



DRAFT

Santa Clarita Valley Water

Groundwater-Surface Water Interaction, Santa Clara River Valley Groundwater Basin, East Subbasin

July 15, 2020

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Abbreviations and Acronyms

AFY	acre-feet per year
Basin	Santa Clara River Valley Groundwater Basin, East Subbasin
Castaic	Castaic Reservoir
ET	evapotranspiration
GDE	groundwater-dependent ecosystem
GSI	GSI Water Solutions, Inc.
GWE	groundwater elevation
I-5	Interstate 5
LiDAR	light detection and ranging
LSCE	Luhdorff & Scalmanini Consulting Engineers
NWD	Newhall Water District
SCV Water	Santa Clarita Valley Water Agency
SCV-GSA	Santa Clarita Valley Groundwater Sustainability Agency
USGS	U.S. Geological Survey
UWCD	United Water Conservation District
WRP	water reclamation plant

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SECTION 1: Introduction

Santa Clarita Valley Water Agency (SCV Water) on behalf of the Santa Clarita Valley Groundwater Sustainability Agency (SCV-GSA) engaged GSI Water Solutions, Inc. (GSI), to examine the relationship between groundwater and surface water in the Santa Clara River Valley Groundwater Basin, East Subbasin (Basin). This work was completed as part of the Santa Clara River Valley Groundwater Basin, East Subbasin Groundwater Sustainability Plan development scope. The goals of this evaluation are as follows:

1. Evaluate the relationship between alluvial groundwater levels and surface water flows in the Santa Clara River downstream of the Saugus and Valencia Water Reclamation Plants (WRPs).
2. Understand the principal factors affecting groundwater levels downstream in comparison with other factors.
3. Identify where groundwater levels lie relative to the bottom of the river channel (thalweg) as an indication of whether the river is gaining (groundwater discharging into the river) or losing (surface water infiltrating to groundwater) during different climatic conditions.

The following section describes the authors' conceptual understanding of the relationship between the surface water and groundwater in the Basin.

SECTION 2: Conceptual Understanding of the Relationship between Groundwater and Surface Water and Effects of Urbanization

The Santa Clara River is the primary surface water drainage feature in the Basin, flowing generally from east to west ([Figure 1](#)). The river is interconnected directly with the Alluvial Aquifer, primarily in the western and central portions of the Basin. The river also has an indirect connection with the Saugus Formation in the western portion of the Basin, which is an area where the Saugus Formation is discharging its water into the Alluvial Aquifer, and thereby providing an upwards driving force for groundwater to discharge into the Santa Clara River in certain localized reaches west of Interstate 5 (I-5) at certain times. [Figure 2](#) is a conceptual diagram that illustrates the various components of the hydrologic cycle in the Basin and the relationship between the river, the Alluvial Aquifer, and the Saugus Formation. Rainfall falling in the upper elevations of the watershed infiltrates into the soil, where some of the water evaporates or is transpired by vegetation and the remainder becomes stormwater that can also infiltrate to groundwater. A portion of the rainfall runs off the land surface and flows into side canyons and tributaries to the river. In the urban areas, precipitation falling on impervious surfaces is directed to storm drains that flow to the river or the stormwater is directed to swales and allowed to percolate in some locations.

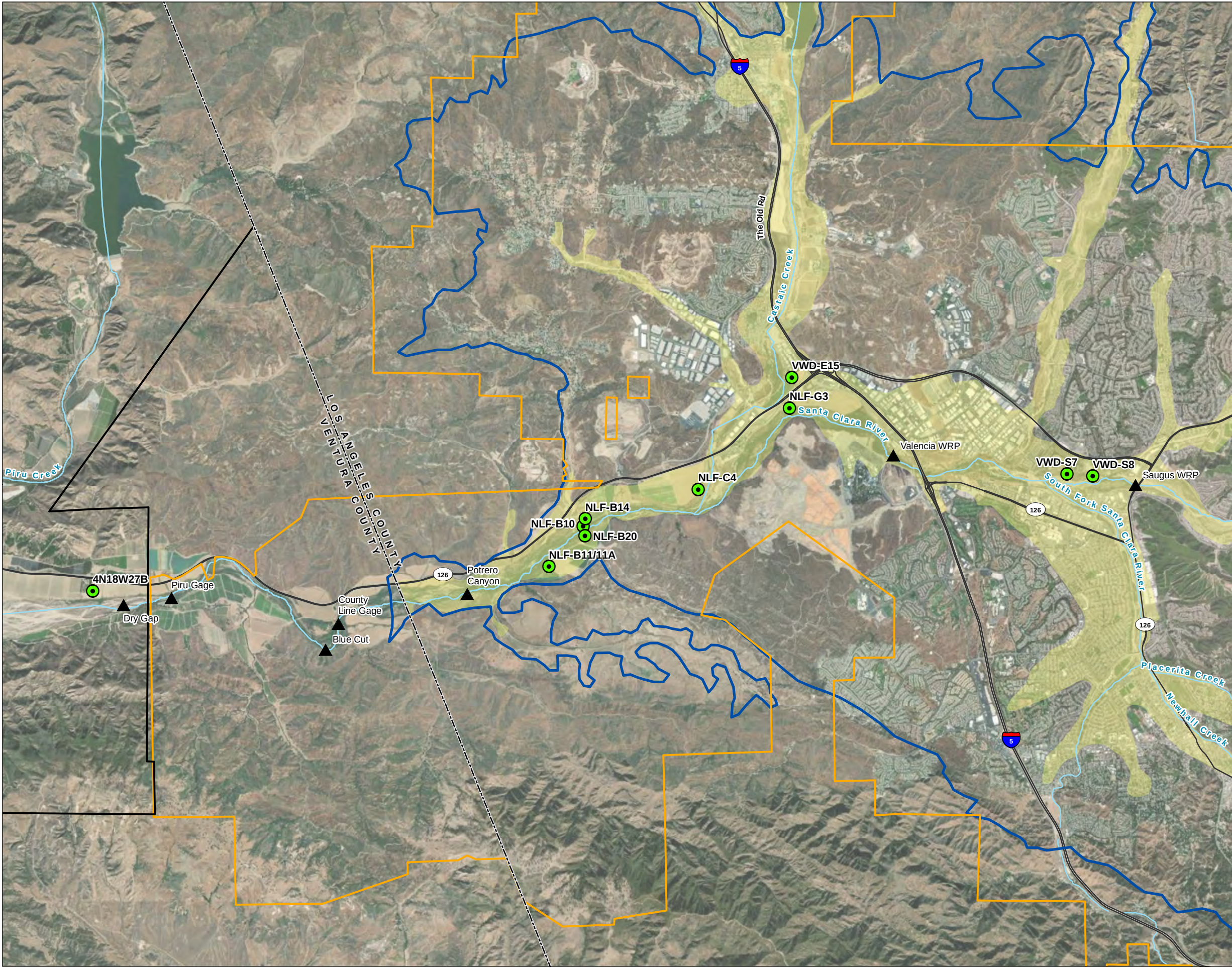


FIGURE 1

Site Map

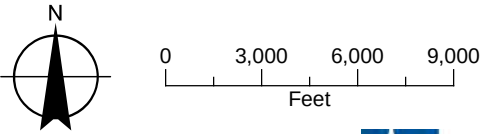
Santa Clara River Valley
Groundwater Basin,
East Subbasin

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LEGEND

- Key Well
- Point of Interest
- Alluvium
- Service Area Boundary for SCV Water
- UWCD Boundary
- Santa Clara River Valley Groundwater Basin, East Subbasin
- All Other Features**
- County Boundary
- Major Road
- Watercourse

NOTE:
SCV Water: Santa Clara Valley Water Agency
UWCD: United Water Conservation District



Date: July 14, 2020
Data Sources: USGS, Maxar Imagery 2019,
DWR Bulletin 118



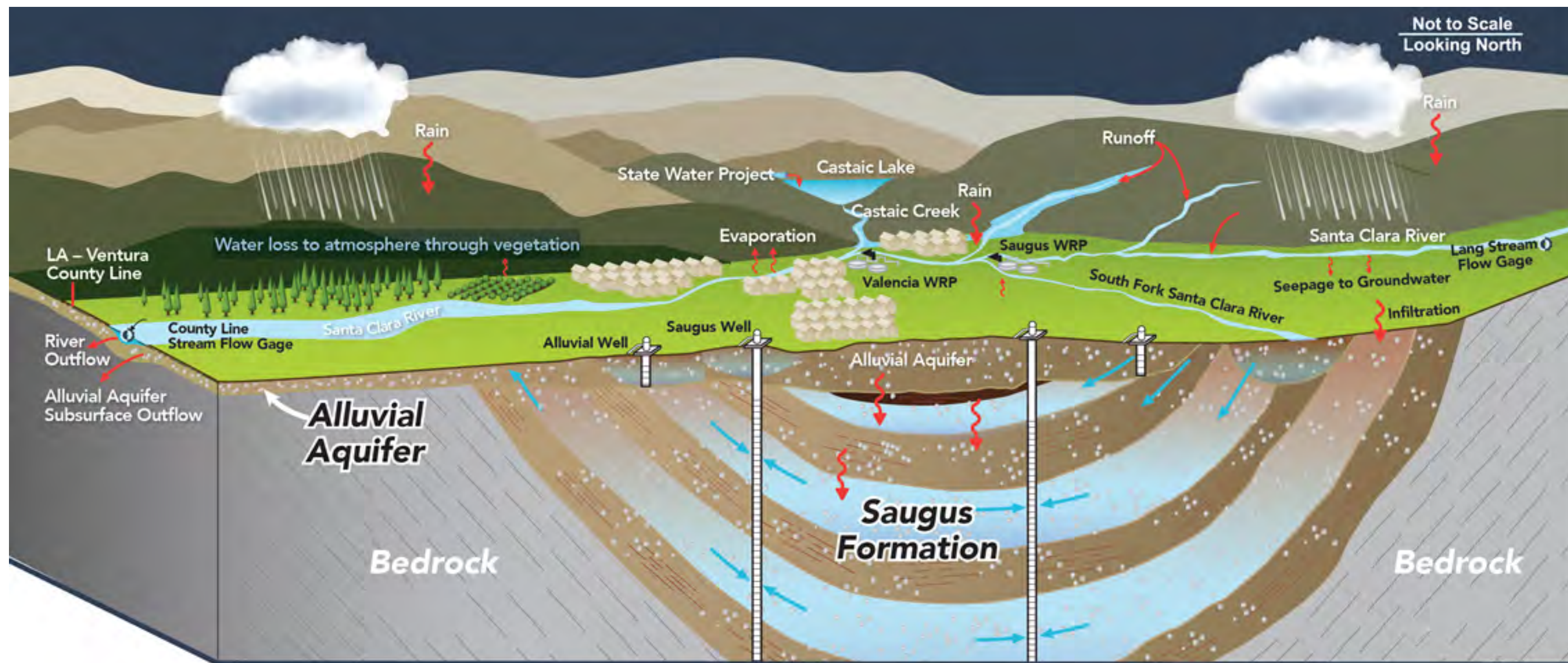


FIGURE 2
Conceptual Surface Water and Groundwater Flow Diagram
 Santa Clara River Valley Groundwater Basin, East Subbasin

2.1 Groundwater Pumping

The history of groundwater pumping in the Basin dates back to at least the 1930s. Groundwater pumping peaked in the 1950s and 1960s, when groundwater was extracted almost exclusively for agricultural operations. Estimated groundwater extraction based on the number of acres of agriculture, typical crops, and growing practices during that period indicate annual demand of approximately 50,000 acre-feet per year (AFY).

In the late 1960s agricultural operations began to be replaced by urban land uses. Newly built urban uses were served by local water companies that provided only groundwater. As agricultural groundwater pumping was being reduced, urban groundwater pumping became the largest groundwater demand, and between 2005 and 2014 pumping ranged from 27,000 AFY to 35,000 AFY for urban and 13,000 AFY to 17,000 AFY for agricultural purposes. Generally, over the past 70-year history, groundwater extraction transitioned from its highest volume serving primarily agriculture to a moderately lower volume serving urban uses and some agriculture.

Water demand for agricultural and municipal use varies seasonally, with the highest demand in summer due to agricultural and urban irrigation demand. Locally, municipal water supply is made up by roughly a 50:50 blend of groundwater and imported water each year. Municipal pumping data indicate groundwater pumping in August, the period of highest demand, is almost twice the lowest-demand period in February. Groundwater extraction for agriculture is also higher during the summer months but is dependent on a variety of criteria that are highly dependent on cropping patterns.

Increased groundwater extraction in the summer months temporarily lowers the water table and, thus, can temporarily reduce the amount of shallow groundwater discharging to the river in some areas. Shallow groundwater levels and river flows in the summer are also affected by other important factors, principally water consumption from vegetation in and near the river corridor. It is believed that invasive species such as *Arundo donax* (*Arundo*) significantly contribute to this water consumption.

2.2 Influences of Urbanization

As land use shifted from agricultural to urban use, it also changed the groundwater and surface water interactions in some areas. While less water was pumped from the groundwater basin for irrigation of crops, less recharge from deep percolation of irrigation water below the root zone was also occurring. Some of this reduction in groundwater recharge was offset by deep percolation from urban landscaping irrigation. Additionally, less infiltration from precipitation occurs because of the addition of impervious surfaces that accompany urbanization.

Importation of State Water Project water into the Basin began in the 1980s. These flows increased the recharge into the Basin from urban irrigation and discharges from the WRPs, resulting in a net increase in water into the groundwater/surface water system. The net effect of these factors has resulted in more water entering and leaving the Basin.

Water used indoors makes its way to either the Saugus or Valencia WRPs, and most of the water that is treated at these WRPs is discharged to the river or is redirected into a non-potable recycled water system. A portion of the pumped groundwater and imported water also is used for outdoor irrigation of yards, parks, and landscaping; this irrigation water is transpired by vegetation and a lesser portion infiltrates to groundwater. In more rural areas where individual parcels are served by private wells, a portion of the water recharges the groundwater system through septic tank drain fields. Some of this water that recharges the water table has the potential to make its way back to the river, though most of the septic systems are located away from the river in alluvial tributary valleys or on bedrock outcrops of the Saugus Formation and older rock units.

