APPENDIX I

The Nature Conservancy GDE Tech Memo

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Technical Memorandum
Assessment of Groundwater Dependent Ecosystems for the Las Posas Valley Basin Groundwater Sustainability Plan

INTRODUCTION

The Sustainable Groundwater Management Act (SGMA) requires agencies to identify and consider groundwater dependent ecosystems (GDEs) during the development of Groundwater Sustainability Plans (GSPs). The Fox Canyon Groundwater Management Agency's Technical Advisory Group (TAG) for the development of its GSPs formed an ad hoc committee, comprised of TAG members from The Nature Conservancy, United Water Conservation District, and Calleguas Municipal Water District, to support the assessment of GDEs for the Fox Canyon Groundwater Sustainability Plans. The assessment coincided with development of a statewide GDE Guidance by The Nature Conservancy (TNC) to identify and consider GDEs under SGMA (Rohde et al., 2018). Thus, this GDE assessment served two purposes: 1) to aid in the development of the GDE Guidance, and 2) serve as a case study of the utility of the guidance. This technical memorandum follows the five steps laid out in the GDE Guidance:

I. Identify GDEs
II. Determine Potential Effects on GDEs
III. Consider GDEs when Establishing Sustainable Management Criteria
IV. Incorporate GDEs into the Monitoring Network
V. Identify Projects and Management Actions to Maintain or Improve GDEs

I. Identify of GDEs

One groundwater dependent ecosystem (GDE) unit was identified in the Las Posas Valley groundwater basin. The Arroyo Simi - Las Posas GDE is defined by a dominant surface water feature, which is hydrologically connected to the shallow aquifer (Figure 1). The primary source of water to both the Arroyo and to the shallow aquifer is discharges from the Simi Valley Water Quality Control Plant, dewatering wells operated by the City of Simi Valley, and discharges from the Moorpark Water Treatment Plant percolation ponds adjacent to Arroyo Las Posas. The former two sources are external to the groundwater basin. The external water is also a primary source of poor water quality (high total dissolved solids, chloride, and sulfate). Currently, there is little pumping of the shallow aquifer; however, downward flow of groundwater from the shallow aquifer into deeper units of the basin is an important source of recharge to the primary pumping zones. The feasibility of pumping and desalting shallow aquifer groundwater is being evaluated by several entities within the basin.

Mapping Basin GDEs from the Statewide Database of GDE Indicators

The GDE unit was identified using an earlier version of the statewide database of GDE indicators (iGDE v0.3.1; TNC, 2017) and groundtruthed using local information to confirm whether or not a hydrologic connection to groundwater exists, as described in The Nature Conservancy's GDE Guidance (Step 1.1; Rohde et al., 2018). The statewide database of GDE Indicators (iGDE database) for Las Posas Valley (Figure 2) is based on best available statewide data on phreatophytic vegetation, which are known to use groundwater (US NBVC, 2013; US FS, 2014), wetlands, water bodies, and perennial streams identified in the National Wetland Inventory (US FWS, 2016).

The statewide iGDE database was assessed for the Las Posas Valley Basin, and iGDEs found within that boundary were groundtruthed using aerial photos, local knowledge, and field verification (described below). The verified iGDEs were mapped and are presented in Figure 3. Because the statewide iGDE data relies on vegetative surveys conducted over multiple years, some of the mapped vegetation have undergone residential housing and agricultural development since the survey date; these removed areas are noted on the map as "cultivated" or "developed". Several agricultural drainage channels and ephemeral natural drainages were also removed. No unmapped GDE areas were added based on local knowledge.

The hydrologic connection of the iGDEs was assessed using an initial screening worksheet provided in the GDE Guidance Document (Worksheet 1). Two areas in the Las Posas Valley groundwater basin had been identified as having unconfined aquifers: the shallow alluvial aquifer underlying Arroyo Las Posas and Arroyo Simi, shown in Figure 4, and the Fairview Area unconfined aquifer (included as part of the Epworth Gravels aquifer), shown in Figure 5. The depth to groundwater in the Fairview Area/Epworth Gravels aquifer exceeds 150 feet below ground surface (bgs), based on wells screened in the Fairview Area (Figure 5); thus lack of hydrologic connectivity to the unconfined aquifer confirmed exclusion of these iGDE areas. The statewide iGDE database included phreatophytic vegetation along the numerous ephemeral drainages along the northern side of Las Posas Valley. These areas are outside the identified unconfined aquifers and are geologically disconnected from the deeper confined San Pedro Formation and Fox Canyon aquifers. It is assumed that these phyreatophytic vegetation areas are most likely supported during dry summer periods by agricultural runoff, and/or residential development outdoor water use. The remaining ground-truthed iGDEs were consolidated into one GDE unit based on the proximity of the polygons to the Arroyo Las Posas and Arroyo Simi watercourses with Arroyo Simi flowing into the Arroyo Las Posas near Hitch Boulevard downstream of the city of Moorpark, and association to the shallow unconfined aquifer (Figure 4).

Characterize GDE Condition

Descriptions of the hydrologic and ecological conditions for the Arroyo Simi-Las Posas GDE are below, as described in The Nature Conservancy's GDE Guidance Document (Step 1.2; Rohde et al., 2018).

Hydrologic Condition

Historically, the Arroyo Simi - Las Posas was an ephemeral stream with flashy flows from winter storm events and no flows during dry summers. Since the 1960s, the arroyo has become a perennial stream with the addition of "dry-weather" water sources. Currently, dry weather surface water flow in Arroyo Simi - Las Posas is composed of groundwater, municipal wastewater, urban non-storm water discharges, and agricultural runoff. The Simi Valley Water Quality Control Plant (WQCP) discharges an average of 9,527 acre-feet per year (AFY) to the Arroyo Simi upstream of the eastern basin boundary (Todd Groundwater, 2016). The Moorpark Wastewater Treatment Plant (WTP) discharges between 1,559 and 2,534 AFY (since 1985) primarily to percolation ponds near the Arroyo Las Posas, downstream of the city of Moorpark. The Arroyo Las Posas is a gaining stream in this area, with MWTP percolation contributing to surface flows (Figure 6). Direct discharges to the Arroyo Las Posas from the Moorpark treatment plant occur during extremely wet periods (Larry Walker Associates 2007). The City of Simi Valley operates a number of dewatering wells near the western end of the city to dewater the Simi Valley Basin. The dewatering operations discharge an estimated 1,700 AFY to the Arroyo Simi upstream of Madera Road east of the basin boundary (Todd Groundwater 2016). The water treatment plant and dewatering discharges provide a constant base flow in Arroyo Simi - Las Posas. Baseflow, defined by monthly minimum, average daily flow ranges between 6 and 30 cfs at Stations 841/841A in the middle of the gaining reach (Table 1-2, Las Posas Valley Basin Groundwater Sustainability Plan, 2017).

Two field studies in 2011 and 2012 monitored and characterized the interconnection of surface water and groundwater in the Arroyo Simi - Las Posas under baseflow conditions (LWA, 2012 and 2013). The studies characterize the Arroyo Simi as a losing reach from upstream of the basin boundary just downstream of the Simi Valley WQCP to approximately Leta Yancy Road in Moorpark, a gaining reach to approximately a mile downstream of the Moorpark WTP, and a losing reach extending into the Pleasant Valley groundwater basin (Figure 6). Perennial flow generally ends near the boundary of the Las Posas Valley and Pleasant Valley basins. Visual observation during the recent drought years in 2014 and 2015 has confirmed the upstream retreat of the Arroyo Las Posas throughout the year (LWA, 2015 and 2016). Figure 7 presents the stream terminus as it recedes approximately one mile upstream from the basin boundary during summer 2014, and moves back downstream by winter 2014. The stream terminus locations for 2015 was in the same spatial range as 2014, but fluctuated up and downstream from month to month in 2015.

Significant diurnal fluctuations were observed in the surface water flow data (LWA, 2012). This periodic signal may indicate the water consumption of the riparian vegetation (Robinson, 1958). In particular, non-native plants such as giant reed are considered to have high water consumption, much more than the native vegetation (Cal-IPC, 2011).

The shallow aquifer that underlies the arroyo floodplain (see extent of shallow aquifer in Figure 6) has been continuously recharged from the wastewater and Simi Valley dewatering discharges since the 1960s (Las Posas Users Group. 2012). Much of this recharge flows downward into the underlying confined aquifers. The shallow groundwater levels have risen and stabilized since the mid 1970s (see Figures 8 - 10). The figures present the estimated depths to groundwater in the GDE, based on interpolation of water elevation data from representative wells along the arroyo to reference point locations within the GDE[1]. In general, groundwater levels have been relatively constant for 30 years since the mid-1980s. Groundwater levels generally vary less than 15 feet for wells with longer time records, although variations up to 30 feet of variation are also observed.

Figure 8 presents groundwater conditions in the eastern losing reach of the GDE. Near the easternmost well at the basin boundary, 02N19W03A01S, the estimated depth to groundwater averages 3 feet bgs, with a 3.5-foot variation in depth for quarterly measurements for 1972-1991. Near the second easternmost well, 02N19W09E01S, the estimated depth to groundwater is approximately 15 feet bgs, and only a one-foot variation in depth for the daily measurements for 2015-2016. Moving downstream in the transition zone between the losing and gaining reaches, the depths to groundwater based on wells 02N19W08G03S and 02N19W08H02S average 13 feet bgs and exhibit larger variations of approximately 15 feet across the

[1] Nearby groundwater wells provide an estimate of groundwater elevations within the GDE. To convert from a groundwater elevation to a depth to groundwater, a representative ground surface elevation was chosen (see GDE reference point location on figure). The depth to groundwater within the GDE is the ground surface elevation at the GDE reference point minus the groundwater elevation at the well.

1985 to 2010 period. The depths based on well 02N19W08H02S for the most recent years of quarterly data (2006 to 2010) are also constant around 8 feet bgs with only a 2-foot seasonal variation.

Figure 9 presents groundwater conditions in the central gaining reach of the GDE. Wells 02N19W07K04S and 02N19W07G01S in the gaining reach are constant at approximately 5 ft bgs for 2015. In the gaining reach by the Moorpark WTP ponds, the depths to groundwater are estimated between 14 to 23 feet bgs in 02N20W12MMW1 above the WTP ponds, and between ground surface and 12.5 feet adjacent and downgradient of the ponds in 02N20W12MMW2 and 02N20W12MMW3, based on data between 2000 and 2015.

Figure 10 presents groundwater conditions in the western losing reach of the GDE. The depths to groundwater near well 02N20W16A04S range between 22 and 47 feet bgs for the years 1992 to 1999. The depths to groundwater near well 02N20W09Q08S range between 5 and 10 feet bgs for the two years of data (2015 – 2016), higher than expected compared to data from adjacent well 02N20W16A04S. The depths to groundwater at well 02N20W17J06S, located near the Las Posas Valley – Pleasant Valley groundwater basin boundary, range between 45 and 85 feet bgs and decrease 40 feet across the two years of data (2015 – 2016). In this losing reach of Arroyo Las Posas, between the upstream location near well 02N20W09Q08S and well 02N20W17J06S, as the depths to the shallow aquifer increase to depths much greater than 30 feet, the riparian vegetation is unlikely to utilize groundwater to sustain growth.

As described above, the ecohydrology of the Arroyo Simi - Las Posas GDE is complex. There is uncertainty with the spatial and temporal variability that limits the understanding and accuracy of this assessment. In general, the gaining and losing reaches based on the surface water monitoring locations are corroborated by the depth to groundwater data. One limitation is that estimated groundwater levels in the GDE are approximated based on wells outside the GDE. The selection of GDE reference points (used to interpolate well data outside the GDE to a depth to groundwater within the GDE) is another source of variability and inaccuracy. The ground surface elevation varies as the GDE traverses upslope from the stream channel to the floodplain terraces and also longitudinally up or downstream. As a result, this analysis is a simplification of the groundwater depth representation for the Arroyo Simi - Las Posas GDE. The GDE reference point elevations were estimated using Google Earth aerial imagery. Refinement of the GDE reference points for both reference point selection and field elevation measurements will provide better baseline characterization. Better understanding of the hydrology in this vicinity would aid in determining the impacts of decreasing groundwater levels on the riparian habitat. The degree to which the vegetation is reliant on groundwater versus unsaturated soil water is also uncertain.

