linkage between groundwater and the other communities that compose the ecosystem. Previous work has shown that decreases in vegetation vigor are correlated to decreases in remote sensing metrics such as NDVI (e.g., Huntington et al. 2015) and that decreases in vegetation health often correlate with decreases in overall ecosystem health. Tracking the change in NDVI and NDMI for individual polygons shows how the greenness of those polygons change through time. It is crucial to remember that the Santa Clara River and its tributaries in the Fillmore and Piru groundwater basins are dynamic braided rivers that shift through time. This shifting uproots vegetation and creates new surfaces for seedlings to establish. Following floods, the proximity to the river channel (and hence distance to groundwater) as well as the relative elevation of a given vegetation polygon may change. It is therefore useful to average changes over the different GDE units to account for these changes.

To assess potential groundwater thresholds for vegetation health, we compared the average summer NDVI in each GDE unit to depth to water at corresponding monitoring wells. For each vegetation polygon within a GDE unit, the average NDVI for each year was downloaded from the GDE Pulse tool (TNC2021). This tool calculates the mean summer NDVI for each mapped vegetation polygon based on NDVI values from Landsat imagery from July 9 to September 7 (Klausmeyer et al. 2019). The annual average NDVI for each GDE unit was then calculated as the area-weighted mean of the vegetated polygons. This data is used to assess both NDVI trends through time as well as to compare NDVI data with groundwater depth changes.

For each GDE unit, the representative groundwater elevation for comparison with NDVI data was determined for the wells in Table 4.1-1. We used the depth to water measurement for the well in Section 4.1 on the closest date to August 8 (the median of the date of the summer NDVI data), for measurements taken from June 24 to September 22, a period of three months. If no groundwater data were available during this period, the water depth was not included in the analysis.

Because the NDVI analysis above does not account for changes in the extent of groundwater dependent vegetation during the 2012–2016 drought, we also analyzed the change in summer NDVI over the entire GDE unit and adjacent area from 2011–2020. For this analysis linear regression was used to fit a line to the data to track changes in NDVI through time to identify areas of NDVI decline and areas where NDVI increased using code provided by Zach Nelson of the Inyo County Water Department on Google Earth Engine.

NDVI is not a useful tool to track changes in interconnected surface water and the effect of these changes on the aquatic ecosystems. While Figure 4.3-1 shows changes to the magnitude and extent of rising groundwater through the recent drought and subsequent recovery, the effect of these changes on the aquatic ecosystem is difficult to quantify because of a paucity of species data and a lack of data on changes in surface water flows in various tributaries.

6.2.1 Piru Groundwater Basin

Del Valle

The mean NDVI and NDMI for the Del Valle GDE Unit from 1985–2018 were 0.41 and 0.08, respectively. The Del Valle GDE Unit had relatively steady NDVI values, with drops during the early 1990s drought, the 2005 flood, and after 2015. The NDVI values were lower than the other forested riparian complexes (e.g., the East Grove and Cienega GDE units), but the declines during the drought were much less severe than for the Cienega GDE unit. Mean NDMI has declined slowly since 1995, but the overall change was relatively small. This site has experienced extensive changes in vegetation in response to floods, as visible from comparison of aerial photographs. The Santa Clara River in this GDE unit has a highly dynamic braided channel that is subject to extensive erosion and deposition, even during smaller floods, which uprooted vegetation at the site. There is no evidence that the decline in NDVI (which is very small) was due to changes in groundwater management (Figure 6.2-1).

From 2011–2020, NDVI increased as indicated by the slope of a best-fit line to NDVI values through time (Figure 6.2-2). Using the slope of NDVI through time limits the importance of individual years and gives a more representative picture of NDVI changes. For the Del Valle GDE Unit, NDVI increased from 2011–2020 in the upstream sections of the riparian complex and decreased at the downstream end, likely due to decreased extent of rising groundwater during the drought.

There is no apparent correlation between NDVI at Del Valle and depth to water at Well 04N18W27B025 (Figure 6.2-3). The highest NDVI values, between 0.45 and 0.50, occur at a wide range of depth to water values, from 30 ft bgs to 108 ft bgs.

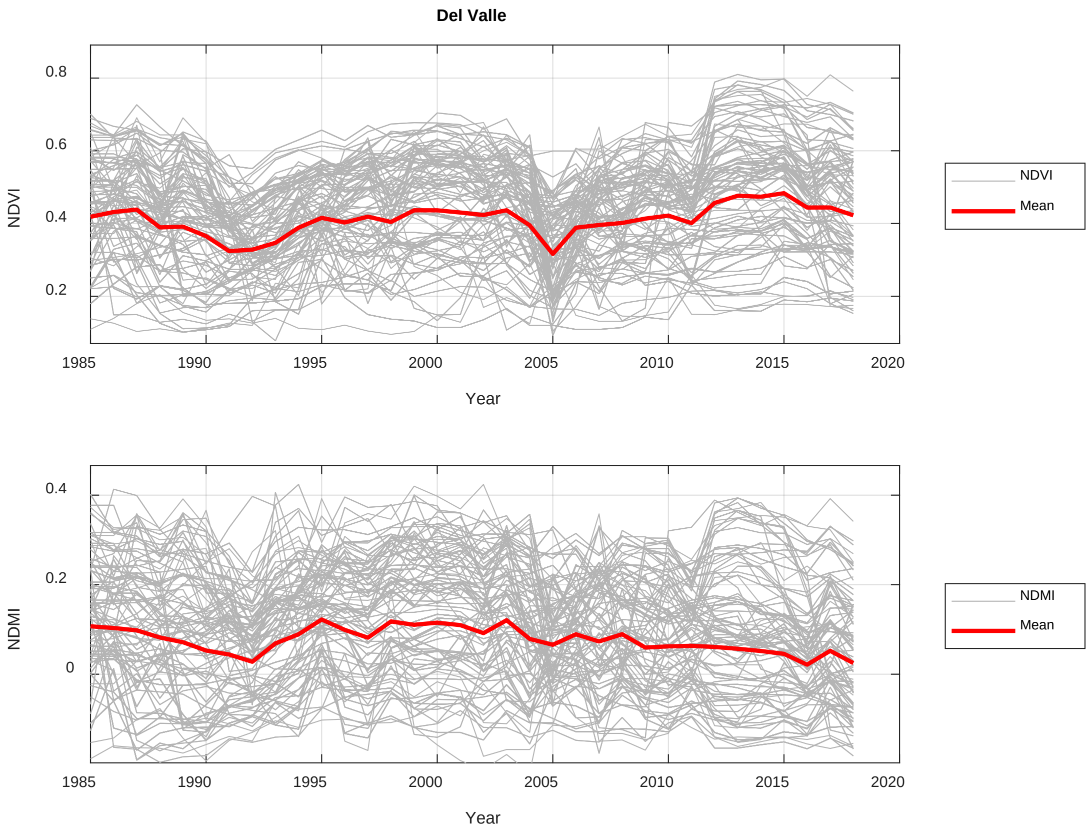
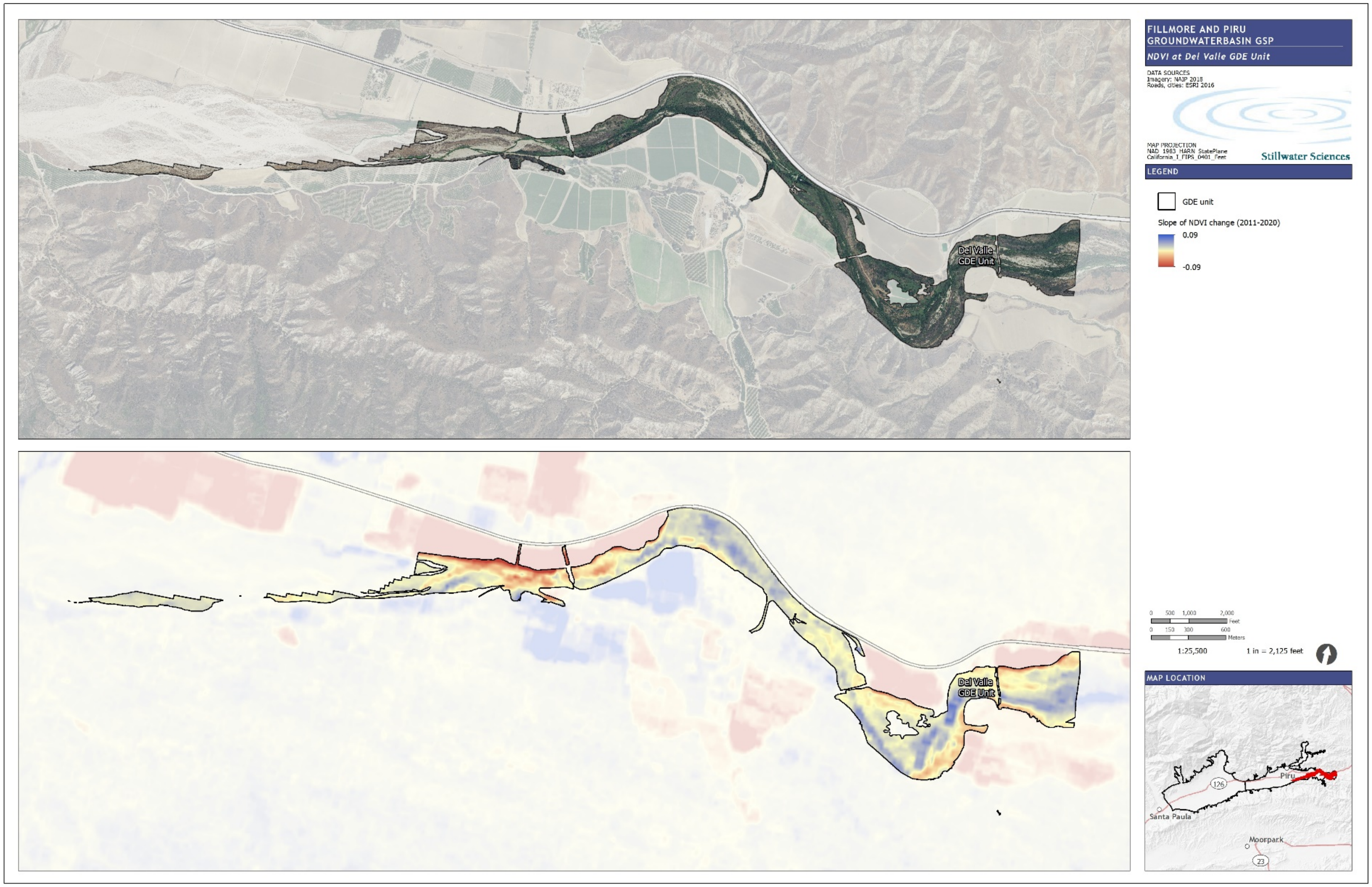


Figure 6-16.2-1. NDVI and NDMI for the Del Valle GDE Unit in the Piru Groundwater Basin.



FILLMORE AND PIRU
GROUNDWATERBASIN GSP
NDVI at Del Valle GDE Unit
DATA SOURCES
Imagery: NAIP 2018
Roads, cities: ESRI 2016
MAP PROJECTION
NAD_1983_HARN_StatePlane
California_I_FIPS_0401_Feet
Stillwater Sciences
LEGEND
GDE unit
Slope of NDVI change (2011-2020)
0.09
-0.09
Del Valle GDE Unit
1:25,500
1 in = 2,125 feet
MAP LOCATION
Santa Paula
Piru
Moorpark
126
23

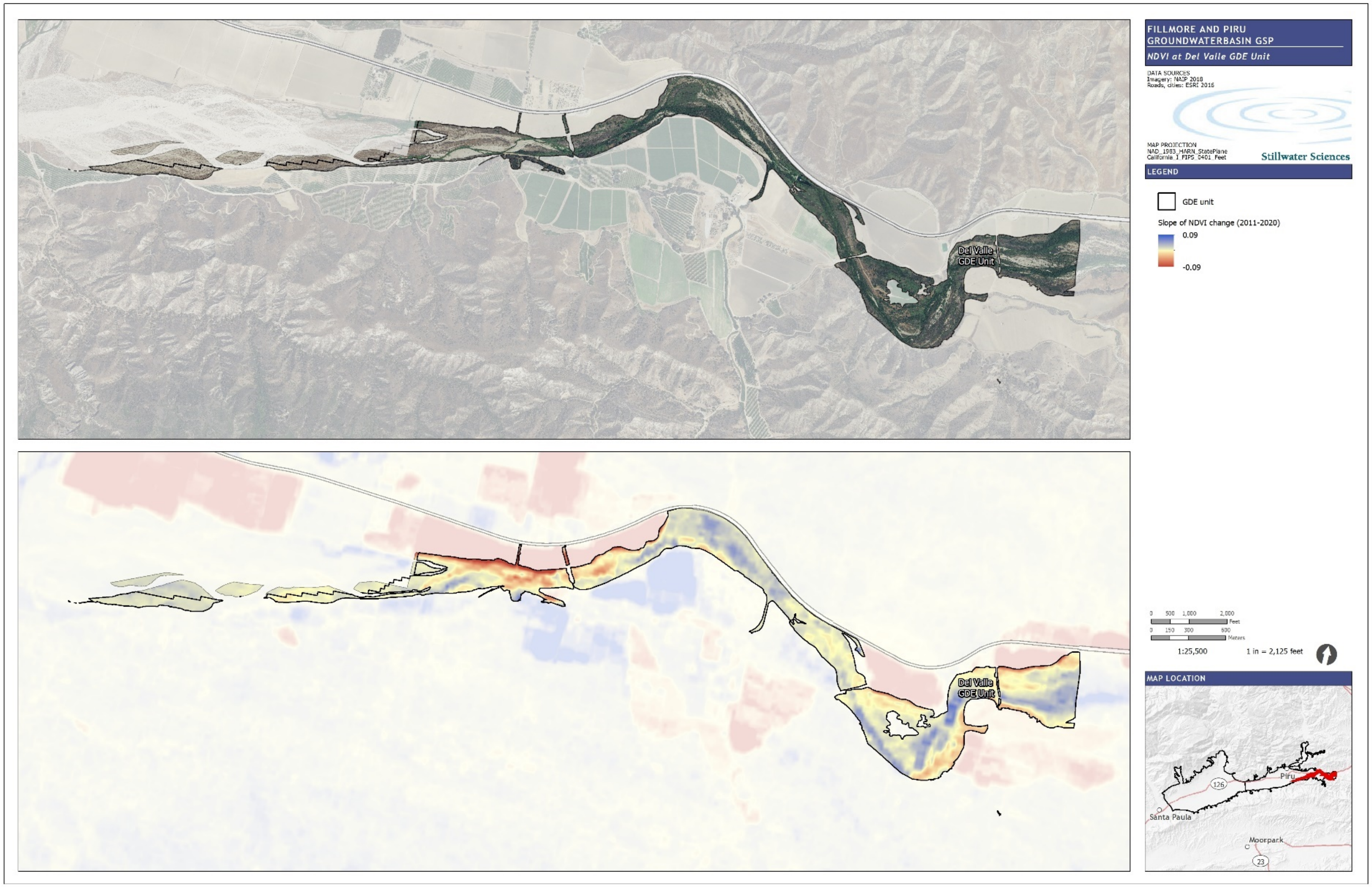


Figure 6-26.2-2. Slope of NDVI changes from 2011–2020 for the Del Valle GDE Unit. Blue represents increases in NDVI while red represents decreases in NDVI.