2.3 Groundwater-Surface Water Exchange

The amount and direction of the exchange between the river and the alluvial groundwater system is dependent on a number of factors including cycles of wet/normal/dry rainfall conditions, WRP discharges to the river, releases from Castaic Reservoir, evapotranspiration (ET) from riparian vegetation along the river corridor, stormwater flows, and groundwater pumping. As will be discussed later in this report, there are areas where it is likely that the river is receiving groundwater flow and other areas where the river is recharging groundwater, depending on the time of year and the hydrologic factors mentioned here.

Because the river flows across the alluvium in the Basin, the river is an important source of recharge to the Alluvial Aquifer and the Saugus Formation, particularly east of I-5 and in the river's tributary valleys. Groundwater flows horizontally within the alluvium and, in some locations, percolates downward into the underlying Saugus Formation. As presented in the Luhdorff & Scalmanini Consulting Engineers (LSCE) Technical Memorandum on the Hydrogeological Conceptual Model of the Basin (LSCE, 2020), most of this deep percolation recharge from the alluvium into the Saugus Aquifer Formation occurs on the eastern end of the Basin from just west of the mouth of Mint Canyon downstream to roughly the location of the Saugus WRP. The river is generally losing (meaning that river water is infiltrating to the groundwater table) in this portion of the Basin. Beginning roughly at the mouth of San Francisquito Canyon, significant reaches of the river appear to be gaining (meaning that groundwater is discharging to the river), particularly during normal and wet years. A significant reason for this is the addition of water into the river from WRP discharges. In addition, the reach from Castaic Creek to just upstream of Potrero Canyon appears to be gaining during most hydrologic periods as a result of Saugus Formation groundwater discharging to the alluvium and then to the river in this area. West of this location to the Los Angeles (LA)/Ventura County Line (County Line), the river flows on top of a thin layer of alluvium that is roughly 30 feet thick. Because only low-permeability Pico Formation mudstone and claystone underlies this area, flow across the County Line into the Piru Subbasin occurs in the alluvium and as surface water, but this river section is predominantly losing in this area because of the lack of an upwelling of deeper groundwater from the Pico Formation (which occurs further upstream where the Saugus Formation is present).

SECTION 3: Data Evaluation Methodology

The area of interest for this study is the reach of the Santa Clara River west of the Saugus WRP to the Piru Dry Gap, which is located in Ventura County approximately 3 miles west of the County Line (Figure 1). This study area was selected because it contains the portion of the Basin where there are exchanges between surface water and groundwater and because there are sensitive habitats in this section of the river. Upstream to the east, the river and tributaries are ephemeral, flowing only during high-flow storm events. GSI identified a number of alluvial wells located near the river channel and obtained historical water level data from SCV Water, Five Point (the Newhall Land and Farming Company), and United Water Conservation District (UWCD). The following data sets were used in the hydrograph analysis:

- Depth to water data from various alluvial wells located within the study area
- Precipitation data, dating as far back as 1883, from the U.S. Geological Survey (USGS) Newhall-Soledad FC32CE gage in Newhall and (beginning in 1979) the Newhall Water District (NWD) gage.
- Monthly discharge volume data from both the Saugus and Valencia WRPs, dating back to 1980
- Monthly release volume data from the Castaic Lagoon, dating back to 1980
- River bottom (thalweg) elevation data for the Santa Clara River, which was collected by ESA Associates in 2016 using light detection and ranging (LiDAR) methods

The observed fluctuation in groundwater levels observed in the hydrographs may be affected by a number of seasonal and annual factors including precipitation, seasonal climate, surface water flow, WRP discharges, and changes in pumping. In order to examine some of these effects, multiple hydrographs that had sufficient groundwater level data available during wet, dry, and normal hydrologic periods were created for each well. Each hydrograph has two data sets in common: groundwater elevation over time and channel bottom elevation (also referred to as thalweg). Groundwater elevation data illustrate the historical trends and fluctuations in groundwater levels. GSI used reference point elevations at each wellhead estimated from Google Earth to convert depth to water measurements to groundwater elevations. The reference point elevation data accuracy are accurate to within approximately +/- 5 feet, which affects the amount of uncertainty that arises when comparing groundwater level elevations to river thalweg elevations obtained from the more accurate LiDAR data source.

The river thalweg is a single data point that represents the lowest point in the river channel nearest to the well. Using the LiDAR data in conjunction with ArcGIS, a cross-section of the channel bottom was created perpendicular to the river and in line with the well. The lowest point in the cross section was used as the thalweg and it was assumed that this value has not changed significantly over the years.¹ This data point is portrayed as a horizontal line on each hydrograph. The significance of this line is that when the groundwater elevation is equal to or above the channel bottom elevation, groundwater has the potential to contribute to surface flow, assuming that the groundwater level is above the surface elevation of the river. Because information about the elevation of the river at each location (and how that has likely changed over time) is lacking, it is possible to say only that there is a potential for the river to be gaining at these locations. As indicated by the hydrographs, water levels in a number of wells stop at the thalweg elevation and so we infer that groundwater must be flowing into the river. In contrast, when the groundwater elevation is below the channel bottom elevation, we infer that groundwater is not contributing to surface flow in the river (regardless of river elevation) because it may not reach the channel bottom; the area is thus identified as a

¹ LiDAR data are a snapshot in time, representing present conditions. The data include both the elevation of the channel invert and the location of the channel. However, the current channel conditions are not necessarily the same as they have been in the past. Channel characteristics change over time, particularly due to large flood events such as those that occurred in 1993, 1997–1998, and 2004–2005.

losing reach where a portion of the streamflow is seeping downward to the underlying water table in the alluvium.

For each well, the base hydrograph (showing groundwater elevation and thalweg) was duplicated and plotted with at least one other factor that may affect groundwater levels, such as WRP discharges and precipitation (the latter of which relates to stormwater flows). This enables a demonstration of how a certain factor correlates with groundwater levels, if at all. For example, if the hydrograph shows a trend of increasing precipitation and an increase in groundwater elevation during the same time frame, it is likely that precipitation has a strong influence on groundwater levels in that area.

The raw form of precipitation data is in measurement units of inches per month, but—for evaluating longer-term correlations—precipitation data are better presented as a cumulative departure from average rainfall. When plotted on a hydrograph, the slope of a cumulative departure curve is indicative of the climatic conditions during a given period of time. An increasing slope represents a period of above-average precipitation and a decreasing slope represents a period of below-average precipitation.

Results from the calibrated groundwater flow model were used in some cases to examine some reaches of the river where measured groundwater data at certain wells are suspect (e.g., not representative of static conditions) or inconclusive. In other cases, the groundwater flow model was used to corroborate observations about where the Saugus Formation is discharging to the alluvium and then the river where water level data is lacking. Details of the model setup and calibration will be presented in a separate document.

The data and results of this evaluation were synthesized to create three maps showing the elevation of groundwater relative to the thalweg at various locations along the river during wet, normal, and dry climatic conditions. Wet conditions are defined by periods of above-average precipitation during the past 30 years, normal conditions are defined by periods of average precipitation, and dry periods are defined by periods of drought, or below-average precipitation. The average annual precipitation between 1980 and 2019 was 21.25 inches at the NWD rain gage. Wet and dry conditions are generally defined by periods with approximately 50 percent differences in annual precipitation compared with the 1980–2019 average precipitation (i.e., 31.8 inches or more during wet years and 10.5 inches or less during dry years). The maps display locations where groundwater levels are as follows:

- Above the thalweg or no deeper than 1 foot below the thalweg (blue)
- 1 foot to 5 feet below the thalweg (green)
- 5 feet to 15 feet below the thalweg (yellow)
- 15 feet to 30 feet below the thalweg (orange)
- Greater than 30 feet below the thalweg (brown)

In addition to representing where the river has the potential to be gaining or losing, the maps provide an aid to assessing areas where groundwater levels are shallow and may be supporting groundwater-dependent ecosystems (GDEs).

SECTION 4: Limitations

Interpretations made on the basis of the data presented in this report have a number of important limitations. First, most of the alluvial wells used in this evaluation are relatively deep and have screens that begin are present over a depth interval ranging between 18 and 130 feet below ground surface. Shallow monitoring wells (not pumping wells) would be preferred for monitoring because they would be more sensitive to water level changes near the river and may be more representative of the shallow portions of the alluvium that are connected to the river. Some of these the existing wells also are not located adjacent to the river channel, which means that the water level in the well may not be strongly connected to the river. In addition, there are large distances along the river where well data are lacking, which makes it necessary to infer and extrapolate an understanding of conditions between locations. Inspection of the water level data for all of the agricultural wells in the region suggests that a large number of measurements that are reported to be static water levels are not truly static, perhaps because the water levels were measured (1) while the well was still recovering from having been turned off prior to the measurement, or (2) while nearby wells were pumping and thereby lowering the water level in the measured well. For example, well NLF-B14 shows a reading in early 2015 that is 5 to 6 feet higher than most other static water level measurements in this well; nearby well NLF-B10 shows four readings that are 6 to 7 feet higher than other static water level readings; and well NLF-C10 shows a 10- to 20-foot decrease in its water levels after it was installed and began operating in 2008. Lastly, the reference point elevations on existing monitoring wells have been estimated using Google Earth, which limits the accuracy of the computed groundwater elevations at each well. The elevation of the river thalweg was estimated using LiDAR data from 2016 and not actual surveyed elevations. Each of these factors reduces the accuracy of the data and were considered when interpreting the data.

There is a plan to install shallow piezometers and temperature probes as part of this project to supplement and enhance the existing monitoring well data. Likewise, the plan includes surveying reference-point elevations and the river thalweg elevation. Unfortunately, access to properties along the river has been limited due in part to the COVID -19 pandemic that began in early 2020 and that affected the priorities of the landowners involved. Once the piezometers and probes are installed and the reference point elevations are obtained, monitoring of the wells and probes will reduce the uncertainties and improve the understanding of the river and groundwater interconnection and factors affecting that interconnection. Even with the limitations described herein, the authors believe that the analysis presented in this report provides important information about (1) the relationship between groundwater and surface water in the Basin, (2) the factors affecting those relationships, and (3) how they vary under various climatic conditions.

SECTION 5: Results

5.1 Hydrograph Analysis

Hydrographs were created for wells completed within the Alluvial Aquifer and located near the river from the vicinity of the Saugus WRP downstream to just past the County Line gage. Hydrographs for six wells (Figures 3a through 8B) are embedded in the text of this report; hydrographs for four additional wells are included in Attachment A. These wells were selected based on location and value of the data (e.g., a sufficiently long period of record over multiple climatic conditions). The following wells are listed in order by location, from the easternmost well (VWD-S7) to the westernmost well (4N18W27B). Refer to Figure 1 for well locations.