Ecological Condition

The Arroyo Simi-Las Posas GDE is comprised of approximately 305 acres of southern riparian scrub/southern willow scrub, 105 acres of riparian mixed hardwood, and 127 acres of non-native vegetation (TNC, 2017). Nearly 420 acres are classified as wetlands by the National Wetlands Inventory (USFWS, 2016), which includes riparian habitat in the 100-year floodplain (Wildscape Restoration, 2015). Seventy-six percent of the vegetation in this GDE is considered native vegetation (TNC, 2017). Riparian vegetation types in the eastern portion of the GDE along Arroyo Simi known as Virginia Colony include arroyo willow, laurel sumac, blue elderberry, coast live oak, mulefat, red willow, scalebroom scrub and western sycamore/Fremont cottonwood woodlands (VCWPD and Aspen Environmental Group, 2013a). Riparian vegetation present on the Arroyo Simi occurs primarily near surface or subsurface perennial water (VCWPD and Aspen Environmental Group, 2013b). Non-native eucalyptus and giant reed (Arundo donax) also occur within the GDE. Giant reed densities vary from less than one percent to more than 75 percent cover throughout Arroyo Simi and Arroyo Las Posas, with the majority of the area consisting of less than 49 percent giant reed cover (Wildscape Restoration, 2015).

The Arroyo Simi -Las Posas GDE is characterized as having a moderate ecological value (Step 1.2; Rohde et al., 2018), since the GDE supports state- and federally-listed endangered species and has designated beneficial uses of ecological importance. State-and federally-listed species include Least Bell's Vireo in both Arroyo Las Posas and Arroyo Simi (CDFW, 2017). In the Virginia Colony area[2], the state-listed endangered northwestern willow flycatcher was detected in a survey in 2011, but were considered transient individuals. The federally threatened and California species of special concern California gnatcatcher is resident in the GDE (VCWPD and Aspen Environmental Group, 2013b). One hundred and three species of common and sensitive birds were identified on the Virginia Colony area on the eastern portion of the GDE during surveys completed in 2011 (VCWPD and Aspen Environmental Group, 2013b). The native arroyo chub is found in Arroyo Simi (CDFW, 2017) as are the southwestern pond turtle and the San Diego desert woodrat. These are all California species of Special Concern (Padre Associates, 2009).

The Basin Plan (RWQCB, 2014) for Arroyo Las Posas and Arroyo Simi lists the following beneficial uses: groundwater recharge (GWR), warm freshwater habitat (WARM), cold freshwater habitat (COLD) (potential), Wildlife Habitat (WILD) and

[2] The Virginia Colony area is located inside the California Department of Water Resources basin boundary, but outside of the Fox Canyon Groundwater Management Area jurisdiction.

Freshwater Replenishment (FRESH). Additionally, Rare, Threatened, or Endangered Species (RARE) beneficial use is listed for Arroyo Simi (east of Hitch Road).

The Arroyo Simi - Las Posas GDE ranges from a natural channel consisting of riparian woodland/wetland habitat (Caltrans 1987) to a confined rip-rapped channel on the sides with a soft bottom that is maintained in a largely vegetation-free state by the Ventura County Watershed Protection District (Bonfiglio Allen, 2017). In the natural areas of the stream channels, the active channel generally supports a dense canopy of vegetation, although winter storm events can scour the active channel and mid- to lower terraces, leaving some areas free of vegetation for extended periods of time (VCWPD and Aspen Environmental Group, 2013).

Critical habitat for the coastal California gnatcatcher is adjacent to and present in portions of the easternmost portion of the GDE. This unit of critical habitat includes the only known breeding population of coastal California gnatcatchers in Ventura County (USFWS, 2007). Habitat for the least Bell's vireo is extensive throughout the GDE (VCWPD and Aspen Environmental Group, 2013b). An ecological inventory is provided in Worksheet 2.

II. Determine Potential Effects on GDEs

SGMA requires agencies to describe potential effects on GDEs (a beneficial use and user of groundwater) that may occur or are occurring from the six groundwater conditions being used to evaluate sustainability (GSP Regulations §354.26(b)(3)). The three sustainability indicators that could have a direct impact on GDEs are: chronic lowering of groundwater levels, degraded water quality, and depletions of interconnected surface water. Following The Nature Conservancy's GDE Guidance (Step 2; Rohde et al., 2018), potential effects on the Arroyo Simi – Las Posas GDE are evaluated using a combination of hydrologic and biological data. The step concludes with an assessment of the GDE susceptibility (i.e., high, moderate, or low) to current and future groundwater conditions.

This step assumes that if there are little-to-no changes in groundwater conditions from consistent baseline conditions then the corresponding groundwater condition will have little-to-no impact on a GDE. Groundwater elevation (depth to groundwater) hydrologic data are used to assess potential effects on GDEs caused by changes in groundwater levels and interconnected surface water. Three remote sensing indices – Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI) and Normalized Difference Water Index (NDWI) - derived from Landsat imagery from the Arroyo Simi-Las Posas GDE were used as biological data.

Chronic Lowering of Groundwater Levels / Depletions of Interconnected Surface Water

As shown in Figures 8 – 10, the depth to groundwater data show a relatively constant inter-annual trend for these GDE units. A baseline period was defined between 1996 to 2015 based on groundwater data available at the monitoring well 02N20W12MMW1 and the SGMA benchmark date (January 1, 2015; Figure 11). The mean depth to groundwater for the baseline period is 18.2 feet bgs. The range of depth to groundwater over the baseline period is 14 feet to 22 feet bgs. Summary statistics for depth to groundwater from 02N20W12MMW1 by water year type are provided in Table 1. The specific depths to groundwater for different reaches of Arroyo Simi and Arroyo Las Posas are discussed above in Section I and the baseline averages and ranges are listed in Worksheet 3.

Table 1
Summary Statistics for Depth to Groundwater at the Arroyo Simi - Las Posas GDE by Water Year Type

Water Year Type[1]	**n**	**Min**	**1st Quartile**	**Median**	**Mean**	**3rd Quartile**	**Max**
Drought	11	17.0	18.0	19.5	19.2	20.0	22.0
Dry	42	16.0	18.0	18.5	18.5	19.0	21.0
Normal	29	14.0	16.0	18.0	17.5	19.0	20.0
Wet	5	15.0	16.5	18.0	17.8	19.3	20.0
All	**87**	**14.0**	**18.0**	**18.0**	**18.2**	**19.0**	**22.0**

[1]Water year types based on the percentage of the water year precipitation compared to the 30-year precipitation average [i.e., drought (≤50%), dry (≤75%), normal (75% – 150%), wet (≥150%)].

To assess the Arroyo-Simi Las Posas GDE susceptibility to potential effects caused by changes in groundwater levels, current groundwater levels were compared to a defined baseline period (1996-2015). Groundwater levels in the GDE unit are relatively consistent over the baseline period and current (2015-2017) groundwater levels fall within the baseline period. Groundwater levels did temporarily drop in the current period during the Fall of 2015 and 2016, but were starting to recover in 2017. This is not surprising, given that stabilizing presence of the external water sources and the limited groundwater pumping in the shallow aquifer for water supply purposes due to its marginal water quality.

To further investigate whether potential effects on the Arroyo-Simi Las Posas GDE caused by changes in groundwater levels exist, remote sensing indices, Normalized

Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI), were selected and downloaded from ClimateEngine for a portion of the Arroyo-Simi Las Posas GDE directly adjacent to well 02N20W12MMW1. NDVI and NDWI were relatively consistent over the baseline and current periods (Figure 11). No significant correlation depth to groundwater to NDVI and NDWI over the baseline and current periods was identified (Figure 12). This could be due to the consistency of the water levels and vegetation indices.

Using The Nature Conservancy's GDE Pulse (Klausmeyer et al., 2019), NDVI and the Normalized Difference Moisture Index (NDMI) were examined at the downstream losing stream reach of the Arroyo-Simi Las Posas GDE. This area is where groundwater levels are deeper and are also declining, as this represents the downgradient edge of the shallow aquifer. The vegetation indices demonstrate the declining vegetative health in the most recent drought years (starting in 2013). Groundwater depth data in this area is not available to perform a correlation analysis. It is possible that the decline in ecosystem health is related to the declining groundwater levels.

Although this analysis uses the hydrologic proxy indicator of groundwater levels, the interconnected surface water behavior should also be noted. Field studies characterize the Arroyo Simi as a losing reach from upstream of the basin boundary just downstream of the Simi Valley WQCP to approximately Leta Yancy Road in Moorpark, a gaining reach to approximately a mile downstream of the Moorpark WTP, and a losing reach extending into the Pleasant Valley groundwater basin (see Figure 6). Out-of-basin Simi Valley WQCP and dewatering discharges and in-basin Moorpark WTP discharges are the sources of the perennial dry season flow in the Arroyo Simi and Arroyo Las Posas and the high groundwater levels in the shallow aquifer. As shown in Figure 7, Arroyo Las Posas seasonally goes dry in this losing reach; thus, as dry weather recharge water diminishes, the shallow aquifer water levels also decline. Thus, this portion of the GDE is the most vulnerable to loss of streamflow and shrinking aquifer extent.

Degraded Water Quality

The primary sources of water to both the Arroyo Simi – Las Posas and to the interconnected shallow aquifer are discharges from the Simi Valley WQCP, dewatering wells operated by the City of Simi Valley, and discharges from the Moorpark Water Treatment Plant percolation ponds adjacent to Arroyo Las Posas. The former two sources are external to the groundwater basin. These water sources are also the primary source of poor water quality (high total dissolved solids, chloride, sulfate and boron). The Los Angeles Regional Water Quality Control Board established water quality objectives for boron, chloride, sulfate and TDS for surface water and groundwater for Arroyo Simi - Las Posas, and the shallow aquifer (RWQCB, 2014). The Calleguas Creek Watershed Salts TMDL (LWA, 2007) notes that chloride may have an impact on the environmental beneficial use of warm water aquatic habitat in the Arroyo Las Posas, but the primary beneficial uses being impacted are agricultural irrigation and groundwater recharge. These water quality parameters can result in high salinity soils, which can negatively affect establishment and growth rate of riparian species (Briggs, 1995). Typically, annual spring floods will remove excess salts. There is no current understanding of the soil conditions nor of any ecological impacts on the riparian species in the GDE. While this is an acknowledged data gap, water quality is not considered further as a factor for evaluating the GDE given the source of the poor water quality is from the primary sources of water and the scope of the GSP is on aquifers managed by the Fox Canyon Groundwater Management Agency.

Classify GDE Susceptibility

Following the GDE Guidance, first the susceptibility of the GDE to potential effects from each groundwater condition for current groundwater conditions is assessed. The Arroyo-Simi Las Posas GDE can be classified as having a Low Susceptibility[3] to changing groundwater levels because there are little-to-no-changes in groundwater levels in the current period compared with the baseline period.

