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Pacheco Creek Restoration Project
Final Feasibility Study

Project #4291-01

Prepared for:

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August 10, 2020

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Section 1. Introduction

1.1 Feasibility Study Purpose and Location

This report presents the methods and findings of the H. T. Harvey & Associates (H. T. Harvey) Team's Pacheco Creek Restoration Project Feasibility Study (feasibility study) conducted for the Santa Clara Valley Habitat Agency's (Habitat Agency) Pacheco Creek Restoration Project. The project is located in the inner coastal range in the southeastern portion of the Santa Clara Valley Habitat Plan (Habitat Plan) permit area (Figure 1). The project study area includes three properties: Pacheco Creek Reserve (owned by the Habitat Agency), Bureau of Reclamation (BOR) property, and the Ciraulo property (recently acquired by the Habitat Agency). Figure 2 shows the boundary of the feasibility study area (referred to herein as the site or study area), which includes the entirety of the two Pacheco Creek Reserve parcels and portions of the BOR and Ciraulo properties.

The Habitat Agency is responsible for implementing the Santa Clara Valley Habitat Plan (Habitat Plan) (ICF International 2012). The Habitat Plan requires the restoration of a range of sensitive habitat types to mitigate development impacts within its service area. The Habitat Agency is also responsible for implementing the U.S. Army Corps of Engineers Regional General Permit #18 and the Interim Mitigation Strategy and Notification and Program Management Process associated with the U.S. Army Corps of Engineers Regional General Permit #18. The purpose of the feasibility study is to identify a suite of feasible habitat preservation, enhancement, restoration, and creation needs and opportunities within the study area that could be developed into one or more projects to generate mitigation credits for the Habitat Agency. This study also describes physical process restoration opportunities to enhance desirable natural processes (e.g., floodplain connectivity, channel dynamism) and habitat conditions.

1.2 Preliminary Restoration Goals

At the start of this feasibility study, the Habitat Agency and the H. T. Harvey team (consisting of H. T. Harvey, cbec eco engineering [cbec], San Francisco Estuary Institute [SFEI], and ICF International [ICF]) identified the following preliminary restoration goals. The H. T. Harvey team sought to identify feasible restoration opportunities that would meet as many of these preliminary goals as possible within the study area. Following the feasibility study, the Habitat Agency and partners will craft a specific restoration project and customize restoration goals to fit the specific project.

- Preserve, enhance, and/or restore Central California sycamore alluvial woodland (SAW). Increase the abundance (through natural regeneration and active revegetation) and fitness of California sycamores (*Platanus racemosa*).
- Preserve, enhance, and/or restore riparian habitat suitable for the state and federally endangered least Bell's vireo (*Vireo bellii pusillus*) which is a Habitat Plan covered species; these actions would also benefit

California Department of Fish and Wildlife (CDFW) species of concern such as the yellow warbler (*Setophaga petechia*) and yellow-breasted chat (*Icteria virens*), as well as other riparian bird species.

- Preserve, enhance, and/or restore in-stream aquatic habitat and floodplain habitat for the federally threatened South Central California Coast (SCCC) steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS).
- Enhance riverine habitat for the federally threatened California red-legged frog (*Rana draytonii*) and CDFW species of concern western pond turtle (*Actinemys marmorata*), which are both Habitat Plan covered species. This enhancement could include the creation or restoration of in-stream scour pools for aquatic wildlife refugia in dry months.
- Enhance off-channel pond habitat for the California red-legged frog and western pond turtle.
- Create or restore off-channel perennial and seasonal freshwater wetlands, including suitable nesting habitat for the state threatened tricolored blackbird (*Agelaius tricolor*), a Habitat Plan covered species.
- Enhance physical processes and dynamism by removing impediments to natural processes or implementing measures that augment, accelerate, and/or amplify natural riverine processes such as floodplain connectivity and groundwater recharge.
- Improve on-site and downstream water quality.
- Accommodate and protect the Habitat Agency's existing site infrastructure (e.g., small parking area, irrigation well) and provide a low-impact creek crossing for Habitat Agency personnel to access the southeast side of Pacheco Creek for site monitoring, maintenance, and management activities.
- Consider climate change in the restoration design.

1.3 Feasibility Study Approach

The H. T. Harvey team identified a suite of feasible restoration opportunities that would meet as many of the above preliminary restoration goals as possible within the study area. We also identified possible constraints that could substantially affect future restoration project design (e.g., existing infrastructure, cultural resources). We identified the preliminary restoration opportunities based upon the following:

- H. T. Harvey ecologists and SFEI leveraged our prior work on the site's historical and SAW ecology, and we reviewed existing relevant information on the biotic and abiotic conditions.
- The H. T. Harvey team conducted several field reconnaissance surveys of the study area.
- cbec's hydrologists and fluvial geomorphologists conducted a hydrologic analysis and geomorphic assessment of the study area and a reconnaissance-level assessment of the broader watershed. This assessment was informed by installing and monitoring piezometers (i.e., shallow groundwater wells) and by monitoring creek and pond water levels within the study area from April 2019 through March 2020.

- H. T. Harvey plant ecologists mapped the distribution of Habitat Plan land cover types within the study area.
- ICF archaeologists conducted a reconnaissance-level assessment of cultural and historical resources.
- The H. T. Harvey team held internal meetings to identify preliminary restoration opportunities by collaborating across the fields of restoration ecology, restoration hydrology and geomorphology, wildlife ecology, and historical ecology.
- Our team subsequently held a series of working meetings with the Habitat Agency to qualitatively evaluate the pros and cons of the restoration opportunities relative to the restoration goals; these meetings resulted in the deletion of several preliminary opportunities and refinement of the remaining opportunities.

The findings of our study will be used to facilitate early planning discussions between the Habitat Agency and stakeholders, including the regulatory agencies. Following completion of the Feasibility Study, the Habitat Agency has synthesized a preliminary conceptual restoration project by selecting a subset of the restoration opportunities identified herein. The Habitat Agency will provide this preliminary project description to the stakeholders and regulatory agencies for collaborative discussion and input (H. T. Harvey & Associates and cbec. 2020).

1.4 Report Organization

This report is organized as follows:

- **Section 2. Existing Conditions**—Summary of existing physical and biological conditions as a basis for restoration opportunities identification.
- **Section 3. Primary Constraints to Restoration—**Summary of primary constraints to future restoration design.
- **Section 4. Sycamore Regeneration Conceptual Model—**This section provides a conceptual model that summarizes the biotic and abiotic conditions and physical processes necessary to drive successful regeneration of sycamores.
- **Section 5. Opportunities for Habitat Preservation, Enhancement, Restoration, and Creation in the Study Area—**This section begins with an overview of the physical process restoration opportunities, such as grading and/or installation of natural wood structures. We then describe the restoration opportunities organized by specific Habitat Plan land cover types (e.g., willow riparian forest, SAW, etc.) and covered species that are targeted by the preliminary restoration goals, all of which will ultimately link to habitat mitigation credits in future restoration project(s). The physical process restoration opportunities are integrated into the land cover type and covered species restoration opportunities.

- **Section 6. Potential Effects of Proposed Pacheco Reservoir Expansion—**This section describes the potential effects that the proposed Pacheco Reservoir Expansion may have on the functions and values of the project site and restoration efforts.
- **Section 7. Pacheco Reservoir Expansion Project Flow Regime Management Opportunities**—This section presents an overview of reservoir flow regime management opportunities to synergize with the Habitat Agency's restoration goals for the study area.
- **Section 8. Habitat Agency Site Access Improvement Opportunities—**This section describes opportunities to improve access to the southeast side of Pacheco Creek for the Habitat Agency's future land management activities.
- **Section 9. Preliminary Restoration Opportunities on Ciraulo Property Upstream of Study Area—** This section provides a brief overview of preliminary restoration opportunities on the reach of Pacheco Creek that is upstream of the study area.

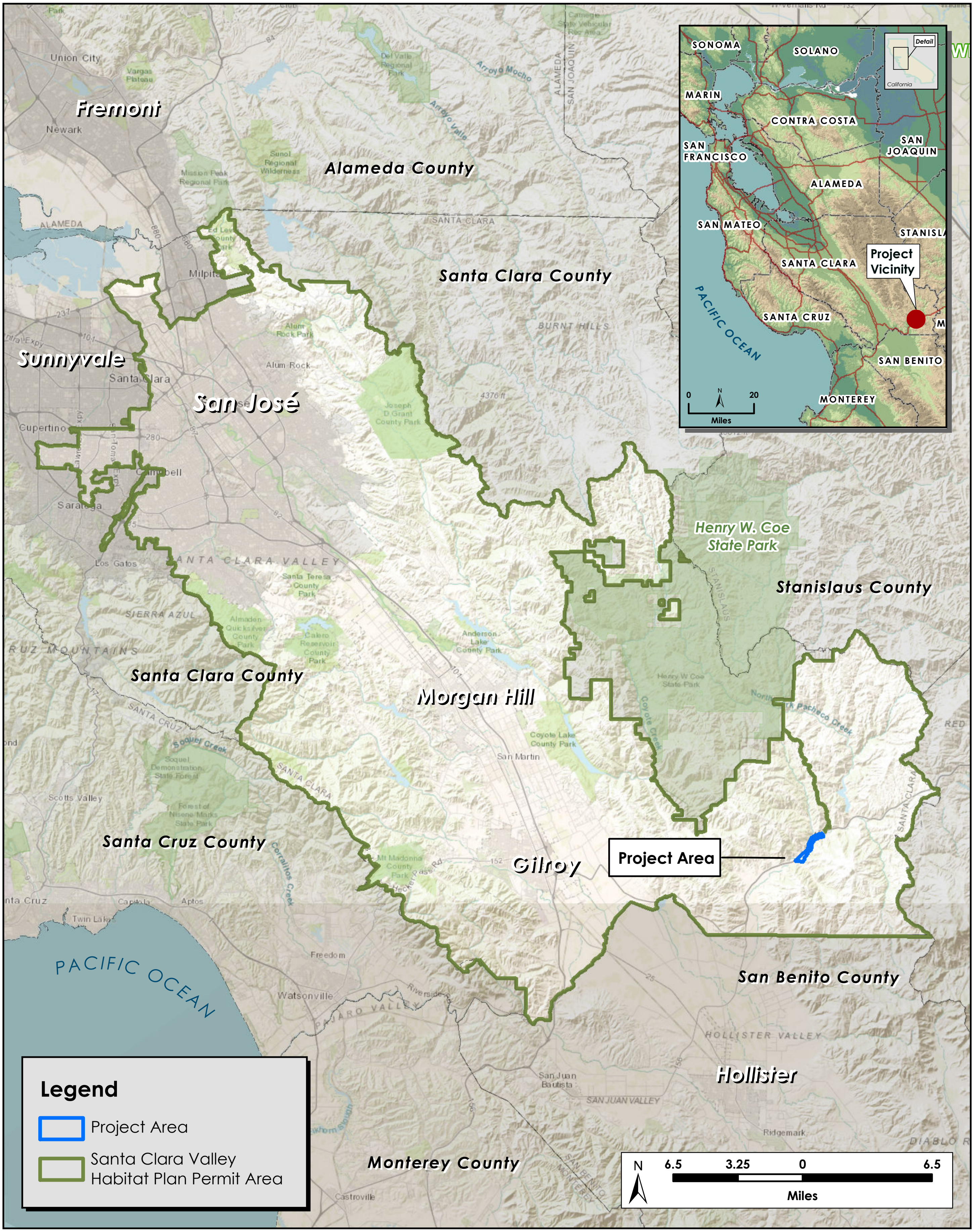

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Figure 1. Vicinity Map

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Figure 2. Feasibility Study Area

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Section 2. Existing Conditions

2.1 Hydrology and Hydraulics

cbec analyzed the surface and groundwater hydrology of Pacheco Creek, using a combination of desk-based analysis of existing data sets for the watershed and deployment of surface and groundwater monitoring instruments in the study area. A concise summary of key takeaways from this work is provided immediately below and a more detailed presentation of the Pacheco Creek surface water and groundwater analyses are provided in the sections that follow.