Well VWD-S7

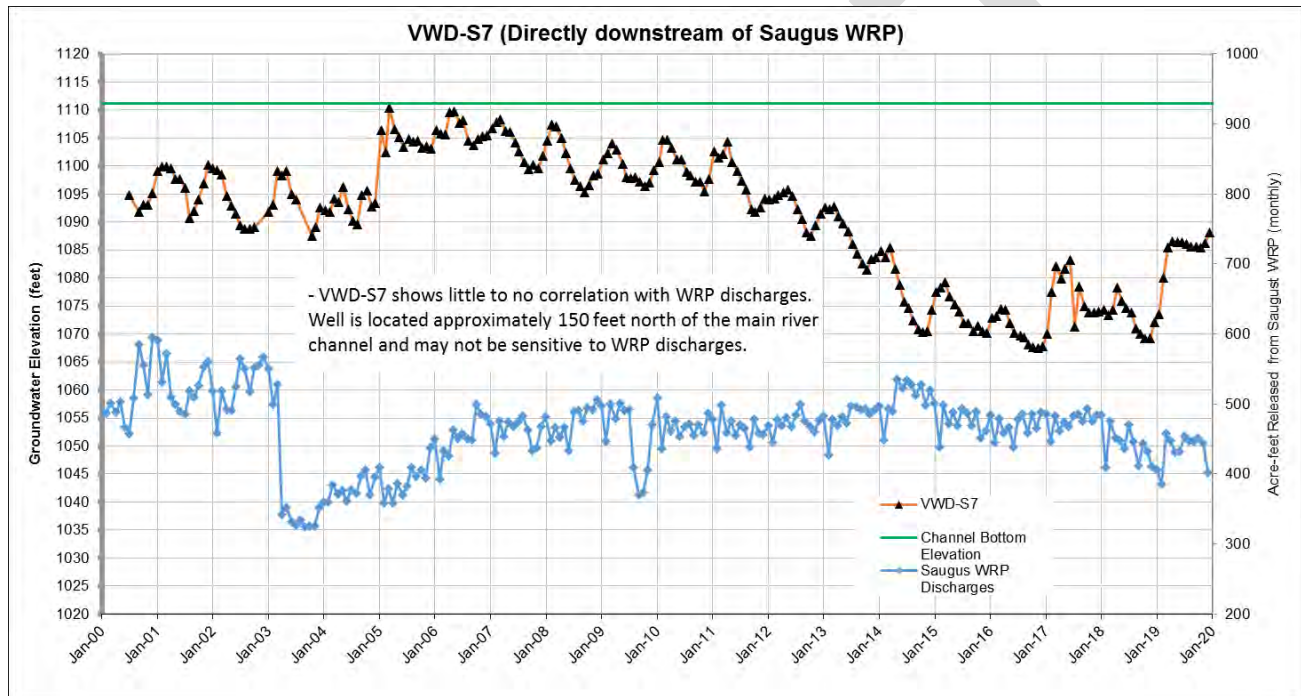


Figure 3A – VWD-S7 Groundwater Elevation (GWE) and Saugus WRP Discharges

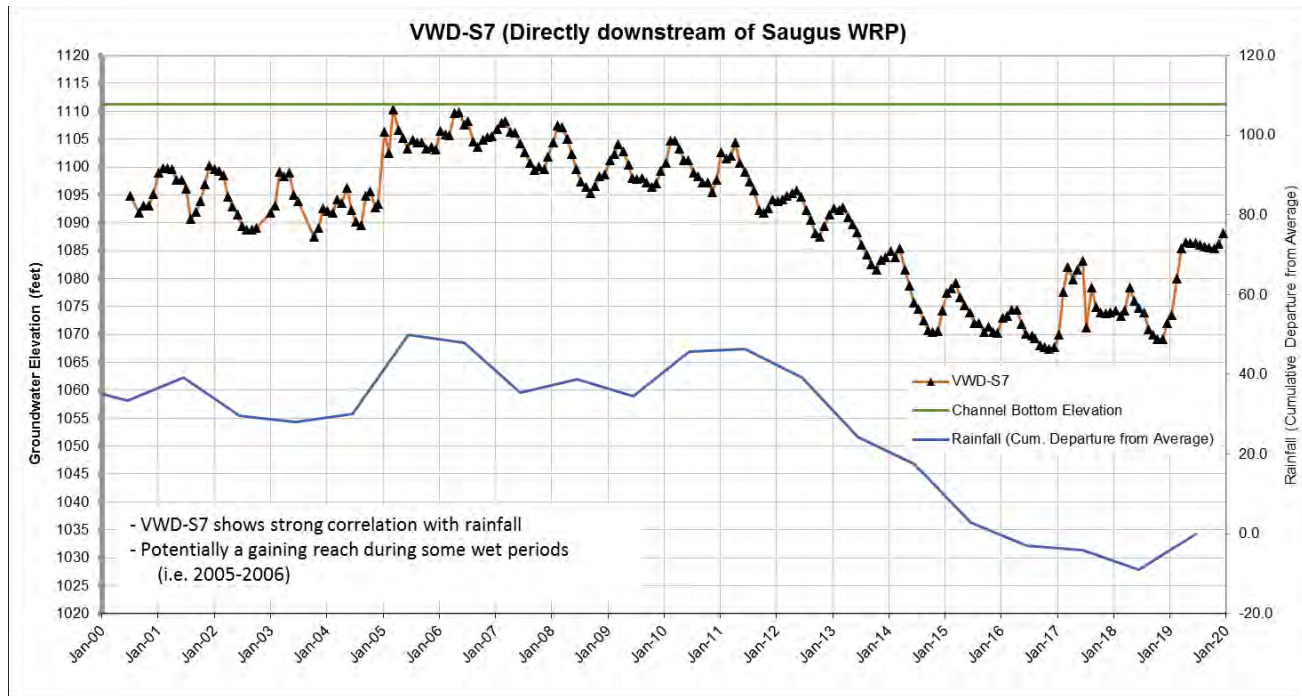


Figure 3B – VWD-S7 GWE and Cumulative Departure from Average Rainfall

Groundwater elevations observed in well VWD-S7 do not appear to be correlated with WRP discharges (Figure 3A) during early 2003 and early 2011. Rather, the abrupt increase in elevations during 2005 and the gradual decrease beginning in 2011 correspond well with precipitation data (Figure 3B). These results appear to indicate that groundwater in the alluvium along this reach of the river between the Saugus WRP and Valencia WRP is weakly influenced by WRP effluent and strongly influenced by precipitation. However, this alluvial well is located approximately 150 feet from the river and may not be sensitive to WRP discharges. Water levels measured during the last drought were more than 30 feet below the river thalweg, but started to show moderate increases in 2019 as precipitation increased.

It is noteworthy that groundwater levels in VWD-S7 show a strong seasonal response to precipitation and perhaps a response to pumping at a nearby well. The high water levels in 2005 and 2006 are within a few feet of the thalweg, indicating that potentially gaining conditions only occur during the winter months, i.e., only seasonally. Large changes in groundwater levels have also been observed seasonally in other Alluvial Aquifer wells located on the east end of the Basin. As will be documented later in this report, groundwater levels in wells located on the west end of the Basin show significantly less seasonal variation because they are affected by WRP discharges, Castaic Reservoir releases, and discharge of Saugus Formation groundwater into the Alluvial Aquifer.

Well NLF-G3

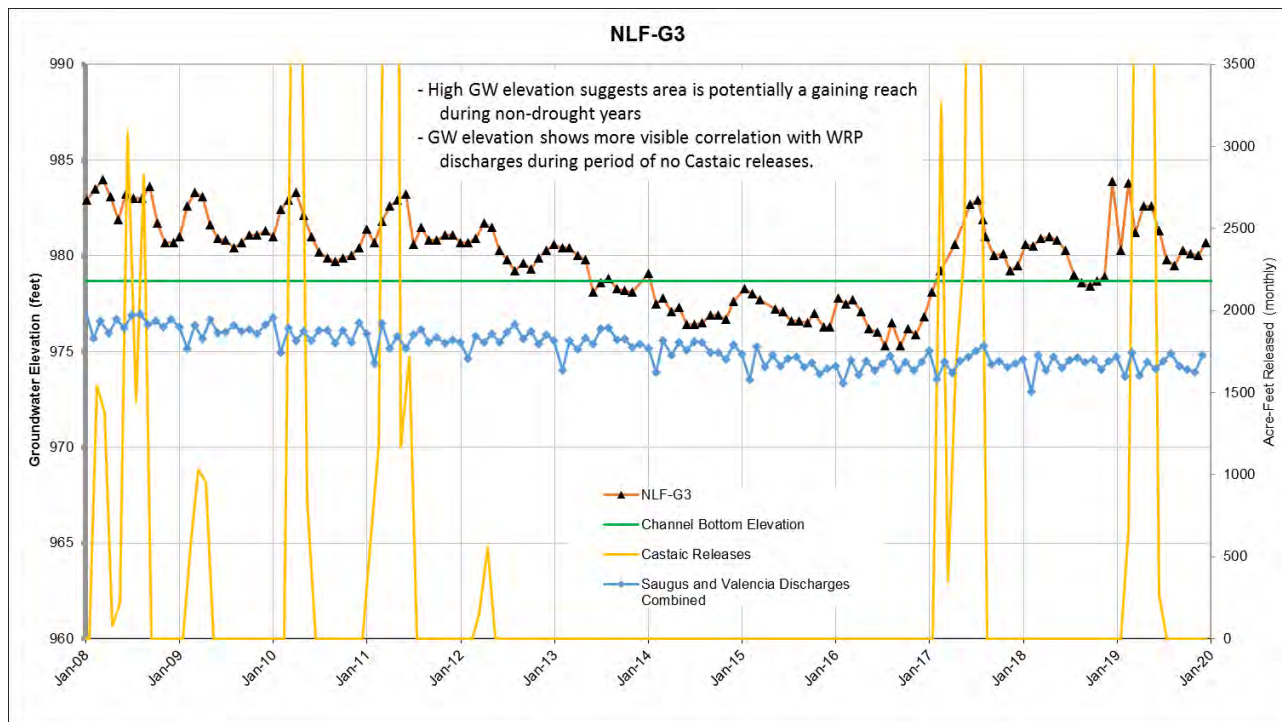


Figure 4A – NLF-G3 GWE, Combined WRP Discharges, and Castaic Reservoir Releases

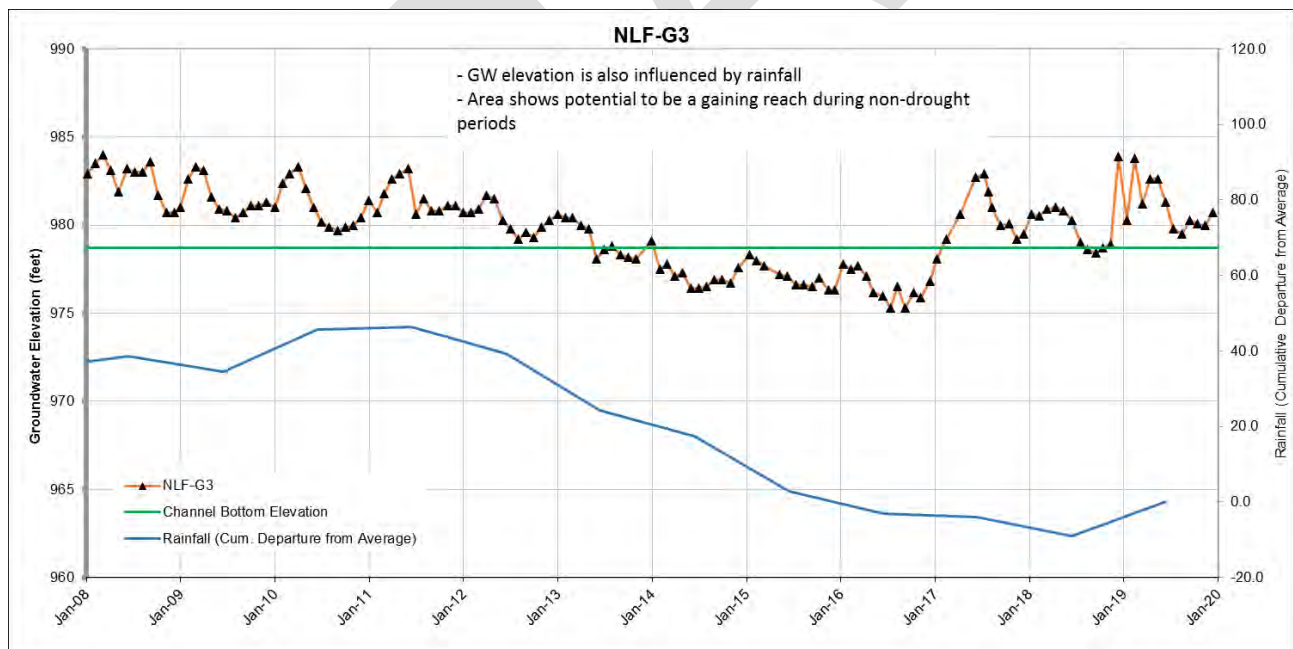


Figure 4B – NLF-G3 GWE and Cumulative Departure from Average Rainfall

Groundwater elevations in NLF-G3 correlate well with Castaic Reservoir releases (Figure 4A) and with the precipitation trend (Figure 4B). The groundwater levels appear to be above the thalweg in this area, indicative of potentially gaining conditions. The river appears to be gaining in this area until the onset of

drought conditions in 2013, when the groundwater levels dropped below the thalweg. Groundwater levels have nearly fully recovered in this well following the recent drought and the groundwater levels since 2017 are above the thalweg, indicating that the river may be gaining again at this location. The lowest measured historical groundwater level has been less than 5 feet below the thalweg.