Next, if there is little-to-no impact to the GDE under current conditions, SGMA requires assessing risk for future adverse impacts (in the next five years or longer). However, reduced flows from external water sources is expected to have the greatest impact on the GDE. Reductions in wastewater flows on the order of 20-30 percent have occurred over the last ten years. Plans for up to 50 percent additional wastewater recycling of the Simi Valley WQCP are anticipated, along with potable use of the Simi Valley shallow groundwater dewatering discharges. Given that these out-of-basin water sources are the primary source of the high groundwater levels of the shallow aquifer and resulted in the connectivity of the Arroyo Simi - Las Posas and the establishment of the GDE, this potential change is likely to have an adverse impact on the GDE. Thus, the Arroyo Simi - Las Posas GDE unit is considered to have a Moderate Susceptibility to changing groundwater conditions because there are currently little-to-no changes in depletions of interconnected surface water in the

[3] The GDE Guidance classifies how susceptible a GDE unit is to changing groundwater conditions using the hydrological data gathered and the following descriptions: (1) High Susceptibility if current groundwater conditions within a GDE fall outside the baseline range; (2) Moderate Susceptibility if groundwater conditions within a GDE currently fall within the baseline range, but future changes are likely to cause groundwater conditions to fall outside the baseline range; and (3) Low Susceptibility if groundwater conditions fall within the baseline range and no future changes in groundwater conditions are likely to occur.

current period compared with baseline period and a high likelihood that future changes will occur due to planned projects to divert upstream streamflow out-of-basin in Simi Valley that is currently supporting the Arroyo Simi – Las Posas GDE.

III. Consider GDEs When Establishing Sustainable Management Criteria

Set the Sustainability Goal

The GDE Guidance recommends that the sustainability goal include the specific goal of protection of the environmental beneficial user – that is, maintaining the Arroyo Simi – Las Posas GDE. The Arroyo Simi – Las Posas GDE is currently in stable baseline conditions with the relatively constant groundwater levels in the shallow aquifer. This goal of maintaining current groundwater levels supporting the Arroyo Simi – Las Posas GDE, is in line with the goals of supporting other beneficial uses and users: recharge of the shallow aquifer for shallow aquifer pumping, deeper recharge to the Fox Canyon Aquifer, and interbasin interflow from the Las Posas Valley Basin to the Pleasant Valley Basin.

However, the consideration of the Arroyo Simi – Las Posas GDE in the Las Posas Valley Groundwater Sustainability Plan is complicated, given the historical source of the shallow groundwater that support the GDE are primarily out-of-basin Simi Valley wastewater and groundwater dewatering flows and the recognition that those out-of-basin water sources are likely to diminish as more demands to recycle that water use are met.

This situation was discussed with the California Department of Water Resources and State Water Resources Control Board[4]. In particular, it was noted that SMGA §354.30(g) states: “An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.” It was recognized that striving for an “aspirational goal” would be appropriate in this circumstance.

Therefore, the sustainability goal would recognize that under circumstances where external constraints result in impacts to the GDE, the Fox Canyon Groundwater Management Agency would not be obligated to address those impacts, if it is at the expense of other beneficial users (e.g., cutting back groundwater extractions by agricultural users). The groundwater sustainability agency would only be obligated to

[4] June 8, 2017 Meeting on Fox Canyon Groundwater Sustainability Plan Development, Impacts on GDEs/ISWs due to WWTP Recycling Meeting Minutes.

address impacts to the GDE caused by changing groundwater conditions resulting from pumping or groundwater management under the jurisdiction of the groundwater sustainability agency that cause undesirable results.

Set Minimum Thresholds for Sustainability Indicators

The Arroyo Simi – Las Posas GDE can be considered under both the chronic lowering of water levels and depletions of interconnected surface water.

Based on literature studies, groundwater depths within the range considered necessary for juvenile establishment of willows and cottonwoods, typical focal phreatophytic species for riparian ecosystems, are less than 10 feet and for mature vegetation growth are less than 20 feet (Stillwater Sciences, 2016). Site-specific knowledge of groundwater use by the riparian vegetation is not known at this time. However, as presented in Section II current groundwater levels, as raised and sustained by wastewater plant and dewatering discharges, have been relatively constant since the 1980s and have provided for establishment and maintenance of the GDE. It is recognized that maintaining such levels is depended upon continued wastewater plant and dewatering discharges, which is not regulated by the GSA. This approach should be revised in future plan updates as more knowledge refines the baseline conditions and assumptions.

Although the literature studies suggest 20 ft bgs as a reasonable minimum threshold value for the GDE, it is uncertain what is the *actual* site conditions in the Arroyo Simi – Las Posas GDE. For example, the recommended key well, 02N20W12MMW1, which is located outside of the GDE, has average depth to groundwater of 21 ft bgs at the well, with a range of 18 to 27 ft bgs. It is extrapolated that the depths to groundwater *within* the GDE is very similar, with an average of 20 ft bgs, and range of 17 to 26 ft bgs.

On the western losing reach of the GDE, there has been a significant decrease in the vegetative health of the GDE since 2013. This decline in ecosystem health is visible in the remote sensing vegetation metrics, NDVI and NDMI (Figure 14). However, as shown in Figure 10, there is a large range in the depth to groundwater in this losing reach, based on the desktop analysis extrapolating the depth to groundwater within the GDE based on the well data outside the GDE. It is recommended that field-based work be conducted to accurately determine depths to groundwater within the GDE and thus define a site-specific minimum threshold for the GDE.

Following the precautionary principle, it is recommended that the minimum threshold for key well 02N20W12MMW1 be set at its minimum level (367 ft MSL). The recommendation recognizes there is uncertainty regarding these analyses herein regarding equivalent GDE depths and correlations with declining ecosystem health that can be addressed with additional field-based assessment and then revised in the next 5-year plan update.

Establish Measurable Objectives and Interim Milestones

As discussed above, the current assumption is that baseline conditions are representative of GDE conditions that currently represent sustainable conditions. The recommendation is therefore to set the measurable objective at the baseline average groundwater elevation. For the key well 02N20W12MMW1, it is recommended that the measurable objective be set to 370 ft MSL.

No interim milestones are necessary given that current conditions are meeting the measurable objectives.

IV. Incorporate GDEs into the Monitoring Network

While only one key well is defined for the evaluation of the sustainability criteria, we recommend continued monitoring of the existing set of shallow aquifer monitoring wells in the vicinity of the GDE to continue a record of groundwater conditions and to assess whether changes occur in the future. These include the wells: 02N19W09E01S, 02N19W0K01S, 02N19W08H02S, 02N19W07G01S, 02N19W07K04S, 02N20W12MMW1 (key well), 02N20W12MMW2, 02N20W12MMW3, 02N20W09Q08S, 02N20W17J06S, 02N20W10K02S.

One limitation of this initial evaluation is that the estimation of groundwater levels in the GDE are approximated based on wells outside the GDE, using single point land surface GDE reference points. As a result, this analysis is a simplification of the groundwater depth representation for the Arroyo Simi - Las Posas GDE. In reality, the ground surface elevation varies as the GDE traverses upslope from the stream channel to the floodplain terraces and also longitudinally up or downstream. Refinement of the depth to groundwater mapping in the GDE would help determine the impacts of decreasing groundwater levels on the riparian habitat. In particular, monitoring of groundwater levels in the GDE will characterize the degree to which the vegetation is reliant on groundwater.

We also recommend that biological indicators be included in the monitoring program. As presented in Section II, vegetation metrics, NDVI and NDMI, are readily available in The Nature Conservancy's online tool GDE Pulse. An assessment of the vegetation metrics correlated with groundwater data, particularly in the western losing reach, would support a better understanding of the riparian vegetation dependency on surface water and/or groundwater.

V. Identify Projects and Management Actions to Maintain or Improve GDEs

There are several water management projects currently proposed in the groundwater sustainability plan that have the co-benefit of enhancing groundwater recharge and enhancing GDE ecosystem conditions. One project is giant reed (arundo) removal, which is estimated to consume six times more water than native vegetation (Cal-IPC, 2011). The second proposed project is the purchase or lease of wastewater and/or groundwater dewatering discharge from the City of Simi Valley and the City would commit to continuing to discharge it into the Arroyo Simi. This project would benefit the GDE by continuing to provide the source of water to maintain high groundwater levels in the shallow aquifer and also continuing to be the major source of water recharging the deeper Fox Canyon aquifer. Because both projects have co-benefits to both groundwater supply and the restoration of native habitat, the projects have access to multiple sources of funding.

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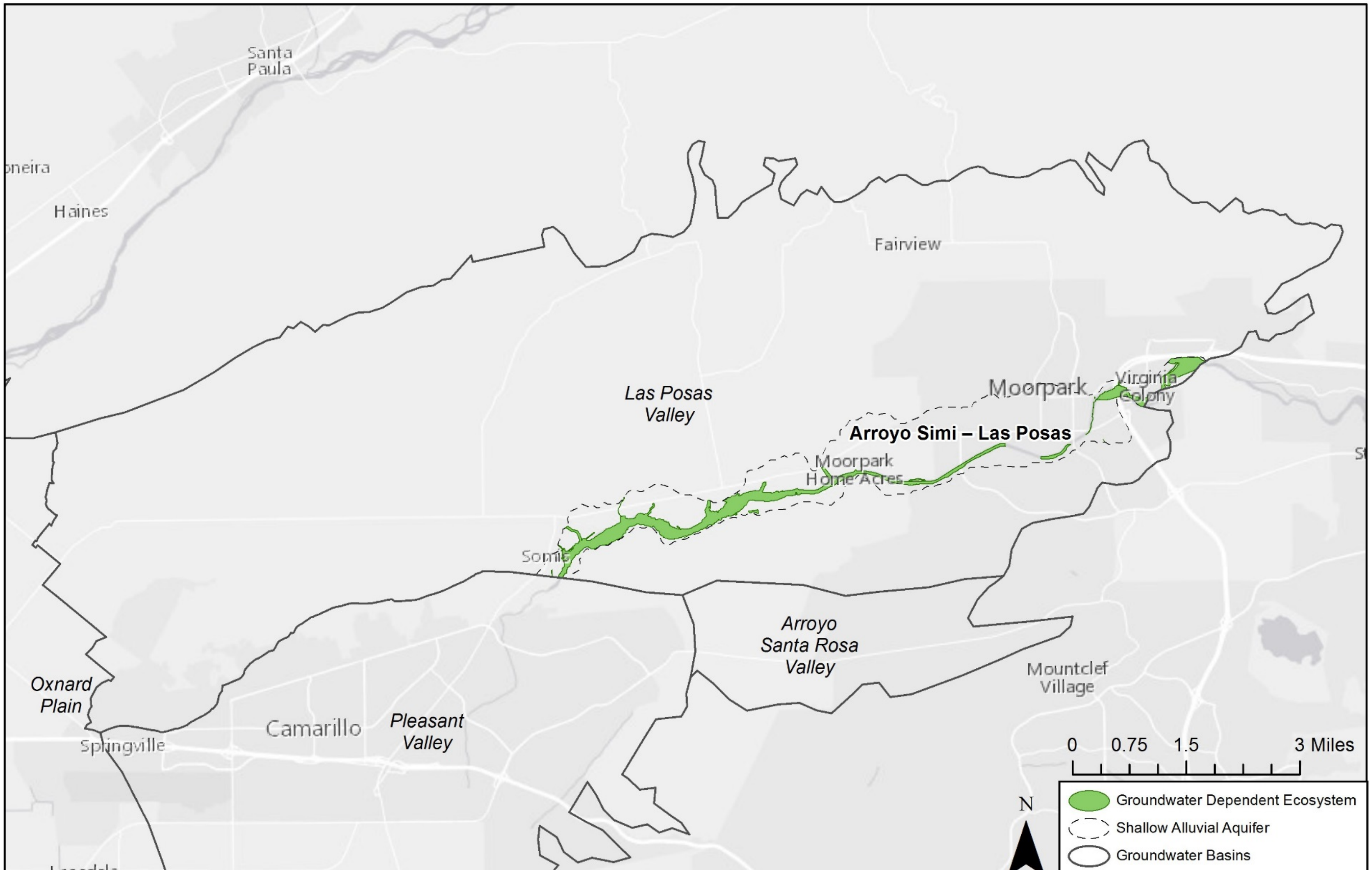
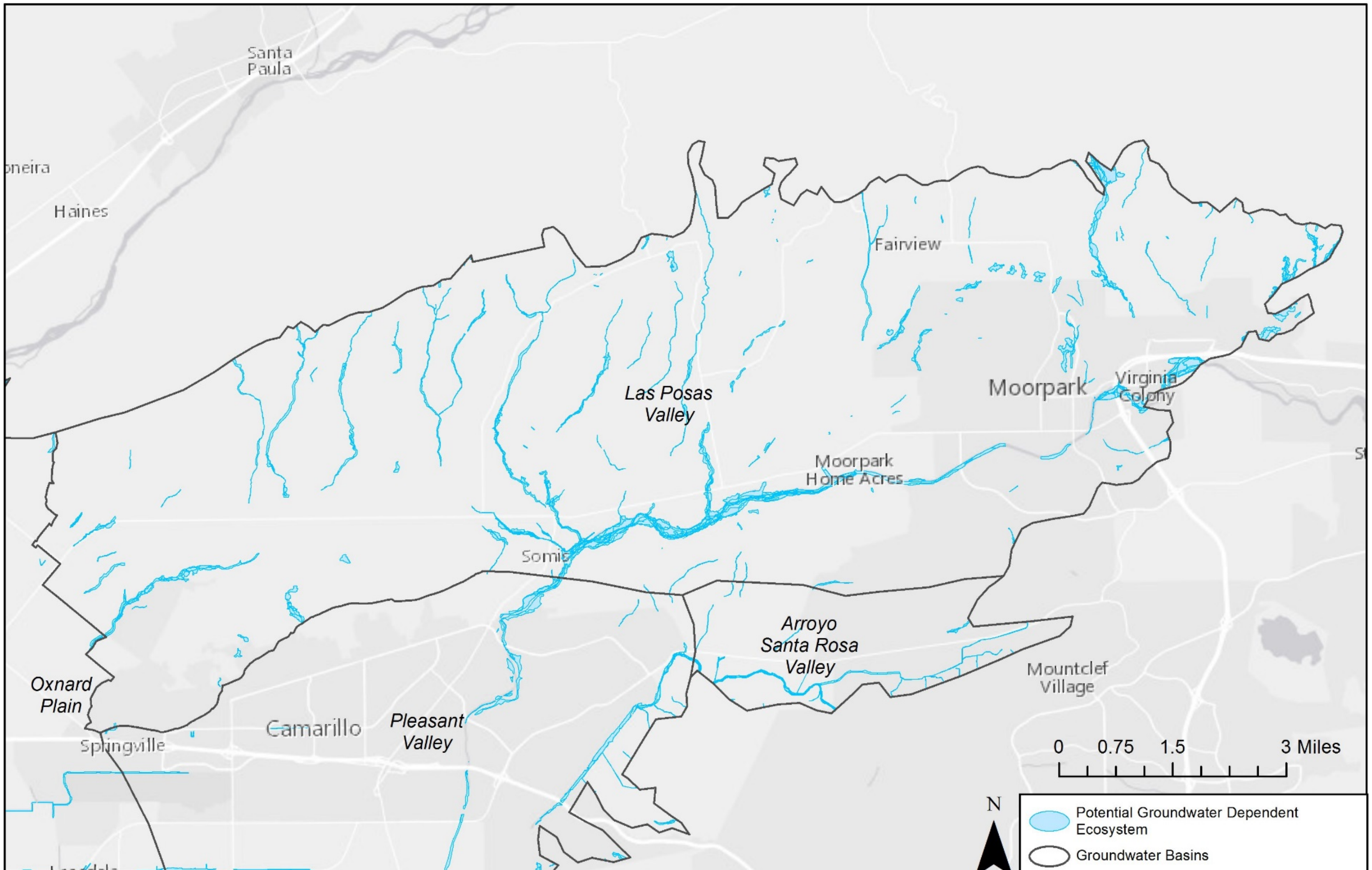