Highlights

- The hydrology is characterized by extreme interannual variability in flow with flood peaks over 10,000 cubic feet per second (cfs) and some years with no recorded surface flow.
- The hydrologic regime has been altered by the 1939 construction of the North Fork Dam/Pacheco Reservoir which has significantly increased summer flows.
- Summer flow releases are believed to be responsible for establishment of a more densely vegetated riparian corridor in the place of an ephemeral, dynamic channel populated by sparsely distributed sycamores.
- cbec installed a network of fourteen surface-water and groundwater monitoring instruments distributed across the study area to monitor water surface elevations (WSEs) and anticipated depth to groundwater (DTG); between April 2019 and March 2020, DTG was significantly less (meaning groundwater is shallower) on much of the Ciraulo property compared with the Pacheco Creek Reserve and BOR properties.
- The groundwater levels at the monitoring locations are highly dependent on surface water flow in Pacheco Creek. The groundwater levels respond quickly to changes in flow in Pacheco Creek indicating high connectivity across the entire study area.
- A two-dimensional hydraulic model was developed for the study area to characterize existing hydraulic conditions and to inform development of restoration opportunities.
- Hydraulic model results indicate that the upper study area (Parcel C) has a relatively well-connected floodplain that includes significant outer floodplain activation during the 5-year runoff event (4,480 cfs) while the lower study area (Parcels A and B) has a lesser-connected floodplain and requires the 10-year runoff event (7,572 cfs) to demonstrate more widespread activation of the outer floodplain.
- The 20-year runoff event (10,550 cfs) inundates nearly the entire valley floor from the left valley wall to the Highway 152 embankment on the right (when looking downstream).

2.1.1 Pacheco Creek Watershed Hydrology

Pacheco Creek forms part of the headwaters of the 1,300 square mile (mi^2) Pajaro River Watershed which drains to Monterey Bay near Watsonville, California. This section focuses on the 146 mi^2 portion of the Pacheco Creek Watershed (PCW) located in southeastern Santa Clara County. This region makes up most of the area of PCW and drains a portion of the Diablo Range extending to the long-term U.S. Geological Survey (USGS) gage northeast of Dunneville, California (USGS 11153000). Downstream of the USGS gage, there is an additional 50 mi^2 of watershed area contributing to Pacheco Creek, which drains to San Felipe Lake near the western side of Pacheco Pass Highway. Ortega Creek also joins San Felipe Lake and the water flowing downstream of the lake is referred to as the Upper Pajaro River. The cumulative watershed drainage area contributing to Pacheco Creek at the downstream extent of the feasibility study area is 129 mi^2.

2.1.1.1 Relevant Sub-Watersheds

This analysis divides the PCW into five major sub-watersheds relevant to the feasibility study (Figure 3). The largest sub-watershed is the 67 mi^2 North Fork, which is located upstream of Pacheco Reservoir. Over half of the PCW at the study area is upstream of the North Fork Dam which impounds Pacheco Reservoir. The area labelled as South Fork drains the southeast portion of the watershed. Other relevant sub-watersheds include Cedar Creek, which is a tributary to Pacheco Creek at the upstream extent of the study area. The USGS operated a gage (11152900) on Cedar Creek from 1961 to 1982. Santa Clara Valley Water District (Valley Water) continued operation of the gage from 1982 to 2003. Several minor tributaries enter Pacheco Creek near the study area, the largest of which is Harper Creek. Harper Creek was dammed about 1.3 mi from its confluence with Pacheco Creek in the 1980s for private use. Downstream of the study area, additional minor tributaries draining side canyons contribute to Pacheco Creek as it passes through a wide alluvial valley before being confined by levees near the USGS Dunneville gage (11153000).

2.1.1.2 Land Use Distribution

The PCW is primarily composed of rangelands used for cattle grazing. The 2011 National Land Cover Database was analyzed to compare land use across sub-watersheds of the PCW (Homer et al. 2015). Across the PCW, most land use falls within three categories: mixed forest (34%), shrubland/scrub (29%), and grasslands/ herbaceous (32%) (Figure 4). The sub-watersheds above and at the study area are similar in composition, while the area downstream of the study area includes low intensity development and croplands. The absence of irrigated croplands upstream of the study area suggest that shallow groundwater pumping above the study area is minimal. However, the USGS Dunneville gage (11153000) located approximately 4 mi downstream of the study area is situated in an irrigated alluvial valley where streamflow during the dry season may be substantially adversely affected by groundwater pumping for irrigation.

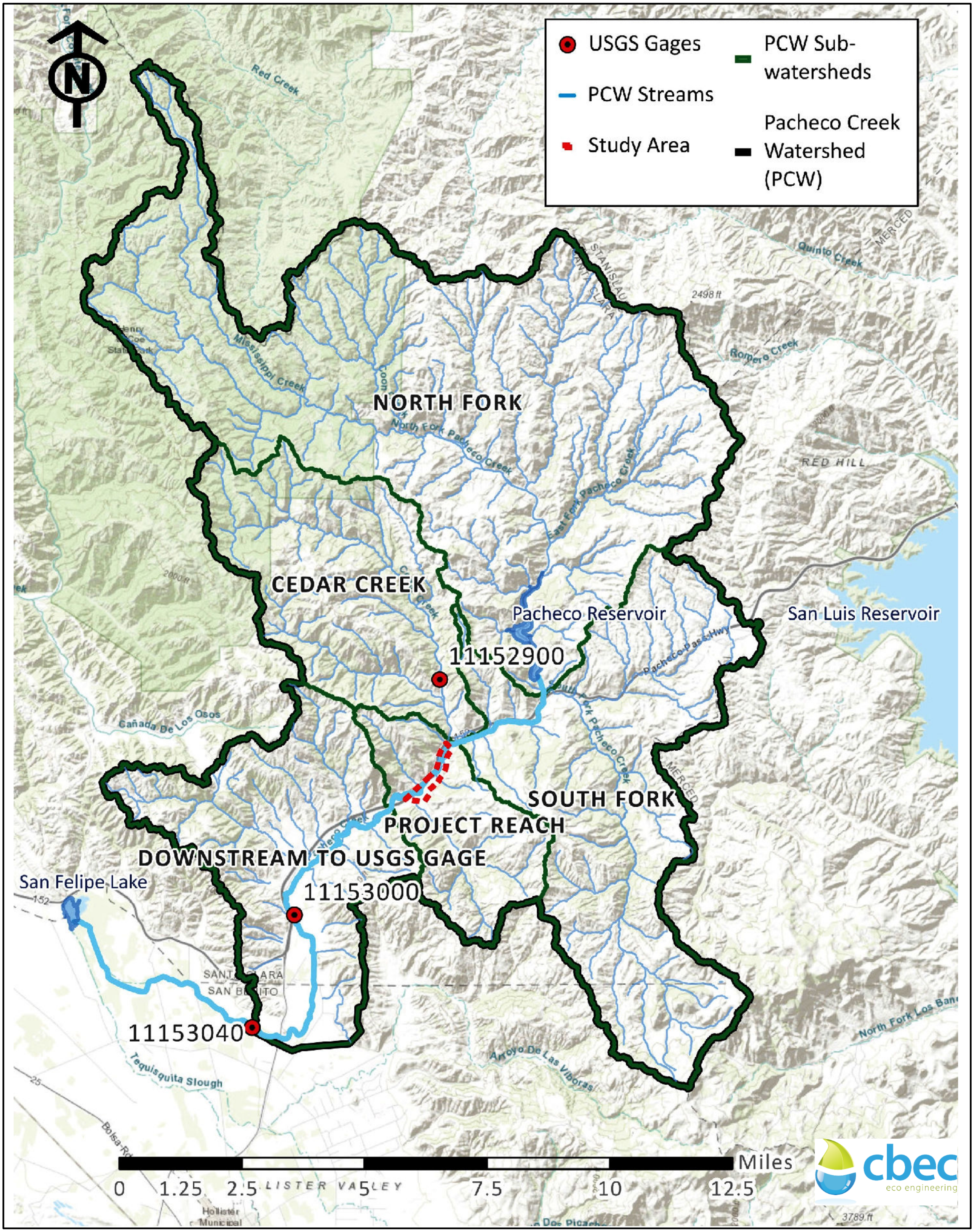

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Figure 3. Major Sub-Watersheds of the Pacheco Creek Watershed
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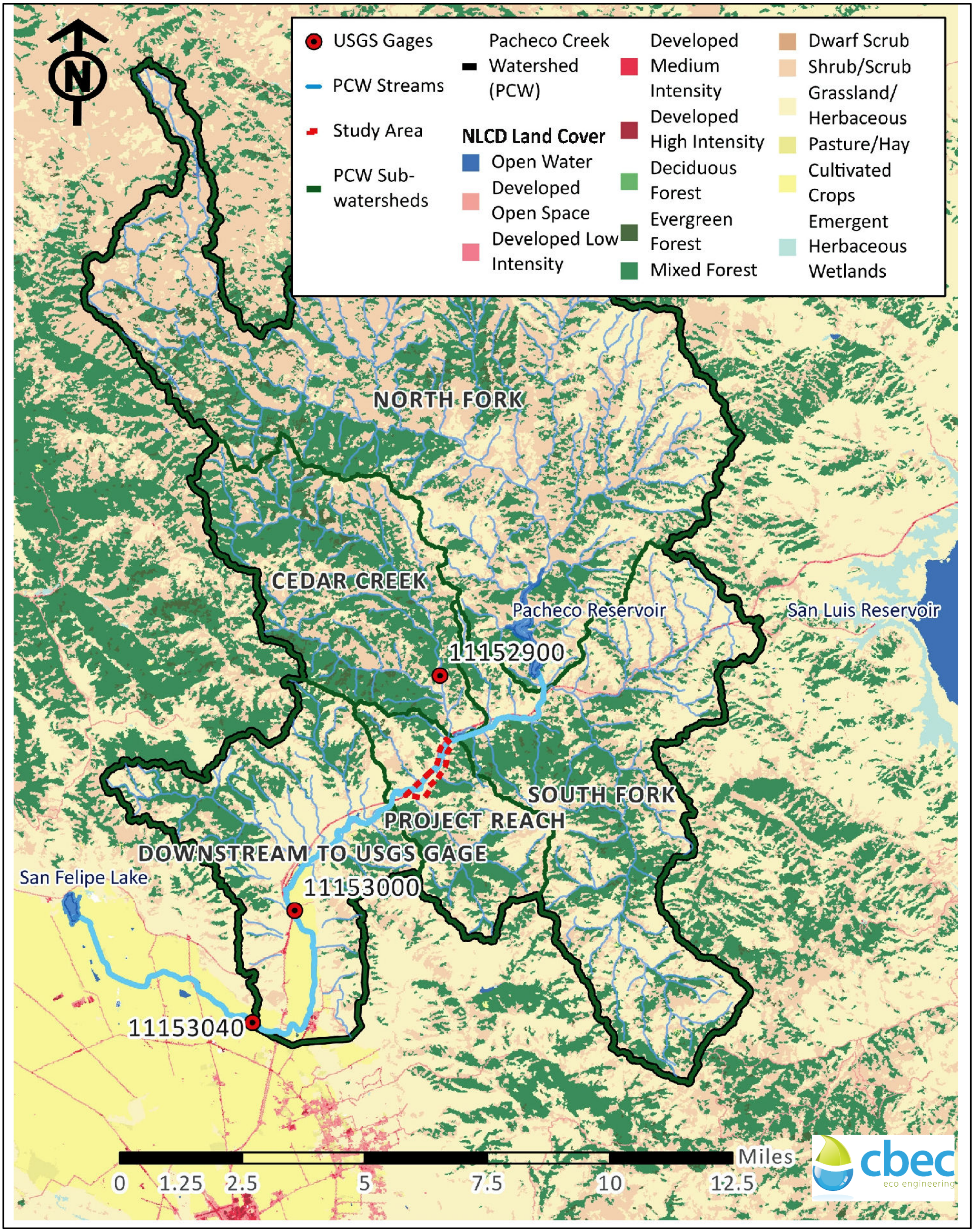

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Figure 4. Land Use of the Pacheco Creek Watershed

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2.1.1.3 Precipitation and Climate

The PCW has a Mediterranean climate with the majority of rainfall occurring during winter months. Since there are minimal long-term rain gages near the study area, the Localized Constructed Analogs (LOCA) dataset that uses data from nearby gages and statistical correction techniques to project precipitation and temperature, was evaluated across the PCW (Pierce et al. 2014). Between 1955 and 2005, an average of 20.4 in/year of precipitation was estimated for the PCW watershed with minor variability among sub-watersheds. Studies focusing on the North Fork sub-watershed have projected 19 in/year of precipitation with high interannual variation ranging from 8–48 in/year (Micko 2014). The average daily precipitation throughout a water year (WY)[1] as well as average and maximum temperature are presented in Figure 5.

2.1.2 Flow Regime

Pacheco Creek is characterized by extreme interannual and seasonal variability in streamflow driven by precipitation and Pacheco Reservoir operations. During dry years, minimal streamflow is observed, while in some wet years the system generates flows measured over 10,000 cfs at the USGS Dunneville gage (11153000). Accurate estimation of streamflow in the study area is challenging due to poorly documented reservoir management operations, considerable surface-groundwater exchange, and groundwater pumping between the study area and USGS Dunneville gage (11153000) for irrigation.