Well NLF-C4

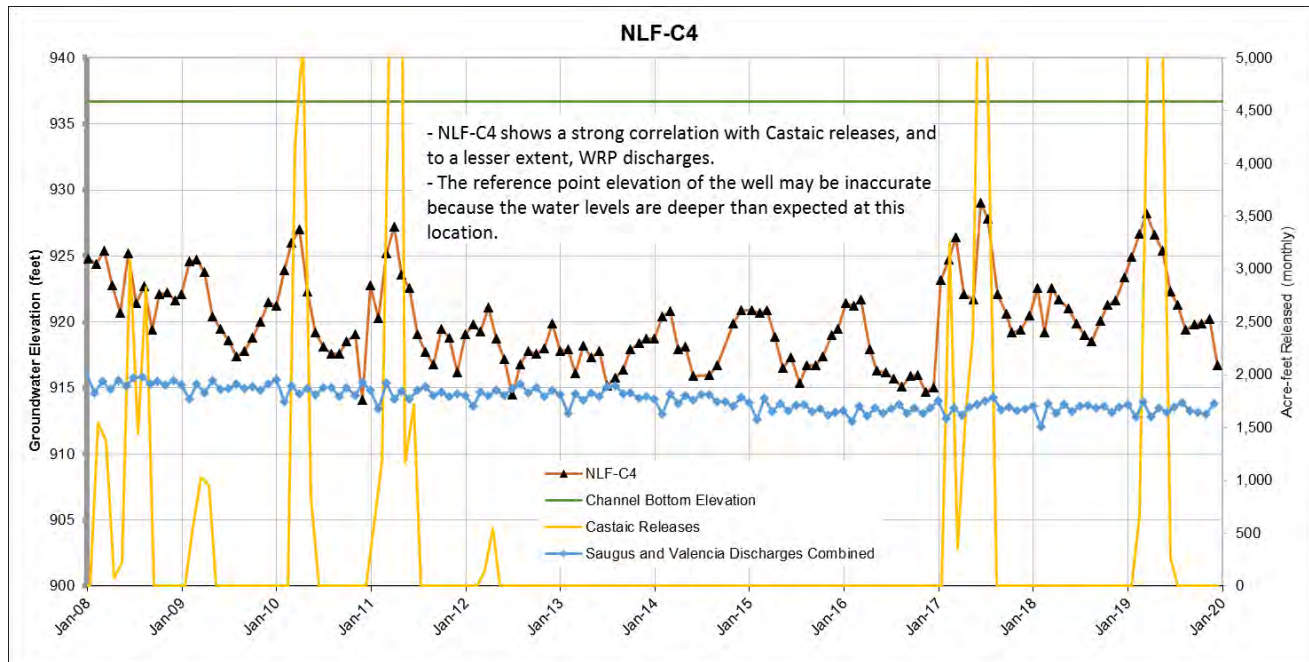


Figure 5A – NLF-C4 GWE, Combined WRP Discharges, and Castaic Reservoir Releases

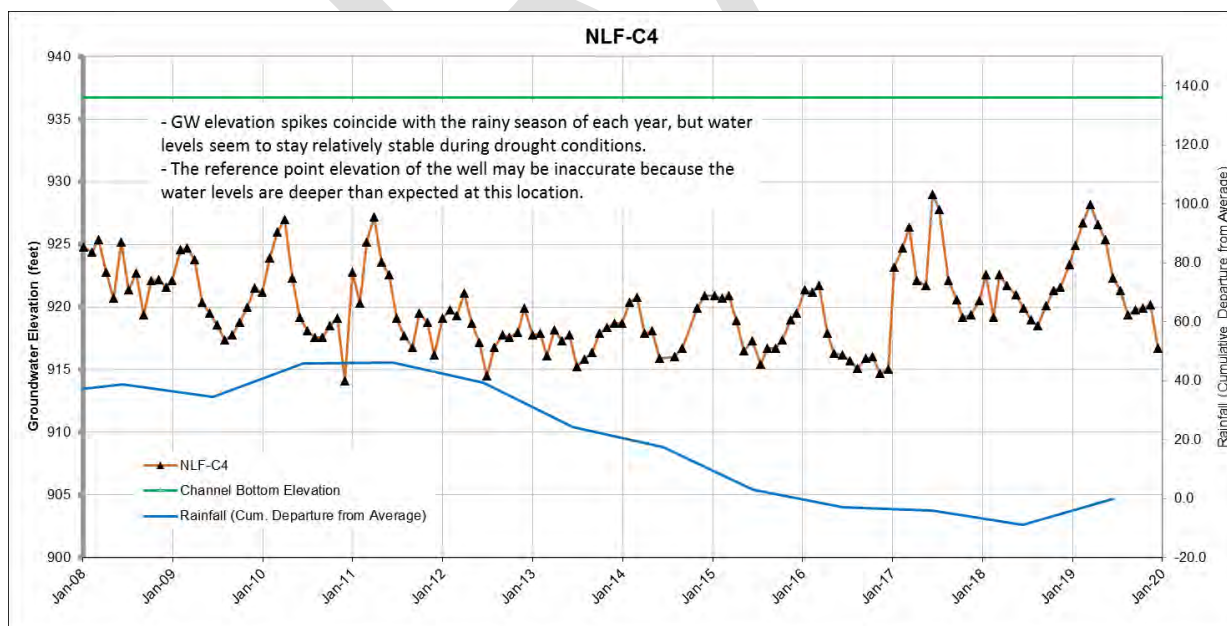


Figure 5B – NLF-C4 GWE and Cumulative Departure from Average Rainfall

Groundwater elevations in NLF-C4, located along Castaic Creek just north of the confluence of Castaic Creek and within the main river channel, correlate strongly with Castaic releases as expected; however, it is not clear whether there is any correlation with WRP discharges (Figure 5A). Groundwater elevations appear to be less dependent on precipitation trends (Figure 5B), as demonstrated by the stable groundwater levels persisting through the drought conditions between 2011 and 2017. The available data at well NLF-C4 suggest that this is a losing reach at all times; however, the authors believe that the reported water level elevations are too deep, based on (1) indications that another well in this wellfield (C-10) has static water levels that are greatly affected by pumping in nearby wells and (2) preliminary indications from the groundwater model. Given that Castaic Creek receives a significant amount of recharge from reservoir releases, it seems likely that groundwater levels would be higher at well NLF-C4 and the river would be gaining downstream of the confluence with Castaic Creek. The groundwater model shows a close correlation with the northern-most well in the NLF-C wellfield (well NLF-C6, which was not been pumped since 2004 and thereby is providing truly static water level data), but more difficulty matching the reportedly “static” water levels in the interior of this wellfield (e.g., well NLF C-4), which is a further sign that the water levels in wells such as NLF-C4 (which is used each year to meet agricultural water demands) may not be truly static water levels, as discussed previously in Section 4. Based on the location along the river, water levels observed at other wells, observations of conditions along the river, and conceptual model understanding of the river at this location, the river is potentially gaining at this location, in contrast to what groundwater levels indicate at well NSF-C4. The reference elevations and thalweg elevations will need to be checked and a better understanding of the role of local pumping influences on groundwater levels must be developed before too many conclusions can be drawn at this location.

Well NLF-B14

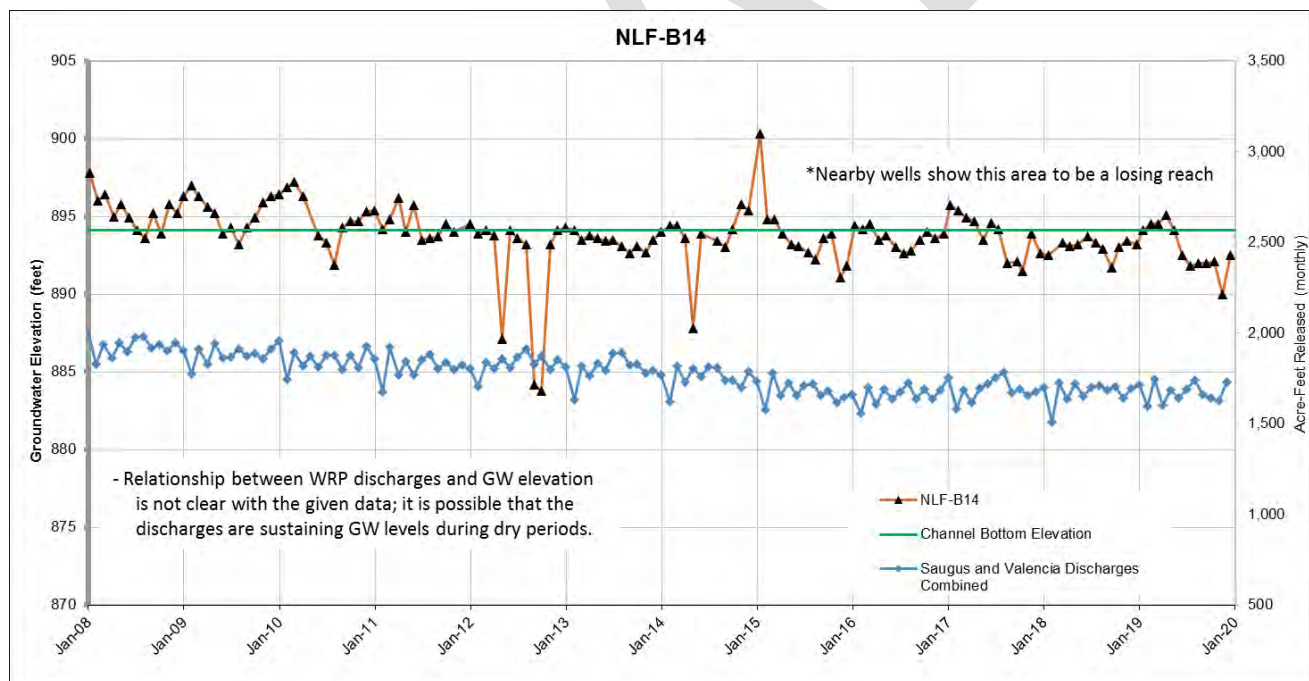


Figure 6A – NLF-B14 GWE and Combined WRP Discharges

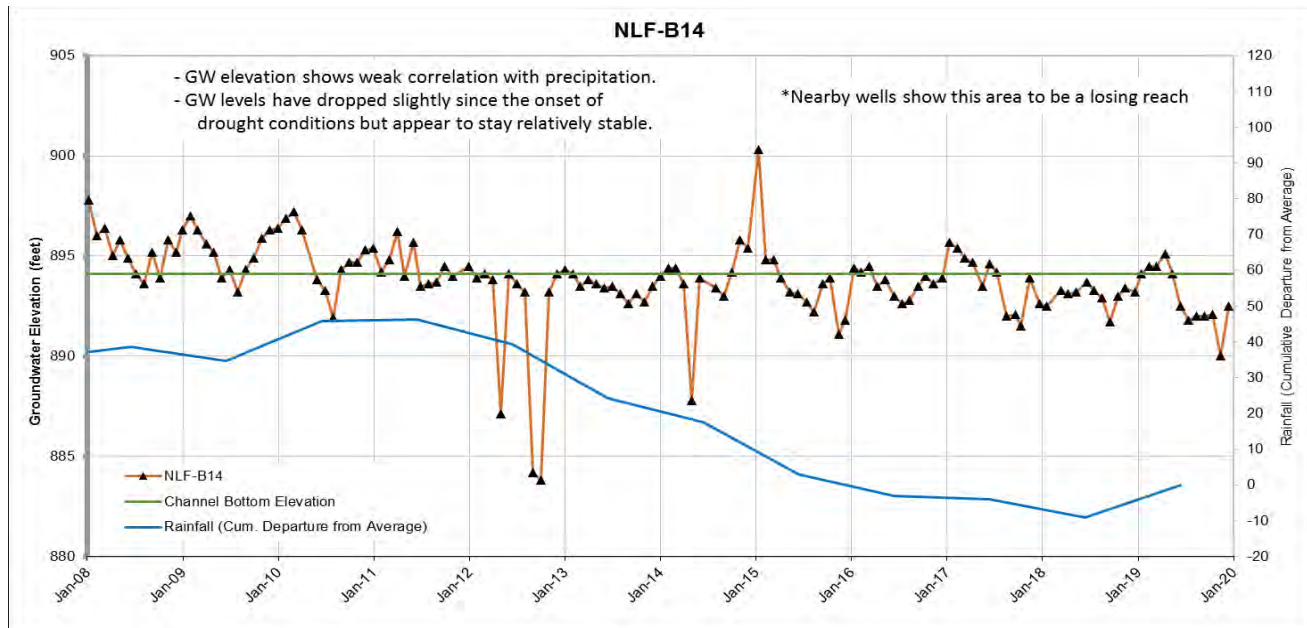


Figure 6B – NLF-B14 GWE and Cumulative Departure from Average Rainfall

Groundwater elevations in NLF-B14, located 1.5 miles downstream from NLF-C4, cannot be easily correlated with WRP discharges due to lack of variability in WRP discharges (Figure 6A) or with precipitation trends (Figure 6B), which is consistent with evaluations that were done during groundwater model calibration. Groundwater levels have remained constant through the drought (unlike wells located to the east). The NLF-B14 hydrographs show groundwater levels are relatively stable and are at or above the thalweg during most periods, the groundwater model shows this part of the river is gaining and thus, the authors infer this area to be primarily a gaining reach. However, other nearby wells (B-10 and B-20, screened shallower; see Attachment A) show groundwater levels between 2 and 5 feet below the thalweg, indicating potentially losing conditions while the groundwater model shows that this part of the river is gaining. This inconsistency may be due to the fact that the wells are screened at different depths, or may be the result of uncertainties in the water level data set (such as elevation survey control and/or pumping influences on water level measurements). In the author's extensive experience studying this area, we believe discharge from the Saugus Formation into the alluvium is the biggest reason for the observed stability. It is important to note too that the Saugus Aquifer water elevations tend to change more slowly than the alluvial aquifer water elevations. That is, flow out of the Saugus Formation is very likely not affected much at all by hydrologic cycles or (certainly) WRP flows. Additionally, both the measured data sets and the groundwater model both show short-term and long-term stability (e.g., no apparent trends). Based on the location along the river, water levels observed at NLF-B14, proximity to where the Saugus Formation pinches out against the low permeability Pico Formation, and conceptual model understanding supported by ongoing modeling work, the authors infer that the river in this area is primarily a gaining reach.

Well NLF-B11/11A

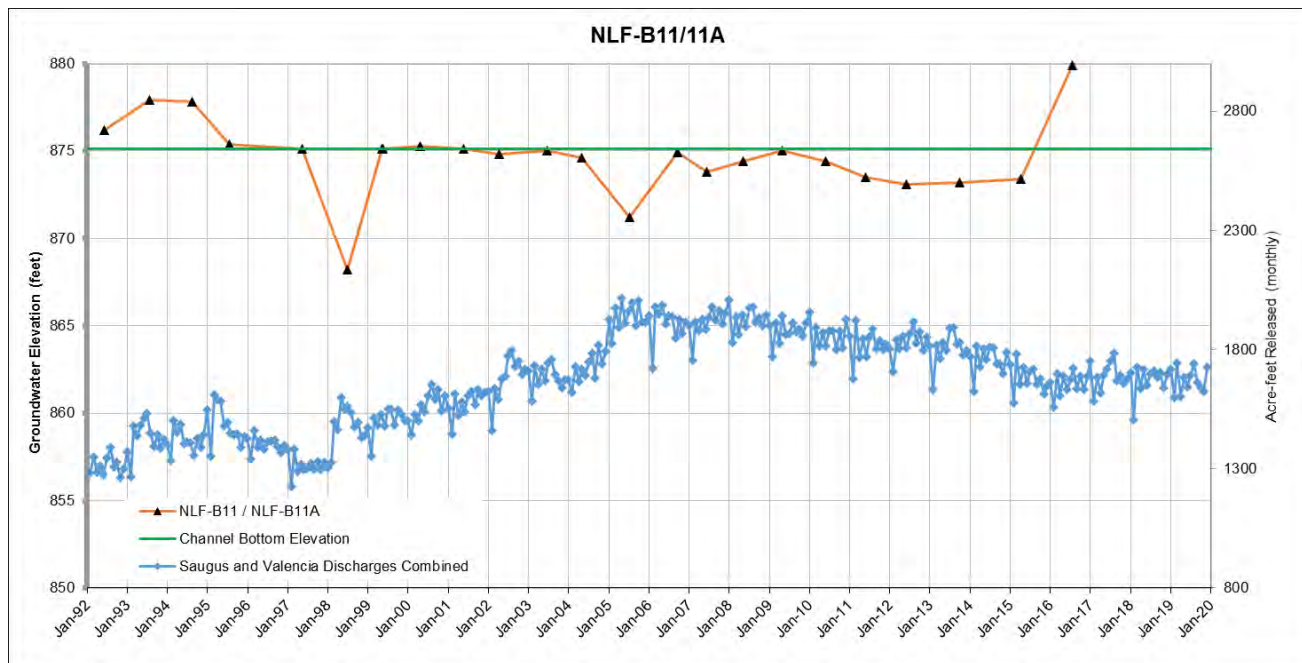


Figure 7A – NLF-B11/11A GWE and Combined WRP Discharges

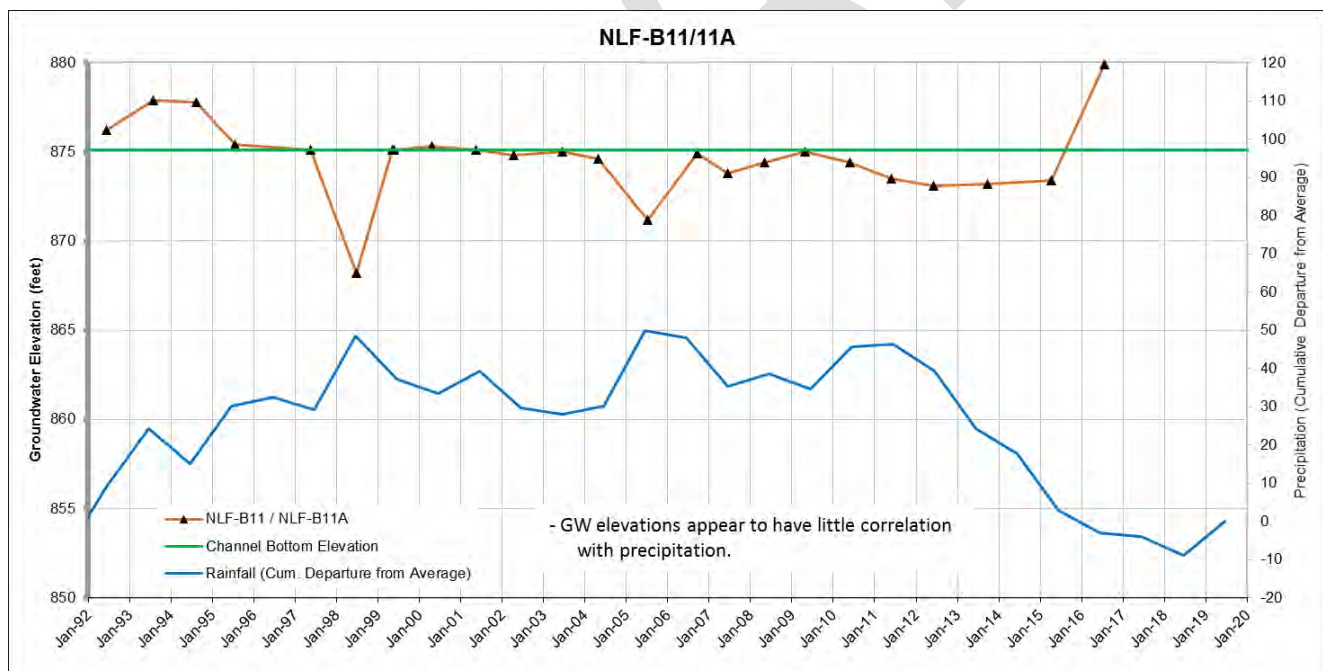


Figure 7B – NLF-B11/11A GWE and Cumulative Departure from Average Rainfall

Groundwater elevations in NLF-B11/11A, located between the mouth of Potrero Canyon and NLF-B14, do not correlate well with WRP discharges (Figure 7A) or precipitation (Figure 7B). There are indications that some readings are either affected by nearby pumping or that the water level measurement was not truly representing static conditions (see 1998 and 2005). The annual groundwater elevation readings do not