The Nature Conservancy

Source: pGDE-2016, NWI- 2016, CalVeg- 2014, VegCamp- 2015.

Figure 1
Groundwater Dependent Ecosystem (GDE) units identified in the Las Posas Valley Groundwater Basin

Assessment of Groundwater Dependent Ecosystems for the Las Posas Valley Basin Groundwater Sustainability Plan – DRAFT



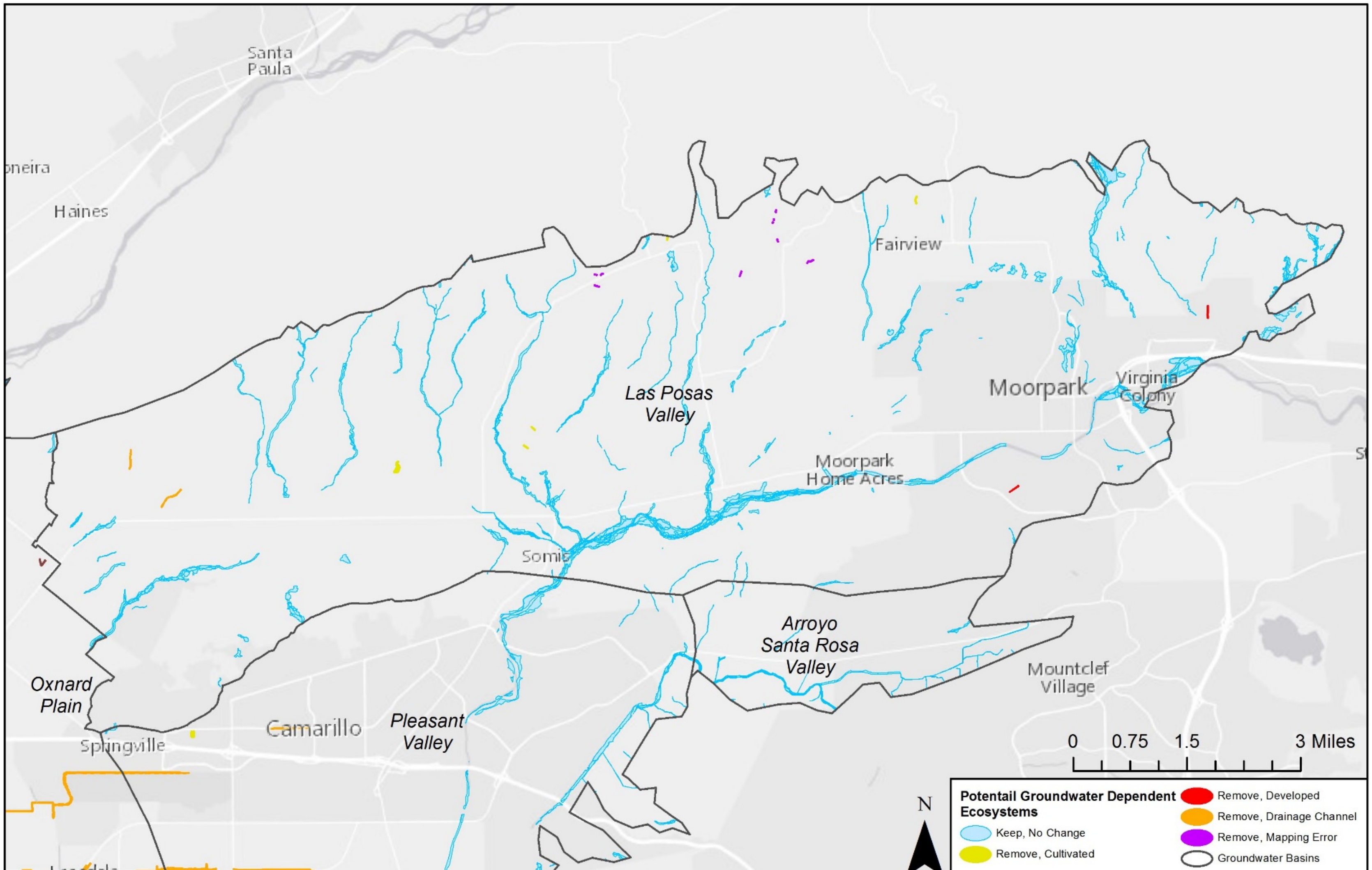
The Nature Conservancy

Source: pGDE-2016, NWI- 2016, CalVeg- 2014, VegCamp- 2015.

Figure 2

Statewide Potential Groundwater Dependent Ecosystem (GDE) Mapping of Las Posas Valley Groundwater Basin

May 1, 2017. N:\Projects\Groundwater\sites\VenturaCounty\mxds\pGDEs_FoxCanyon_MappingChanges_Cori_LasPosas.mxd



The Nature Conservancy

Source: pGDE-2016, NWI- 2016, CalVeg- 2014, VegCamp- 2015.

Figure 3
Groundtruthing of Potential Groundwater Dependent Ecosystems (GDE) in Las Posas Valley Groundwater Basin

Assessment of Groundwater Dependent Ecosystems for the Las Posas Valley Basin Groundwater Sustainability Plan – DRAFT

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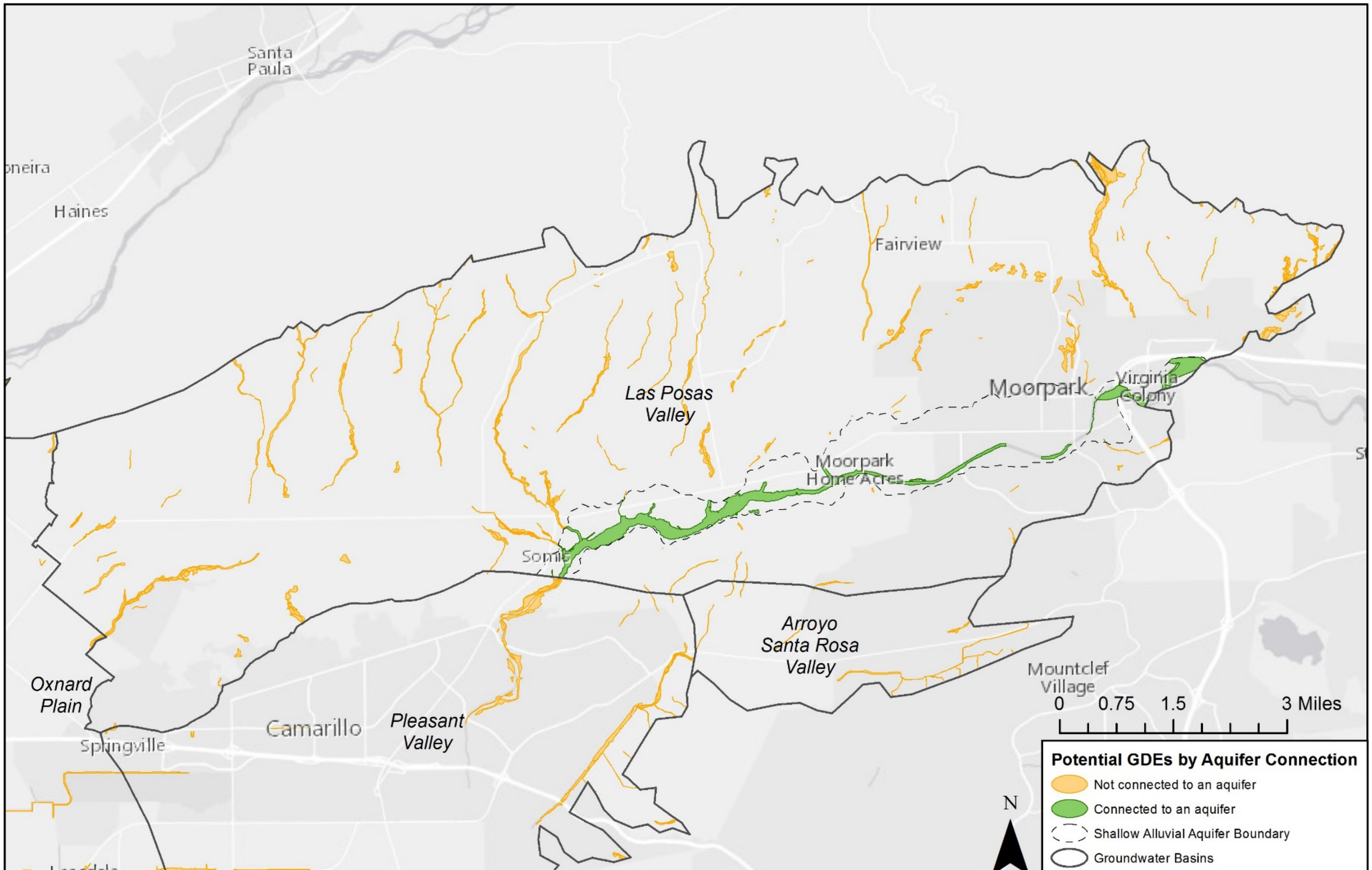

Source: pGDE-2016, NWI- 2016, CalVeg- 2014, VegCamp- 2015.