2.1.2.1 Historical Reservoir Operations

Pacheco Reservoir, impounded by North Fork Dam, was constructed in 1939 by the Pacheco Pass Water District (PPWD) with an operational storage capacity of 5,500 acre-feet. The original purpose of the reservoir was to recharge groundwater within the service area of the PPWD, which is primarily comprised of land along Pacheco Creek. The management of Pacheco Reservoir changed when imported water became available to PPWD through the San Felipe Branch of the Central Valley Project in 1987, which reduced demand for releases from Pacheco Reservoir. Additionally, irrigation demand has changed over the decades as crop mix and irrigation techniques have evolved (Micko 2014). The historical operation was generally considered effective at recharging groundwater although PPWD's management and maintenance of the reservoir have been minimally resourced in terms of finances and personnel and reservoir operations records were generally not kept until very recently (pers. comm. Jeff Micko 2020). In 2013, reservoir operations caught the attention of NOAA which resulted in studies conducted by Jeff Micko and Jerry Smith and the subsequent development of new operational guidelines that were intended to improve potential steelhead habitat within Pacheco Creek, while continuing to meet groundwater recharge goals (pers. comm. Jeff Micko 2020; Micko 2014). The new operational guidelines were developed with the understanding that PPWD would only adjust reservoir releases on a monthly basis. While some changes in reservoir operations have been made, the reservoir has generally not been operated consistent with the new guidelines (pers. comm. Jeff Micko 2020). In 2017, heavy runoff events also exacerbated existing damage to the reservoir's emergency spillway to a level that the California

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[1] A water year (WY) is defined as the period between October 1st of one year and September 30th of the next. A WY is identified by the WY in which it ends, so that WY 2019 is the period of October 1st, 2018 through September 30, 2019.

Department of Water Resource's Division of Safety of Dams (DSOD) mandated that PPWD implement interim and long-term repairs to be able to continue operating the reservoir. However, PPWD was unresponsive to these mandates and DSOD notified PPWD to maintain the reservoir's release valve in the fully open position moving forward (DWR 2018). While the reservoir and outlet have been instrumented and monitored in recent years to track reservoir levels and releases, concerns regarding data gaps, inconsistencies and accuracy resulted in these data being omitted from this Feasibility Study.

2.1.2.2 USGS Streamflow Gage Data Analysis

The USGS began operation of gage 11153000 "Pacheco Creek near Dunneville" in October of 1939. The location is approximately 3.4 mi from the downstream end of the study area (Figure 3). The gage was operated through September of 1982. Following a 24-year data gap, gage operation resumed in October 2006 and continues through the present (2020). cbec analyzed data from this gage to characterize flows within the study area. A separate USGS gage (11153040) was operated 5 mi downstream of 11153000 between October 1981 and September 1985. Because this operating period was brief compared to the 11153000 data record and the location and contributing watershed characteristics were not identical, this dataset was not included in the analysis.

Flow frequency statistics were calculated for the entire period of record of the USGS Dunneville gage (11153000) and evaluated to characterize the flow regime. It should be noted that the reservoir was present during this entire period, yet operations have changed. The flows for average, 90th, 75th, 50th, and 25th percentiles are displayed in Figure 6. These results illustrate a highly flashy system. In some years, high winter flows can surge through the valley, which drives geomorphic change. Even in wet years, summer flows are very low and highly modified by reservoir operations.

The variability in streamflow in this highly flashy system is evident in the instantaneous peak streamflow[2] observed each WY (Figure 7). Instantaneous peak flows for the period of occurred on December 23, 1955 (12,600 cfs), January 11, 2017 (11,700), and January 25, 1969 (11,300 cfs). One important note is that the second highest observed flow occurred recently in 2017. This flow resulted in geomorphic changes to the stream and floodplain discussed in subsequent sections. Annual peak flows of less than 2 cfs were also observed in four WYs. The difference between annual peak flows also illustrates the significant interannual variability of high flows in Pacheco Creek.

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[2] In a flashy system such as Pacheco, it is not uncommon to have instantaneous peak streamflow values that are two to three times the size of the daily average value.

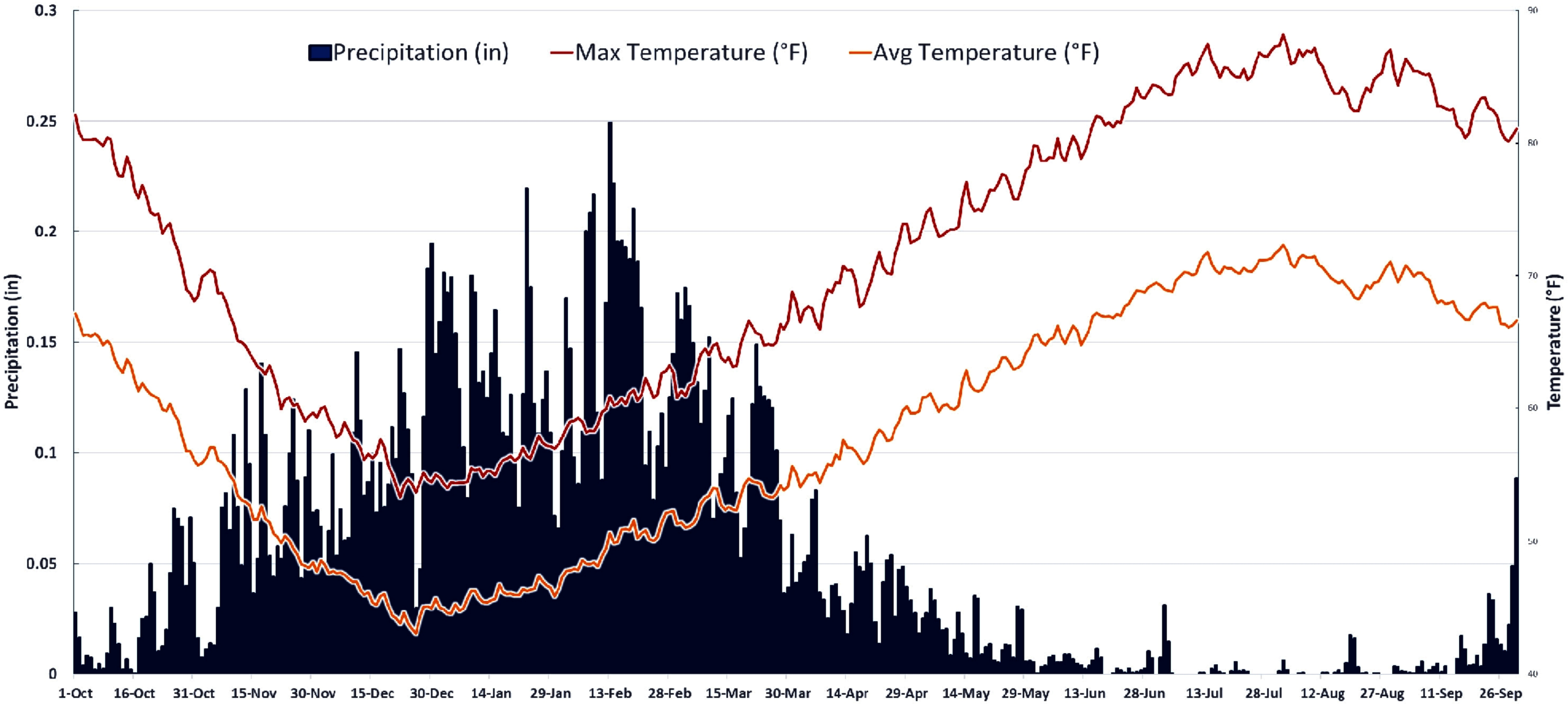

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Figure 5. Distribution of Daily Average Precipitation, Maximum Temperature and Average Temperature

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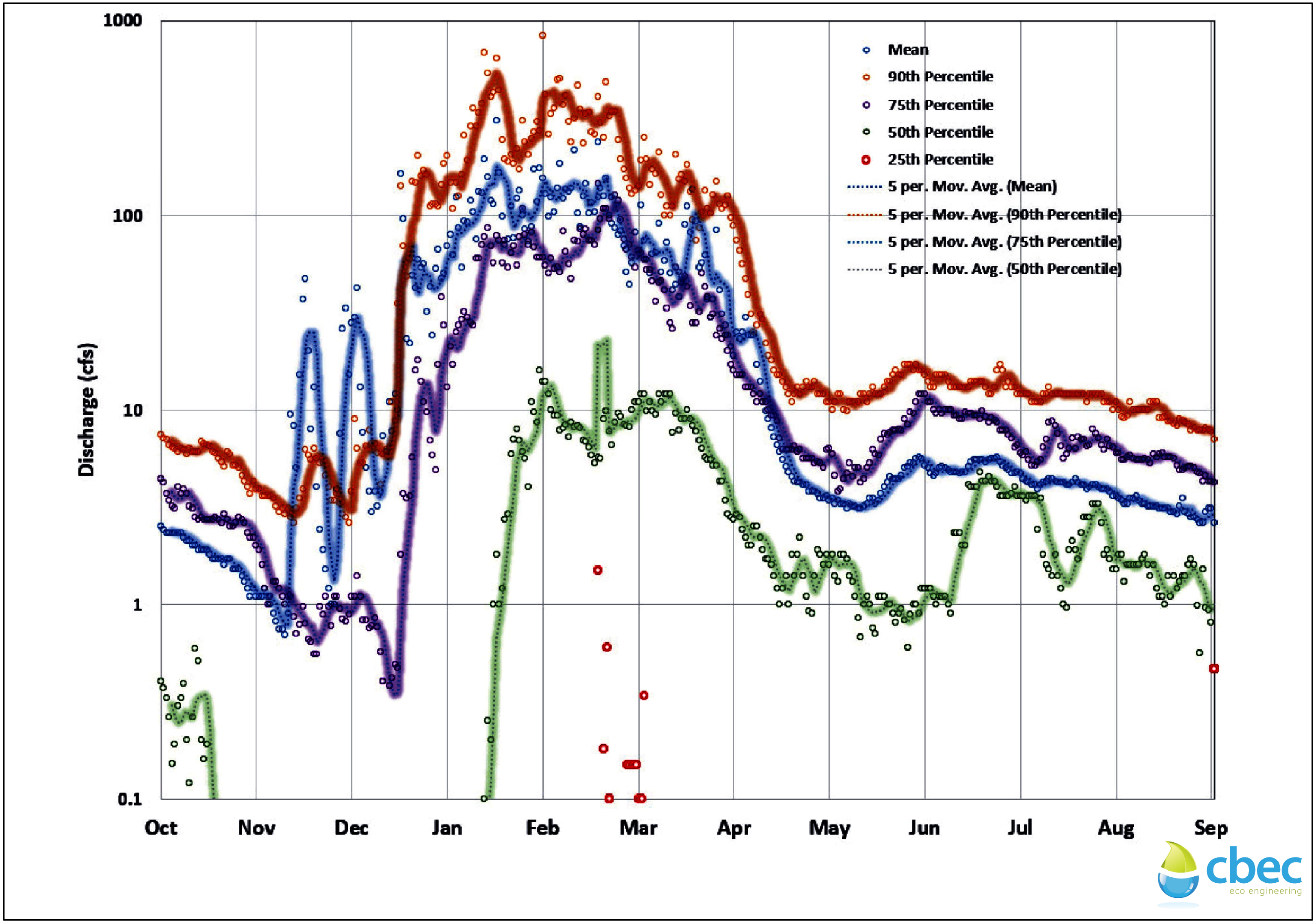

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Figure 6. Average Daily Flow Distribution for USGS Gage 11153000