show much detail, but it seems that groundwater levels have remained very stable during the period of record in this location. The authors believe this is because the Saugus Formation is believed to discharge to the alluvium upstream of NLF-B11/11A, providing additional recharge to the alluvium that results in stable groundwater levels at in much of the western end portion of the groundwater Basin. Downstream of this well location, the alluvium is underlain by the low-permeability Pico Formation, which is considered to be non-water bearing. As a result, there is no additional upward flow coming from the Saugus Formation, and groundwater resides within the alluvium or discharges to the river, depending upon whether climatic conditions are wet, dry, or normal. The deepest historically measured groundwater levels at well NLF-B11 were often no more than 5 feet below the thalweg, and often within 1 foot of the thalweg in this area. The authors believe that the river is transitioning from generally gaining to generally losing in this general area.

Well 4N18W27B

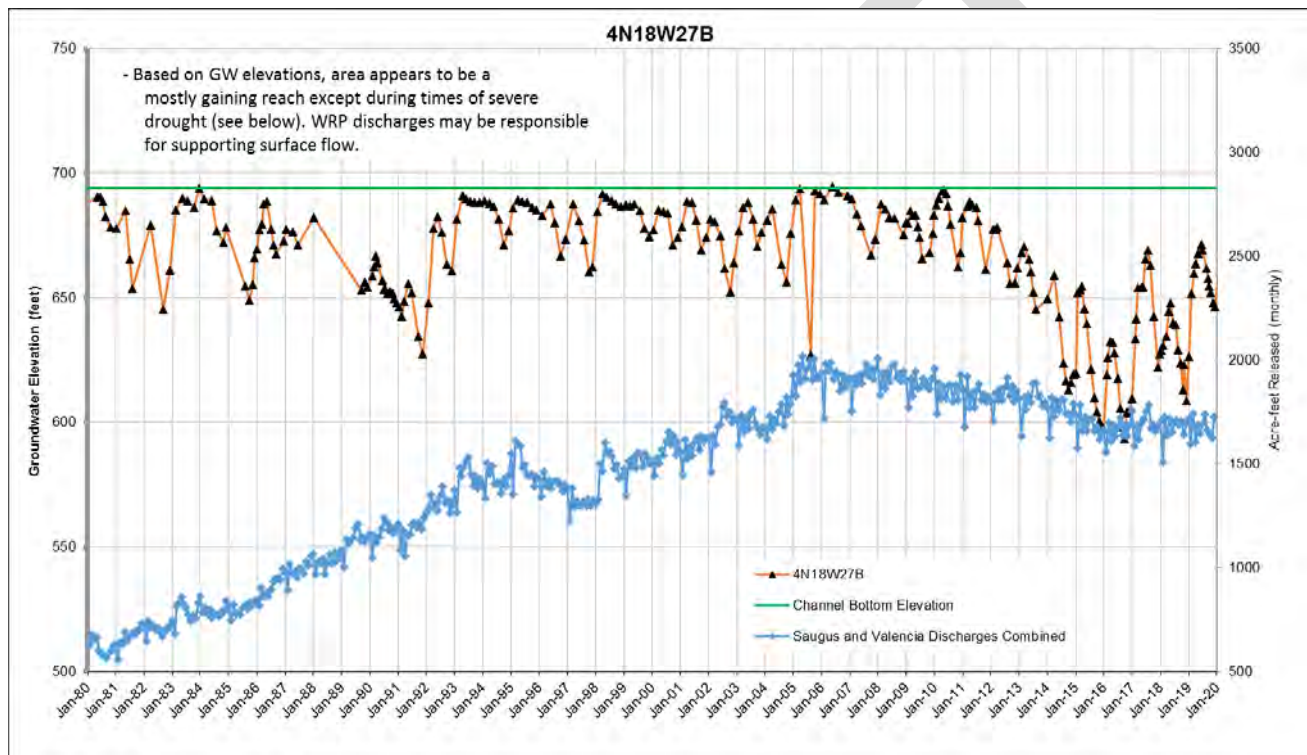


Figure 8A – 4N18W27B GWE and Combined WRP Effluent

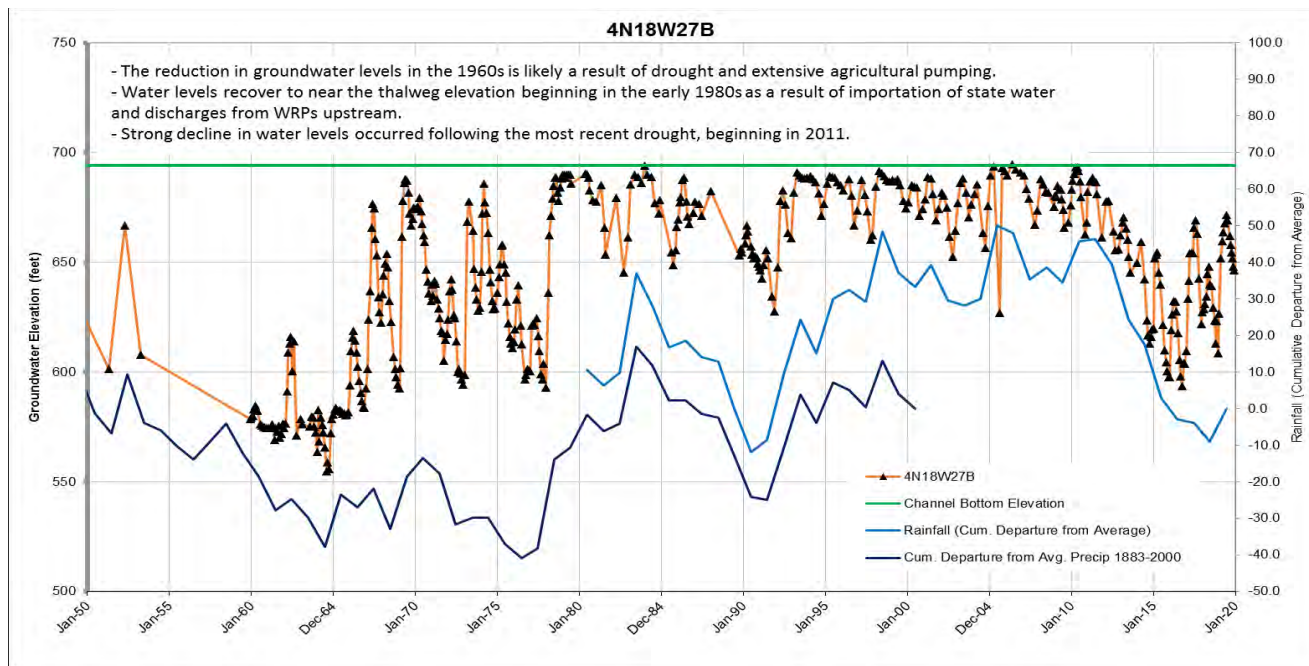


Figure 8B – 4N18W27B GWE and Cumulative Departure from Average Rainfall

Well 4N18W27B, located west of the Basin and just west of the Piru Dry Gap, is the westernmost and furthest downstream well in the study. Groundwater elevations at Well 4N18W27B correlate very well with precipitation trends since the late 1970s, but appear to differ from precipitation trends from the mid-1960s through the mid to late 1970s (Figure 8B). Low groundwater levels observed in the 1960s (Figure 8A) are likely a result of a prolonged drought beginning in the 1940s and extensive agricultural pumping that is known to have occurred through the 1960s. Water levels recover to near the thalweg elevation beginning in the late 1960s as a result of discharges from the Saugus and Valencia WRPs upstream as well as increasing generally normal precipitation (as seen by the lack of a slope in the rainfall cumulative departure curve). Water levels declined significantly during the most recent drought beginning in 2011. Water levels have recovered substantially since the end of the drought in 2016, but not quite to pre-drought levels. As shown in Figure 8B, it is likely that importation of water upstream and discharges from the WRPs have caused average groundwater elevations in this area to rise significantly since the late 1960s.

Well 4N18W27B appears to be located at a point that is likely where the alluvium has just started to thicken substantially (i.e., the well is just downstream of where the Piru Dry Gap begins). The river at this location appears to be losing during the summer and during drought conditions, partly because the alluvium is thickening as expected (which is why there is a dry gap).

5.1.1 Effects of Precipitation, WRP Discharges, and Basin Pumping on River Flows

On the basis of available river gage data, it is believed that the WRP flows and the groundwater discharges from the Alluvial Aquifer to the river in Los Angeles County are providing a base flow to the river as it moves through the Basin and out of the Blue Cut area into Ventura County. As shown on Figures 9A, 9B, and 9C, surface water flow measured at the County Line gage during non-storm events has steadily increased since the late 1970s. This increase appears to be unrelated to rainfall trends (see Figure 9A) and more likely related to increased urbanization in the Basin that has resulted in importation of state water and discharge of treated water from the WRPs into the river (see Figure 9B). As shown in Figure 9C, pumping of the Alluvial and Saugus Aquifers in the Basin appears to have had little effect on river flows.