Figure 4
Evaluation of Hydrologic Connection of Potential Groundwater Dependent Ecosystems (GDE) in Las Posas Valley Groundwater Basin

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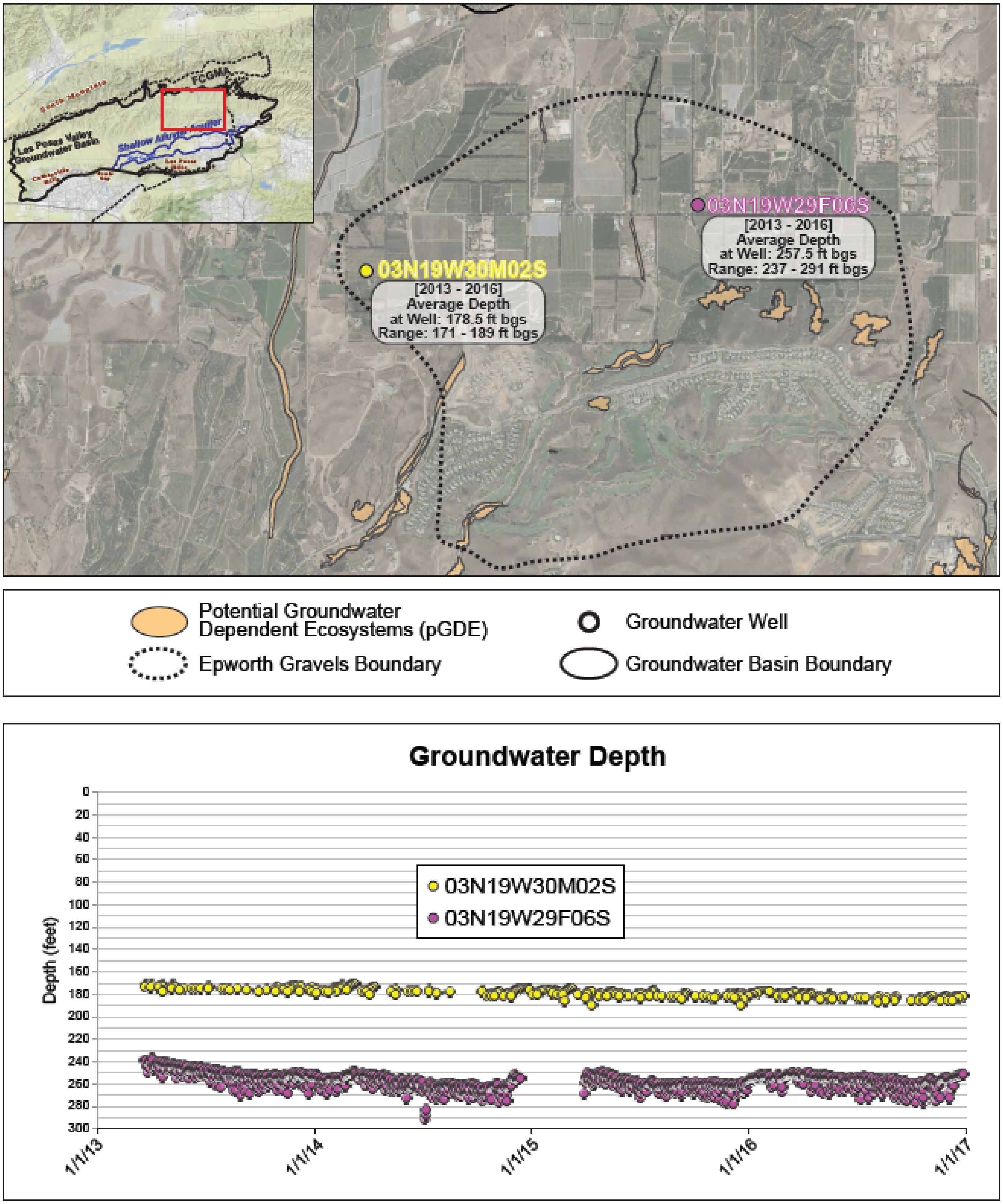
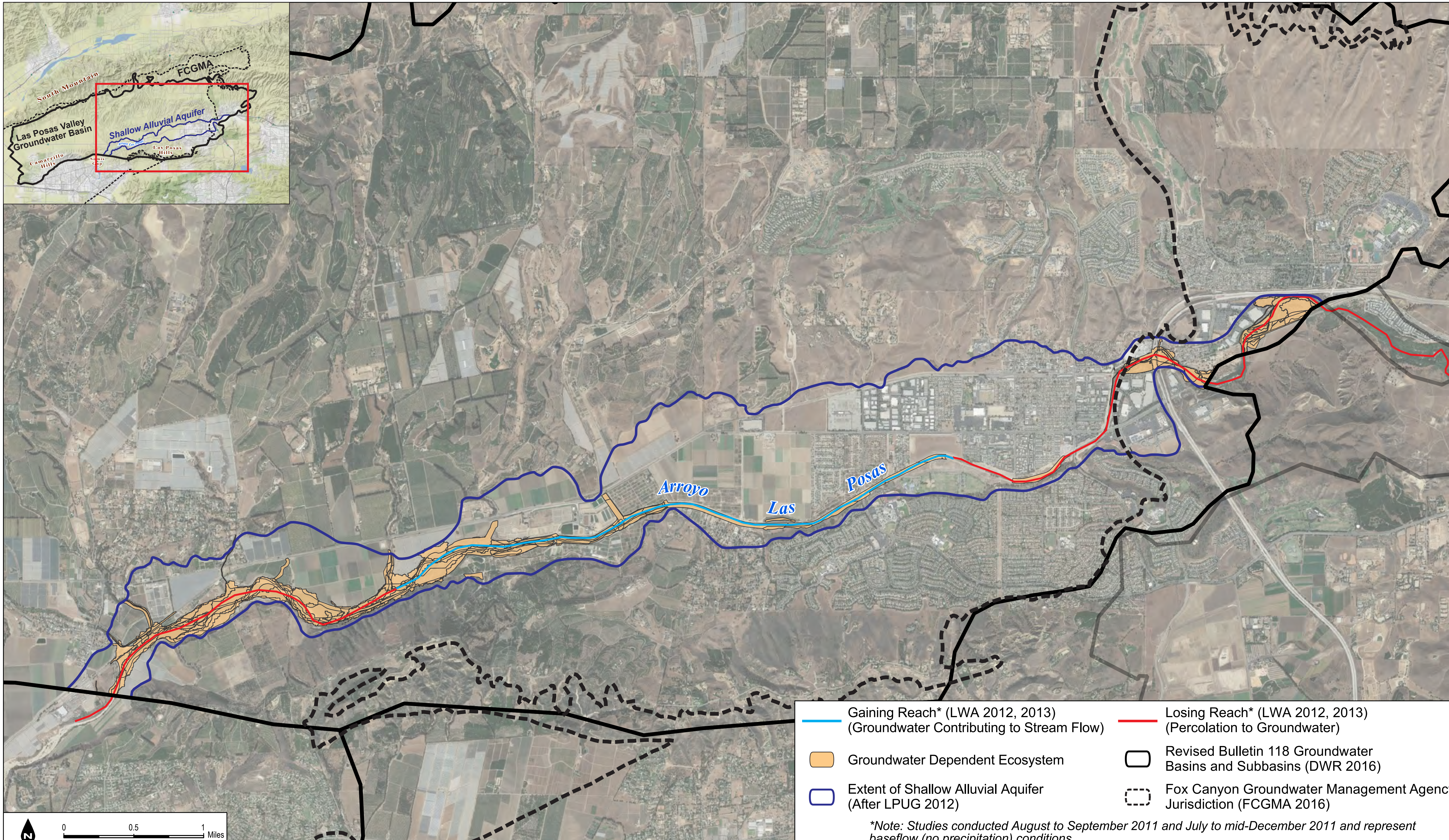


Sources: Google Earth (2-Oct-2016) [Aerial Image], Calleguas Municipal Water District [Well Data], DWR, FCGMA, LPUG (2012) [Epworth Gravels]

Figure 5. Depth to Groundwater in the Epsworth Gravels.



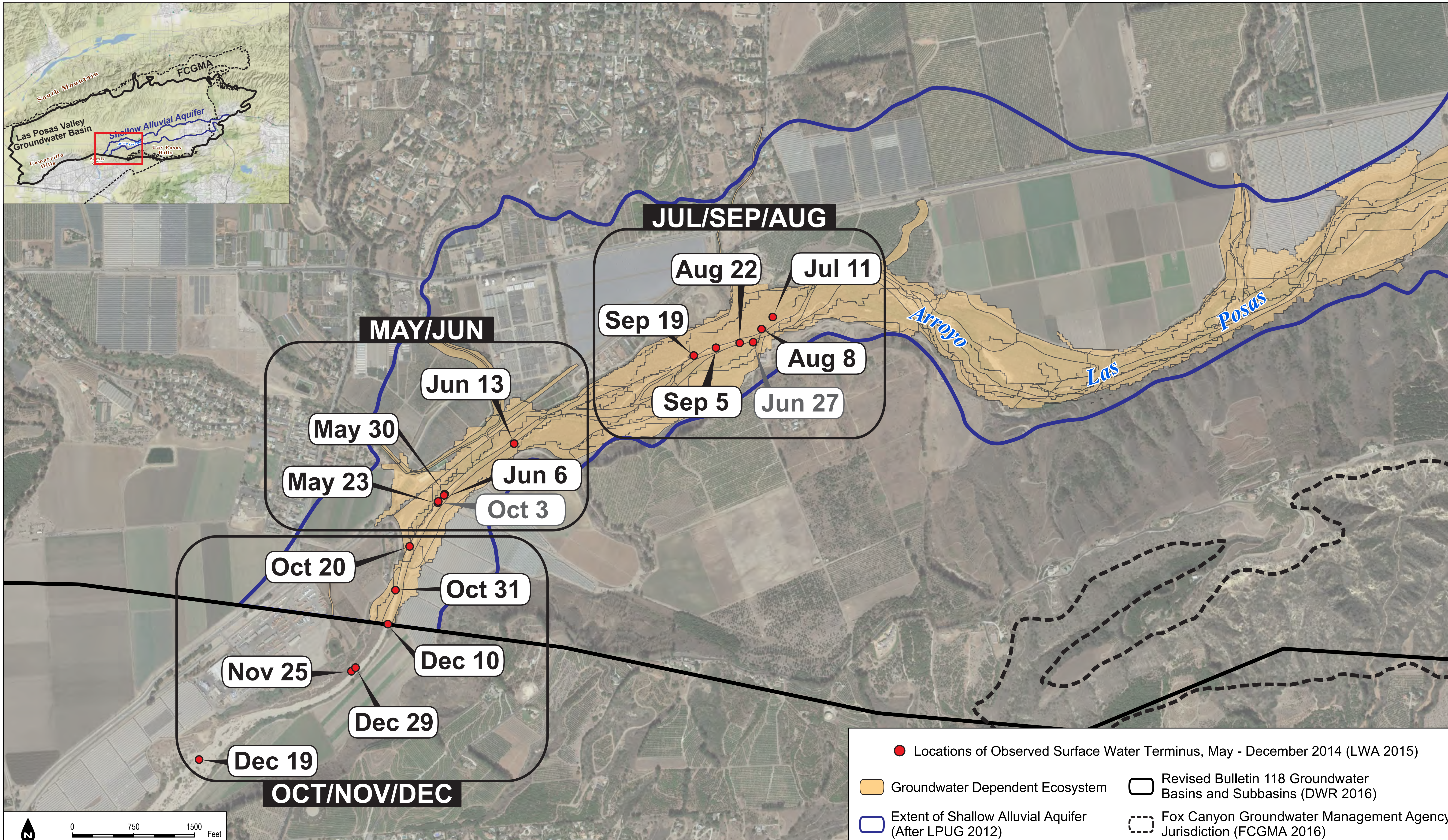
KEAR GROUNDWATER

SOURCE: DWR; Ventura County; FCGMA; Las Posas Users Group (2012) Las Posas Basin-Specific Groundwater Management Plan; Larry Walker Associates (2012) Phase I Study: Surface Flow and Groundwater Recharge in Arroyo Las Posas; Larry Walker Associates (2013) DRAFT Data Report for the Phase II Program for Long-term Monitoring of Flow and Recharge in Arroyo Las Posas