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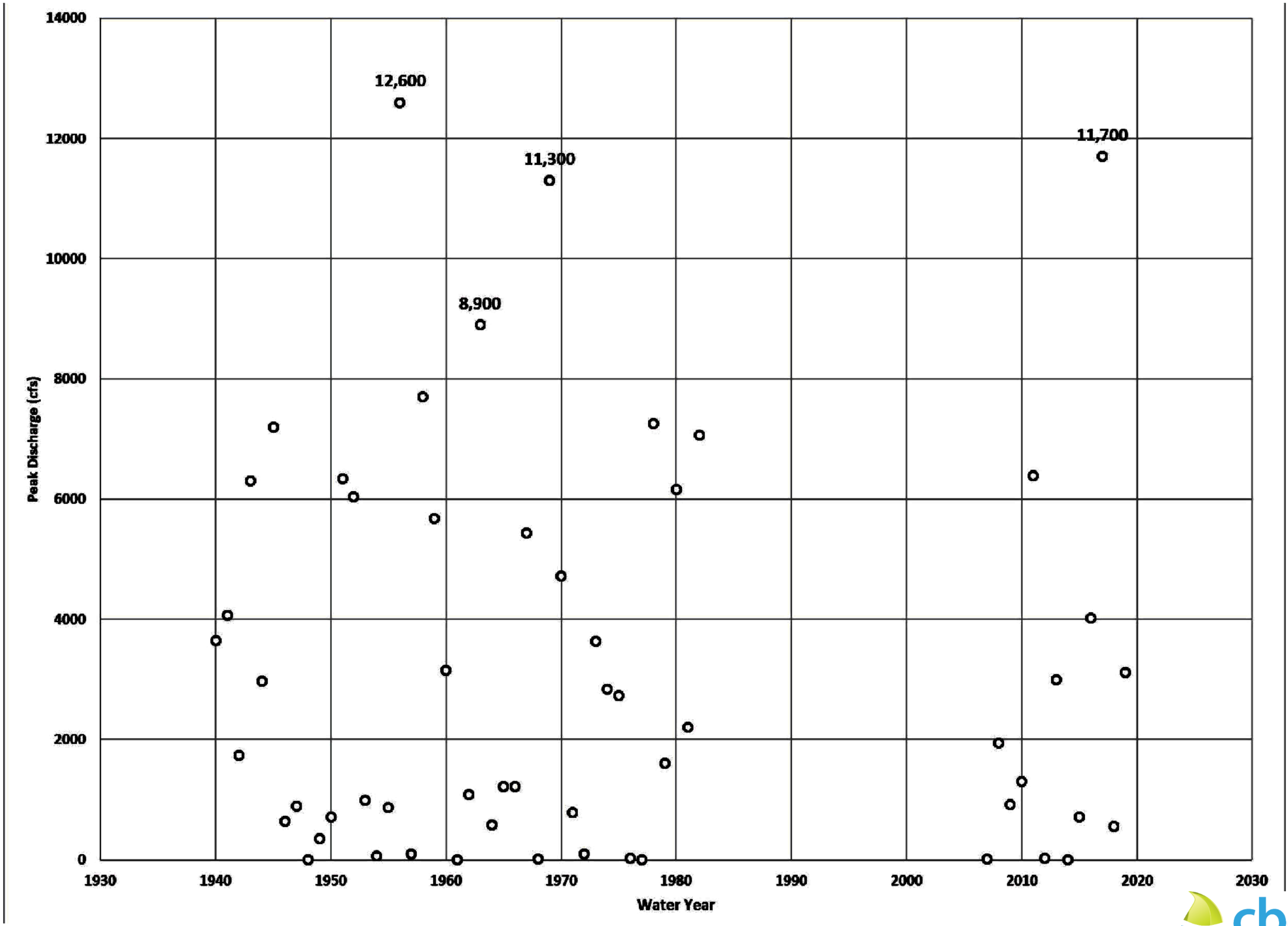

Figure 7. Annual Peak Streamflow Observed at USGS Gage 11153000

2.1.2.3 Flood Frequency Analysis

In order to evaluate the magnitude and frequency of peak annual streamflow, a uniform statistical flood frequency analysis following methods outlined in Bulletin 17B was conducted (Interagency Committee on Water Data 1982). Results from the flood frequency analysis show the likelihood that a given recurrence interval event is exceeded in a given year. This analysis was applied to the Pacheco Creek's annual peak flow record from the USGS gage at Dunneville. The analysis included the entire period of record 1939 to present (which includes the data gap from 1981 to 2006) and is displayed in Table 1.

Table 1. Bulletin 17-B Results of Peak Flows for Water Year 1940–2019 at USGS Gage 11153000

Chance of Exceedance (%)	Recurrence Interval	Peak Flow Rate (cfs)
1	100	16,597
2	50	14,992
5	20	12,127
10	10	9,337
20	5	6,090
50	2	1,787
80	1.25	277
90	1.111	79
95	1.052	24
99	1.010	2

2.1.2.4 Effects of Reservoir Operations on Unimpaired Flows

Comparing Observed Flows to Unimpaired Flows—The effects of reservoir operations on Pacheco Creek's seasonal runoff distribution were coarsely explored by comparing current conditions measured at the USGS gage with unimpaired flows estimated by an uncalibrated hydrologic model. Because the reservoir was constructed shortly before installation of the USGS gage, there is no direct measurement of unimpaired flows. To better understand unimpaired flows and the PCW's overall water balance, a hydrologic model called the Soil and Water Assessment Tool (SWAT) was used to coarsely approximate key elements of the water budget including surface runoff, subsurface or lateral groundwater flow and evapotranspiration. This model simulated the period of 1955-2005 using LOCA inputs of precipitation and temperature. The model does not include representation of the reservoir, thus estimating unimpaired flows. While the SWAT model was not calibrated and hence the precise timing of various processes is not highly accurate, its general representation of physical watershed processes such as conversion of rainfall to runoff on a seasonal basis is useful.

Evaluating the differences in monthly contribution to the annual discharge between USGS and SWAT flows provides a coarse approximation of how much the natural flow distribution has been altered by reservoir operations (Table 2). The results of this analysis suggest that reservoir management has significantly altered the seasonal distribution of runoff. Averaged over the 50-year simulation period, the reservoir delays the onset of early winter flows in Pacheco Creek and shifts the overall seasonal flow distribution from the winter to the summer. During the start of the rainy season in November, there is significant reduction in flow as the season's early runoff from the North Fork of Pacheco Creek is captured by the reservoir. December shows a smaller reduction in flow as the reservoir may have generally reached the desired storage allocation. January through April exhibit minimal change as Pacheco Reservoir is likely managed to allow additional runoff to pass through unregulated. May shows a reduction in discharge which could be explained by the reservoir again capturing flows during this period. June through August show significant increases in flow as water is released from the reservoir. July and August show a particularly large increase in managed conditions relative to unimpaired conditions with a USGS observed average of 4.7 cfs. During historical conditions, the summer discharge is estimated by the model as 0.2 cfs.

Table 2. Comparison of Current and Unimpaired Flow Seasonal Changes in Discharge

	October	November	December	January	February	March	April	May	June	July	August	September
USGS 11153000 Average (cfs)	1.9	6.3	27.3	97.4	129.4	75.7	39.6	4.1	4.5	4.9	4.0	3.1
SWAT Normalized[1] Average (cfs)	1.7	18.5	46.9	98.3	103.9	72.2	38.5	12.8	2.0	0.2	0.1	3.0
USGS % of WY Discharge	0%	2%	7%	24%	32%	19%	10%	1%	1%	1%	1%	1%
SWAT % of WY Discharge	0%	5%	12%	25%	26%	18%	10%	3%	1%	0%	0%	1%
% Change[2]	12%	-66%	-42%	-1%	25%	5%	3%	-68%	122%	2384%	6862%	3%

[1] The SWAT normalized average is calculated to make the total average water year flow directly comparable between the hydrologic model and the observed flows at the USGS. The normalized average value is calculated by taking the SWAT % of monthly WY Discharge multiplied by the sum of USGS WY average flows.

[2] % Change is calculated as the (USGS%-SWAT%)/SWAT%. Positive values indicate increased discharge relative to historical conditions, and negative values indicate a decrease.

Prior to construction and operation of the reservoir, runoff in Pacheco Creek likely occurred almost entirely between November and May. June through August flows likely exist due to reservoir operations. This shift in the timing of runoff has significant implications for the type and distribution of riparian habitat and associated species and for the restoration and management of the Pacheco Creek ecosystem. Due to the relatively small capacity of the reservoir, channel forming flows likely still occur during wetter WYs. However, the peaks of those runoff events are likely attenuated under current operations if they occur before the reservoir reaches its desired storage capacity.

2.1.3 Surface-Water and Groundwater Monitoring

2.1.3.1 Monitoring Plan Design and Objectives

cbec designed and installed a network of 14 surface-water and groundwater monitoring instruments distributed across the study area to provide a continuous dataset of water level and temperature in key locations (Figure 8). Objectives of the monitoring plan were to:

- measure seasonal surface and groundwater WSEs at monitoring locations,
- understand the connection between Pacheco Creek and the shallow alluvial aquifer during low flow periods, and
- estimate DTG in areas considered in the study area for planting or restoration efforts.

Seven piezometers (P-1 through P-7) were installed in transects perpendicular to the orientation of the valley floor of Pacheco Creek, each instrumented with a water level logger (logger). Each of the piezometers was constructed by Pacific Crest Engineering using a drill rig with maximum depths ranging from 20–25 feet (ft). The piezometers were fitted with 2-inch (in) well casing and screened from 5 ft from the surface to the maximum depth of the well. P-1 through P-4 were installed in April 2019 while P-5 through P-7 were installed in June 2019. Four in-stream loggers (C-1through C-4) were installed in Pacheco Creek along the piezometer transects. These instream loggers inform an understanding of the connection between Pacheco Creek and the adjacent groundwater level. A logger (Pond) was also installed in Pond 1 on the Pacheco Creek Reserve property as the water level in the pond is believed to provide a surface expression of shallow groundwater (i.e., it would read the same as if a piezometer was installed in close proximity). The Habitat Agency uses an existing well (EW-1) as a water source to irrigate native riparian tree and shrub plantings at the site. Therefore, cbec instrumented EW-1 with a logger to represent the Pacheco Creek water surface elevation (WSE) and to be able to potentially evaluate the impact of pumping on groundwater elevations.

2.1.3.2 Monitoring Results and Analysis

cbec staff conducted field visits on April 17, 2019, June 3, 2019, July 31, 2019, October 11, 2019, and March 26, 2020 to install monitoring equipment, measure WSEs and download water level data. The following data summary is based on the July 31, 2019 and March 26, 2020 field visits in which all 14 of the instruments were downloaded and data were processed to ensure data quality and to convert water level records to continuous WSE measurements. Additional measurements of WSE along Pacheco Creek were performed to increase the spatial density of WSE measurements for a single point in time and to allow for improved interpolation of the groundwater surface across the extent of the study area. These data were interpolated using natural neighbor techniques. The interpolated surface combining all measurements of WSE for March 26, 2020 is presented in Figure 9. Groundwater surfaces were also developed for other monitoring periods as described in the subsequent Depth to Groundwater section below (also part of Section 2.1.3.2).

Subsurface Flow—The slope of the groundwater surface can indicate the direction of subsurface flow and is a useful way to infer whether streams are gaining or losing[3]. Groundwater surface elevations were sampled on July 31, 2019 along a longitudinal profile following the direction of the valley surface adjacent Pacheco Creek with an average slope of 0.4%. The groundwater slope across transects (i.e., perpendicular to the stream) can indicate whether the stream is gaining or losing at a given reach location and point in time. Along the

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[3] In a gaining stream, WSE in the channel is lower than the surrounding groundwater elevation such that water flows from the groundwater table to the stream, while in a losing stream the groundwater elevations are lower than the WSE in the channel resulting in flow from the channel to the surrounding groundwater table.

downstream transect (C-1, P-1, P-2), the groundwater slopes at 0.3% toward Pacheco Creek, likely driven largely by Harper Creek which flows into Pacheco Creek immediately downstream of the transect. Even though Harper Creek had been dry for months at the time of observation, the groundwater flow would be expected to continue downslope towards Pacheco Creek. The data from each of the upstream transects show that the groundwater slope along the valley floor is relatively flat and will respond quickly to changes in Pacheco Creek water levels. Across the study area, Pacheco Creek appears well connected to the aquifer and the groundwater levels mirror WSEs in the channel except where other water sources (e.g., Harper Creek) may create more localized complexity.

DTG—A DTG dataset was developed by differencing the March 26, 2020 WSE interpolated surface from the topographic surface developed by cbec as part of the hydraulic model development described in Appendix A (Figure 10). Much of the Pacheco Creek Reserve property is 7–10 ft above the estimated March 26, 2020 groundwater table, while the Ciraulo Property (at the upper end of the study area) is in closer proximity to the groundwater table with most areas within 3–7 ft of groundwater. The March 26, 2020 DTG is representative of conditions while there is surface water (~2 cfs measured at USGS gage) flowing in Pacheco Creek.

The groundwater table elevation in the study area declines once streamflow ceases. The minimum groundwater surface elevation (i.e., deepest groundwater table) during the monitoring period occurred on December 1, 2019. An interpolated groundwater surface was projected based on monitoring instrument measurements for this seasonal minimum groundwater level, and similarly differenced from the ground surface to create the DTG estimate for December 1, 2019, displayed in Figure 11. At this point in time, the Pacheco Creek Reserve Property was 10 – 15 ft above the groundwater table across much of the floodplain, and the Ciraulo Property was 5-10 ft above the groundwater table. The average decline in the groundwater table observed in the piezometers and pond loggers from the beginning of June to the seasonal low on December 1st, 2019 was 5 ft. Implications of this range variability in DTG for SAW are discussed in Sections 4.3 and 6.