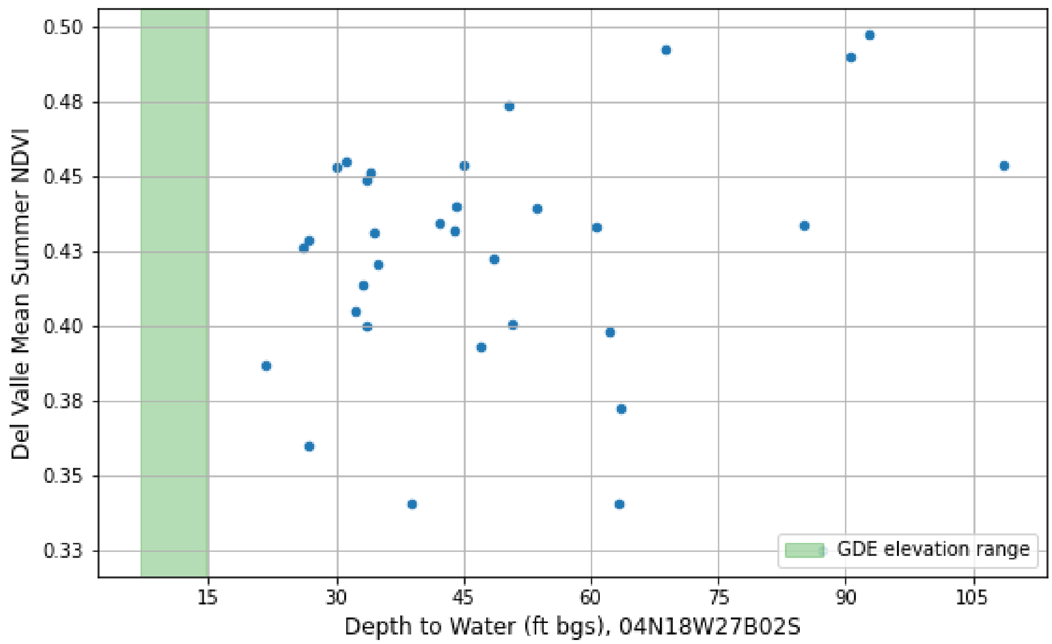


Figure 6-36.2-3. Mean Summer NDVI in the Del Valle GDE unit versus depth to water at Well 04N18W27B02S. Depth to water data selection method is outlined in Section 5.2.

Piru Basin Santa Clara River Riparian Shrub

The mean NDVI and NDMI for the Santa Clara River Riparian Complex in the Piru Groundwater Basin from 1985–2018 were 0.21 and -0.11, respectively (Figure 6.2-4). These values are relatively low compared to other GDE units in the Fillmore and Piru groundwater basins. The NDVI and NDMI peaked in 1995, 2006, and 2011, following relatively wet years, and declined back to background levels between these peaks. There is no long-term trend in either NDVI or NDMI for this GDE unit (Figure 6.2-4).

The highest NDVI values (>0.26) in the Santa Clara River (Piru Basin) unit typically occur when depth to water in Well 04N19W34K01S is less than 14 ft bgs, within 1 foot of the lowest potential GDEs (Figure 6.2-5).

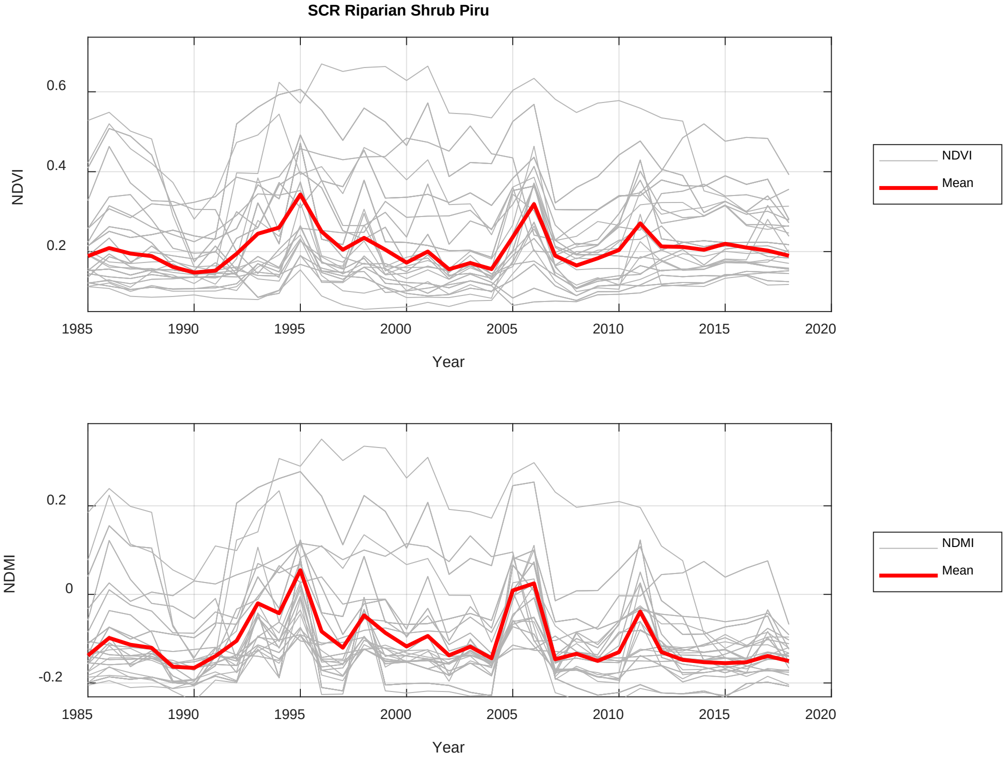


Figure 6-46.2-4. NDVI and NDMI for the Santa Clara River Riparian Shrub GDE Unit in the Piru Groundwater Basin.

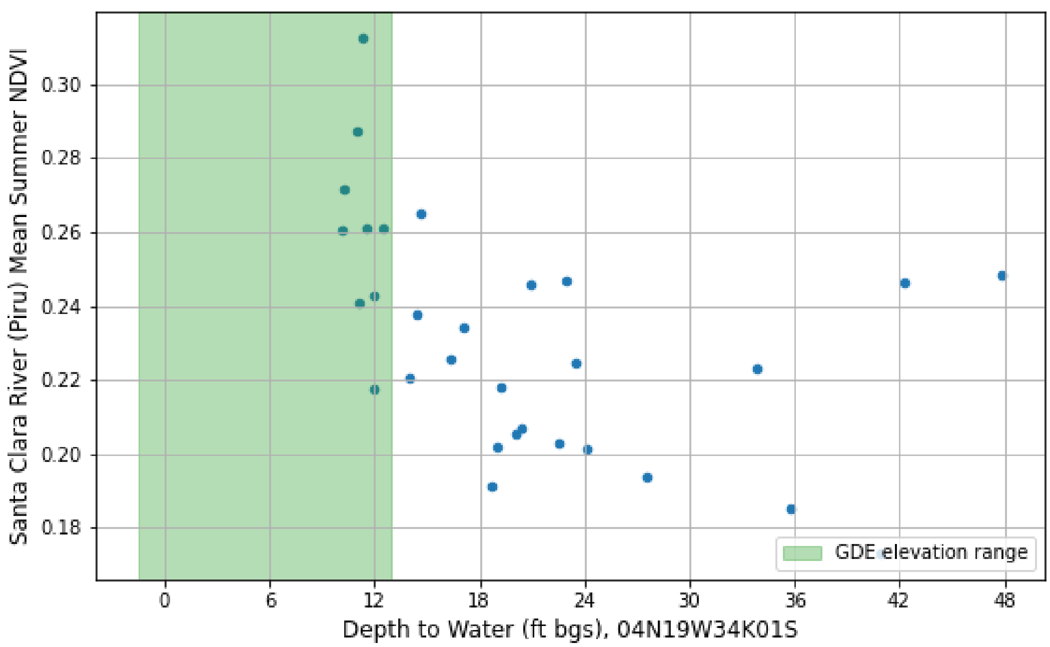


Figure 6-56.2-5. Mean Summer NDVI in the Piru Basin Santa Clara River GDE unit versus depth to water at Well 04N19W34K01S. Depth to water data selection method is outlined in Section 5.2.

Piru Creek Riparian GDE Unit

The mean NDVI and NDMI for the Piru Creek Riparian GDE from 1985–2018 were 0.36 and -0.026, respectively. NDVI values have been relatively steady, with a small decrease in 1996 and a gradual increase starting in 2006 through 2018 (Figure 6.2-6). There was only a small decline in NDVI during the 2012–2016 drought.

Figure 6-66.2-6. NDVI and NDMI for the Piru Creek Riparian GDE Unit.

Piru Basin Tributary Riparian GDE

The mean NDVI and NDMI for the Tributary Riparian GDE Unit in the Piru Groundwater Basin from 1985–2018 were 0.30 and -0.07, respectively. The NDVI was relatively steady from 1989–2007 before increasing in 2008 and remaining relatively steady through 2018 (Figure 6.2-7). NDVI was relatively steady during the 1989–1991 and 2012–2016 droughts. Drops in NDVI occurred in 1996 and 2002, but were small compared to changes in other GDE units. NDMI varied more than NDVI from 1989–2007, and had a similar increase in 2008, but declined from 2010–2018 to the mean value over the period of record.

Figure 6-76.2-7. NDVI and NDMI for the Piru Basin Tributary Riparian GDE Unit.

6.2.2 Fillmore Groundwater Basin

Fillmore Basin Santa Clara River Riparian Shrub

The mean NDVI and NDMI for the Santa Clara River Riparian Shrub GDE in the Fillmore Groundwater Basin from 1985–2018 were 0.29 and -0.046, respectively (Figure 6.2-8). The Santa Clara River Riparian Shrubland in the Fillmore Groundwater Basin has relatively low NDVI values typical of low-density vegetation in the GDE. The NDVI varies over 2- to 5-year cycles (Figure 6.2-8). The NDVI and NDMI values declined during the early 1990s and the 2012–2016 drought. NDVI and NDMI have not recovered from the most recent drought (Figure 6.2-8).

There is no apparent correlation between NDVI in the Santa Clara River (Fillmore Basin) unit and depth to water at Well 03N20W03N01S (Figure 6.2-9). NDVI declined when groundwater is lower but the data is sparse. Summer depth to water data typically fall in a narrow range, between eight and 13 ft bgs.

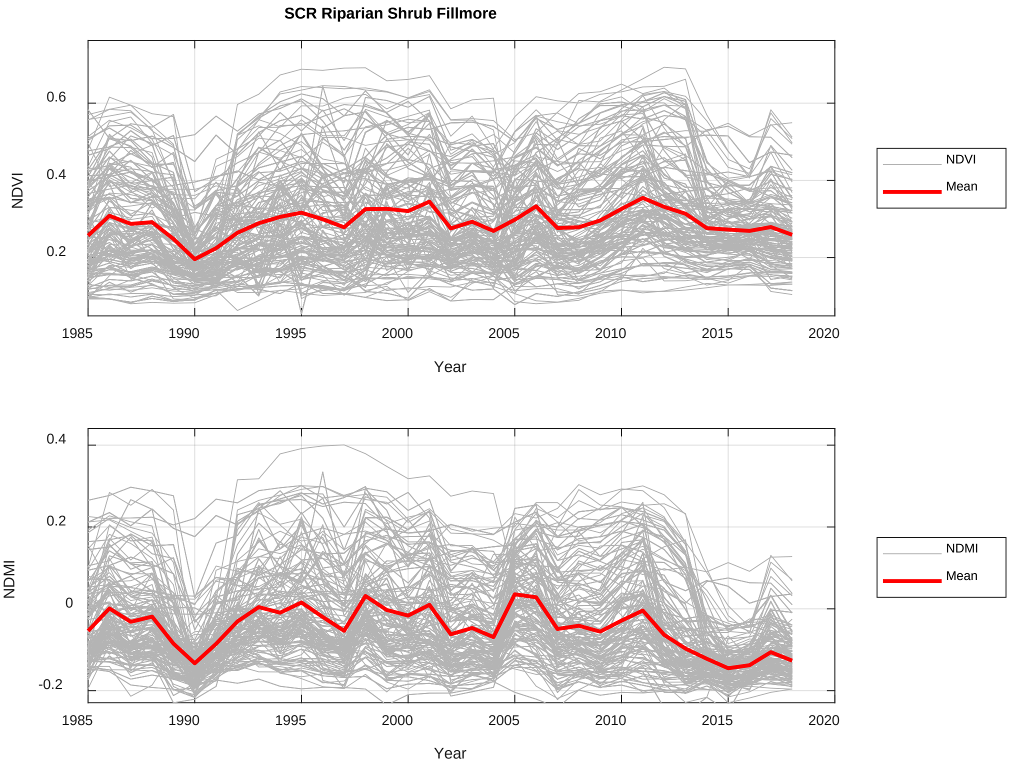


Figure 6-8~~6.2-8~~. NDVI and NDMI for the Santa Clara River Riparian Shrub GDE Unit in the Fillmore Groundwater Basin.

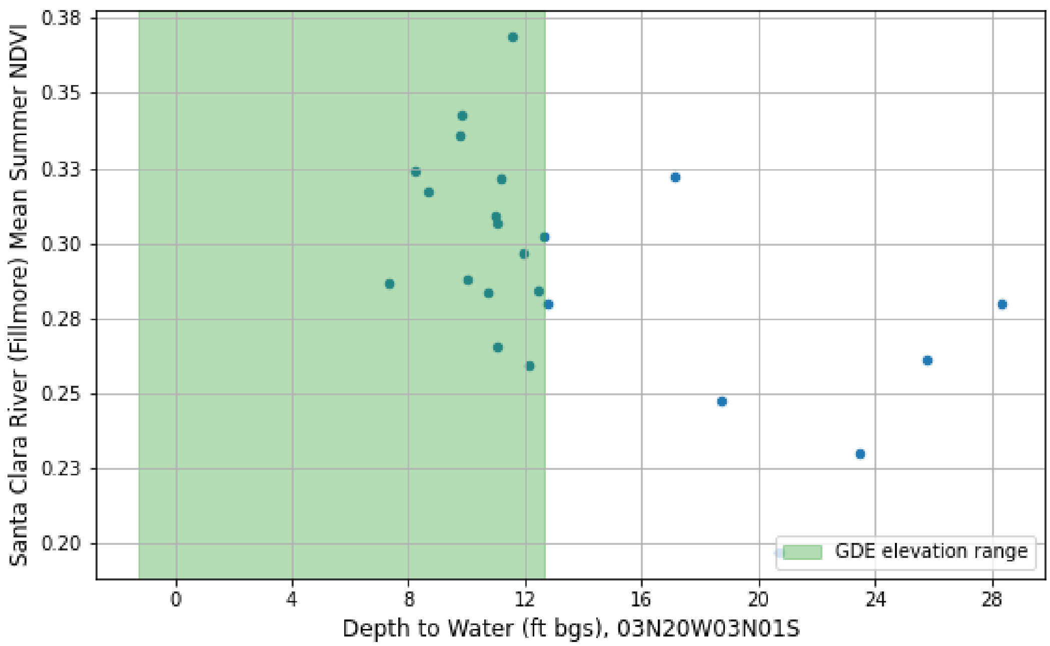


Figure 6-9~~6.2-9~~. Mean Summer NDVI in the Fillmore Basin Santa Clara River GDE unit versus depth to water at Well 03N20W03N01S. Depth to water data selection method is outlined in Section 5.2.