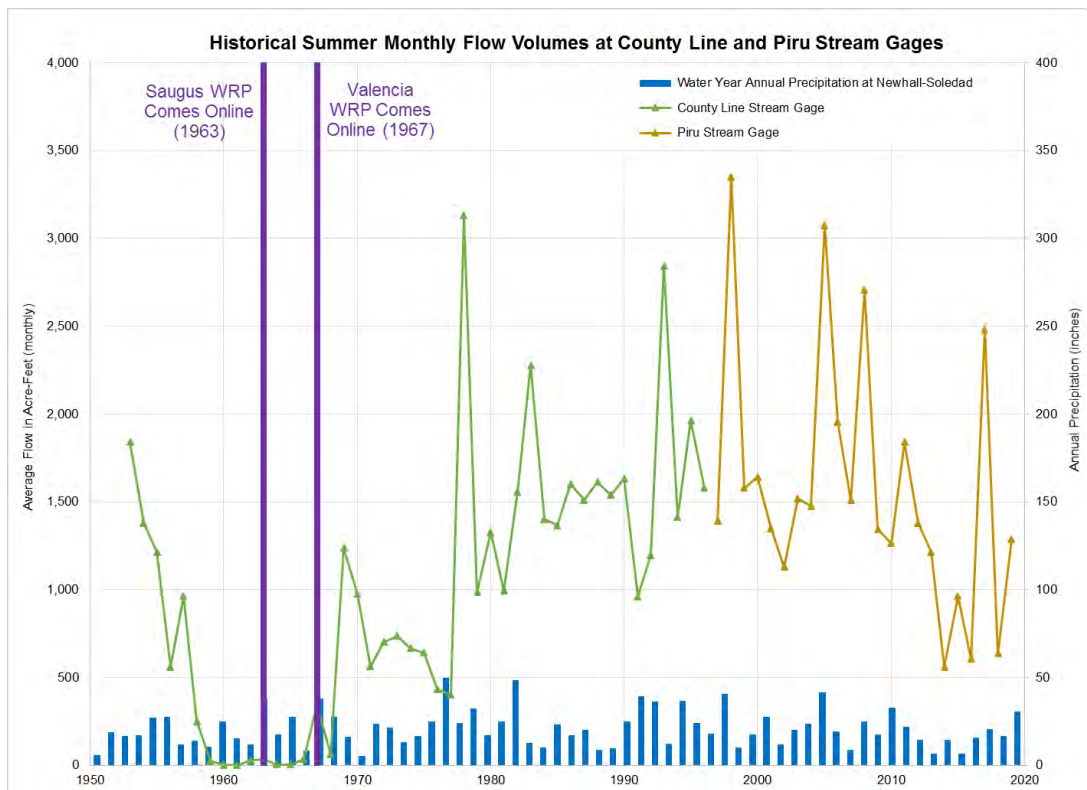


Figure 9A – Santa Clara River Flow at County Line Gage and Precipitation

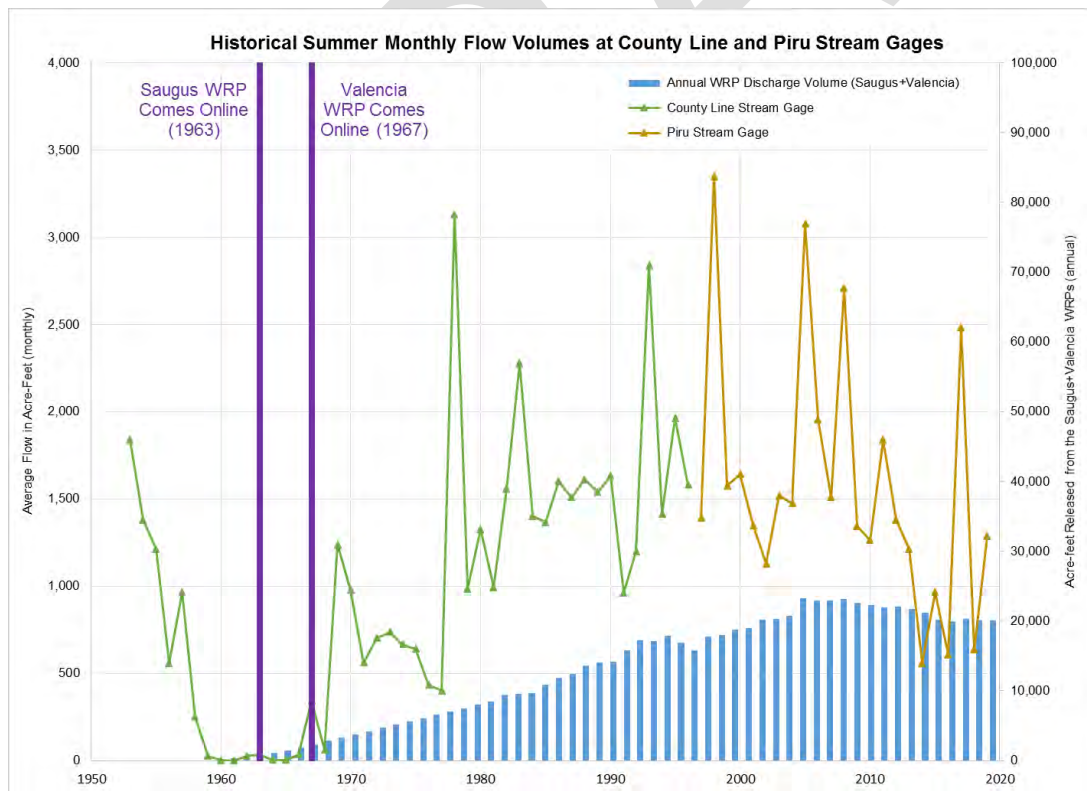


Figure 9B – Santa Clara River Flow at County Line Gage and WRP Discharges

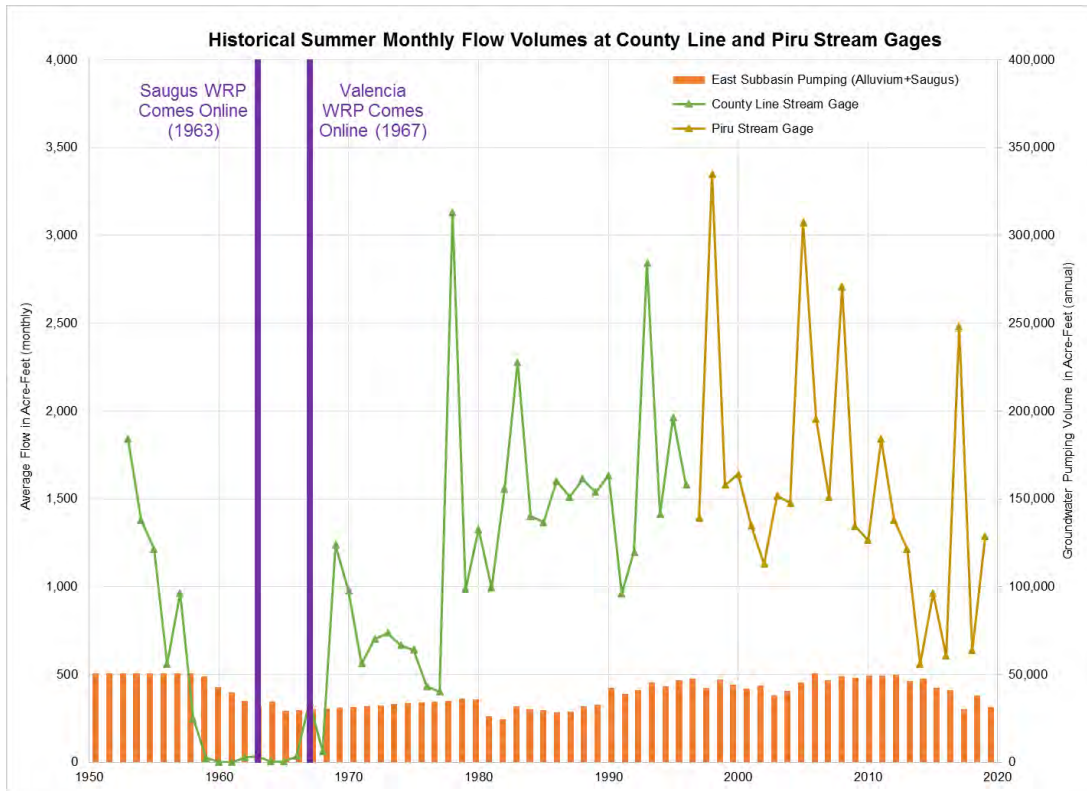


Figure 9C – Santa Clara River Flow at County Line Gage and Total Basin Pumping

5.1.2 Extent of Gaining and Losing Reaches

Findings from the hydrograph analysis were used to create three separate maps that indicate the nature of surface water and groundwater exchanges along the Santa Clara River during wet, normal, and dry climatic conditions. Each map identifies six unique reaches in the study area and shows where groundwater levels are vertically positioned relative to the river thalweg during a given climatic condition. Reaches were defined by a combination of factors including the water level response in nearby wells, geological conditions such as thinning of the surficial alluvium, visual observations, and preliminary results from the groundwater model. This information can be used to provide an indication of where the river is potentially gaining or losing. It is important to note that there are limitations associated with the data sets used in this analysis (refer to Section 4); interpretation of the results considered those limitations.

5.1.2.1 Wet Conditions

Figure 10 illustrates the potentially gaining and losing reaches of the river during periods of increased precipitation (wet conditions), using data from 1991 to 1993, 2005, and 2017 to 2019. Though some wells do not have groundwater elevation data during these intervals, groundwater levels may be estimated based on the elevation trends during other periods.

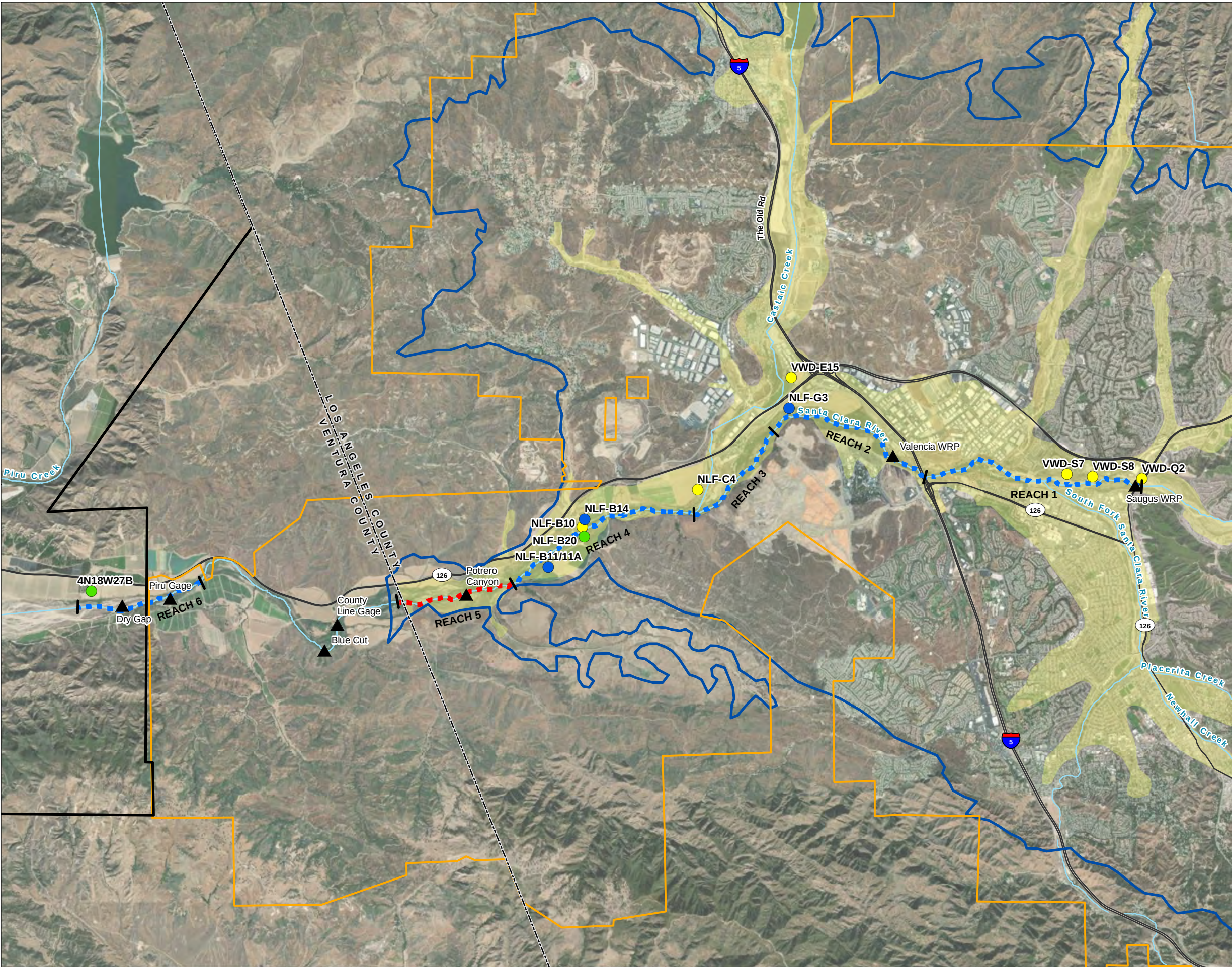


FIGURE 10

Gaining and Losing Reaches of the Santa Clara River During Wet Conditions

Santa Clara River Valley Groundwater Basin, East Subbasin

DRAFT

LEGEND

Potentially Gaining Reach

Potentially Losing Reach

Key Well Depth to Water (ft)

0 - 1

1 - 5

5 - 15

15 - 30

> 30

All Other Features

Point of Interest

Alluvium

Service Area Boundary for SCV Water

UWCD Boundary

Santa Clara River Valley Groundwater Basin, East Subbasin

County Boundary

Major Road

Watercourse

NOTE:

SCV Water: Santa Clarita Valley Water Agency

UWCD: United Water Conservation District

N

0 3,000 6,000 9,000

Feet

Date: July 14, 2020

Data Sources: USGS, Maxar Imagery 2019, DWR Bulletin 118

- Reach 1** **Potentially Gaining** – Increased precipitation brought seasonal groundwater levels to near the thalweg during wet periods. Gaining conditions in this reach would likely only occur during the winter months of wet years, except for the short section of river east of the I-5 bridge, where groundwater upwelling has been observed even in drought conditions (see Section 5.1). This upwelling appears to be a result of thinning of the alluvium at this location.
- Reach 2** **Potentially Gaining** – Groundwater levels were consistently above the thalweg until 2 years after the onset of the drought in 2011, as indicated by groundwater level data at well NLF-G3.
- Reach 3** **Potentially Gaining** – Groundwater levels downstream of the confluence with Castaic Creek are likely close to the thalweg; however, there is a lack of reliable data in this reach.
- Reach 4** **Potentially Gaining** – The water level data in this reach are too uncertain to provide a clear indication of gaining or losing conditions. However, each well in this area (including well B-11 and NLF-B14) shows relatively steady groundwater levels throughout the decades, with little difference in wet to normal to dry years. This stability is unlike what is observed east of I-5 or in the Castaic Valley north of the river corridor. This remarkable stability is likely reflective of WRP flow contributions to the river from upstream plus the discharge of groundwater from the underlying Saugus Formation into the alluvium (which then discharges this water into the river throughout this reach).
- Reach 5** **Potentially Losing** – There is a lack of long-term groundwater elevation data in this reach; however, in 2007, geophysical surveys and exploratory borings at the mouth of Potrero Canyon and at the County Line indicated that the water table is near ground surface at the mouth of Potrero Canyon but approximately 20 feet deep at the County Line, suggesting that the river could be gaining upstream of Potrero Canyon and likely losing downstream of Potrero Canyon (in the lower half of Reach 5). Results from the groundwater model (that includes thinning of the alluvium and streamflow records at the former County Line stream gage) also support this interpretation. In this reach, the alluvium overlies the low-permeability Pico Formation, which does not contain a significant groundwater resource and therefore does not substantially recharge the alluvium or the river, as does occur further upstream where the Saugus Formation is present beneath the alluvium.
- Reach 6** **Potentially Gaining** – Beginning in the late 1960s, periods of heavy precipitation coupled with WRP discharges to the river upstream have raised the groundwater elevation in 4N18W27B nearly to the thalweg during wet periods. On occasion, the data suggest that groundwater levels might even briefly rise above the thalweg elevation. The river corridor widens and becomes devoid of riparian vegetation just downstream of 4N18W27B; therefore, it is highly likely that a much more prevalent losing reach begins just west of this well.

5.1.2.2 Normal Conditions

Figure 11 illustrates the gaining and losing reaches of the river during periods of average precipitation (normal conditions), using data from 2008 to 2011.