Temporal Analysis of Groundwater and Streamflow—It is important to understand the response of groundwater to changes in streamflow, as this type of information is pertinent when considering how future releases from Pacheco Reservoir will affect the shallow alluvial aquifer (i.e., the groundwater elevation). Instruments P-1 through P-4, C-1, C-2, EW-1 and Pond were installed on April 17, 2019. At that time, flow in Pacheco Creek was still elevated (59 cfs) from winter storms. The remaining instruments (P-5, P-6, P-7, C-3, C-4) were installed on June 3, 2019 after the piezometers were constructed. The WSE time series for each instrument is displayed in Figure 12.

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 8 Groundwater Monitoring Locations.mxd

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Figure 8. Groundwater Monitoring Locations

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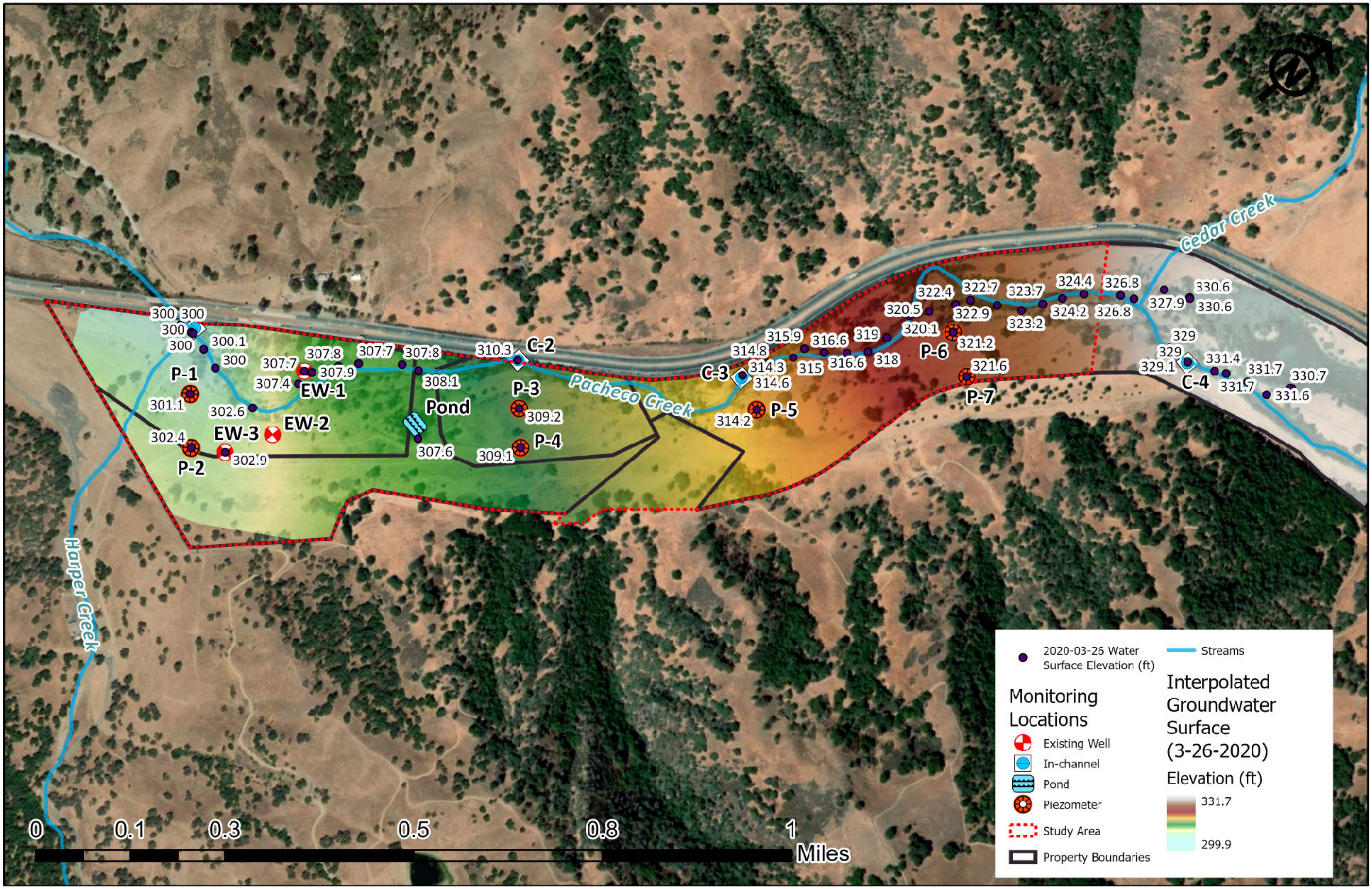

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 9 WSE Measurements.mxd

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Figure 9. Direct Measurements of WSE Collected
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N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 10 Depth to Groundwater Created from WSE Data CollecteMarch 26 2020 and DEM.mxd

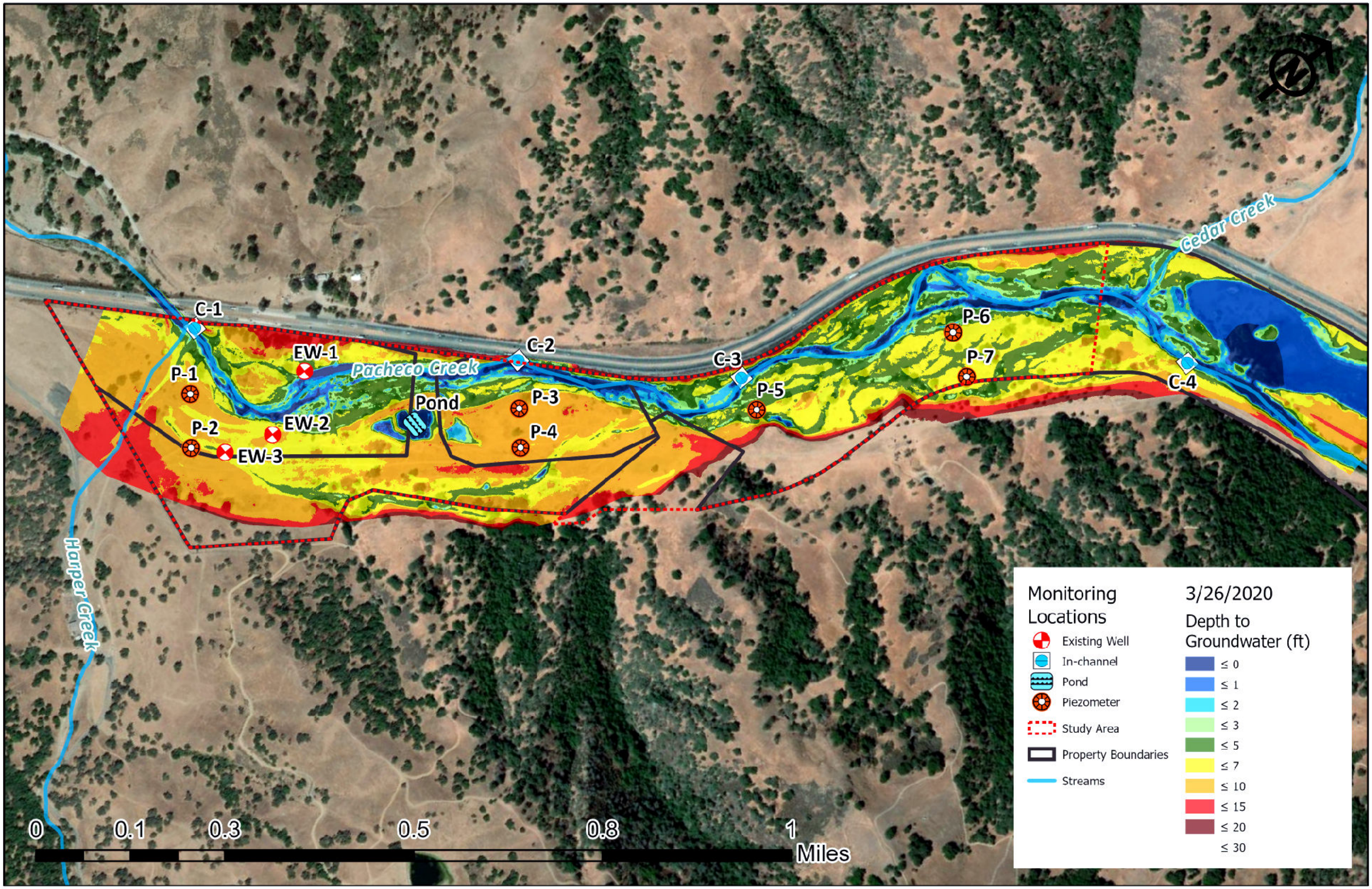

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Figure 10. Depth to Groundwater Created from WSE Data Collected March 26, 2020 and DEM

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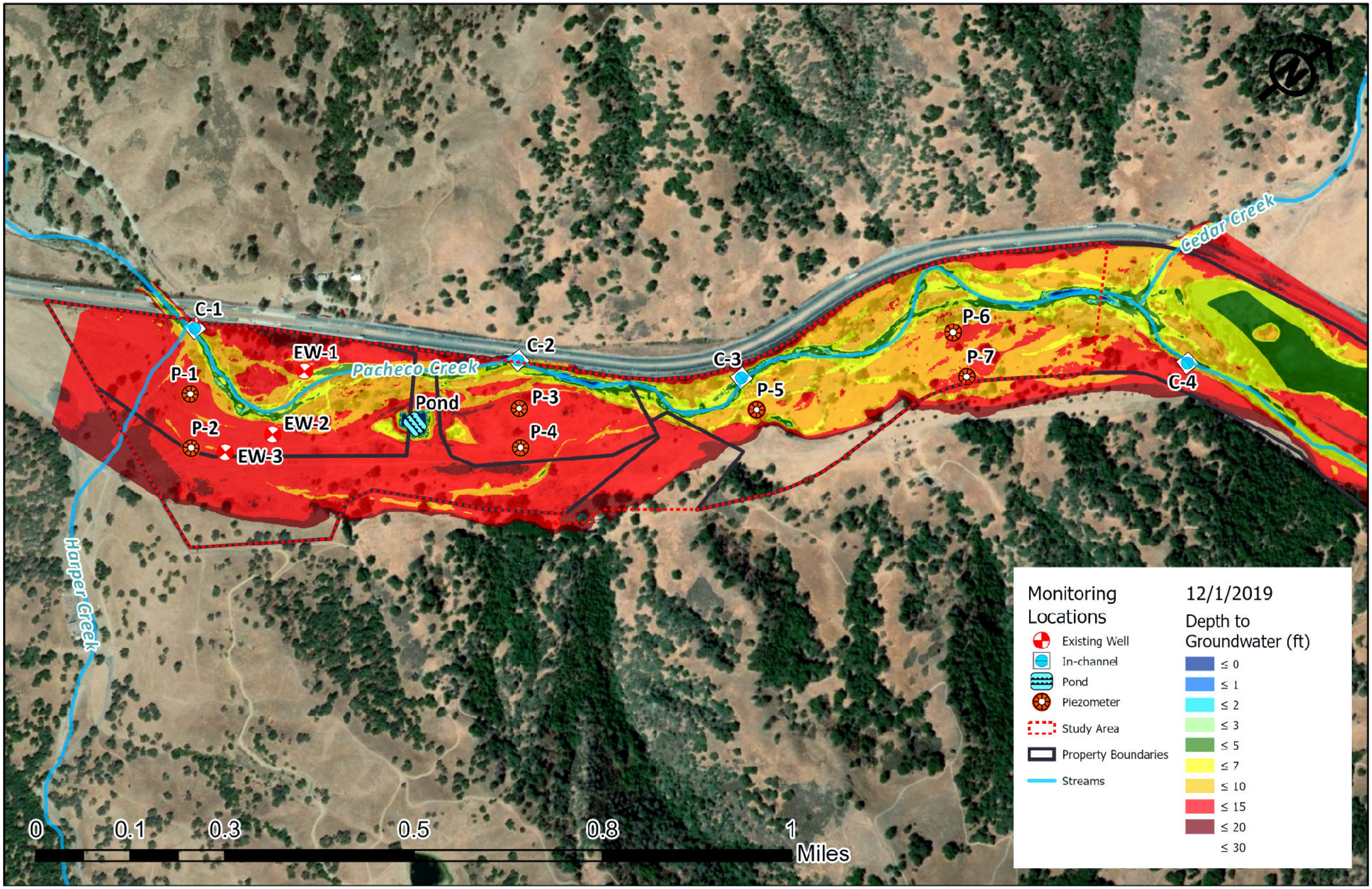

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Figure 11. Depth to Groundwater Created from WSE Data Collected December 1, 2019 and DEM