FIGURE 6

Gaining and Losing Reaches of Arroyo Simi-Las Posas

Assessment of Groundwater Dependent Ecosystems for the Las Posas Valley Basin Groundwater Sustainability Plan - DRAFT

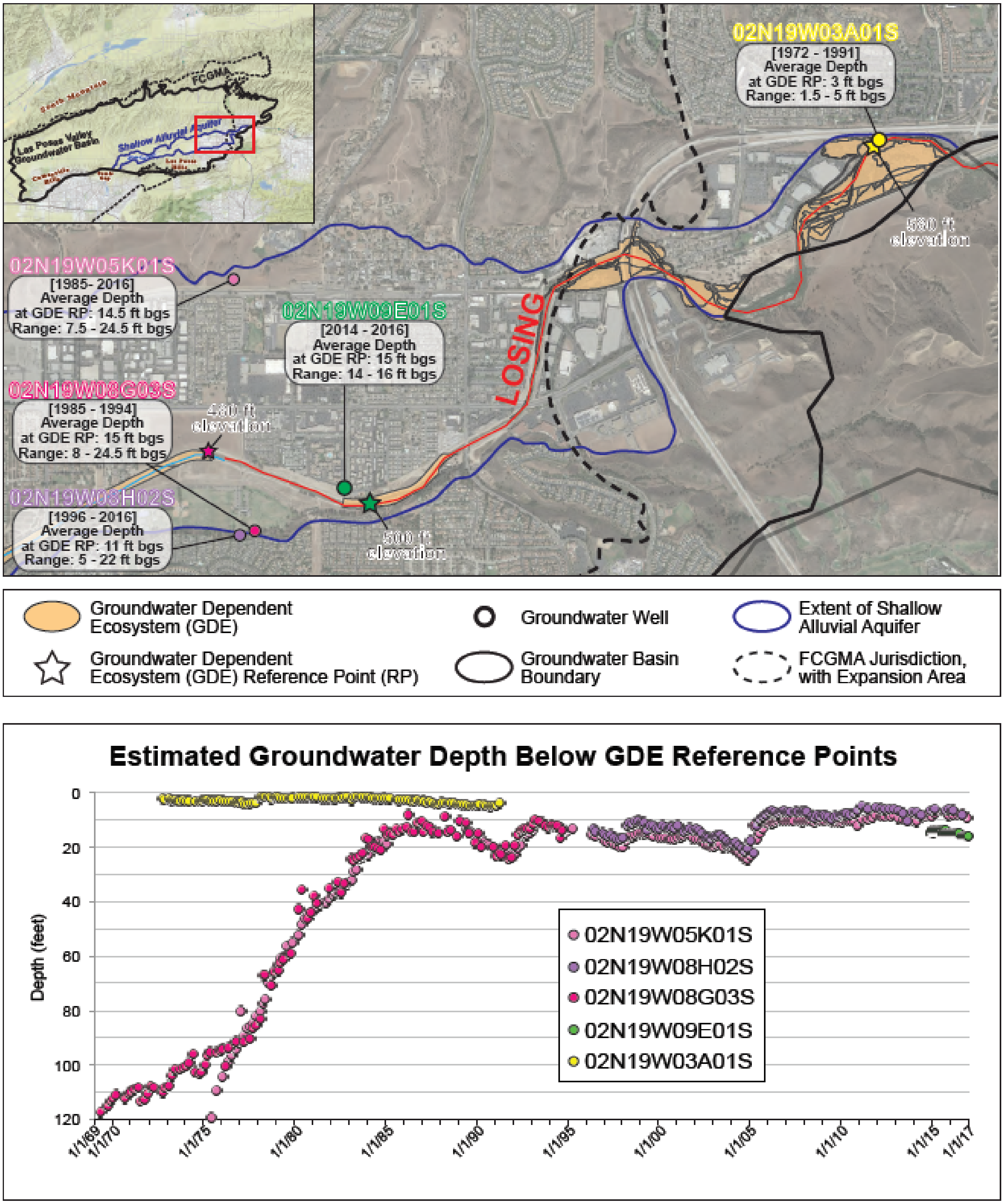


KEAR GROUNDWATER

SOURCE: DWR; Ventura County; FCGMA; Las Posas Users Group (2012) Las Posas Basin-Specific Groundwater Management Plan; Larry Walker Associates (2015) Results of Water Quality Sampling Events and Tracking of the Surface Flow Terminus in Arroyo Simi/Las Posas

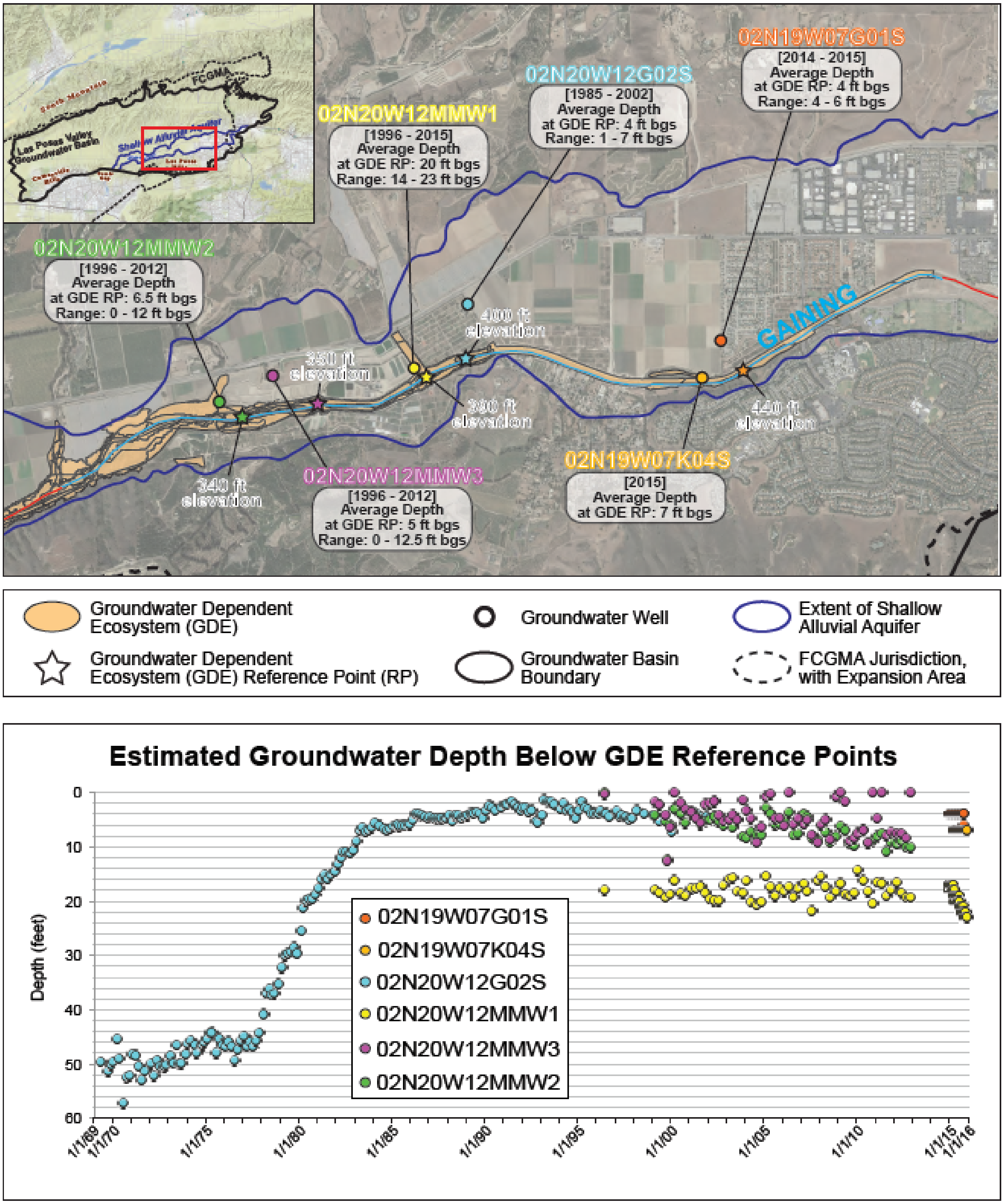
FIGURE 7

Extent of Arroyo Simi-Las Posas Perennial Stream



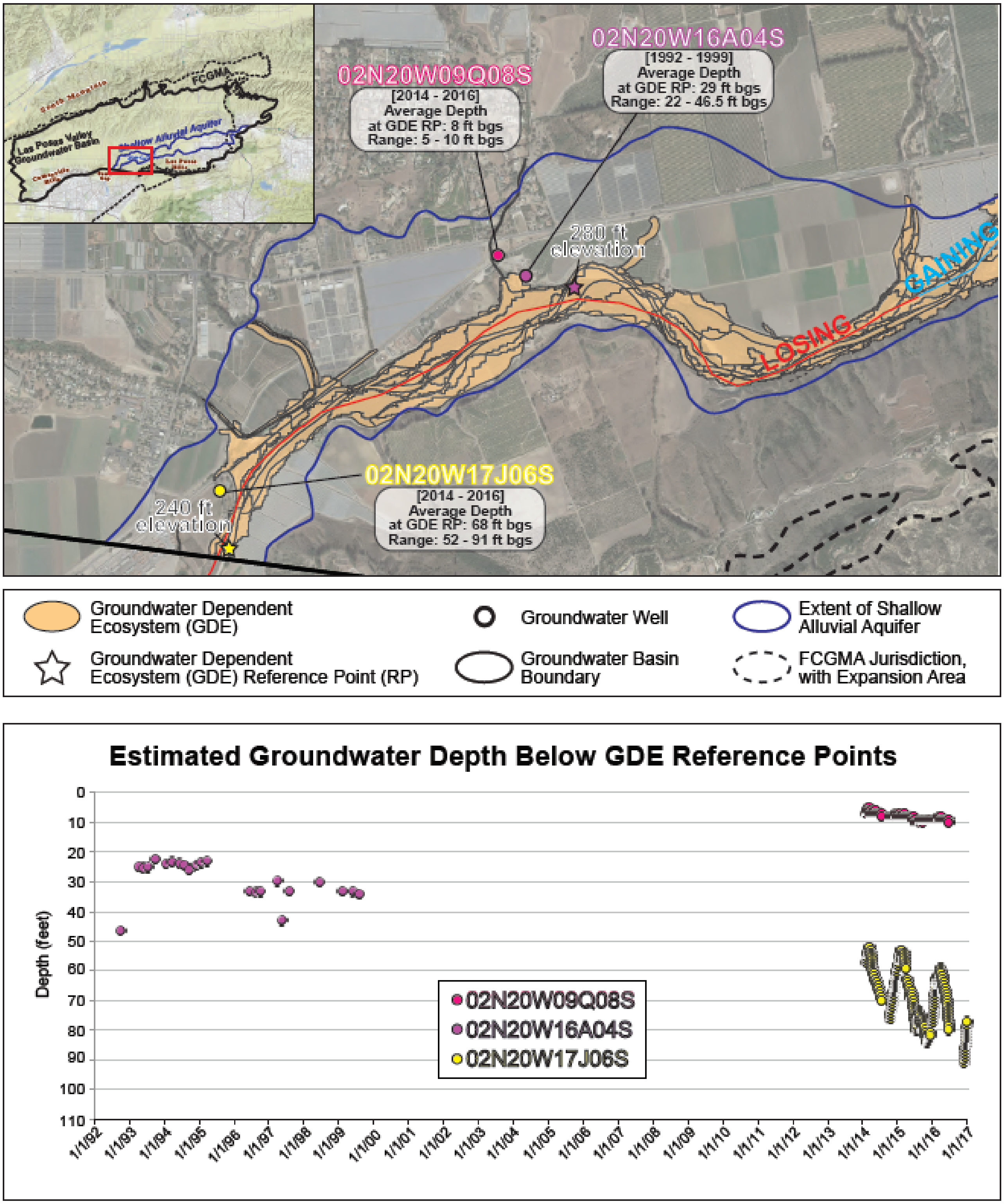
Sources: Google Earth (2-Oct-2016) [Aerial Image], DWR Water Data Library [-5K1, -8H2, -8G3, -3A1 Well Data], Ventura County/ CMWD [-9E1 Well Data], DWR, FCGMA, LPUG (2012) [Shallow Aquifer], LWA (2012, 2013) [Gaining/Losing Reaches]

Figure 8. Depth to groundwater in the eastern losing reach of the Arroyo Simi- Las Posas GDE.