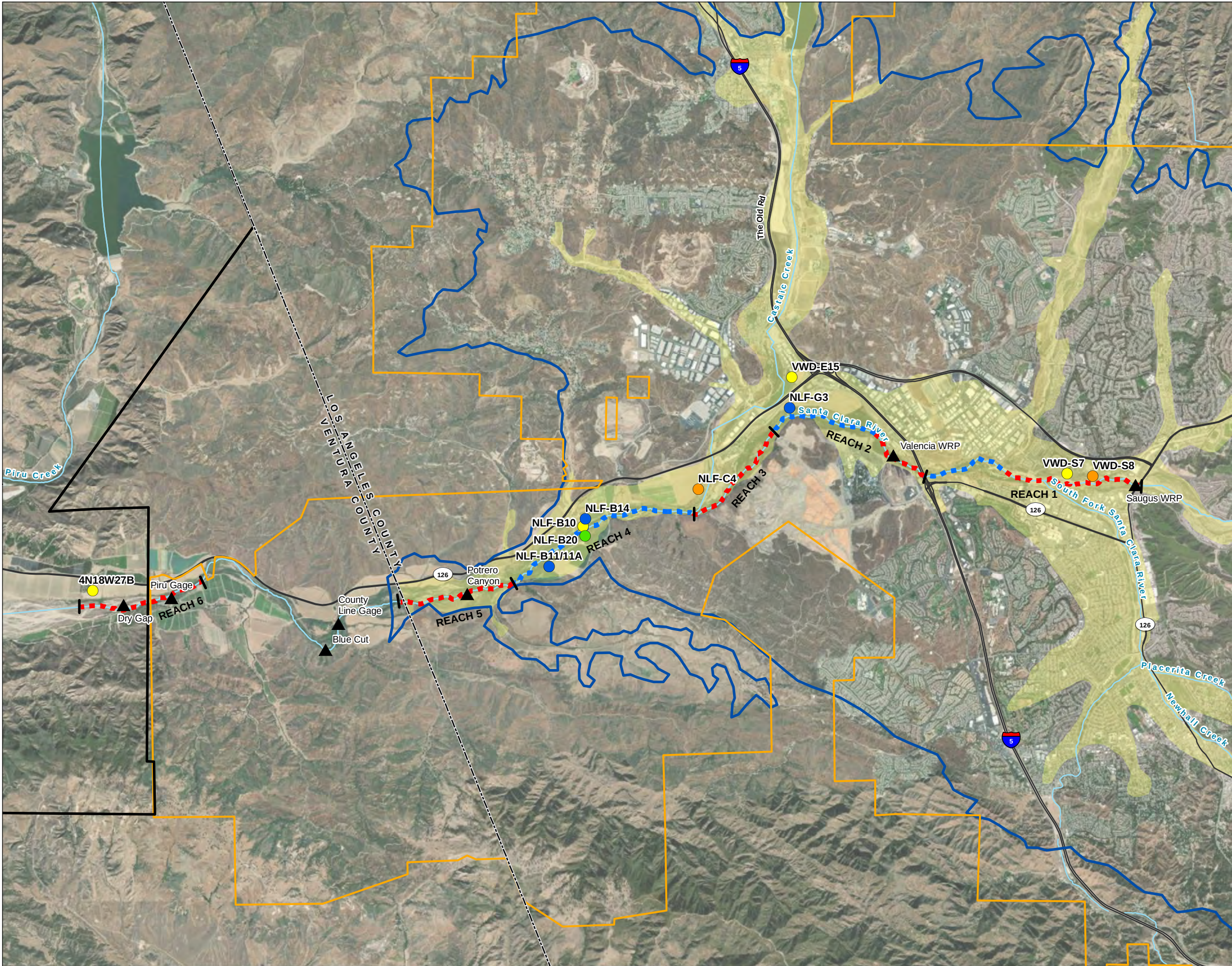


FIGURE 11
Gaining and Losing Reaches
of the Santa Clara River
During Normal Conditions

Santa Clara River Valley
Groundwater Basin,
East Subbasin

DRAFT

LEGEND

- Potentially Gaining Reach
- Potentially Losing Reach

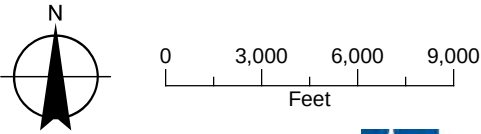
Key Well Depth to Water (ft)

- 0 - 1
- 1 - 5
- 5 - 15
- 15 - 30
- > 30

All Other Features

- Point of Interest
- Alluvium
- Service Area Boundary for SCV Water
- UWCD Boundary
- Santa Clara River Valley Groundwater Basin, East Subbasin
- County Boundary
- Major Road
- Watercourse

NOTE:
SCV Water: Santa Clarita Valley Water Agency
UWCD: United Water Conservation District



Date: July 14, 2020
Data Sources: USGS, Maxar Imagery 2019,
DWR Bulletin 118



- Reach 1** **Potentially Losing / Potentially Gaining** – Groundwater levels are consistently below the channel bottom, except in the section of river just east of the I-5 bridge, where groundwater upwelling has been visually observed even in drought conditions.
- Reach 2** **Potentially Losing / Potentially Gaining** – Groundwater levels in NLF-G3 are consistently above the channel bottom until 2 years after the onset of the drought in 2011, indicating potentially gaining conditions in the western portion of Reach 2. Preliminary groundwater modeling results indicate that the eastern portion of Reach 2 is potentially losing, until a point downstream of the Valencia WRP where the river turns westward. This may be a result of changing aquifer thickness. Groundwater levels in well NLF-G3 are consistently above the channel bottom until 2 years after the onset of the drought in 2011, indicating potentially gaining conditions in the western portion of Reach 2.
- Reach 3** **Potentially Losing** – Groundwater levels are well below the thalweg elevation in NLF-C4; however, the authors believe that the reference level elevation is not accurate at this location. The river is assumed to be potentially losing upstream of the confluence with Castaic Creek.
- Reach 4** **Potentially Gaining** – The portion of river directly downstream of the confluence with Castaic Creek would likely be gaining. Further downstream, the hydrographs for multiple wells in this area do not consistently show this reach to be gaining; however, well NLF-B14 shows groundwater levels at or above the thalweg. The wells in this area have differing screen depths and the thickness of the alluvium in this area may vary, causing local highs or lows in groundwater level. The reference point elevations of the wellheads may also be erroneous. NLF-B14 shows relatively steady groundwater levels at or above the channel bottom elevation at all times that likely reflect discharge of Saugus groundwater into the alluvium in this reach.
- Reach 5** **Potentially Losing** – See the discussion in Section 5.1.2.1 for wet years, which identifies that the river is likely losing in the lower half of Reach 5, but may be either gaining or losing in the upper half of Reach 5. Groundwater modeling results and the field-observed stability of groundwater elevations at the well furthest downstream (NLF-B11) suggest that the gaining/losing characteristics of the river during wet years are likely also occurring during years of normal rainfall. The river resides in a relatively thin layer of alluvium that overlies the low-permeability Pico Formation; therefore, it is likely that this region is losing.
- Reach 6** **Potentially Losing** – Beginning in the late 1960s, periods of heavy precipitation coupled with WRP discharges to the river upstream have raised the groundwater elevation in 4N18W27B nearly to the thalweg for prolonged periods of time. On occasion, the data suggest that groundwater levels might even briefly rise above the channel invert elevation. The river corridor widens and becomes devoid of riparian vegetation just downstream of 4N18W27B, so it is highly likely that a much more prevalent losing reach begins just west of this well.

5.1.2.3 Dry Conditions

Figure 12 illustrates the gaining and losing reaches of the river during periods of below-average precipitation (dry conditions), using data from 2012 to 2016.

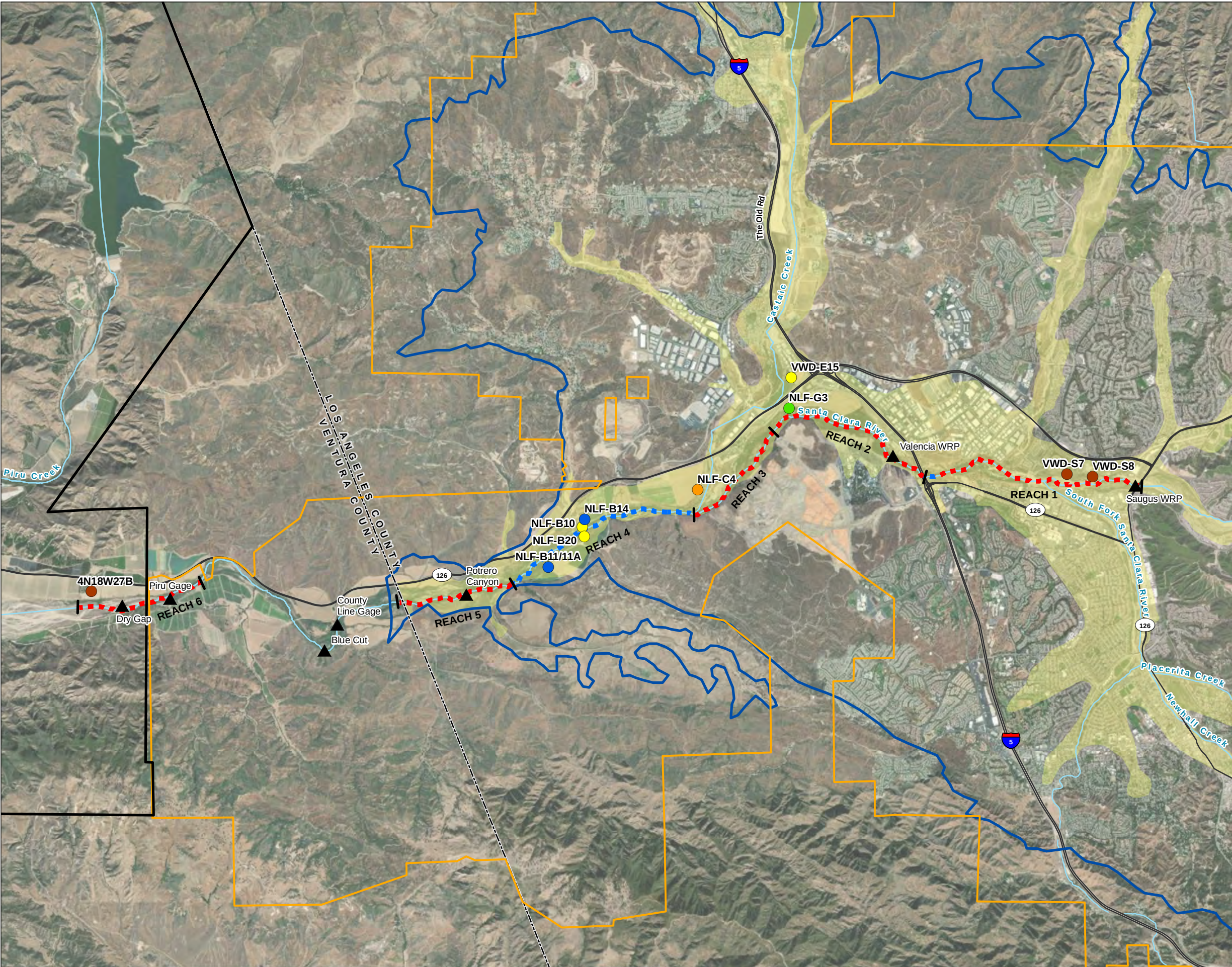


FIGURE 12

Gaining and Losing Reaches of the Santa Clara River During Dry Conditions

Santa Clara River Valley Groundwater Basin, East Subbasin

DRAFT

LEGEND

Potentially Gaining Reach

Potentially Losing Reach

Key Well Depth to Water (ft)

- 0 - 1
- 1 - 5
- 5 - 15
- 15 - 30
- > 30

All Other Features

- Point of Interest
- Alluvium
- Service Area Boundary for SCV Water
- UWCD Boundary
- Santa Clara River Valley Groundwater Basin, East Subbasin
- County Boundary
- Major Road
- Watercourse

NOTE:

SCV Water: Santa Clara Valley Water Agency

UWCD: United Water Conservation District

N

0 3,000 6,000 9,000

Feet

Date: July 14, 2020

Data Sources: USGS, Maxar Imagery 2019, DWR Bulletin 118

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- Reach 1** **Potentially Losing** – Groundwater levels are consistently below the channel bottom. However, in 2016, during the recent drought, lateral seepage of alluvial groundwater (springs) were observed to be still present beneath the I-5 bridge in the western portion of this reach, creating small pools at the base of steeply sloping ground surface topography and coinciding with an area where the alluvium is very thin (along the south side of Round Mountain). These pools were observed to transition into a small, distinct flowing channel starting at the Old Road Bridge.
- Reach 2** **Potentially Losing** – Groundwater levels slowly declined as drought conditions starting in 2011 progressed and eventually fell below the channel bottom elevation in the summer of 2013. Prolonged drought is likely to render this length of river a losing reach, even with regular discharges from the WRPs.
- Reach 3** **Potentially Losing** – The river appears to be losing throughout this reach. During the last drought, there were fewer releases from Castaic Reservoir and as a result, groundwater levels declined in NLF-C4 by 5 feet to 10 feet.
- Reach 4** **Potentially Gaining** – The hydrographs for multiple wells in this area do not consistently show this reach to be gaining; however, well NLF-B14 shows groundwater levels at or above the thalweg during the last drought from 2011 to 2016. The wells in this area have differing screen depths and the thickness of the alluvium in this area may vary, causing local highs or lows in groundwater level. The estimated reference point elevations of the wellheads may also be erroneous. NLF-B14 shows relatively steady groundwater levels at or above the channel bottom elevation during drought conditions that likely reflects discharge of Saugus groundwater into the alluvium in this reach.
- Reach 5** **Potentially Losing** – Because of a lack of data in this reach, it is not known whether the river is gaining or losing; however, the river resides in a relatively thin layer of alluvium that overlies the low-permeability Pico Formation; therefore, it is likely that during low rainfall periods, this region of the river is losing.
- Reach 6** **Potentially Losing** – Water levels in 4N18W27B have fallen steadily and dramatically below the thalweg since the onset of the drought in 2011, to depths of as much as 100 feet below ground surface during 2015. Other below-average rainfall periods also show this reach to be potentially losing.

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SECTION 6: References

Luhdorff and Scalmanini Consulting Engineers (LSCE, 2020), Santa Clara River Valley East Subbasin Hydrogeological Conceptual Model (HCM): Groundwater Conditions Report. Prepared as part of the Groundwater Sustainability Plan Development project for SCV Water.