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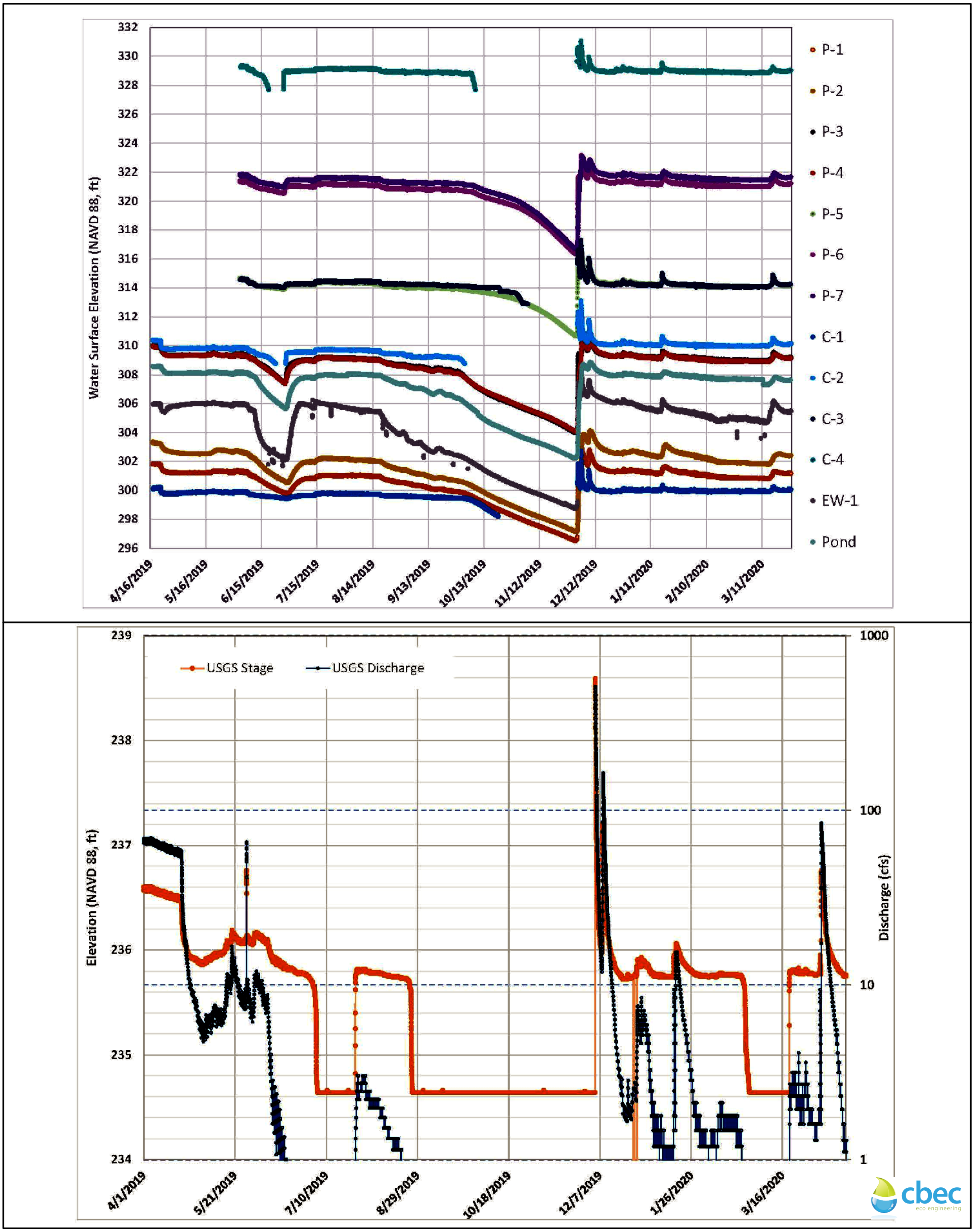

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 12 Water Surface Elevation Records for Monitoring Network.mxd

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Figure 12. Water Surface Elevation Records for Monitoring Network

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The water level at each location stayed nearly constant until early or mid-June. The discharge measured at the USGS Dunneville gage on June 1, 2019 was 12.3 cfs but had decreased to less than 1 cfs by June 15 and 0 cfs by June 22, 2019 (Figure 12). Water appears to have been released from Pacheco Reservoir in late July and 2.5 cfs was again recorded at the USGS Dunneville gage on July 26, 2019. This gage does not accurately reflect the discharge or timing of flows at the study area because there are losing reaches between the study area and the USGS gage location (i.e., streamflow was likely higher within the study area than at the gage). On July 31, 2019, 4.5 cfs was measured at the project site, while only 2.6 cfs was reported downstream at the USGS gage.

This reduction in streamflow can be observed in the project site with surface and groundwater levels beginning to decline on June 11 and starting to rebound by June 28 (Figure 12). Analysis of how quickly WSEs at each monitoring location rebounded when water was released from the reservoir is useful in order to understand the amount of water necessary to sustain a constant shallow groundwater level across the study area, and the duration that releases need to be sustained to achieve them. As the flow in Pacheco Creek dropped, the water level at two of the instream loggers (C-2, C-4) fell below the elevation of the loggers, as the stream likely went dry or nearly dry in those locations. The logger at C-1 was placed in a deeper pool and showed minimal elevation drop from the reduction of flow through the reach.

The groundwater elevation in most piezometers began rising within 24 hours of the levels observed in the instream monitoring locations and rebounded to nearly their previous level within 1 week. Sites P-1 and P-2 took the longest to rebound (12 days). This makes sense as the gradient for the groundwater table is steepest laterally across the piezometer transect in those locations. Pond, P-3, P-4, and EW-1 all took approximately 7 days to rebound. The upper sites, P-4, P-5, P-6, P-7, and C-3, all rebounded to nearly previous levels within 3 days. This indicates that upstream where the DTG is shallower in general, the aquifer responds more quickly to changes in Pacheco Creek flow. The recovery timing at each transect makes sense when the slope of the groundwater surface perpendicular to the valley slope is considered.

Surface flow at the USGS gage ceased for the summer of 2019 on August 26, 2019 and did not resume until December 4, 2019. Each of the in-stream loggers went dry during this period without surface flow present in the channel. For the period of August through November of 2019, an average decline in groundwater elevation of approximately 5 ft was observed (Figure 12). Note that the groundwater elevation of the downstream instruments (P-1, P-2) began dropping first in mid-August, while groundwater elevations at the upstream instruments (P-6, P-7) did not decline until October. This is evidence that the groundwater decline is advancing upstream along Pacheco Creek which can also be seen in the rate of groundwater decline. Between October 11 and December 1, the average rate of decline was 1.6 ft per month. It could be presumed that this decline in groundwater may continue at a similar rate until the aquifer is replenished by surface water. The storm that began on December 4, 2019 caused the flow in Pacheco Creek to jump from 0 cfs to a peak of 509 cfs within 3 hours. This runoff event returned groundwater levels to similar levels as those documented during April through July of 2019 when surface water was flowing at the Pacheco Creek USGS gage.

The relationship between flow releases from the North Fork Dam and the groundwater levels in Pacheco Creek has been explored by others in a case study following a very dry period in 2013 (Micko, 2014c). Water was released from the North Fork Dam at a rate of approximately 10-12 cfs, and the discharge was measured at various points downstream to characterize percolation rates and aquifer storage volumes. The decrease in measured discharge between the North Fork Dam and the Highway 152 bridge at the downstream extent of the study area was 3.2 cfs on average for three observation dates. The duration of time that passed from the initial release of water from North Fork Dam until surface water was observed at downstream points along Pacheco Creek was used to estimate the aquifer storage. A storage volume of 300 acre-ft was estimated for shallow groundwater aquifer along the reach of Pacheco Creek beginning near the confluence of the North and South Forks of Pacheco Creek to the just below the second Highway 152 crossing, and 1,200 acre-feet for the shallow groundwater aquifer extending from downstream of the second Hwy 152 crossing to the USGS gage (Micko, 2014c). These values can help roughly constrain the volume of surface water needed to raise the water table from an extremely dry period to a level where surface water will persist in Pacheco Creek.

Water temperature was also recorded at each monitoring location and is presented for select locations in Figure 13. The piezometer temperature record shows negligible daily fluctuations in temperature, while the instream loggers frequently demonstrate a daily fluctuation of temperatures of 6-10°F or greater. The temperature record also shows when each in-stream logger (C-1 through C-4) were exposed to the atmosphere as water level in Pacheco Creek fell.

The annual trends in water temperature help illuminate the connection between surface and groundwater in the study area. Each of the piezometers follows a similar trend with seasonal temperature lows between 56 and 61 °F in early May, and peaks ranging from 66 to 70°F in late October. Of the piezometers, P-3 reported the highest range in temperature indicating increased connection with the surface water flows. Conversely, P-2 shows a more muted signal suggesting that region of the floodplain does not exchange as much water with the channel. With its proximity to the stream channel, EW-1 responds very similarly to the instream loggers, suggesting that the well is effectively drawing from Pacheco Creek.

At the valley scale, each monitoring location is well connected to streamflow in Pacheco Creek. Daily fluctuations in water level, presumably due to evapotranspiration, are observed at all instream and groundwater monitoring sites. Groundwater level response times to reduction in streamflow depend on the streamflow range, distance from the channel, transmissivity of the substrate and many other factors. As such, specific sites exhibit different magnitudes of response in groundwater level depending on their location and local conditions. To better understand the dynamics of groundwater fluctuations under a range of conditions, it is recommended that a significant drought year (or years) be monitored and the data analyzed. Sustained periods without streamflow along Pacheco Creek due to reservoir operations or sustained drought conditions may cause a much larger response than those observed over the results summarized above.

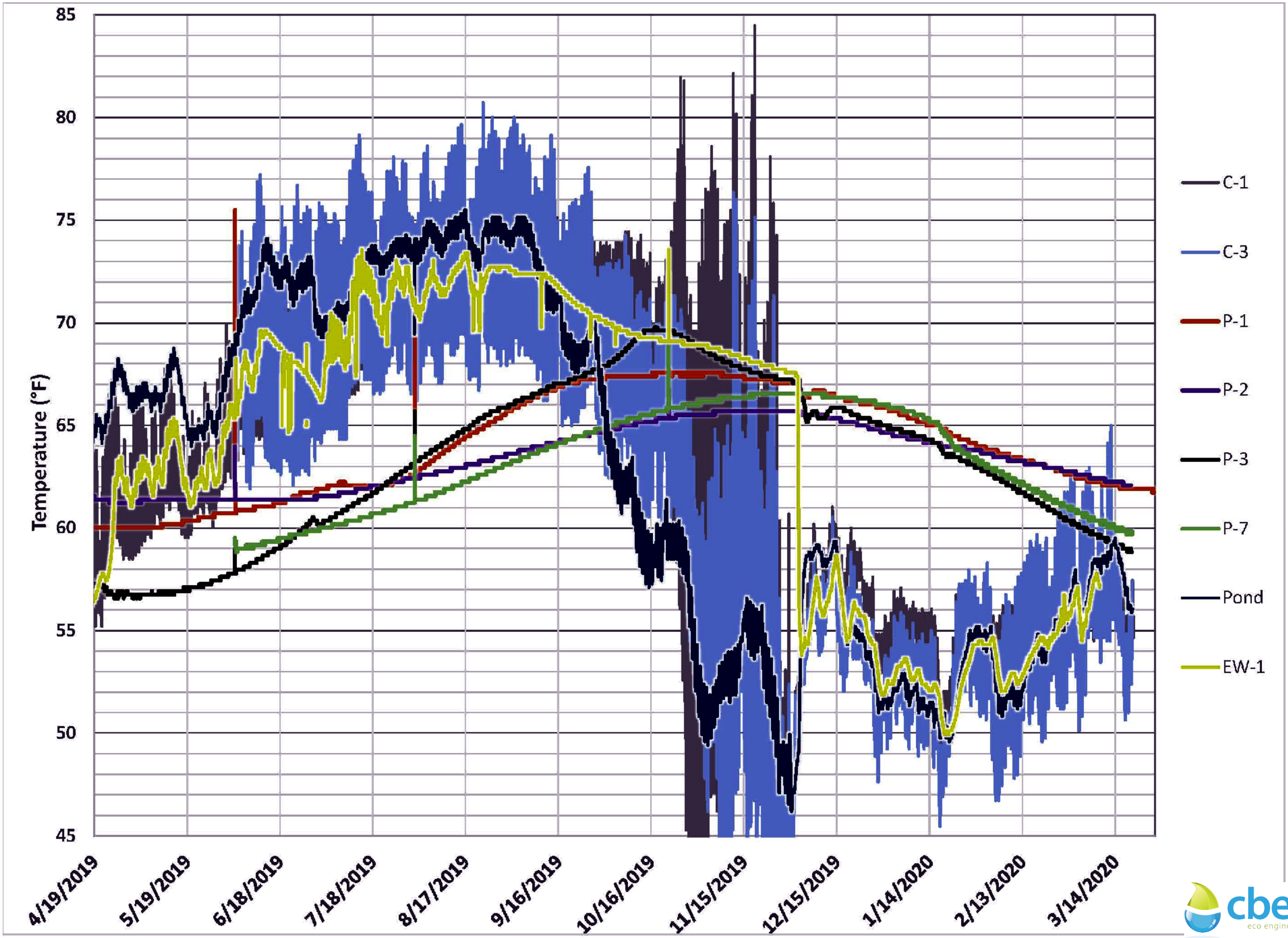

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Figure 13. Temperature Datasets for Monitoring Network