Sources: Google Earth (2-Oct-2016) [Aerial Image], CMWD [-7G1, -7K4, -12MMW1, 2, 3 Well Data], DWR Water Data Library [-12G2 Well Data], DWR, FCGMA, LPUG (2012) [Shallow Aquifer], LWA (2012, 2013) [Gaining/Losing Reaches]

Figure 9. Depth to groundwater in the central gaining reach of the Arroyo Simi- Las Posas GDE.



Sources: Google Earth (2-Oct-2016) [Aerial Image], DWR Water Data Library [-16A4 Well Data], Ventura County/CMWD [-9Q8, -17JS Well Data], DWR, FCGMA, LPUG (2012) [Shallow Aquifer], LWA (2012, 2013) [Gaining/Losing Reaches]

Figure 10. Depth to groundwater in the western losing gaining reach of the Arroyo Simi-Las Posas GDE.

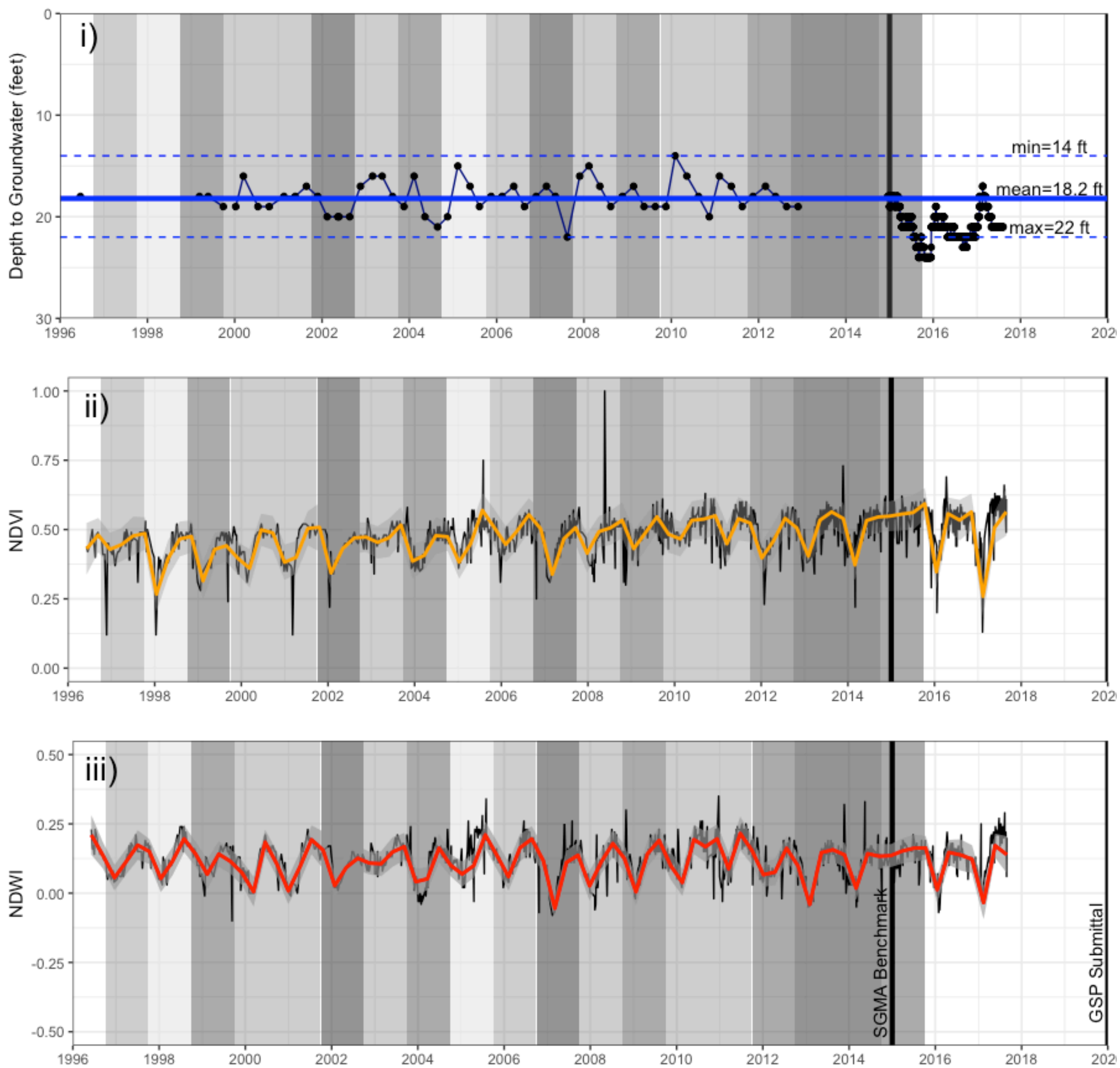


Figure 11. Historical trends for i) depth to groundwater (DTW), ii) Normalized Difference Vegetation Index (NDVI) and iii) Normalized Difference Water Index (NDWI). Horizontal lines in subplot i) indicate min, mean, and max DTW for the baseline period (1996-2015). Vertical lines indicate SGMA dates. Water year types based on the percentage of the water year precipitation compared to the 30-year precipitation average [i.e., drought (≤50%), dry (≤75%), normal (75% – 150%), wet (≥150%)] are denoted for each year in grey, where the darkest shade of grey denotes a drought year and the lightest shade of grey denotes a wet year.

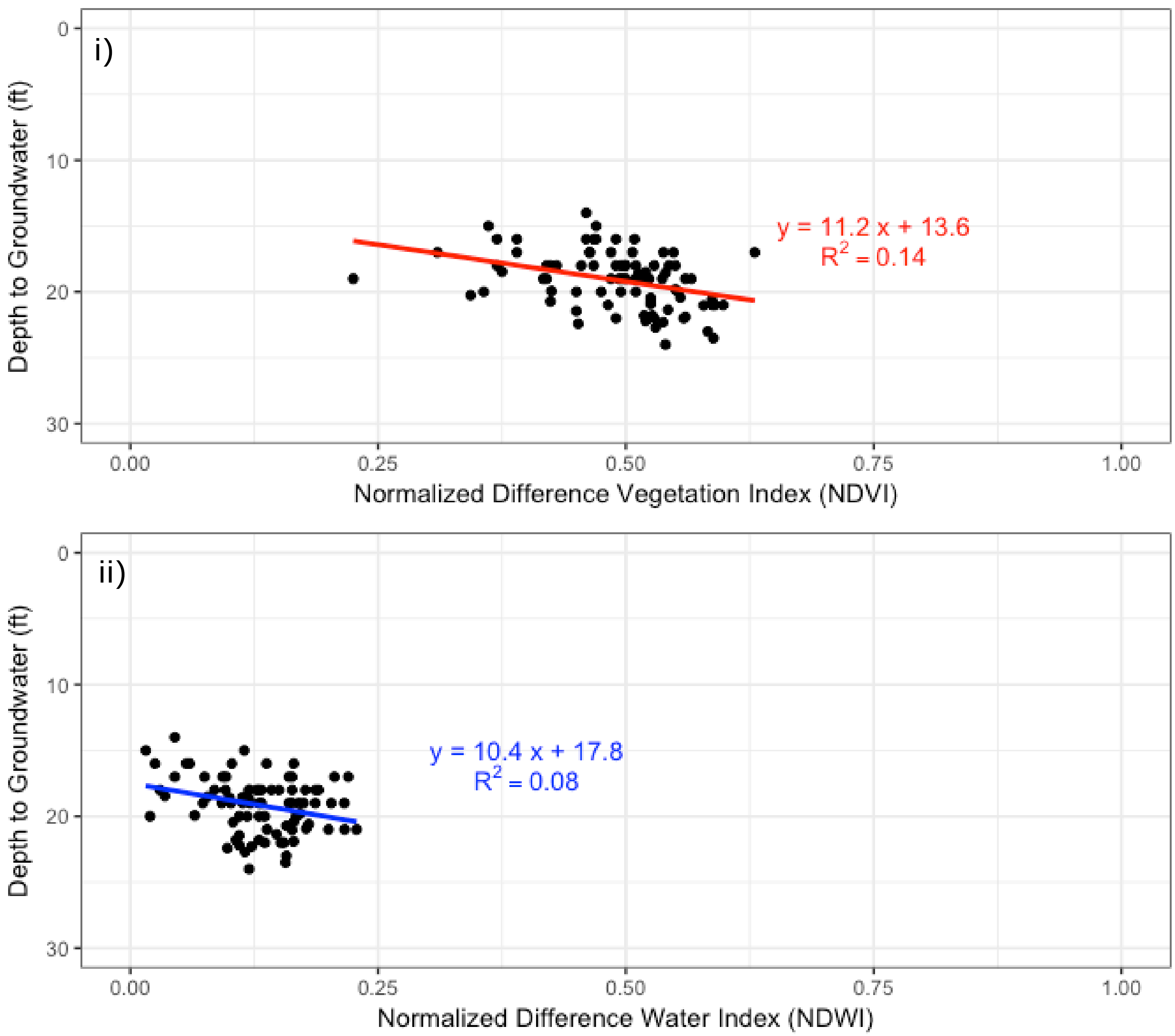


Figure 12. Correlation analysis between i) depth to groundwater and Normalized Difference Vegetation Index (NDVI) and ii) depth to groundwater and Normalized Difference Water Index (NDWI).