Cienega

The NDVI analysis of the Cienega GDE Unit focuses on the Fillmore Basin where most of the mapped GDEs occur. The mean NDVI and NDMI values for the Cienega GDE Unit from 1985–2018 were 0.48 and 0.12, respectively. The mean NDVI in the Cienega GDE Unit was relatively consistent between 1995 and 2014 (Figure 6.2-10) but dropped by about half during the 1989–1991 and 2012–2016 droughts (Figure 6.2-10). Following the early 1990s drought, the NDVI recovered to its pre-drought value within two to three years. A similar recovery did not occur following the 2012– 2016 drought, and field observation confirms that much of the willow and cottonwood forest died during the drought (Figure 6.2-11). The 2005 flood was the only major flood during this period and resulted in a short-term increase in NDVI, likely because the wet water year supported extensive vegetation growth and new surfaces were rapidly colonized.

NDMI values declined slightly from 1995–2014 and had similar drops during the early 1990s and 2012–2016 droughts. The reason for the decline in NDMI from 1995–2014 is not known. A similar drop in vegetated health using a different remote sensing technique was observed by Kibler et al. (2019). Anecdotal evidence suggests that some of the arundo stands are recovering following the drought, but much of the willow and cottonwood forest in the GDE died during the drought.

The highest NDVI values (>0.4) in the Cienega (Fillmore Basin) unit are clustered between depth to water values of -1 and 5 ft bgs, within the elevation range of GDEs (Figure 6.2-12). When groundwater depth declines to 6-8 ft bgs, NDVI declines to below 0.40.

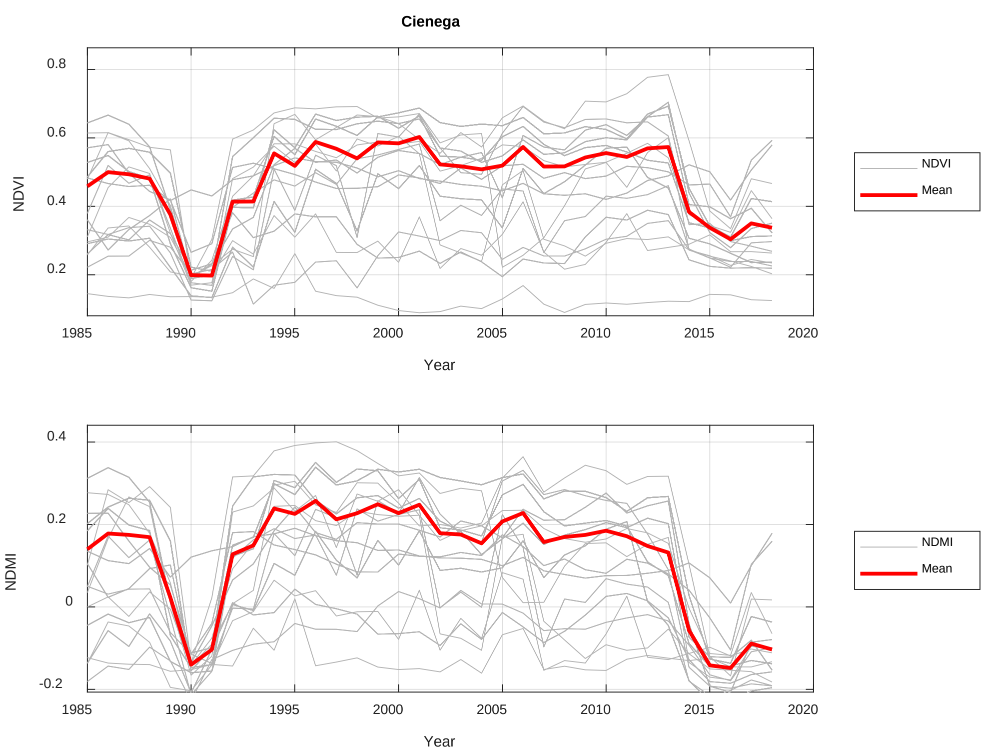
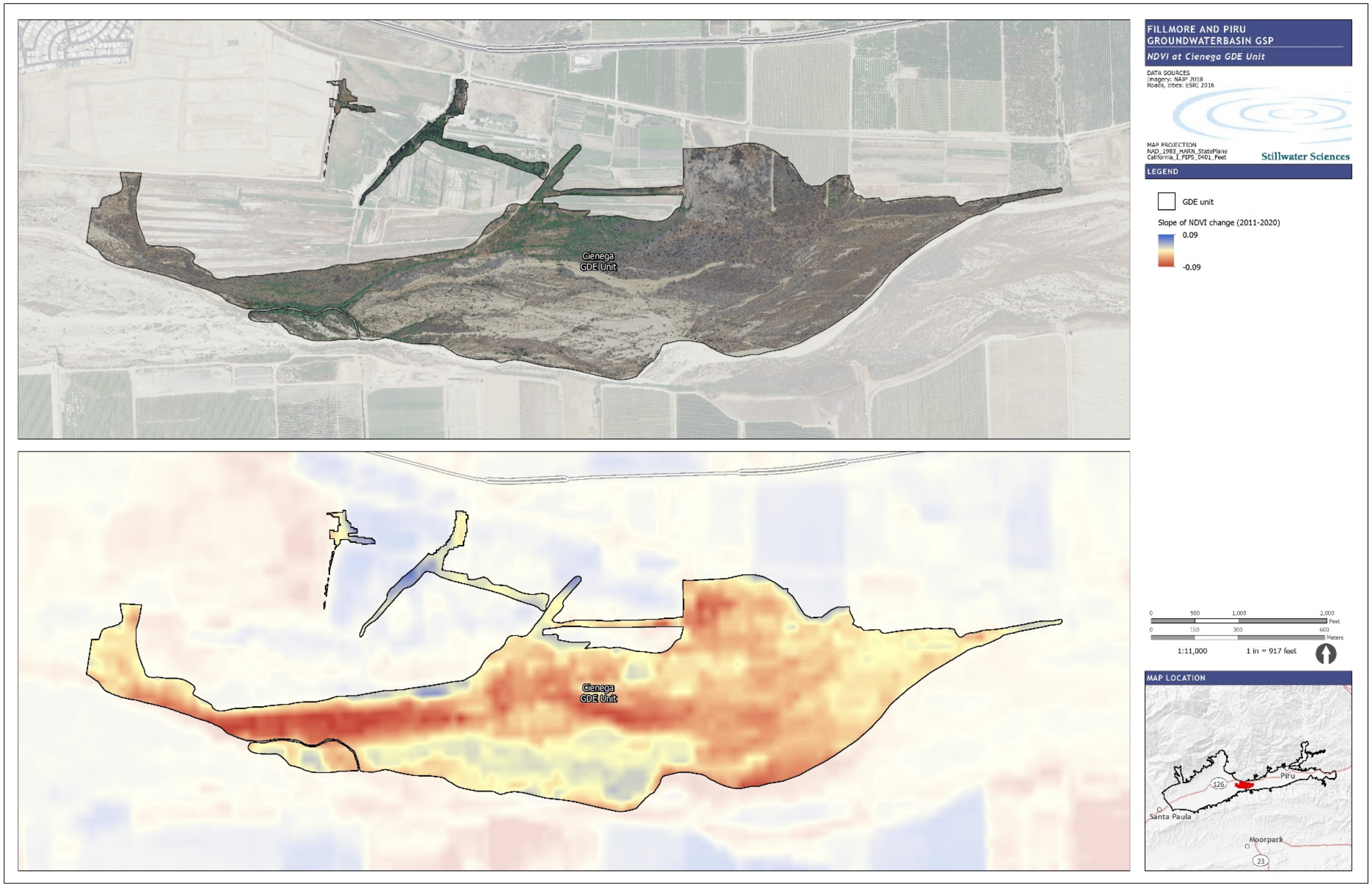


Figure 6-106.2-10. NDVI and NDMI for the Cienega GDE Unit.



Cienega GDE Unit
Cienega GDE Unit
FILLMORE AND PIRU GROUNDWATERBASIN GSP
NDVI at Cienega GDE Unit
DATA SOURCES
Imagery: NAIP 2018
Roads, cities: ESRI 2016
MAP PROJECTION
NAD_1983_HARN_StatePlane California_I_FIPS_0401_Feet
Stillwater Sciences
LEGEND
GDE unit
Slope of NDVI change (2011-2020)
0.09
-0.09
0 500 1,000 2,000 Feet
0 150 300 600 Meters
1:11,000
1 in = 917 feet
MAP LOCATION
126
Piru
Santa Paula
Moorpark
23

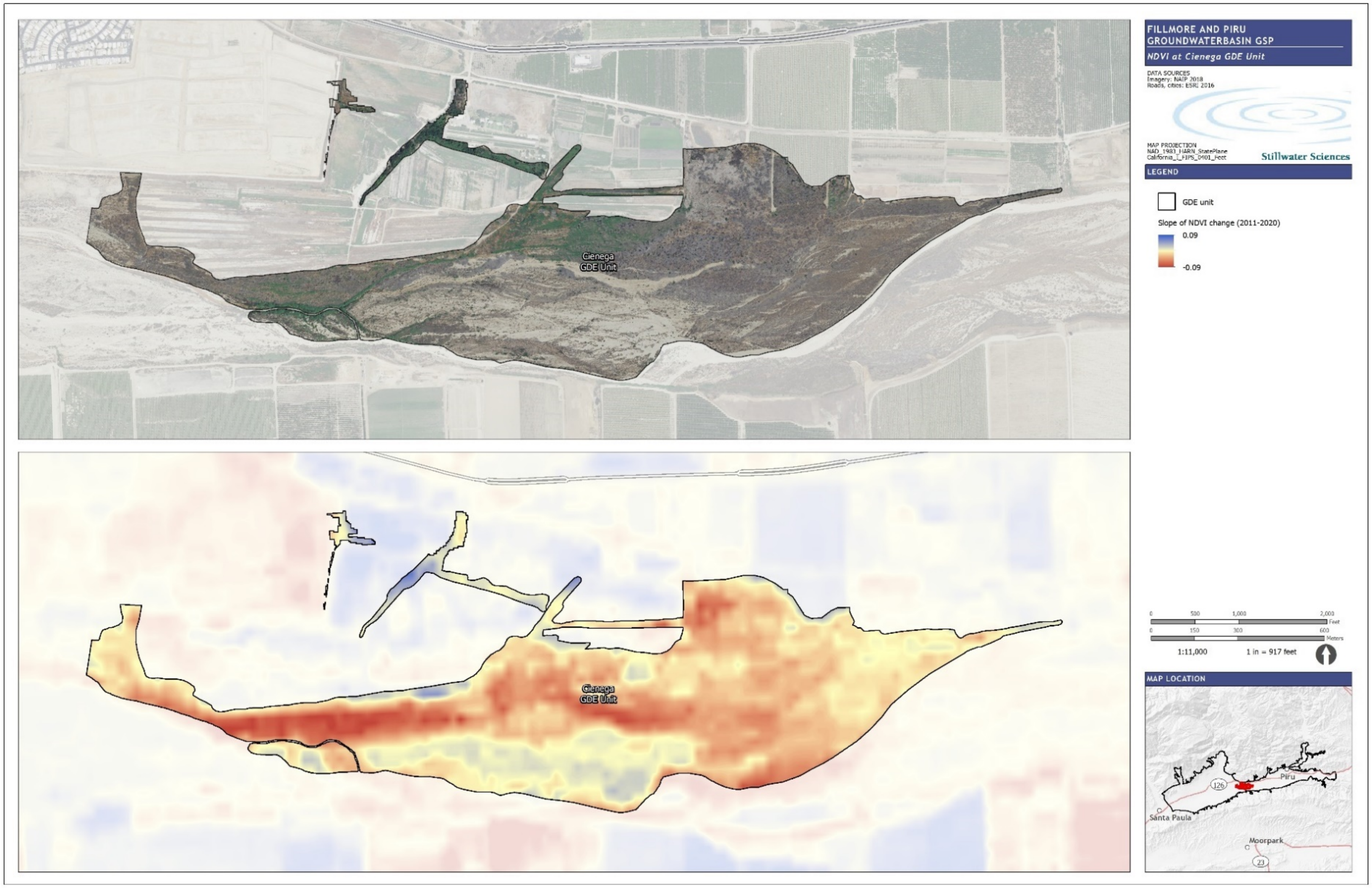


Figure 6-116.2-11. Slope of NDVI change in the Cienega GDE Unit in the Fillmore and Piru Basins from 2011–2020. Red areas have declining NDVI and blue areas have increasing NDVI.

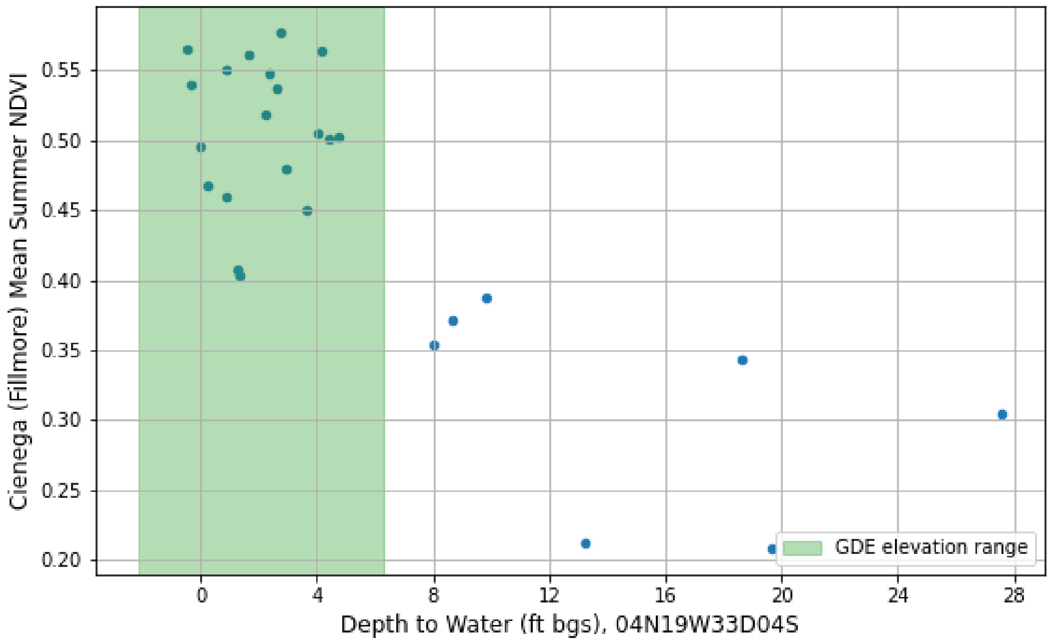


Figure 6-126.2-12. Mean Summer NDVI in the Fillmore Basin Cienega GDE unit versus depth to water at Well 04N19W33D04S. Depth to water data selection method is outlined in Section 5.2.

East Grove

The mean NDVI and NDMI for the East Grove GDE Unit from 1985–2018 were 0.52 and 0.16, respectively. NDVI values for the East Grove Riparian Complex were relatively steady through about 1997, with a small drop following the early 1990s drought (Figure 6.2-13).

Starting around 1998, the NDVI steadily increased until declining in 2013. There was a slight increase in NDVI following the 2005 flood. Mean NDMI was relatively constant until increasing in 2005. NDMI declined more than NDVI during the 2012–2016 drought (Figure 6.2-13).