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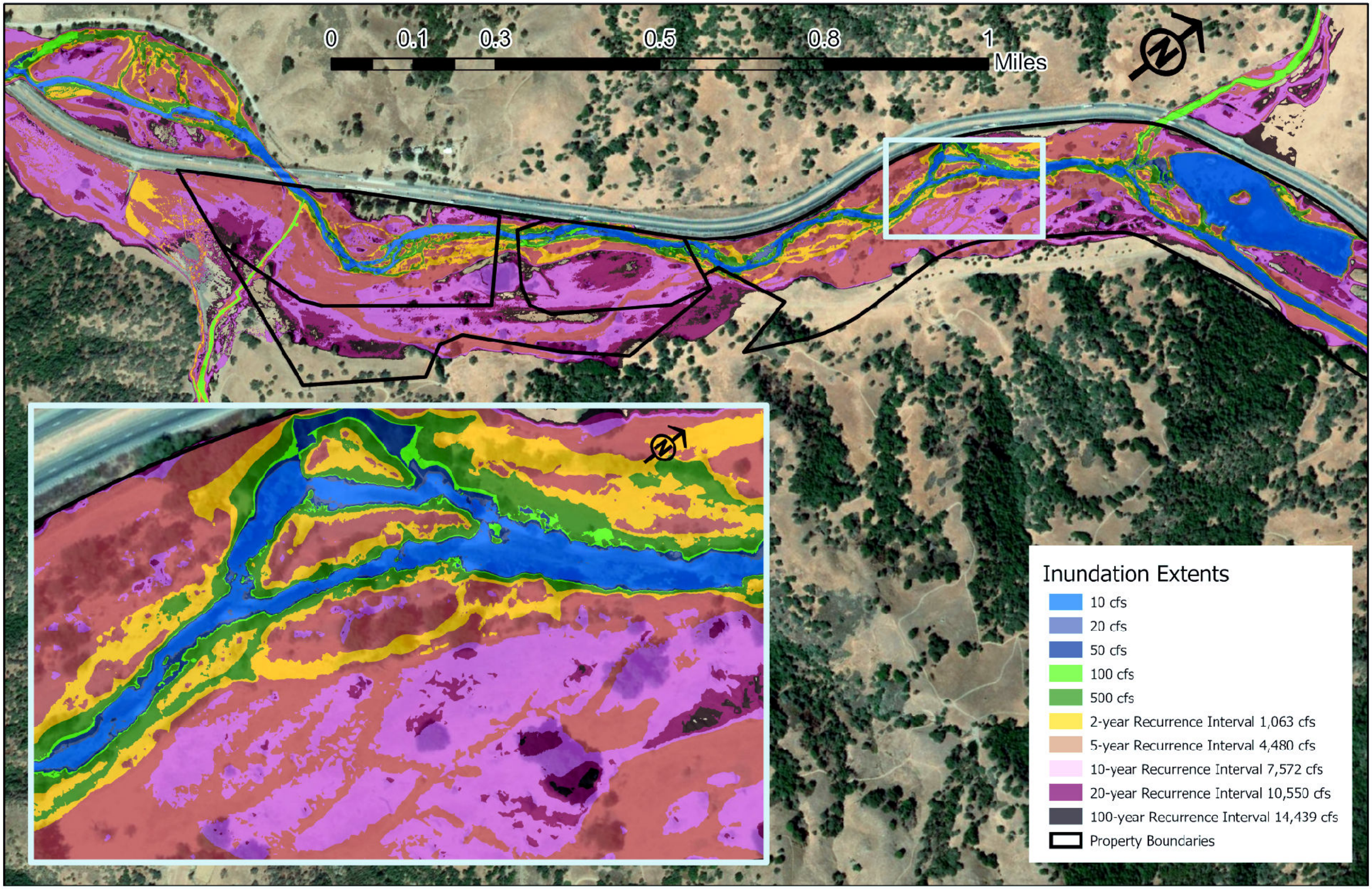
2.1.4 Hydraulic Conditions

In order to characterize hydraulic conditions (i.e., depth and velocity) of the stream channels and floodplain environments within the study area, cbec developed a two-dimensional hydraulic model for a 3.2 mile reach of Pacheco Creek, which extends from above the Ciraulo property downstream to the Cal-Fire Station below the second Highway 152 crossing. cbec used the hydraulic model to simulate hydraulic conditions for the existing topography for a range of streamflow. Details of the hydraulic model development including model inputs, domain and assumptions are described in the Pacheco Creek Hydraulic Model Development Technical Memorandum (Appendix A).

The simulated inundation extents for flows ranging from 5 cfs to 14,439 cfs (the 100-year recurrence interval flow magnitude at the study area) provide valuable context regarding secondary channel activation and floodplain connectivity within the study area (Table 3 and Figure 14). Flows are largely contained within the primary channel through the 100 cfs flow with the exception of some multi-thread channels located within the Ciraulo property. At a flow rate of 500 cfs, some secondary channel features within the inner floodplain corridor are activated (i.e., become connected to the main channel and are inundated with surface water). Flows generally remain contained to the inner floodplain corridor through the 2-year recurrence interval event (1,063 cfs) while results for the 5-year recurrence interval event (4,480 cfs) demonstrate activation of a number of secondary channel features on the broader (outer) floodplain, particularly in the upper portions of the study area. The 10-year event (7,572 cfs) shows more extensive inundation of the outer floodplain and the 20-year event (10,550 cfs) largely inundates the full floodplain extent (i.e., extending to the valley wall on the left and Highway 152 embankment on the right, when looking downstream). The simulated inundation extents of the 100-year event (14,439 cfs) are not significantly greater than the extents of the 20-year event, although depths are greater during the 100-year event.

Table 3. Flows Simulated with the Hydraulic Model

Simulation Name	Flow at USGS Location (cfs)	Flow at Study Area (cfs)
100-year	16,597	14,439
20-year	12,127	10,550
10-year	8,704	7,572
5-year	5,149	4,480
2-year	1,222	1,063
500 cfs	500	500
100 cfs	100	100
50 cfs	50	50
20 cfs	20	20
10 cfs	10	10
5 cfs	5	5



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 14 Flood Extents.mxd

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Figure 14. Flood Extents
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The simulated inundation extents demonstrate differing degrees of floodplain connectivity within the study area. The Ciraulo property (upper portion of the study area) generally exhibits greater floodplain connectivity than the downstream portion of the study (lower study area). As described in the Fluvial Geomorphology Section 2, the stream channel within the upper study area is generally well connected to a number of secondary channel features and much of the floodplain while flows in the lower study area are largely contained to the main channel and inner floodplain until the 10-year recurrence interval event. The differences in broader floodplain inundation extents between the upper and lower portions of the study area are the most pronounced for the 5-year recurrence interval flow, which drives fairly broad floodplain activation in the upper study area, but is limited to a single secondary channel on the outer floodplain in the lower study area. Described in another way, the upper study area has a much broader and well-connected inner floodplain as well as a more frequently connected outer floodplain when compared to the lower study area.

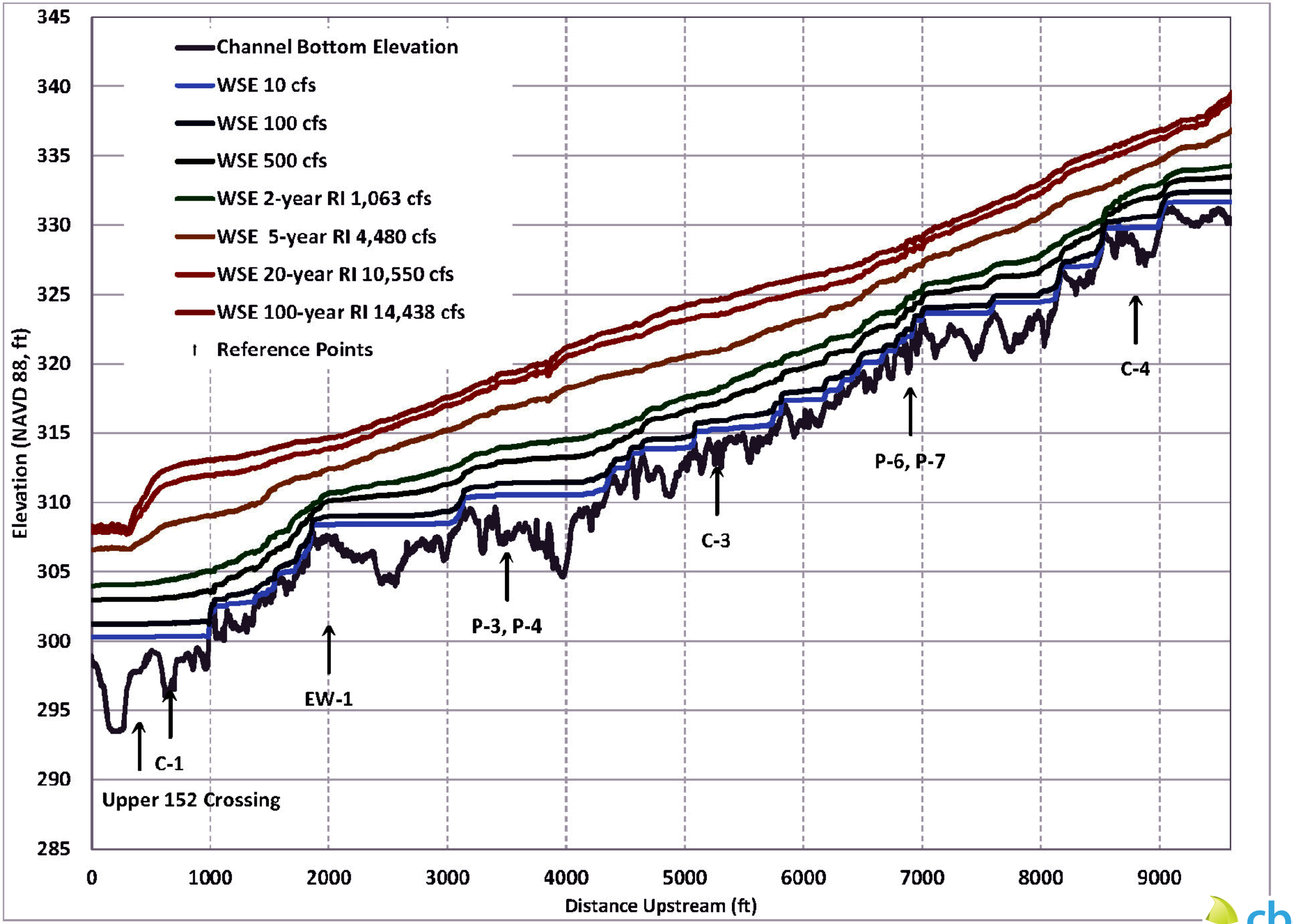
Longitudinal profiles of WSE for the simulated flows also help characterize hydraulic conditions throughout the study area (Figure 15). At lower flows, WSEs are driven by local, in-channel topographic controls (i.e., riffle crests). At higher flows such as the 20- and 100-year recurrence interval events, larger valley-wide controls (i.e., limitations on flow conveyance capacity) such as the Highway 152 bridge and abutments become more apparent.

Velocity results from the hydraulic model are used for analyses of potential for geomorphic work (i.e., the ability to mobilize sediment) and the effects of the potential expansion of the reservoir on physical processes. These analyses and results are described in Section 6 (Potential Effects of Proposed Reservoir Expansion). Hydraulic modeling of proposed topographic conditions will be conducted as part of subsequent phases of design development.

2.2 Fluvial Geomorphology

2.2.1 Geology and Soils

The geology of the PCW is primarily composed of Franciscan Complex metamorphic rocks formed during the Cretaceous period interspersed with pockets of volcanic and sedimentary rocks (Graymer et al. 2006). The study area is located on a pocket of Holocene alluvium, meaning that the valley floor was formed by soil and rock deposits transported by water. The parent material, or geology from which the soils were derived, is displayed in Figure 16. The parent material of the hillslope is "weathered from shale residuum". Most of the study area is composed of different types of alluvium. Inputs from upslope, including Cedar and Harper Creeks, are gravelly alluvium, while the valley floor is mostly loamy alluvium.