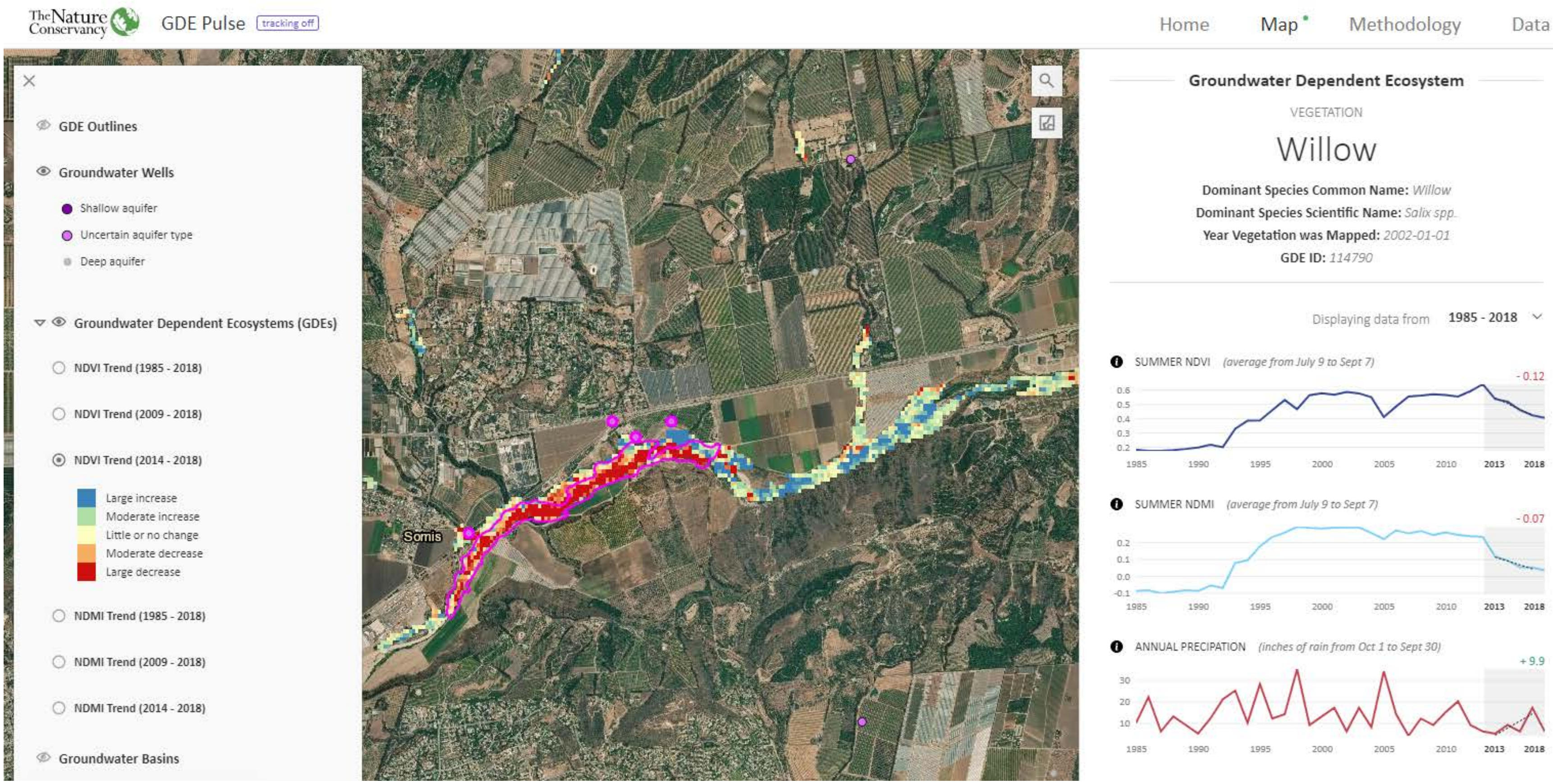


Figure 13. Arroyo Simi - Las Posas GDE Vegetation metrics: Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) for GDE polygon in the western losing reach of Arroyo Las Posas (purple outline).

WORKSHEET 1. ASSESS A CONNECTION TO GROUNDWATER

Use the following questions to assess whether iGDE polygons are connected to groundwater.	Arroyo Simi - Las Posas	Fairview Area Unconfined Aquifer	Areas outside delineated shallow unconfined aquifers
GENERAL QUESTIONS FOR ALL GDE TYPES			
Is the iGDE underlain by a shallow unconfined or perched aquifer that has been delineated as being part of a Bulletin 118 principal aquifer in the basin?	Yes	No	No
Is the depth to groundwater under the iGDE less than 30 feet?	Yes	No	No
Is the iGDE located in an area known to discharge groundwater (e.g., springs/seeps)?	Yes	No	No
*If you answer **Yes** to any of the above questions, then you likely have a GDE. Stop here. If you selected **No** or **Insufficient Data** or cannot confidently answer any of the above questions, then answer the following questions to infer groundwater dependency.*			
RIVERS, STREAMS, AND ESTUARIES			
Is the iGDE located in a portion of a river or stream that is likely a gaining reach?	Yes		
Are water temperatures around the iGDE relatively constant over time, indicating a potential for gaining conditions?			
Are there stable/permanent natural flows detected by stream gauges near the iGDE, indicating a potential for gaining conditions?	Yes permanent but wastewater discharge & other discharges		
Is there water or flows around the iGDE during summer months?	Yes		
For iGDEs near estuaries, does the salinity drop below that of seawater in the absence of surface water inputs (e.g., surface runoff or stormwater)?			
Are the isohaline contour lines of the saline wedge relatively constant under an iGDE?			
WETLANDS			
Is the level of water around the iGDE maintained during extended dry periods without surface water inflow or management?			

Use the following questions to assess whether iGDE polygons are connected to groundwater.	Yes	No	Insufficient Data
Is the location of the iGDE consistently associated with known areas of groundwater discharge (e.g., springs or seeps) in terrestrial and/or coastal environments?			
TERRESTRIAL VEGETATION			
Does vegetation in the iGDE remain green and physiologically active during extended dry periods of the year?	Yes		
Does the iGDE have higher evapotranspiration rates in summer months compared to other nearby vegetation unlikely to be dependent on groundwater?			
SEEPS AND SPRINGS			
Are there breaks in the slope of the land surface or areas of stratigraphic change causing groundwater to emerge or vegetation to congregate on the surface?			
Is there a presence of hydric (very wet) soils in areas with little summer precipitation, indicating persistent soil saturation throughout the year?			
Are there elevated surface water temperatures from an influx of geothermal groundwater discharge?			

*If you answered **Yes** to any of the questions above, then you likely have a GDE.*
*If you answered **No** to all the questions, then you likely do not have a GDE.*
*If you answered **Insufficient Data** to all the questions, then assume you have a GDE until sufficient data is collected. Refer to Appendix IV and Step 4.*

WORKSHEET 2. GDE ECOLOGICAL INVENTORY

Ecological Inventory for GDE Unit ID Arroyo Simi - Las Posas

		DESCRIPTION / NOTES
Species	○ Locally Important or Endemic ■ Special Status ○ Rare ■ Threatened ■ Endangered Presence of ○ Native Vegetation ___76_____% ○ Non-Native __24______%	state & federally listed endangered least Bell's vireo, state species of special concern arroyo chub, federally listed threatened and state species of concern California coastal gnatcatcher
Habitat	■ Critical Habitat ■ Recognized Wetland ■ Part of a Protected Area ○ Part of Local Conservation Plan ○ Part of a Wildlife Corridor Plan	California coastal gnatcatcher (Virginia Colony area) (Source- CH, 2016) 417 acres (Sources- NWI, 2016; iGDE, 2017) Open Space: City of Moorpark Arroyo Vista Community Park, 0.8 acres (Source: CPAD, 2016)
Environmental Beneficial Uses*	○ Aquaculture ■ Cold Freshwater Habitat ○ Estuarine Habitat ○ Inland Saline Water Habitat ○ Marine Habitat ○ Migration of Aquatic Organisms ○ Preservation of Biological Habitats of Special Significance ■ Rare, Threatened, or Endangered Species ○ Protected/Special Status/Sensitive Species ○ Spawning, Reproduction, and/or Early Development ■ Warm Freshwater Habitat ■ Wildlife Habitat ■ Other: _Groundwater recharge____ ■ Other: _Freshwater replenishment_	Reach 7 (Downstream of Hitch Road): GWR, WARM, COLD (Potentially), WILD, FRESH Reach 6 (Upstream of Hitch Road): GWR (Intermittent), FRESH (Intermittent), WARM, WILD, RARE

* Relevant environmental beneficial uses listed in Bulletin 118 (2003 update)—Appendix E.

Sources:
CPAD: Greeninfo Network. 2016. California Protected Area Network, 2016b. Oakland, California. http://www.calands.org/.
NWI: US Fish and Wildlife Service. 2016. National Wetlands Inventory, v2, California Wetlands. Accessed May 2016.
"CH: U.S. Fish and Wildlife Service, Endangered Species Program, ECOS Joint Development Team. 2016. Critical Habitat Polygons and Lines. Accessed from https://ecos.fws.gov/ecp/report/table/critical-habitat.html in December 2016.
iGDE: The Nature Conservancy. 2017. Early version. Indicators of Groundwater Dependent Ecosystems Database, v0.3.1.

WORKSHEET 3. POTENTIAL EFFECTS ON GDE SUMMARY

GDE Unit ID Arroyo Simi - Las Posas

Ecological Value (Step 1.2)—*Check the one that applies* ☐ High ■ Moderate ☐ Low ☐ Insufficient Data/Not Applicable

Susceptibility to Changing Groundwater Conditions (Step 2.1)—*Check the one that applies*
☐ High ■ Moderate ☐ Low ☐ Insufficient Data/Not Applicable

Corresponding Sustainability Indicator	Groundwater Levels	Groundwater Levels	Groundwater Levels/ Interconnected Surface Water	Groundwater Levels/ Interconnected Surface Water	Groundwater Levels/ Interconnected Surface Water
Hydrologic Data (Step 2.1)	Depth to groundwater	Depth to groundwater	Depth to groundwater	Depth to groundwater	Depth to groundwater
Area	Virginia Colony (Eastern Boundary to RR track)	Losing Reach (RR track to Arroyo Vista Community Park)	Gaining Reach (Arroyo Vista Community Park to Santa Rosa Drive)	Gaining Reach (Santa Rosa Drive to Moor Park WWTP Ponds)	Losing Reach (Balcom Canyon Road to La Cumbra Road)
Baseline Average (Step 2.1)	02N19W03A001S: 577 ft MSL At well: 6.1 ft bgs At GDE RP: 3 ft bgs	02N19W09E01: 485 ft MSL At well: 20 ft bgs At GDE RP: 15 ft bgs	02N19W07K04 (2015-2016) Average: 433 ft MSL At well: 12 ft bgs At GDE RP: 7 ft bgs Range: 0 ft 02N19W07G01 (2014-2016) Average: 436 ft MSL At well: 16 ft bgs At GDE RP: 4 ft bgs	02N20W12MMW1 (1996-2015) Average: 370 ft MSL At well: 21 ft bgs At GDE RP: 20 ft bgs 02N20W12MMW2 (1996-2012) Average: 333 ft MSL At well: 24 ft bgs At GDE RP: 6.5 ft bgs 02N20W12MMW3 (1996-2012) Average: 345.6 ft MSL At well: 41 ft bgs At GDE RP: 6 ft bgs	02N20W09Q08 (2014-2016) Average: 272 ft MSL At well: 38 ft bgs At GDE RP: 3 ft bgs 02N20W16A004S (1992-1999) Average: 252 ft MSL At well: 33 ft bgs At GDE RP: 28 ft bgs
Baseline Range (Step 2.1)	02N19W03A001S Range: 3.5 ft 574.9 -578.4 ft MSL	02N19W09E01 Range: 16 ft (based on 02N19W08G003S & 02N19W08H002S) 479 -495 ft MSL	0 ft range for 2015-2016	02N20W12MMW1 (1996-2015) Range: 9 ft 367-376 ft MSL 02N20W12MMW2 (1996-2012) Range: 12 ft 328-340 ft MSL 02N20W12MMW3 (1996-2012) Range: 14.5 ft 337.5-352 ft MSL	02N20W09Q08 Range: 5 ft 270-275 ft MSL 02N20W16A004S Range: 12 ft 246-258 ft MSL

Biological Data (Step 2.2)	NDVI, NDMI	NDVI, NDMI	NDVI, NDMI	NDVI, NDMI, NDWI	NDVI, NDMI
Description of Adverse Impacts to GDE (Step 2.3)	None Identified	None Identified	None Identified	None Identified	2013 – 2018, decreasing trend in NDVI, NDMI (potentially attributed to declining groundwater levels and loss of surface water flow)