Between 2011 and 2020, the slope of the NDVI through time was positive (i.e., NDVI increased), with decreases where the channel shifted (Figure 6.2-14). Decreases in NDVI occurred at the upstream portion of the East Grove GDE Unit, reflecting a change in the flow path of the Santa Clara River as well as a decline in vegetation health on the southeast portion of the GDE. In comparison with the Cienega GDE Unit, the increasing NDVI in the East Grove GDE Unit suggests that groundwater levels did not drop below the rooting zone of the riparian complex and hence the GDE was much more resilient.

There is no apparent correlation between NDVI at East Grove and depth to water at Well 03N20W09D01S (Figure 6.2-15).

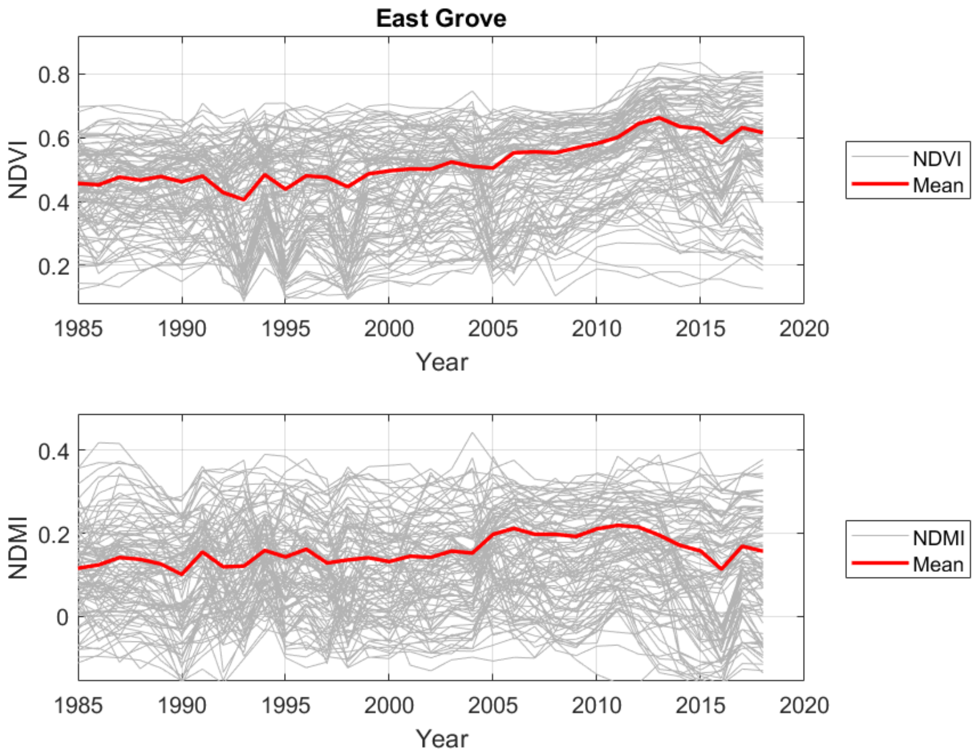
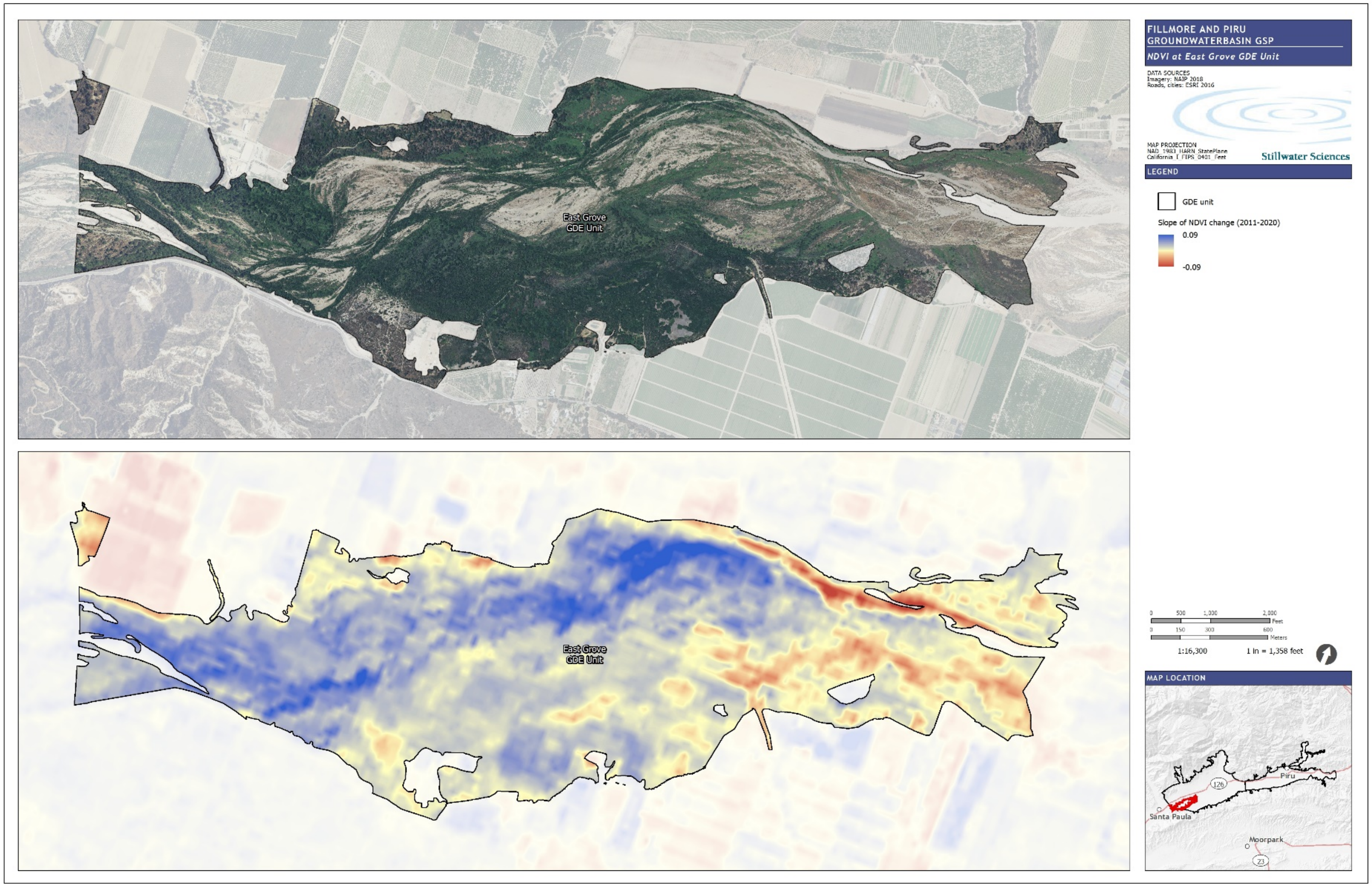


Figure 6-136.2-13. NDVI and NDMI for the East Grove GDE Unit.



East Grove GDE Unit
East Grove GDE Unit
FILLMORE AND PIRU GROUNDWATERBASIN GSP
NDVI at East Grove GDE Unit
DATA SOURCES
Imagery: NAIP 2018
Roads, cities: ESRI 2016
MAP PROJECTION
NAD_1983_HARN_StatePlane
California_I_FIPS_0401_Feet
Stillwater Sciences
LEGEND
GDE unit
Slope of NDVI change (2011-2020)
0.09
-0.09
0 500 1,000 2,000 Feet
0 150 300 600 Meters
1:16,300
1 in = 1,358 feet
MAP LOCATION
126
Piru
Santa Paula
Moorpark
23

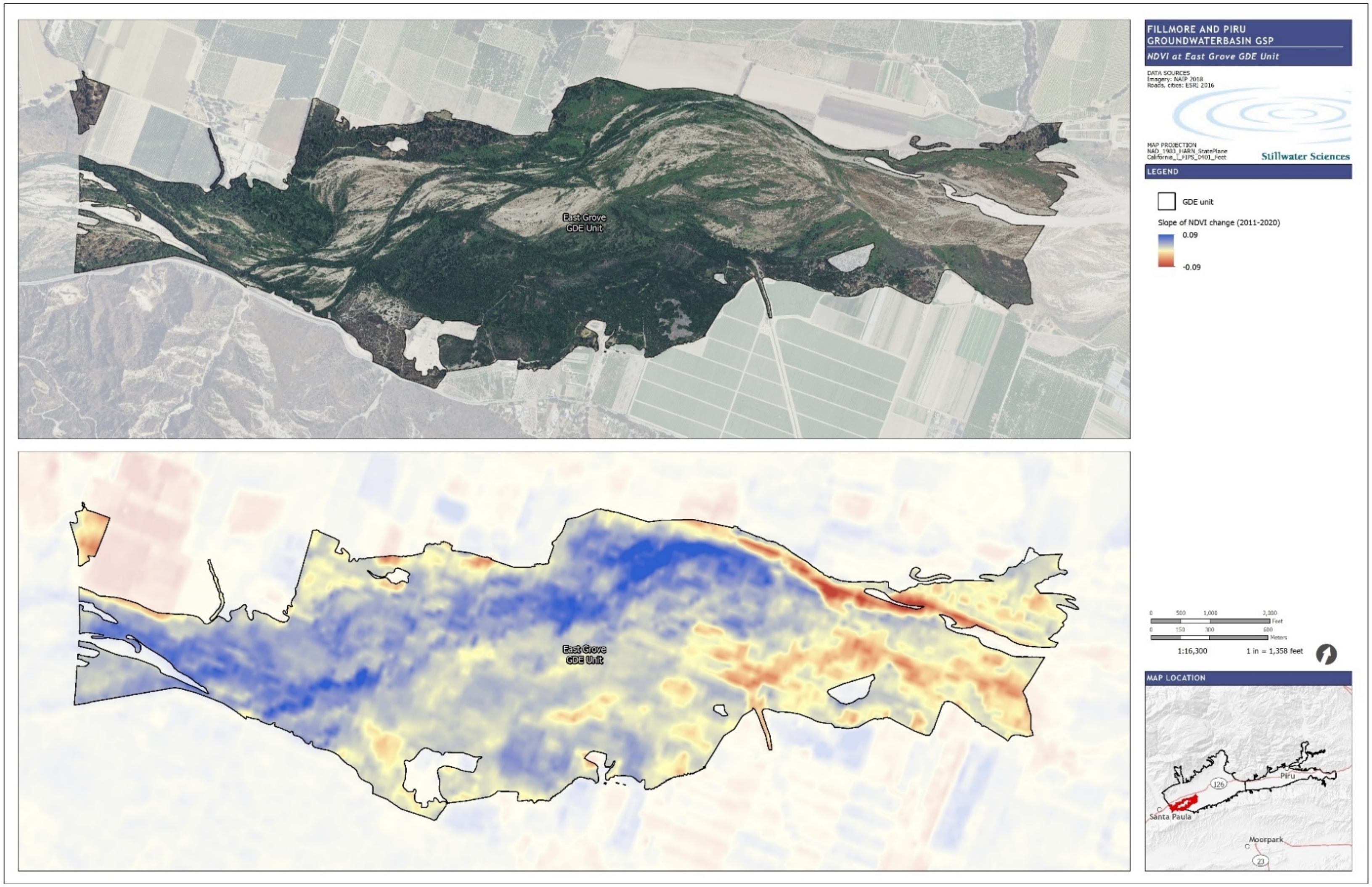


Figure 6-146.2-14. Slope of NDVI change in the East Grove GDE Unit in the Fillmore Basin from 2011-2020. Red areas have declining NDVI and blue areas have increasing NDVI.

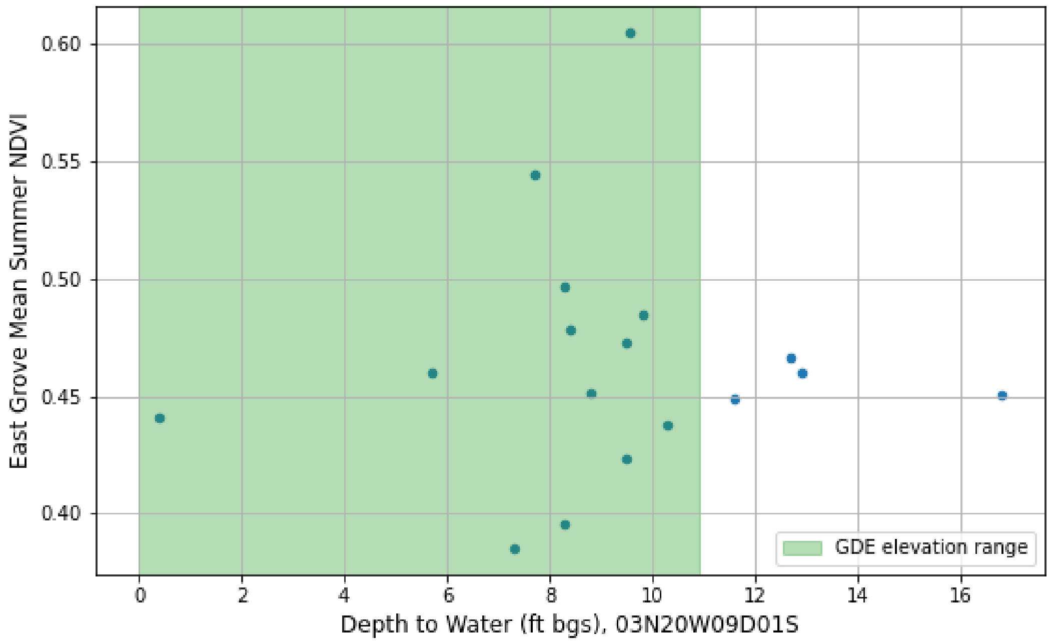


Figure 6-156.2-15. Mean Summer NDVI in the East Grove GDE unit versus depth to water at Well 03N20W09D01S. Depth to water data selection method is outlined in Section 5.2.

Fillmore Basin Tributary Riparian GDE Unit

The mean NDVI and NDMI for the Tributary Riparian GDE in the Fillmore Groundwater Basin from 1985–2018 were 0.50 and 0.058, respectively (Figure 6.2-16). The NDVI was relatively steady through the 1989–1991 drought and through 2017 before dropping in 2018, likely due to vegetation mortality due to the Thomas Fire. Short-term drops in NDVI occurred in 1996 and 2002, but were small compared to changes in other GDE units. NDMI declined in 2012 at the start of the 2012–2016 drought and has remained below the mean. In 2018 the NDMI further declined due to the Thomas Fire (Figure 6.2-16).