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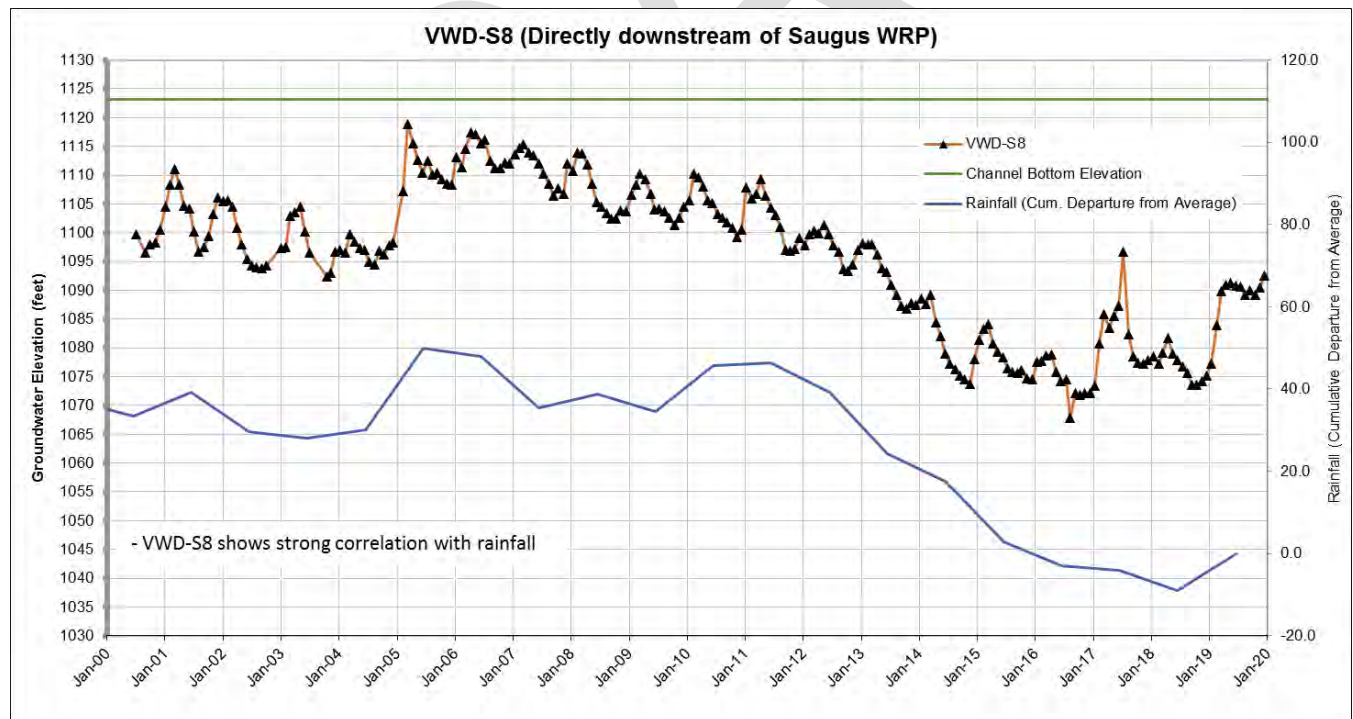
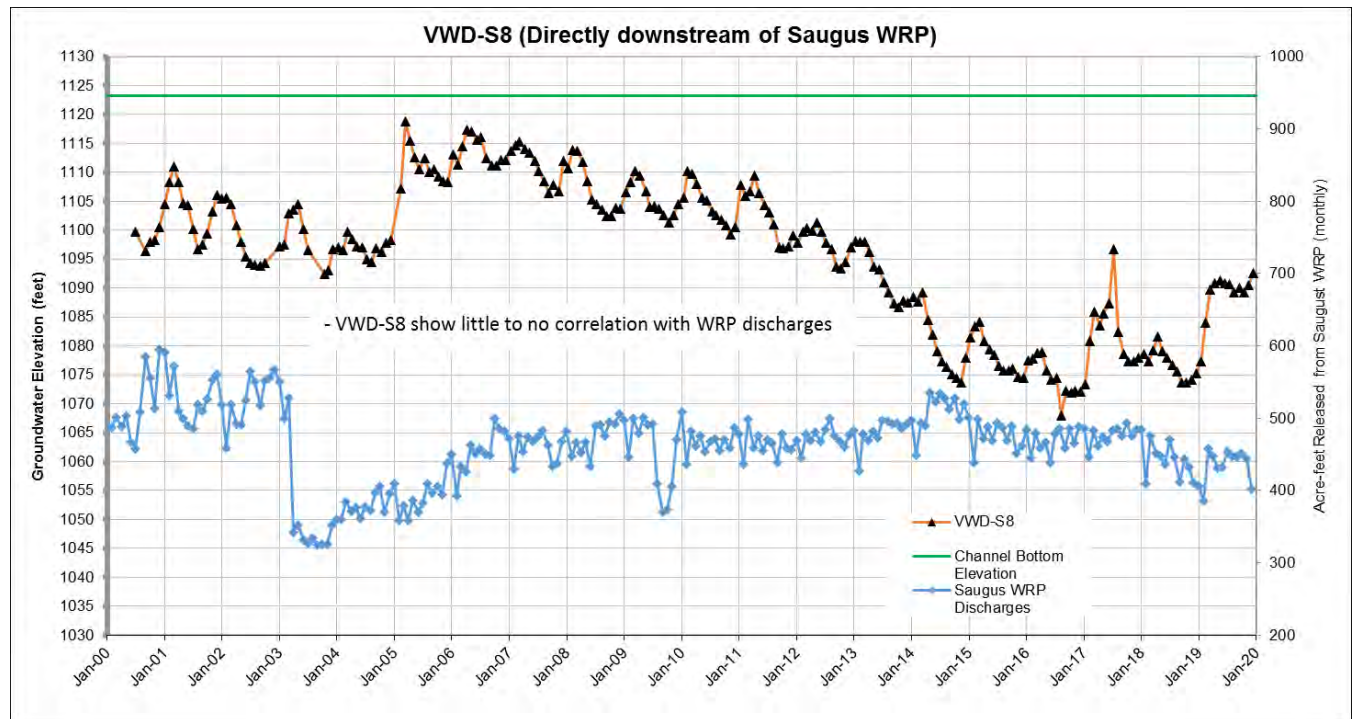
ATTACHMENT A

Additional Hydrographs

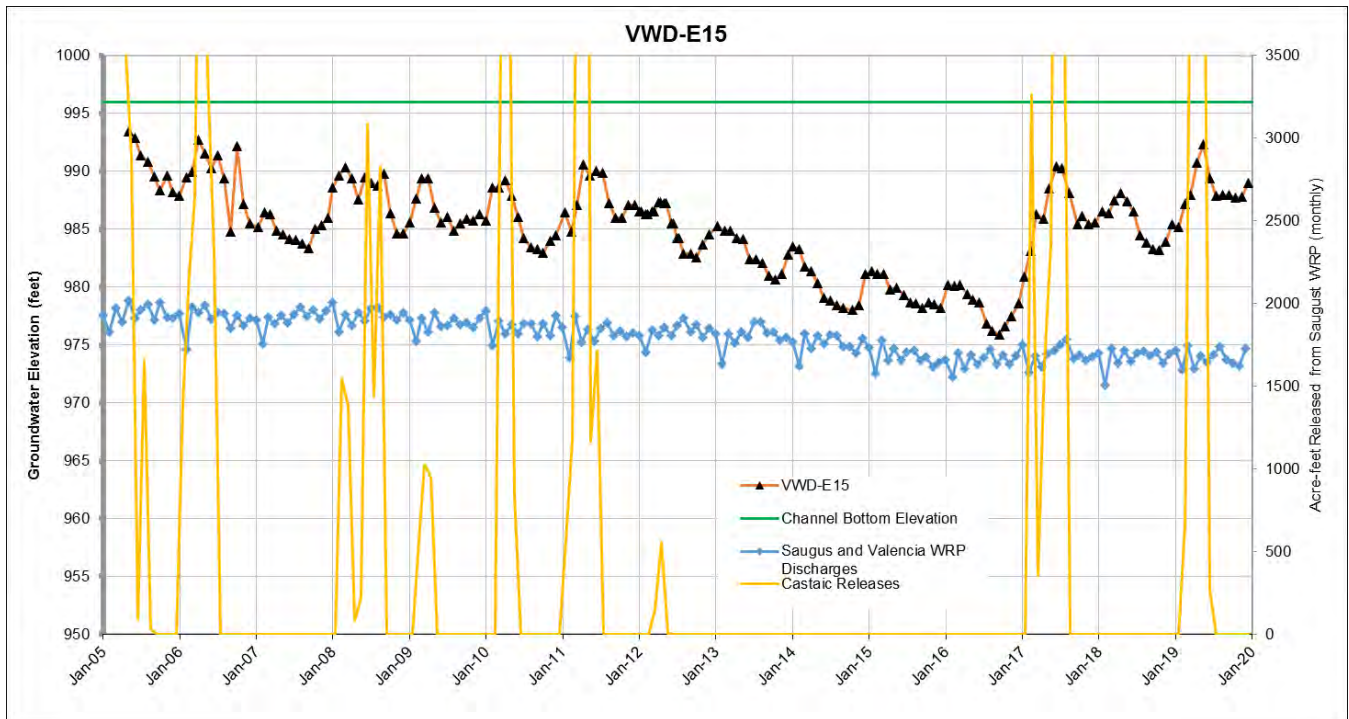
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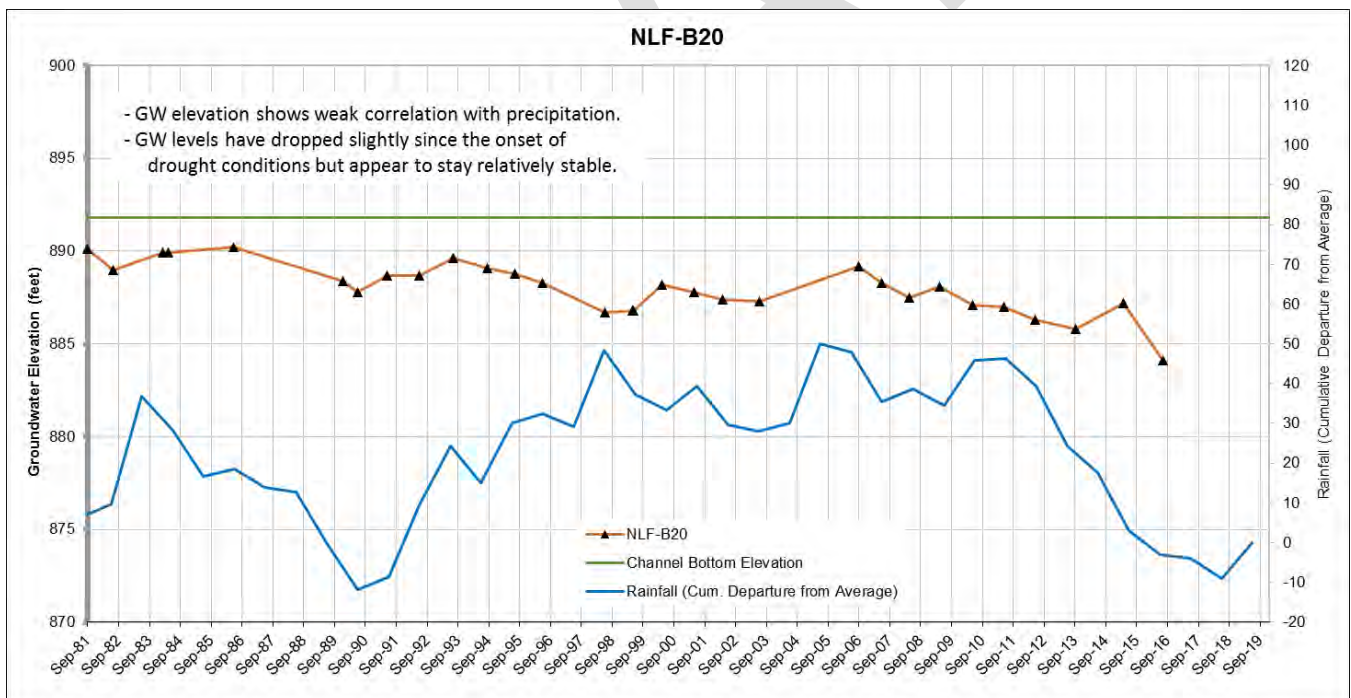
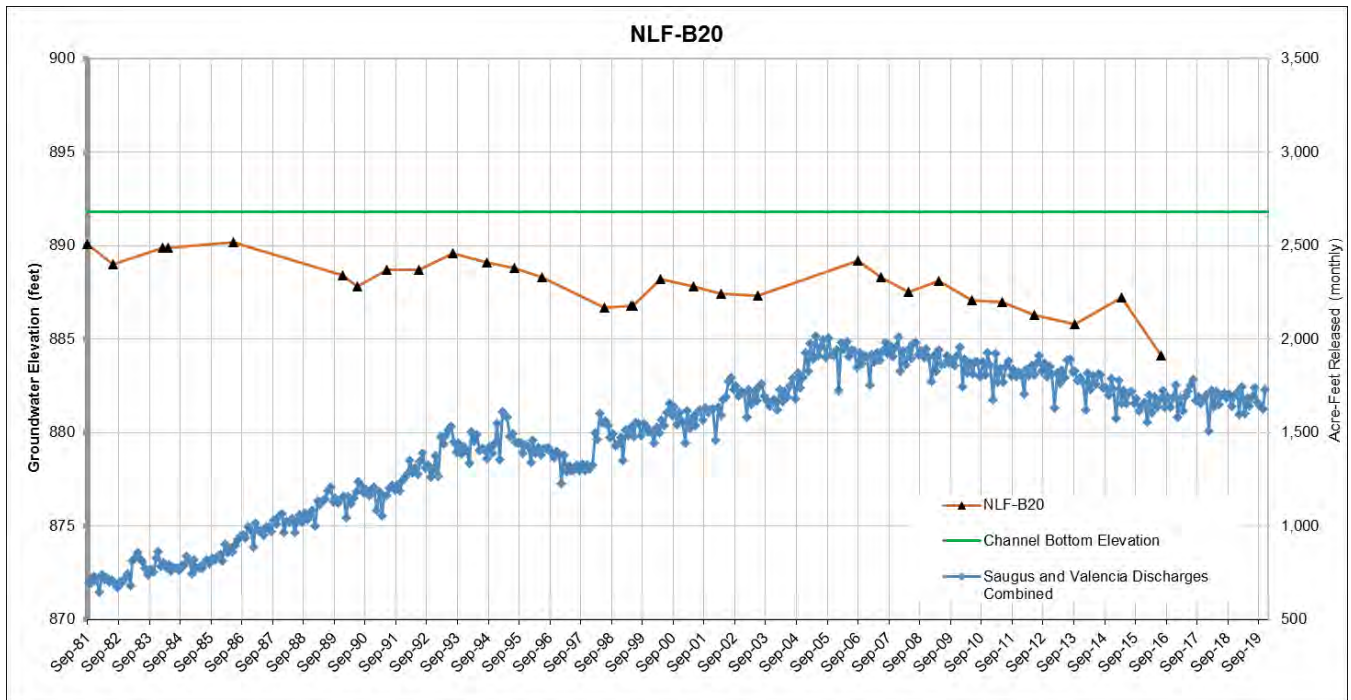
Well VWD-S8



Well VWD-E15



Well NLF-B20



Well NLF-B10