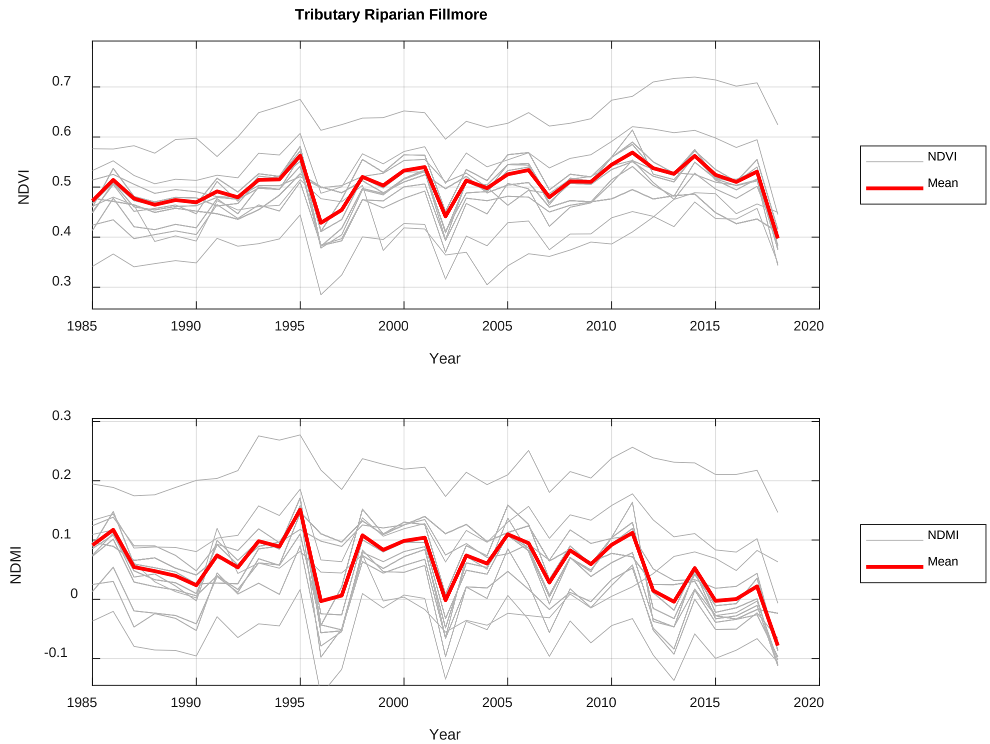


Figure 6-166.2-16. NDVI and NDMI for the Fillmore Basin Tributary Riparian GDE Unit.

Sespe Creek Riparian

The mean NDVI and NDMI for the Sespe Creek Riparian from 1985–2018 were 0.39 and 0.084, respectively. The Sespe Creek Riparian GDE has relatively steady intermediate NDVI of 0.3–0.4 prior to 2005, at which point NDVI dropped (Figure 6.2-17) as a result of the flood. Following the 2005 flood, NDVI gradually increased, as would be expected if the riparian forest were recovering following the flood. NDVI dropped from 2015–2018 (Figure 6.2-17). NDMI has been relatively consistent through time (Figure 6.2-17).

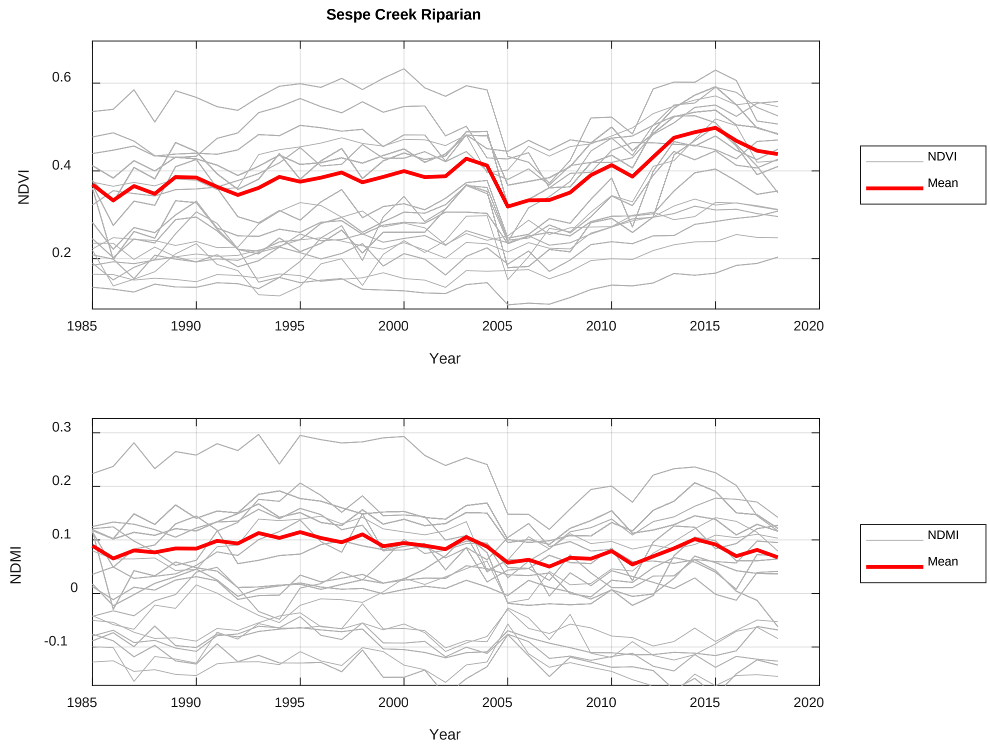


Figure 6-176.2-17. NDVI and NDMI for the Sespe Creek Riparian GDE Unit.

6.2.3 Summary of NDVI analysis

None of the GDE units showed a long-term decline in NDVI or NDMI, but some of the units had declines in NDVI and NDMI following floods and droughts. The largest declines in NDVI occurred following the 2012–2016 drought, where declines in vegetation health occurred in the Cienega, East Grove, and the Fillmore Basin Santa Clara River Riparian Shrubland. The largest declines in NDVI and NDMI were in the Cienega GDE unit where extensive die off of vegetation occurred during the drought and the area has yet to recover. NDVI was relatively constant through time in the Tributary Riparian GDE unit in the Fillmore and Piru Basins (outside of the effects of the Thomas Fire), and the Santa Clara River Riparian Shrubland in the Piru Basin. As expected NDVI dropped for many of the GDE units in 2005 following the 2005 flood which reworked large portions of the floodplain and uprooted vegetation.

6.3 Climate Change Effects

The effects of climate change on groundwater and interconnected surface water are discussed in DBS&A (2021). As an overview, the future groundwater levels forecast with assumed climate change factors (2070CF [climate change factor]) are not materially different from those recorded during the historical record (See GSP). The groundwater basin will continue to fill during wet years and decline during droughts. More frequent or severe droughts than those predicted by the model could affect groundwater levels and vegetation health. There is no suggestion of long-term chronic declines in groundwater levels, and models suggest that groundwater management has a small effect on rising groundwater flow.

Low water levels associated with major droughts (and accounting for future climate) are lower (typically 10–30 ft) than those of the historical time period (i.e., without the effects of climate change). Despite the lower, drought-induced water levels, the water levels return to historical high water level conditions during subsequent wet to normal precipitation periods. Statewide climate models suggest that there could be an increase in the duration, severity, and frequency of droughts and extreme floods through the remainder of 21st century (Swain et al. 2018) that could impact groundwater availability to GDEs but may also increase the frequency of flood events that are crucial for regrowth of the pioneer species that make up the GDEs along the Santa Clara River.

Climate change may alter the water demands of groundwater dependent vegetation, but the response is complex because decreased transpiration associated with increased carbon dioxide in the atmosphere may counter increased evaporation due to temperature increases (e.g., Klove et al. 2014). Monitoring of vegetation health (via NDVI) and components of the water balance in the Fillmore and Piru Basins (including rising groundwater) is therefore crucial for assessing the impacts of climate change.

6.4 Summary of Potential Effects

Potential effects on each GDE unit are summarized here based on four primary criteria:

1. The groundwater dependence of each unit (likely, uncertain, unlikely) based on hydrologic information and links with vegetation or interconnected surface water.
2. Ecological value (high, moderate, low), as described in Section 4.4.
3. Ecological condition of the GDEs within each unit (good, fair, poor), based on the information summarized in Section 4.1 and the NDVI/NDMI data presented in Section 5.2.
4. Susceptibility to changing groundwater conditions (high, moderate, low) based on available hydrologic data, climate change projections, and the GDE susceptibility classifications summarized in Table 6.1-1.

6.4.1 Piru

Del Valle GDE Unit

Groundwater Dependence: **Likely**

- Shallow groundwater measurements are rare in this unit but the historical persistence of the riparian forest and widespread willows and cottonwoods suggest that groundwater is likely within the rooting zone of plants.
- This GDE unit is a mixture of willows and cottonwoods that are likely connected to groundwater and facultative phreatophytes (e.g., mulefat and arrow-weed thickets) that may be connected to groundwater.
- Perennial surface water flows are likely connected with groundwater.

Ecological Value: **High**

- The Del Valle GDE Unit supports a relatively large number of special-status species and ecological communities, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.

- The unit supports species and ecological communities that are vulnerable to changes in groundwater levels.

Ecological Condition: **Good**

- NDVI/ NDMI from 1985–2018 was relatively constant until a flood-related reduction in NDVI in 2005, followed by a gradual recovery until 2015, at which point NDVI began a gradual decline. As of 2018, NDVI had not declined below the long-term average. NDMI has declined slowly since 1995 and in 2018 was below the long-term average. These trends suggest that the structure and function of riparian vegetation in the unit may have experienced declines during the drought, particularly at the unit's downstream end. Although groundwater levels are relatively stable, and this reach receives wastewater effluent from upstream, the limited well data in this GDE unit are insufficient to determine whether groundwater pumping has contributed to the observed declining vegetation condition at the downstream end of the unit.
- Habitat suitability in the downstream portion of the unit may be somewhat compromised by the decline in vegetation condition for special-status species that rely on vegetation (e.g., riparian birds).
- Groundwater contributes to the ecological function and habitat value of the Santa Clara River, which supports native aquatic and semi-aquatic species and beneficial uses in and adjacent to the unit.

Susceptibility to Changing Groundwater Conditions: **Moderate**

- Shallow groundwater conditions in the unit since the 1930s have fluctuated considerably in response to drought and possibly other factors. An 80-ft decline with the 2012–2016 drought has been followed by a slow recovery, and by spring 2020 groundwater depth was again within the baseline range for non-drought conditions. The groundwater well is at the downstream end of the unit and therefore may not reflect groundwater elevation changes further upstream.
- Rooting depths of willows and cottonwoods in this unit range up to 6.9 ft while the average relative elevation is 10 ft for cottonwoods and 5.6 ft for red willow. The mulefat thickets are not likely connected to groundwater.
- The decline in groundwater at the downstream end of the unit exceeded the rooting depth of the vegetation. Groundwater declines in the rest of the unit were likely less based on the vegetation response to the drought, but there are no well data further upstream.
- Future changes in groundwater conditions in the unit related to increased groundwater pumping, declining effluent releases from upstream, or climate change could cause groundwater levels to fall below the baseline range and result in mortality of the trees that comprise the GDE. Projections of climate change and groundwater pumping in the future suggest that changes in groundwater elevation are unlikely.

The unit includes a perennial portion of the mainstem Santa Clara River that is considered an interconnected surface water. The degree to which interconnected surface waters in this reach are maintained by releases from upstream effluent sources is unknown, but is believed to be significant.

Potential for effects

Available data are insufficient to discern a clear effect on GDEs related to groundwater management in the Del Valle GDE Unit. Declines in vegetation health (as shown by NDVI decreases) at the downstream end of the reach suggest that GDEs in this unit are susceptible to drought conditions. However, the extent of GDEs in the unit is moderately susceptible to future decrease in groundwater elevation and surface water conditions and the synergistic effects of climate change (described in Section 5.3). In combination these changes could cause groundwater levels to fall below the baseline range and result in mortality of the trees that comprise the GDE and reduce the extent of the GDE. GDEs in this unit are not expected to experience future water levels that are lower than the historical period, but more frequent or longer duration droughts due to climate change could also affect the extent of vegetation-dominated GDEs.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in the Santa Clara River using remote sensing is recommended and is further discussed in Section 6. Changes to upstream effluent releases may impact aquatic habitat and groundwater elevation in this GDE unit.

Santa Clara River Riparian Shrubland GDE Unit

Groundwater Dependence: **Possible**

- There are few shallow groundwater measurements in this unit. Spring 2019 water contours provided by United Water showed groundwater levels within 5–10 feet of the ground surface in parts of the unit.
- This GDE unit includes a large polygon of giant reed (arundo) at the downstream end of Piru Groundwater Basin, with patches of sandbar willows and large mulefat thickets. Given the shallow rooting depth of mulefat thickets (approximately 2 ft), they likely are connected to groundwater at shallower relative elevations, particularly near the downstream end of the GDE, where groundwater is closer to the surface. Other vegetation communities in the unit may be connected to groundwater. Small patches of sandbar willows are present in this unit and have average relative elevations in the Santa Clara River of 4.8 ft and the relative elevation ranges up to 9 ft (Appendix C).
- Intermittent surface water flows are not connected with groundwater.

Ecological Value: **Moderate**

- The Santa Clara River Riparian Shrubland GDE Unit supports a moderate number of special-status species and ecological communities, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.
- This naturally intermittent reach supports regionally rare alluvial scrub habitat.
- The unit supports species and ecological communities that are somewhat vulnerable to changes in groundwater levels. Although the Santa Clara River in the unit provides migration habitat for southern California steelhead, the migration habitat has low vulnerability to groundwater reduction because most fish migration occurs during seasonal high surface water flow periods.

Ecological Condition: **Fair**

- NDVI/ NDMI values in the unit from 1985–2018 are low compared to other GDE units in the Fillmore and Piru groundwater basins, reflecting the relatively sparse vegetation. Mean NDVI and NDMI during this period increased in response to wet years and returned to long-term average values between the peaks. Mean NDVI or NDMI values in the unit do not appear responsive to drought. There is no evidence that groundwater management affects the ecological condition of this GDE unit.

- Current habitat suitability for those special-status species with likelihood to occur in the unit may have declined relative to historical conditions.
- Groundwater provides little or no contribution to the ecological function and habitat value of the Santa Clara River in the unit, which is intermittent and mainly supports seasonal migration habitat for anadromous fishes.

Susceptibility to Changing Groundwater Conditions: **Low**

- Shallow groundwater conditions in the unit since the 1970s have fluctuated in response to drought, with sharp drops followed by recovery to pre-drought levels. As of fall 2019, the shallow groundwater level recorded in the unit had apparently recovered from the large drop associated with the 2012–2016 drought and was again within the baseline range. So long as the duration and frequency of droughts does not change, the effects on this GDE unit are expected to be minimal. The sandbar willows and eucalyptus occur on the margin of the unit adjacent to agricultural lands and may subsist on agricultural runoff.
- Future changes in groundwater conditions in the unit related to increased groundwater production or climate change are not expected to cause groundwater levels to fall below the baseline range. As a result the potential effects on GDEs are deemed negligible.
- The unit includes an intermittent reach of the mainstem Santa Clara River that does not provide perennial aquatic habitat or beneficial uses.

Potential for effects

Modeling suggests that groundwater levels are likely to be stable in this reach. Moreover, the vegetation that makes up this unit may use groundwater when groundwater levels are high in the spring, but high groundwater levels are likely not persistent in this unit. The unit is therefore likely not strongly dependent upon groundwater and is comprised of sparse low water use species with relatively shallow rooting depths. Therefore, the potential for effects on this unit is low.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in the Santa Clara River using remote sensing is recommended and is further discussed in Section 6.

Cienega GDE Unit

Groundwater Dependence: **Certain**

- Rising groundwater in this unit provides surface flows and keeps groundwater within the rooting zone (5–15 ft) of the vegetation.

Ecological Value: **High**

- The Cienega GDE Unit supports a moderate number of special-status species, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.
- The unit supports species and ecological communities that are vulnerable to changes in groundwater levels.

Ecological Condition: **Poor**

- NDVI/ NDMI trends from 1985–2018 indicate vegetation responds mainly to precipitation and runoff (e.g., drought) but a decline in NDMI from 2005–2014 suggests other factors, potentially including groundwater management, may influence vegetation condition in the unit. As of 2018 the vegetation structure and functions in the Cienega GDE Unit are no longer intact or within the range of natural variability, due at least in part to vegetation mortality from the 2012–2016 drought. The degree to which groundwater management has exacerbated the decline in groundwater elevation during the recent and other droughts is not known.

- Habitat suitability in the unit for special-status species relying on vegetation (e.g., riparian birds) may be compromised by the decline in vegetation condition during droughts.
- Groundwater contributes to the ecological function and habitat value of the Santa Clara River, which supports native aquatic and semi-aquatic species and beneficial uses in and adjacent to the unit.

Susceptibility to Changing Groundwater Conditions: **High**

- Shallow groundwater conditions in the unit since the 1970s have fluctuated in response to drought, with sharp drops followed by recovery within about one year. By 2019–2020, shallow groundwater levels recorded at the single well in the unit were again within the baseline range for the period of record, but the native cottonwoods and willows died during the drought and have not yet recovered. Those species are anticipated to recover once a future flooding event(s) removes the debris and the land surface is better conditioned for repopulation. The recent expansion of arundo in this GDE unit may limit re-establishment of cottonwoods and willows, particularly if groundwater conditions decline below cottonwood and willow rooting depth. The time required for that recovery is unknown.
- Reported maximum rooting depths of willows and cottonwoods in this unit range up to 6.9 ft while the average relative elevation is 10 ft for cottonwoods and 5.6 ft for red willow. The mulefat thickets generally occur at higher relative elevations in this reach and are not likely connected to groundwater.
- Future changes in groundwater conditions in the unit related to increased groundwater production or climate change could cause groundwater levels to fall below the baseline range and result in potential mortality to vegetation that comprises the GDE. Projections of climate change and groundwater pumping in the future suggest that changes in groundwater elevation are unlikely. However, based on widespread tree mortality during the 2012–2016 drought, future changes in the frequency or duration of droughts similar to 2012–2016 could have a deleterious effect on the GDE.
- The unit includes a perennial portion of the mainstem Santa Clara River, which is considered an interconnected surface water.

Potential for effects

Modeling suggests that climate change is unlikely to cause groundwater levels to drop below the baseline range. However, changes to the duration or severity of droughts could impact the health of the GDE through increased tree mortality. Moreover, it is possible that arundo could replace the cottonwood and willow forests that died during the 2012–2016 drought, which would lead to a decrease in habitat for other species (i.e., riparian birds).

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in the Santa Clara River using remote sensing is recommended and is further discussed in Section 6. For this unit, coupling remote sensing and shallow groundwater elevation monitoring, particularly during and following droughts, is recommended.

Piru Creek Riparian GDE Unit

Groundwater Dependence: **Uncertain/Unlikely**

- Groundwater wells in the rooting zone of plants (<30 ft) are rare in this unit.
- Releases from Santa Felicia Dam sustain surface flows.

Ecological Value: **High**

- The Piru Creek Riparian Complex GDE Unit supports a relatively high number of special-status species and ecological communities, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.
- The unit supports species and ecological communities whose habitat in the unit may be vulnerable to changes in groundwater levels.

Ecological Condition: **Good**

- NDVI/ NDMI from 1985–2018 was relatively constant and seemingly unresponsive to droughts and floods. These trends suggest that the structure and function of riparian vegetation in the unit are relatively intact and within the range of natural variability. Riparian vegetation in the unit may be sustained by releases from Santa Felicia Dam, which likely raise the groundwater level in this area. Available information indicates that adverse impacts are not likely occurring in the unit, at least partially as a result of current surface water releases that provide water to at least the near-channel portions of the GDE Unit even if groundwater is below the rooting depth of most riparian plants.
- Suitable habitat is present for those special-status species with likelihood to occur in the unit.
- Releases from Santa Felicia Dam likely raise groundwater levels and help maintain baseflows over some portion of the length of Piru Creek, thus contributing to the ecological function and habitat value of Piru Creek under current conditions. Piru Creek supports native aquatic and semi-aquatic species and beneficial uses in and adjacent to the unit.

Susceptibility to Changing Groundwater Conditions: **Undetermined, likely low**

- There are no monitoring wells in the unit and shallow groundwater conditions and trends in the unit are therefore unknown.
- Assuming continued releases from Santa Felicia Dam, it is unlikely that future changes in groundwater conditions in the unit related to increased groundwater production or climate change will cause groundwater levels to fall below the baseline range. As a result, the potential effects on GDEs are deemed negligible.
- Piru Creek in this GDE unit currently has perennial flow over most of its length due to releases from Santa Felicia Dam, but surface flow is not connected to groundwater. The lower portion of Piru Creek near the confluence with the Santa Clara River periodically lacks surface flow. As described previously, releases from Santa Felicia Dam likely raise groundwater levels and help maintain baseflows in Piru Creek.

Potential for effects

Available data are insufficient to discern a clear effect on GDEs related to groundwater management in the Piru Creek Riparian Complex GDE Unit. However, groundwater levels and baseflows in Piru Creek are likely maintained by releases from Santa Felicia Dam, thus the susceptibility of GDEs in the unit (i.e., vegetation mortality) to future changes in groundwater conditions and the synergistic effects of climate change is low. With continued dam releases, the potential for these combined effects to cause groundwater levels to fall below the baseline range and result in potential effects on GDEs is low.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in Piru Creek using remote sensing is recommended and is further discussed in Section 6. Coupling remote sensing with a shallow groundwater monitoring well would help to assess the degree to which groundwater dynamics affect GDEs in this unit. In this GDE unit, changes to releases from Santa Felicia Dam may affect aquatic habitat and groundwater elevation.

Tributary Riparian GDE Unit

Groundwater Dependence: **Unlikely**

- There are no shallow groundwater measurements in this unit. Based on the position in the landscape, a connection to the regional aquifer is unlikely.
- This GDE unit contains a mixture of obligate and facultative phreatophytes that may be connected to groundwater (unlikely) or surviving on episodic surface water flows.
- Intermittent and ephemeral surface water flows are not connected with groundwater. Hopper Canyon Creek within the Piru Basin may be a passage corridor for *O. mykiss*, but is likely dependent on surface water flows rather than groundwater for passage.

Ecological Value: **Moderate**

- The Tributary Riparian GDE Unit supports a relatively low number of special-status species and ecological communities and the dependence of these species and communities on groundwater is uncertain.
- The unit includes designated critical habitat for one federally listed species.
- The species and ecological communities in the unit have low vulnerability to changes in groundwater levels. The tributary streams in this GDE unit are considered intermittent or ephemeral and are not connected to groundwater. The tributaries within the basin boundary currently provide little habitat value for fish and other aquatic species. Hopper Canyon Creek contains critical habitat for southern California steelhead, but it is not known if flows on Hopper Canyon Creek within the basin are dependent on groundwater. Hopper Canyon Creek and other tributaries support valuable riparian habitat and likely movement corridors for a variety of native wildlife species.

Ecological Condition: **Fair**

- NDVI/ NDMI trends in the unit from 1985–2018 show relatively little change in vegetation condition during most of this period, with little change in response to droughts or floods. It is unlikely that adverse impacts are occurring in the unit as a result of current groundwater management.
- Suitable habitat is present for those special-status species with likelihood to occur in the unit.
- Groundwater likely provides little or no contribution to the ecological function and habitat value of the ephemeral tributaries in the unit, which support vegetation but have little habitat value for fish or other aquatic species.

Susceptibility to Changing Groundwater Conditions: **Moderate**

- There are no monitoring wells in the unit and shallow groundwater conditions and trends in the unit are therefore unknown.
- Model results suggest that the groundwater elevations are unlikely to decline under climate change, unless droughts are more frequent or more severe. Moreover, because this GDE unit is disconnected from the aquifer, future changes in groundwater conditions in the unit related to increased groundwater production or climate change are unlikely to cause groundwater levels to fall below the baseline range and result in mortality to vegetation that comprises the GDE.
- Streams within the unit are ephemeral and do not provide perennial aquatic habitat or beneficial uses.

Potential for effects

Based on the position of this GDE unit in the watershed, it is unlikely that groundwater management will affect the health of the GDE. Model results suggest that the groundwater levels will remain constant in the Fillmore and Piru Basins under climate change (DBS&A 2021). If groundwater pumping were to increase in this GDE unit, monitoring of groundwater levels and GDE health (using remote sensing) would be necessary. GDEs in the unit likely have low susceptibility to future changes in groundwater conditions and the synergistic effects of climate change.

6.4.2 Fillmore

Santa Clara River Riparian Shrubland GDE Unit

Groundwater Dependence: **Possible**

- There are few shallow groundwater measurements in this unit. Spring 2019 water contours provided by United Water showed groundwater levels within 5–10 feet of the ground surface in parts of the unit, but these contours have a large uncertainty in this reach due to the paucity of shallow wells.
- The Santa Clara River Riparian Shrubland GDE unit is primarily made up of vegetation that may or may not rely on groundwater.
- Intermittent surface water flows are likely not interconnected with groundwater.

Ecological Value: **Moderate**

- The Santa Clara River Riparian Shrubland GDE Unit supports a relatively large number of special-status species and ecological communities, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.
- This naturally intermittent reach supports regionally rare alluvial scrub habitat.
- The unit supports species and ecological communities that are vulnerable to changes in groundwater levels. Although the Santa Clara River in the unit provides migration habitat for southern California steelhead and Pacific lamprey, the migration habitat has low vulnerability to groundwater reduction because most fish migration occurs during seasonal high surface water flow periods, and flows in this reach are not connected to groundwater.

Ecological Condition: **Fair**

- NDVI/ NDMI trends in the Unit from 1985–2018 indicate a decline in vegetation condition since 2012 relative to the long-term average, likely in response to decreased precipitation and runoff (e.g., drought). The current vegetation structure and functions may be compromised and somewhat below the range of natural variability. Groundwater management is unlikely to have an adverse effect on this GDE unit because summer groundwater is typically deeper than the rooting depth of vegetation in the reach.

- Current habitat suitability for those special-status species with likelihood to occur in the unit may have declined relative to historical conditions.
- Because surface water in this reach is disconnected from groundwater, groundwater provides little or no contribution to the ecological function and habitat value of the Santa Clara River in the unit, which is intermittent and mainly supports seasonal migration habitat for anadromous fishes.

Susceptibility to Changing Groundwater Conditions: **Moderate**

- Since 2015, shallow groundwater conditions in the unit have fluctuated in response to drought, with a sharp drop in 2013 followed by slow recovery. By 2019, the shallow groundwater level recorded in the unit had nearly returned to the long-term average (i.e., just below the baseline range).
- Future changes in groundwater conditions in the Unit related to increased groundwater production or climate changes that differ from modeled predictions could cause groundwater levels to fall below the baseline range and result in mortality to vegetation that comprises the GDE. Projections of climate change and groundwater pumping in the future suggest that changes in groundwater elevation are unlikely. However, based on widespread tree mortality during the 2012–2016 drought, future changes in the frequency or duration of droughts similar to 2012–2016 could have a deleterious effect on the GDE, particularly at the downstream margin of the unit.
- The unit includes an intermittent reach of the mainstem Santa Clara River that does not provide perennial aquatic habitat or beneficial uses.

Potential for effects

Modeling suggests that groundwater levels near the Santa Clara River Riparian Shrubland GDE Unit are unlikely to change due to climate change or modest changes to groundwater pumping. However, GDEs in the unit are moderately susceptible to future changes in groundwater conditions and the synergistic effects of climate change, which in combination could cause groundwater levels to fall below the baseline range and result in potential effects on GDEs if climate change differs from modeled conditions.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in the Santa Clara River using remote sensing is recommended and is further discussed in Section 6.

East Grove GDE Unit

Groundwater Dependence: **Certain**

- This GDE unit occurs at a site of rising groundwater.
- This GDE unit is primarily made up of cottonwoods and willows that rely on shallow groundwater.
- Perennial surface water flows are rising groundwater.

Ecological Value: **High**

- The East Grove GDE Unit supports a relatively large number of special-status species and ecological communities, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.
- The unit supports species and ecological communities that are vulnerable to changes in groundwater levels.

Ecological Condition: **Good**

- NDVI/ NDMI trends from 1985–2018 show minimal change in the unit and indicate vegetation responds mainly to precipitation and runoff (e.g., drought). The vegetation structure and functions are relatively intact and within the range of natural variability, and adverse impacts are not likely occurring in the unit as a result of current groundwater management.
- Suitable habitat is present for those special-status species with likelihood to occur in the unit.
- With the exception of flow during storm events, Santa Clara River surface flows in this unit are composed of rising groundwater. As a result, groundwater contributes to the ecological function and habitat value of the Santa Clara River, which supports native aquatic and semi-aquatic species and beneficial uses in and adjacent to the unit.

Susceptibility to Changing Groundwater Conditions: **Moderate**

- Shallow groundwater conditions in the unit since the 1960s have fluctuated considerably in response to drought and possibly other factors. By 2019–2020, shallow groundwater levels recorded at the two wells in the unit were again within the baseline range for each well.
- Recorded maximum rooting depths of willows and cottonwoods in this unit range up to 6.9 ft while the average relative elevation is 10 ft for cottonwoods and 5.6 ft for red willow. Mulefat has a rooting depth of 2 ft (Appendix C), and the mulefat thickets are not likely connected to groundwater.
- Future changes in groundwater conditions in the unit related to increased groundwater production or climate change could cause groundwater levels to fall below the baseline range and result in mortality to vegetation that comprises the GDE. Projections of climate change and groundwater pumping in the future suggest that changes in groundwater elevation are unlikely. However, because the extent of rising groundwater decreased and vegetation health declined at the upstream end of the unit during the 2012–2016 drought, changes in the frequency or duration of droughts to make 2012-2016 conditions more common could have a deleterious effect on the GDE.
- The unit includes a perennial portion of the mainstem Santa Clara River, which is an area of rising groundwater.

Potential for effects

Modeling suggests that groundwater levels are unlikely to drop below the baseline range due to climate change. However, changes to the duration or severity of droughts could impact the health of the GDE through increased tree mortality.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in the Santa Clara River using remote sensing is recommended and is further discussed in Section 6. Additionally, monitoring of surface water flows or groundwater elevations should be conducted to assess any changes to hydrology that might impact GDEs.

Cienega GDE Unit

Groundwater Dependence: **Certain**

- Rising groundwater in this unit provides surface flows and keeps groundwater within the rooting zone (5–15 ft) of the vegetation.

Ecological Value: **High**

- The Cienega GDE Unit supports a moderate number of special-status species, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for two federally listed species.
- The unit supports species and ecological communities that are vulnerable to changes in groundwater levels.

Ecological Condition: **Poor**

- NDVI/ NDMI trends from 1985–2018 indicate vegetation responds mainly to precipitation and runoff (e.g., drought) but a decline in NDMI from 2005–2014 suggests other factors, potentially including groundwater management, may influence vegetation condition in the Unit. As of 2018, the vegetation structure and functions in the Cienega GDE Unit are no longer intact or within the range of natural variability, due at least in part to vegetation mortality from the 2012–2016 drought. The degree to which groundwater management has exacerbated the decline in groundwater elevation during the recent and other droughts is not known.
- Habitat suitability in the unit may be compromised by the decline in vegetation condition during droughts for special-status species relying on vegetation (e.g., riparian birds).
- Groundwater contributes to the ecological function and habitat value of the Santa Clara River, which supports native aquatic and semi-aquatic species and beneficial uses in and adjacent to the unit.

Susceptibility to Changing Groundwater Conditions: **High**

- Shallow groundwater conditions in the unit have fluctuated in response to drought since the 1970s, with sharp drops followed by recovery within about one year. By 2019–2020, shallow groundwater levels recorded at the single well in the unit were again within the baseline range for the period of record, but the native cottonwoods and willows died during the drought and have not yet recovered. Those species are anticipated to recovery once a future flooding event(s) removes the debris and the land surface is better conditioned for repopulation. The time required for that recovery is unknown.
- Reported maximum rooting depths of willows and cottonwoods in this unit range up to 6.9 ft while the average relative elevation is 10 ft for cottonwoods and 5.6 ft for red willow. The mulefat thickets are not likely connected to groundwater.
- Future changes in groundwater conditions in the unit related to increased groundwater production or climate change could cause groundwater levels to fall below the baseline range and result in potential mortality to vegetation that comprises the GDE.
- Projections of climate change and groundwater pumping in the future suggest that changes in groundwater elevation are unlikely. However, based on widespread tree mortality during the 2012–2016 drought, future changes in the frequency or duration of droughts similar to 2012–2016 could have a deleterious effect on the GDE.

- The unit includes a perennial portion of the mainstem Santa Clara River, which is considered an interconnected surface water.

Potential for effects

Modeling suggests that groundwater levels are unlikely to drop below the baseline ranged due to climate change. However, changes to the duration or severity of droughts could impact the health of the GDE through increased tree mortality. Moreover, it is possible that arundo could replace the cottonwood and willow forests that died during the 2012–2016 drought, which would lead to a decrease in habitat for other species, including two special-status riparian bird species (i.e., southwestern willow flycatcher and least Bell's vireo). The expansion of arundo could increase evapotranspiration in this reach and reduce water availability for other beneficial users.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in the Santa Clara River using remote sensing is recommended and is further discussed in Section 6. For this unit, coupling remote sensing and shallow groundwater elevation monitoring, particularly during and following droughts, is recommended.

Tributary Riparian GDE Unit

Groundwater Dependence: **Unlikely**

- There are no shallow groundwater measurements in this unit. Based on the position in the landscape a connection to the regional aquifer is unlikely.
- This potential GDE unit is primarily made up of coast live oaks, which are facultative phreatophytes that may be connected to groundwater or episodic surface water flows associated with storm events.
- Ephemeral surface water flows are not connected with groundwater.

Ecological Value: **Moderate**

- The Tributary Riparian GDE Unit supports a relatively low number of special-status species and ecological communities and the dependence of these species and communities on groundwater is uncertain.
- There is no designated critical habitat in the unit.
- The species and ecological communities in the unit have low vulnerability to changes in groundwater levels. The tributary streams in this GDE unit are considered ephemeral and are not connected to groundwater, thus they provide little habitat value for fish and other aquatic species. Pole Creek may have supported steelhead, but access to habitat upstream of the channelized portion of the channel is currently blocked. Currently, flows in Pole Creek within the basin are unlikely to be connected to groundwater. The tributaries support valuable riparian habitat and likely movement corridors for a variety of native wildlife species.

Ecological Condition: **Fair**

- NDVI/ NDMI trends in the unit from 1985–2018 indicate relatively little change in vegetation condition during most of this period, with a decline in response the most recent drought (2012–2016) and potential damage to vegetation in 2018 resulting from the Thomas Fire. As a result, the current vegetation structure and functions may be compromised and below the range of natural variability, but it is unlikely that adverse impacts are occurring in the unit as a result of current groundwater management.

- Current habitat suitability for those special-status species with likelihood to occur in the unit may have declined relative to historical conditions.
- Groundwater currently provides little or no contribution to the ecological function and habitat value of the ephemeral tributaries in the unit, which support vegetation but have little habitat value for fish or other aquatic species. Mapped habitat in Pole Creek is almost entirely upstream of the basin.

Susceptibility to Changing Groundwater Conditions: **Low**

- There are no monitoring wells in the unit and shallow groundwater conditions and trends in the unit are therefore unknown, but the position of the tributaries suggests they are unlikely to be linked to regional groundwater.
- Because this GDE unit is disconnected from the aquifer, future changes in groundwater conditions in the unit related to increased groundwater production or climate change are unlikely to cause groundwater levels to fall below the baseline range and result in mortality to vegetation that comprises the GDE.
- Streams within the unit are ephemeral and do not provide perennial aquatic habitat or beneficial uses.

Potential for effects

Based on the position of this GDE unit in the watershed, it is unlikely that groundwater management will affect the health of the GDE. If groundwater pumping were to increase in this GDE unit, monitoring of groundwater levels and GDE health (using remote sensing) would be necessary. GDEs in the unit likely have low susceptibility to future changes in groundwater conditions and the synergistic effects of climate change on groundwater levels.

Sespe Creek Riparian GDE Unit

Groundwater Dependence: **Possible**

- This GDE unit occurs downstream of the confined canyon reach of Sespe Creek.
- Groundwater depths are typically >30 ft bgs, but there are few wells within the shallow groundwater zone.
- This GDE unit is primarily made up of willows and cottonwoods that rely on shallow groundwater or surface water and some communities (e.g., mulefat) that may rely on groundwater for part of their water needs.
- Surface water flows are perennial for the upper portions of the reach and intermittent downstream. The connection to groundwater in the upper portion of Sespe Creek is likely, while the connection in the downstream reaches in uncertain. ~~unknown but unlikely.~~

Ecological Value: **Moderately High**

- The Sespe Creek Riparian GDE Unit supports a moderate number of special-status species and ecological communities, some of which are directly dependent on groundwater.
- The unit includes designated critical habitat for one federally listed species.
- The unit supports species and ecological communities whose habitat in the unit may be vulnerable to changes in groundwater levels.

Ecological Condition: **Good**

- NDVI/ NDMI from 1985–2018 was relatively constant until a sharp flood-related reduction in NDVI in 2005 followed by a gradual recovery until 2015, at which point NDVI began a gradual decline. As of 2018, NDVI was still within the historical range of variability. NDMI has fluctuated little during the period of record. These trends suggest that the structure and function of riparian vegetation in the unit are relatively intact and within the range of natural variability. Available information indicates that adverse impacts are not likely occurring in the unit as a result of current groundwater management. Invasive species, particularly arundo, are a continuing threat to existing GDEs in this unit.
- Suitable habitat is present for those special-status species with likelihood to occur in the unit.
- It is undetermined if or to what extent groundwater contributes to the ecological function and habitat value of Sespe Creek, which supports native aquatic and semi-aquatic species and beneficial uses in and adjacent to the unit.

Susceptibility to Changing Groundwater Conditions: **Low**

- There are no shallow monitoring wells in the unit and shallow groundwater conditions and trends in the unit are therefore unknown.
- Climate change effects on Sespe Creek are unknown. Changes to the duration or extent of droughts may cause tree mortality within the GDE unit.
- The upper 2 miles or so of Sespe Creek in this GDE unit are considered perennial, while the lower portion of Sespe Creek is likely intermittent. Sespe Creek's connection to groundwater is undetermined.

Potential for effects

Modeling suggests that groundwater elevations along the Santa Clara River are unlikely to change due to changes in climate or groundwater pumping in the future. The effects of climate change on groundwater levels further upstream on Sespe Creek are uncertain. However, changes in the duration or severity of droughts could impact the health of the GDE through increased physiological stress to riparian vegetation, leading to branch dieback or whole tree mortality.

Monitoring of ecological conditions and trends in vegetation-dominated GDEs and in Sespe Creek using remote sensing is recommended and is further discussed in Section 6. Additionally, monitoring of surface water flows or groundwater elevations should be conducted to assess any changes to hydrology that might impact GDEs. Further assessing the extent of interconnected surface water in the reach will help to determine potential groundwater impacts to aquatic habitat.

6.4.3 GDEs important to consider when establishing sustainable management criteria

The evaluations of the GDE units in the Fillmore and Piru basins suggests that the following units are the most important for inclusion in the GSP analyses and the development of Sustainable Management Criteria:

- Del Valle,
- Cienega, and
- East Grove.

These units encompass areas of rising groundwater (and hence aquatic habitat) and have historically supported large, tree-forested wetland complexes. For all of the units, impacts to aquatic and riparian habitat occur during droughts. The Del Valle GDE Unit is likely sensitive to upstream effluent releases, and decreases in effluent releases could impact habitat. Because the aquifer is thin in this GDE unit, there are few wells present.

The Cienega GDE Unit is the most sensitive to changes in groundwater associated with droughts. Prolonged droughts result in groundwater levels below the rooting depth of vegetation and caused extensive die-off during the 2012–2016 drought. During the 2012–2016 drought, the decreased elevation of groundwater stopped rising groundwater in this reach and caused the channel to go dry.

In the East Grove, impacts during the 2012–2016 drought resulted in decreased vegetation health at the upstream end of the unit, and decreased the extent of rising groundwater, but surface flows persisted over at least part of the reach for the duration of the drought. If droughts become more severe in magnitude or duration, the East Grove may be more susceptible to impacts from droughts.

7 GDE MONITORING

GDEs were considered as part of the groundwater Monitoring Program (DBS&A 2020). Remote sensing, particularly NDVI data derived from Landsat imagery, is recommended to monitor GDE vegetation health through time. ~30-m resolution Landsat images are collected every 16 days. Pre-processed, atmospherically corrected Landsat data are available through the Google Earth Engine API, with new imagery added approximately every two weeks (see https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C02_T1_L2). Tools developed by The Nature Conservancy (see Klausmeyer et al. 2019 for further description of methods) may be applied to these data to calculate summer medoid NDVI for ongoing monitoring of GDE health through time.
~~GDEs were considered as part of the groundwater Monitoring Program (DBS&A 2020). Remote sensing of GDEs using NDVI or other widely available data is recommended to monitor the health of GDEs through time.~~
It is expected that NDVI will exhibit some natural variability given the dynamic nature of this river system. For example, NDVI would be expected to initially decline following the large floods that tend to uproot vegetation and provide fresh bare mineral surfaces and appropriate hydrological conditions for seedling establishment of cottonwoods and willows, but then increase again as native cottonwood and willow vegetation becomes established and individual shrubs and trees develop and mature. As part of the GSP, additional groundwater monitoring wells are proposed in both basins. Groundwater wells near the basin boundaries (the Del Valle, Cienega, and East Grove GDE units) can be used to determine changes in groundwater levels. Such data on groundwater levels through time could then be examined to see if there are clear correlations with observed trends in NDVI or related indicators of GDE health. Continued monitoring of rising groundwater at the Cienega and East Grove sites will help to validate future models and help to assess the availability of aquatic habitat, while wells along Sespe Creek will help to better understand interconnected surface water in this important reach. Optional monitoring elements include supporting aquatic habitat assessments in the East Grove and Cienega areas.

8 PROJECTS AND MANAGEMENT ACTIONS

Projects and management actions (PMAs) are discussed in Section 4 of the GSP. At time of the release of this technical memorandum, the FPBGSA had not determined that projects and/or management actions were needed to sustainably manage the groundwater resources in the Fillmore or Piru basins.

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Appendices

Appendix A

Vegetation Communities in the Fillmore and Piru Groundwater Basins

Table A-1. All vegetation communities mapped in the Fillmore and Piru groundwater basins and corresponding vegetation classification crosswalk.

CALVEG classification	Manual of California Vegetation (MCV)[1]	Acreage	
		Fillmore Groundwater Basin	**Piru Groundwater Basin**
Alkaline mixed grasses and forbs Alliance	*Cressa truxillensis - Distichlis spicata* Herbaceous Alliance	-	2.2
Annual grasses and forbs Alliance	*Brassica nigra - Raphanus* spp. Herbaceous Semi-Natural Alliance	1,291.1	377.4
Arrowweed Alliance	*Pluchea sericea* Shrubland Alliance	-	31.5
Baccharis (riparian) Alliance	*Baccharis salicifolia* Shrubland Alliance	1,216.1	952.2
Barren	Riverwash	138.5	84.9
	Riverwash herbaceous		
Black cottonwood Alliance	*Populus trichocarpa* Forest Alliance	320.6	-
Black walnut Alliance	*Juglans californica* Woodland Alliance	6.8	3.7
Big sagebrush Alliance	*Artemisia tridentata* Shrubland Alliance	4.0	54.1
Blue oak Alliance	n/a	4.0	-
Buckwheat	*Encelia californica - Eriogonum cinereum* Shrubland Alliance	113.8	27.3
	Eriogonum fasciculatum Shrubland Alliance		
California sagebrush Alliance	*Artemisia californica* Shrubland Alliance	1,727.4	639.8
	Salvia apiana Shrubland Alliance		
California sycamore Alliance	*Platanus racemosa* Woodland Alliance	-	4.6
Ceanothus chaparral Alliance	n/a	44.2	-
Chamise Alliance	n/a	2.8	-
Coast live oak Alliance	*Quercus agrifolia* Woodland Alliance	815.8	65.4
Coastal mixed hardwood Alliance	n/a	77.8	4.0
Coyote brush Alliance	*Baccharis pilularis* Shrubland Alliance	4.1	0.9
Eucalyptus Alliance	*Eucalyptus* spp. *- Ailanthus altissima - Robinia pseudoacacia* Woodland Semi-Natural Alliance	74.7	14.4
Fremont cottonwood Alliance	*Populus fremontii* Forest Alliance	0.7	244.8
Giant reed/pampas grass Alliance	*Phragmites australis - Arundo donax* Herbaceous Semi-Natural Alliance	271.6	183.0
Lower montane mixed chaparral Alliance	n/a	170.7	3.1
Manzanita chaparral Alliance	n/a	<0.1	-
Non-native/ornamental conifer/hardwood Alliance	n/a	13.0	2.6
Non-native/ornamental grass Alliance	Non-native Grass and Forb Mapping Unit	195.0	90.2
Non-native/ornamental hardwood Alliance	*Schinus* (*molle, terebinthifolius*) *- Myoporum laetum* Woodland Semi-Natural Alliance	75.7	20.2
Perennial grasses and forbs Alliance	*Corethrogyne filaginifolia - Eriogonum* (*elongatum, nudum*) Herbaceous Alliance	6.3	-
	Leymus cinereus - Leymus triticoides Herbaceous Alliance		
Riparian mixed hardwood Alliance	*Sambucus nigra* Shrubland Alliance	396.2	286.4
	Salix laevigata Woodland Alliance		

CALVEG classification	Manual of California Vegetation (MCV)[1]	Acreage	
		Fillmore Groundwater Basin	**Piru Groundwater Basin**
Riparian mixed shrub Alliance	*Heterotheca* (*oregona*, *sessiliflora*) Herbaceous Alliance	152.2	557.1
	Salix exigua Shrubland Alliance		
Riversidean alluvial scrub Alliance	n/a	52.5	3.6
Saltbrush Alliance	*Atriplex lentiformis* Shrubland Alliance	54.1	58.1
Scalebroom Alliance	*Lepidospartum squamatum* Shrubland Alliance	320.1	118.0
Scrub oak Alliance	n/a	1.1	-
Soft scrub-mixed chaparral Alliance	n/a	62.9	-
Sumac shrub Alliance	n/a	522.4	0.9
Tamarisk Alliance	*Tamarix* spp. Shrubland Semi-Natural Alliance	-	37.6
Tule-cattail Alliance	*Schoenoplectus* (*acutus*, *californicus*) Herbaceous Alliance	8.1	3.3
	Typha (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance		
Wet meadow	n/a	0.4	-
Willow/Willow (shrub) Alliance	*Salix lasiolepis* Shrubland Alliance	63.5	3.9
	Salix lucida Woodland Alliance		
No corresponding CalVeg type[2]	*Olea europaea* Woodland Semi-Natural Alliance [Provisional]	-	2.7
	Pseudognaphalium leucocephalum Herbaceous Alliance [Provisional]	-	0.2
	Ricinus communis Shrubland Semi-Natural Alliance [Provisional]	-	2.2
All agriculture		12,436.9	6,123.8
All water		6.7	14.6
All development		1,968.6	903.2
Total		**22,620.3**	**10,922.0**

1 An n/a in this column signifies that no corresponding MCV type was mapped in the Vegetation Mapping of Santa Clara River dataset (Stillwater Sciences 2019).
2 These are provisional MCV alliances and as such do not have a corresponding CalVeg alliance.

Appendix B

Special-status Terrestrial and Aquatic Wildlife Species from Database Queries with No Reliance on Fillmore or Piru Groundwater Dependent Ecosystem Units

Table. B-1. Special-status terrestrial and aquatic wildlife species from database queries that are not groundwater dependent and/or unlikely to occur in the Fillmore and Piru groundwater dependent ecosystem units.

Common name *Scientific name*	**Status[1] Federal/State**	**Potential to occur in GDE Basins[2]**	**Documented occurrence location**		**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in GDE Management Units**
			Fillmore GDE units	**Piru GDE units**			
Amphibian							
California red-legged frog *Rana draytonii*	FT/SSC	Unlikely	No documented occurrences	No documented occurrences	CAFSD	Direct	Breeds in still or slow-moving water with emergent and overhanging vegetation, including wetlands, wet meadows, ponds, lakes, and low-gradient, slow-moving stream reaches with permanent pools; uses adjacent uplands for dispersal and summer retreat. Relies on surface water that may be supported by groundwater (Rohde et al. 2019).
Foothill yellow-legged frog *Rana boylii*	FSS, BLMS/SE	None	Extirpated	Extirpated	CNDDB, CAFSD	Direct	Shallow tributaries and mainstems of perennial streams and rivers, typically associated with cobble or boulder substrate; occasionally found in isolated pools, vegetated backwaters, and deep, shaded, spring-fed pools. The frog is reliant on surface water that may be fed by groundwater. Population has been extirpated from the Santa Clara River Valley Basin (CDFW 2019).
Western spadefoot *Spea hammondii*	BLMS/SSC	Unlikely	No documented occurrences	No documented occurrences	CAFSD	No known reliance on groundwater	Areas with sparse vegetation and/or short grasses in sandy or gravelly soils; primarily in washes, river floodplains, alluvial fans, playas, alkali flats, among grasslands, chaparral, or pine-oak woodlands; breeds in ephemeral rain pools with no predators.

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to occur in GDE Basins[2]**	**Documented occurrence location**		**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in GDE Management Units**
			Fillmore GDE units	**Piru GDE units**			
Reptile							
California legless lizard *Anniella sp.*	–/SSC	Likely	Santa Clara River Riparian Shrubland	Tributary Riparian	CNDDB	No known reliance on groundwater	Occurs in moist, warm, loose soil with plant cover and in sparsely vegetated areas of chaparral, pine-oak woodlands, desert scrub, and stream terraces with sycamores, cottonwoods, or oaks. Forages in loose soil, sand, and leaf litter for larval insects, beetles, termites, and spiders. Historical observation in the vicinity of Sespe Creek and Santa Clara River confluence in 1981 (CDFW2019). Observations in the vicinity of Tributary Riparian GDE Unit include Hopper Canyon in 2008 (CDFW 2019).
Coast horned lizard *Phrynosoma blainvillii*	FSS, BLMS/SSC	Likely	East Grove Riparian Complex	Santa Clara River Riparian Shrubland	CNDDB	No known reliance on groundwater	Open areas with sandy soil and/or patches of loose soil and low/scattered vegetation in scrublands, grasslands, conifer forests, and woodlands; frequently found near ant hills. Feeds on ants and other small invertebrates (e.g., spiders, beetles, and grasshoppers).
Coast patch-nosed snake *Salvadora hexalepis virgultea*	–/SSC	Likely	No documented occurrences	No documented occurrence	CNDDB	No known reliance on groundwater	Coastal chaparral, desert scrub, washes, sandy flats and rocky areas. Predominately preys upon lizards. Documented outside of groundwater basins on Hopper Canyon Creek, 2 miles northwest of Piru (CDFW 2019).
San Diegan Coastal whiptail *Aspidoscelis tigris stejnegeri*	–/SSC	Likely	No documented occurrences	Piru Creek Riparian	CNDDB	No known reliance on groundwater	Habitat generalists found in desert, woodland, and riparian communities. Feeds on small invertebrates (e.g., spiders, scorpions, centipedes, and termites) and small lizards. Documented on Piru Creek in 2009 (CDFW 2019)

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to occur in GDE Basins[2]**	**Documented occurrence location**		**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in GDE Management Units**
			Fillmore GDE units	**Piru GDE units**			
Bird							
Bank swallow *Riparia riparia*	BLMS/ST	None	Extirpated	Extirpated	CNDDB, CAFSD	Indirect	Nests in vertical bluffs or banks, usually adjacent to water (i.e., rivers, streams, ocean coasts, and reservoirs), where the soil consists of sand or sandy loam. Feeds on caterpillars, insects, frog/lizards, and fruit/berries. Relies on surface water that may be supported by groundwater (Rohde et al. 2019). Historical population documented in the 1920s Santa Clara River is extirpated (CDFW 2019).
Black swift *Cypseloides niger*	FSS/SSC	Unlikely	No documented occurrences	No documented occurrences	CAFSD	No known reliance on groundwater	Nests in moist crevices behind or beside permanent or semipermanent waterfalls in deep canyons, on perpendicular sea cliffs above surf, and in sea caves; forages widely for insects over many habitats.
Burrowing owl *Athene cunicularia*	FSS/SSC	Likely	Santa Clara River Riparian Shrubland	Santa Clara River Riparian Shrubland	CNDDB	No known reliance on groundwater	Level, open, dry, heavily grazed or low-stature grassland or desert vegetation with available burrows. Preys on invertebrates and vertebrates. Occurrences along or near the bank of the Santa Clara River near Fillmore and one mile south of Buckhorn (CDFW 2019).
California condor *Gymnogyps californianus*	FE/SE	Unlikely	Sespe Creek Riparian	Piru Creek Riparian	CNDDB	Indirect	Requires vast expanses of open savannah, grasslands, and foothill chaparral in mountain ranges of moderate altitude; deep canyons containing clefts in rocky walls and large trees provide nest sites; forages up to 100 miles from roost to nest. Forages in grasslands, oak savanna habitats; condors may rely on groundwater

Common name ***Scientific name***	**Status[1] Federal/State**	**Potential to occur in GDE Basins[2]**	**Documented occurrence location**		**Query source[3]**	**GDE . association[4]**	**Habitat and documented occurrences in GDE Management Units**
			Fillmore GDE units	**Piru GDE units**			
							dependent vegetation for nesting in foothill grasslands, oak savanna habitats, and old-growth forest (Rohde et al. 2019). Habitat for condors in the basins is therefore unlikely to be groundwater dependent. Condors observed drinking water at a small perched pool near spillway canyon just west of the Santa Felicia Dam in the vicinity of the Piru Creek Riparian GDE Unit and within Piru Canyon (CDFW 2019, eBird 2021).

Common name *Scientific name*	Status[1] Federal/State	Potential to occur in GDE Basins[2]	Documented occurrence location		Query source[3]	GDE . association[4]	Habitat and documented occurrences in GDE Management Units
			Fillmore GDE units	Piru GDE units			
Mammal							
Pallid bat *Antrozous pallidus*	FSS, BLMS/SSC	Likely	No documented occurrences	No documented occurrences	CNDDB	No known reliance on groundwater	Roosts in rock crevices, tree hollows, mines, caves, and a variety of vacant and occupied buildings; feeds in a variety of open woodland habitats. Habitat and prey (e.g., insects and arachnids) not associated with aquatic ecosystems. Commonly found roosting under the bark of dead riparian trees in the Santa Clara River Watershed (UWCD 2018). Historical observations in the vicinity of Fillmore documented in 1906 and 1942 (CDFW 2019).

[1] Status codes:

Federal
- FT = Listed as threatened under the federal Endangered Species Act
- FSS = Forest Service Sensitive Species
- BLMS = Bureau of Land Management Sensitive Species

State
- SE = Listed as Endangered under the California Endangered Species Act
- ST = Listed as Threatened under the California Endangered Species Act
- SSC = CDFW species of special concern

[2] Potential to Occur:
Likely: the species *has* documented occurrences and the habitat is high quality or quantity
Possible: no documented occurrences and the species' required habitat is moderate to high quality or quantity
Unlikely: no documented occurrences and the species' required habitat is of low to moderate quality or quantity
None: no potential to occur due to lack of habitat and/or the population is assumed extirpated

[3] Query source:
CAFSD: California Freshwater Species Database (TNC 2020)
CNDDB: California Natural Diversity Database (CDFW 2019)
eBird: (eBird 2021)

[4] Groundwater Dependent Ecosystem (GDE) association:
Direct: Species directly dependent on groundwater for some or all water needs
Indirect: Species dependent upon other species that rely on groundwater for some or all water needs

Appendix C

Rooting Depths for Selected Species

Table C-1. Maximum rooting depth of dominant species.

Dominant species	Vegetation type (MCV)	Vegetation type (CalVeg)	GDE?	Maximum rooting depth (ft)	Data source
Adenostoma fasciculatum		Chamise	no	25.0	Hellmers et al. 1955 as cited in Fan et al. 2017
Artemisia tridentata	*Artemisia tridentata* Shrubland Alliance		yes	9.8	Link et al. 1995 as cited in Tumber-Davila 2017
Arundo donax	*Phragmites australis - Arundo donax* Herbaceous Semi-Natural Alliance	Giant reed/pampas grass	yes	16.1	Stromberg 2013
Baccharis pilularis	*Baccharis pilularis* Shrubland Alliance	Coyote brush	no	12.1	Naumovich 2017
Baccharis salicifolia	*Baccharis salicifolia* Shrubland Alliance	Baccharis (riparian)	yes	2.0	Stromberg 2013
Ceanothus crassifolius		Ceanothus chaparral	no	4.5	Hellmers et al. 1955 as cited in Fan et al. 2017
Elymus triticoides	*Leymus cinereus - Leymus triticoides* Herbaceous Alliance		yes	3.8	Weaver 1919 as cited in Fan et al. 2017
Eriogonum fasciculatum	*Eriogonum fasciculatum* Shrubland Alliance	Buckwheat	no	4.0	Hellmers et al. 1955 as cited in Fan et al. 2017
Eucalyptus globulus and other *Eucalyptus* species	*Eucalyptus* spp. - *Ailanthus altissima - Robinia pseudoacacia* Woodland Semi-Natural Alliance	Eucalyptus	yes	16.4	Dawson and Pate 1996 as cited in Fan et al. 2017
Juglans californica	*Juglans californica* Woodland Alliance	Black walnut	no	5.9	Faber 2017
Pluchea sericea	*Pluchea sericea* Shrubland Alliance		yes	4.3	Stromberg 2013
Populus fremontii	*Populus fremontii* Forest Alliance	Freemont cottonwood	yes	6.9	Stromberg 2013
Populus trichocarpa	*Populus trichocarpa* Forest Alliance		yes	4.1	Zhang et al. 1999 as cited in Fan et al. 2017
Quercus agrifolia	*Quercus agrifolia* Woodland Alliance	Coast live oak / Coastal mixed hardwood alliance	yes	35.1	Schenk and Jackson 2002

Dominant species	Vegetation type (MCV)	Vegetation type (CalVeg)	GDE?	Maximum rooting depth (ft)	Data source
Quercus douglasii		Blue oak	no	80.0	Schenk and Jackson 2002
Salix exigua	*Salix exigua* Shrubland Alliance	Willow (shrub)	yes	6.9[1]	Pulling 1918 as cited in Fan et al. 2017
Salix laevigata	*Salix laevigata* Woodland Alliance		yes	6.9[1]	Pulling 1918 as cited in Fan et al. 2017
Salix lasiolepis	*Salix lasiolepis* Shrubland Alliance		yes	6.9[1]	Pulling 1918 as cited in Fan et al. 2017
Salix lucida	*Salix lucida* Woodland Alliance		yes	6.9[1]	Pulling 1918 as cited in Fan et al. 2017
Salix spp		Riparian mixed shrub / Willow	yes	6.9	Pulling 1918 as cited in Fan et al. 2017
Salvia apiana	*Salvia apiana* Shrubland Alliance		no	5.0	Hellmers et al. 1955 as cited in Fan et al. 2017
Schoenoplectus spp	*Schoenoplectus* (*acutus*, *californicus*) Herbaceous Alliance		yes	2.1[1]	Stromberg 2013
Tamarix spp	*Tamarix* spp. Shrubland Semi-Natural Alliance		yes	16.1	Stromberg 2013
Typha spp	*Typha* (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance		yes	0.8[1]	Shaver and Billlings 1975 as cited in Fan et al. 2017

[1] Rooting depth assigned by genus or close species association.

Table C-2. Relative elevation of dominant species. Data from Stillwater Sciences (2007).

Dominant species	Alliance	Relative elevation (ft)			
		mean	**SE**	**min**	**max**
Adenostoma fasciculatum					
Artemisia tridentata	*Artemisia tridentata* Shrubland Alliance	5.2	0.5	1.0	11.0
Arundo donax	*Arundo donax* Semi-Natural Alliance	7.6	0.3	0.0	32.8
Baccharis pilularis	*Baccharis pilularis* Shrubland Alliance	15.9	1.2	2.5	26.7
Baccharis salicifolia	*Baccharis salicifolia* Shrubland Alliance	9.6	1.8	2.3	24.6
Eriogonum fasciculatum and *Artemisia californica*	*Artemisia californica- Eriogonum fasciculatum* Shrubland Alliance	18.2	2.2	7.7	27.4
Eucalyptus globulus and other *Eucalyptus* species	*Eucalyptus* spp. - *Ailanthus altissima* - *Robinia pseudoacacia* Woodland Semi-Natural Alliance	15.4	2.6	12.5	23.0
Populus fremontii	*Populus fremontii* Forest Alliance	9.7	0.8	0.0	25.0
Populus trichocarpa	*Populus balsamifera* ssp *trichocarpa* Forest Alliance	7.4	0.4	2.1	20.5
Salix exigua	*Salix exigua* Shrubland Alliance	4.8	0.4	1.0	9.4
Salix laevigata	*Salix laevigata* Woodland Alliance	5.6	0.5	0.0	20.6
Salix lasiolepis	*Salix lasiolepis* Shrubland Alliance	12.4	0.7	0.6	24.8
Salix lucida	*Salix lucida* Woodland Alliance	4.9	0.8	0.2	12.3
Tamarix spp	*Tamarix* spp. Semi-Natural Alliance	6.3	1.1	4.0	9.0

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