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 15 WSE Profile.mxd

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Figure 15. WSE Profile

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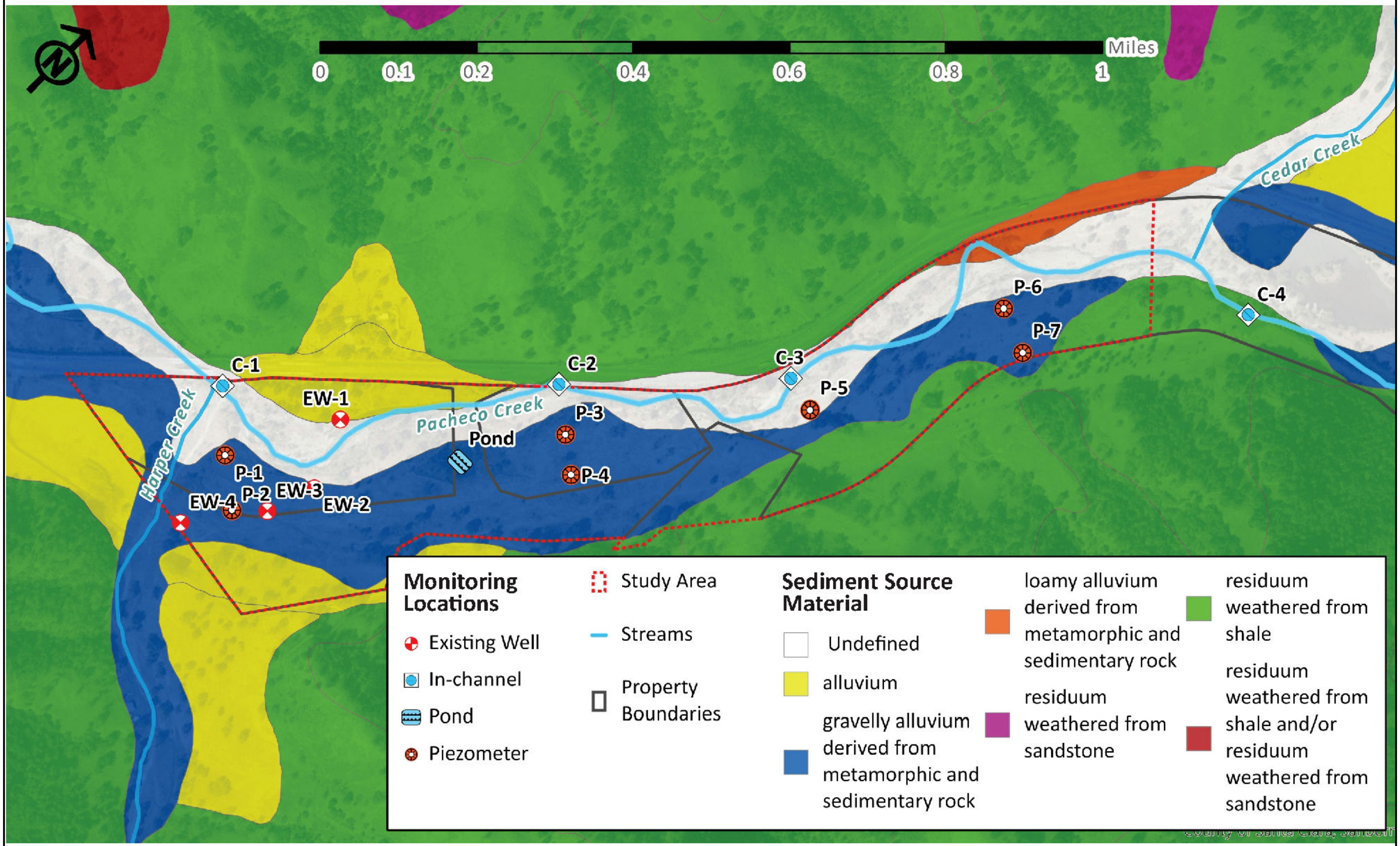

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 16 Sediment Source Material.mxd

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Figure 16. Sediment Source Material as Mapped by NRCS SSURGO 4.1

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Soils within the study area are mostly composed of two map units: Cortina very gravelly loam and Riverwash (Figure 17). The unit displayed in yellow is the Cortina very gravelly loam, 0 to 5 percent slopes. This is an excessively well drained soil series on alluvial fans and floodplains. The map unit displayed in black is Riverwash, which generally refers to deep alluvial materials that were erratically deposited during flood events. SFEI noted that Riverwash is indicative of a multi-thread channel system, which extended across the entirety of the valley in the 1927 soil survey (SFEI 2008).

The alluvial aquifer was also characterized by a geologist from Pacific Crest Engineering during the piezometer installation effort. The geologist concluded that the alluvium encountered during test borings was generally consistent with map units from adjacent hills around the study area that are "Franciscan Assemblage and includes deposits of Grawhacke sandstone, Melange, Greenstone, Conglomerate and Chert." The piezometers were installed to a depth of 20-25 ft below the ground surface and provide snapshots into the composition of the aquifer. The drill logs report that the subsurface lithology "consists of interbedded sandy to gravelly soils with varying amounts of clay and silt." A weathered conglomerate described as dense to very dense was encountered 19–19.5 ft below the ground surface in wells P-2, P-4, P-5, P-6 and P-7. In general, the geology is composed of silty gravels and sands interspersed with larger cobbles from the surface to a depth of approximately 19 ft which is underlain by a weathered conglomerate layer. The thickness of the underlying weathered conglomerate layer is unclear, but the report noted increased density in this layer suggesting that it is at least partially restrictive to the vertical flow of water. Appendix B provides additional details on soil observations and the boring logs prepared during the piezometer installations.

2.2.2 Geomorphic Overview of Larger Study Reach

cbec's geomorphologists conducted a combination of desk-based analysis and field-based reconnaissance to inform a geomorphic assessment of a larger study reach that extends both upstream and downstream of the study area. The area of focus includes Pacheco Creek from North Fork Dam, through the confluence with the South Fork and downstream to Casa de Fruta (Figure 18a). Field reconnaissance was conducted between May 29, 2019 and June 3, 2019 along Pacheco Creek from the upstream end of Casa de Fruta to sub-reach 3. Reconnaissance was also conducted along the lower 0.6 mi of Cedar Creek and the lower 1.3 mi of Harper Creek.

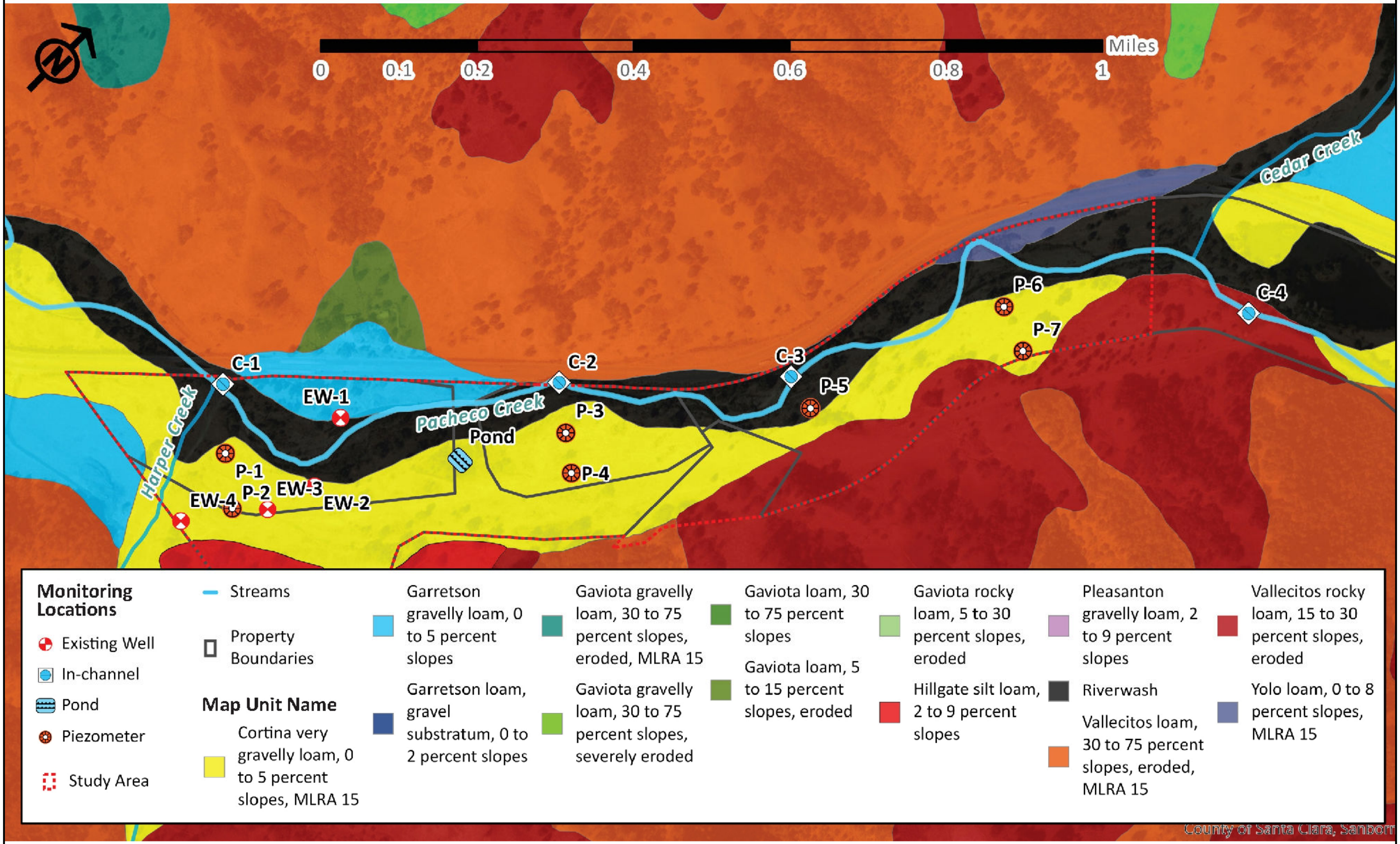
The general character of the larger study reach transitions from a steeper, laterally confined valley bottom at the upstream end to a lower-gradient, broader alluvial valley bottom at the downstream end. The valley slope decreases most prominently near the confluence of the North Fork and South Forks of Pacheco Creek (Figure 19). Approximately 1.5 mi downstream of the confluence, the valley width broadens significantly (starting at sub-reaches 3 and 4 on Figure 18b). However, physical processes along these two sub-reaches are constrained by historical disturbances including channel realignment and straightening, channel incision, floodplain encroachment and floodplain gravel extraction.

At the confluence of Cedar Creek (located at the upstream end of sub-reach 5 on Figure 18c), the channel's connectivity with the floodplain increases substantially as do the complexity and dynamism of the stream channel and floodplain. As the valley width and active floodplain width increase while valley slope diminishes, the level of historical sediment deposition and storage increase significantly. Sub-reaches 5, 6, and 7 possess multiple secondary and tertiary channels as well as prominent riparian vegetation along much of the primary channel (Figure 18c). Along sub-reach 8, Pacheco Creek passes under State Route (SR) 152 twice. Between these crossings, the channel recently cut off a significant meander bend and now flows directly into the SR 152 embankment before passing under the second crossing.

Continuing downstream, Pacheco Creek flows through a visibly disturbed floodplain area (potentially caused by mining that left behind tailings mounds) along the downstream end of sub-reach 9 (Figure 18d). The channel meanders through a maze of ridges or mounds studded with large sycamores. Sub-reach 10 is characterized by a broad and dynamic floodplain corridor with substantially less riparian vegetation establishment than present from sub-reach 5 through the upstream end of sub-reach 9. Along sub-reach 10, Pacheco Creek has also intercepted the outlet of a pond (likely a legacy gravel extraction area) and now has a direct surface connection with this feature during base flow conditions. As Pacheco Creek approaches Casa de Fruta along sub-reach 11, the active channel and floodplain corridor is dramatically reduced in width due to the construction of berms or levees along both creek banks (Figure 18d). The channel also appears to have been realigned and straightened. The combination of these factors greatly impairs natural physical processes and results in the most significant transition in the geomorphic character of Pacheco Creek along the larger reconnaissance reach.

2.2.2.1 Spatial Trends in Scour and Deposition

To further characterize spatial trends in physical processes and channel dynamism, inner channel and floodplain areas that were recently subject to scour, deposition or both processes were coarsely digitized between the North Fork Dam and the Casa de Fruta leveed reach (Figure 20). Much of this scour and deposition can likely be attributed to high flows during WY 2017's winter flood events. The WY 2017 peak flow was the second greatest of the period of record for the USGS Dunneville gage (11153000) and appears to have driven significant geomorphic change along Pacheco Creek. As described above, channel and floodplain dynamism appear limited between the North Fork Dam and the Cedar Creek confluence due to a combination of lateral confinement of the valley bottom, channel realignment, and channel incision. Between Cedar Creek and Harper Creek, channel and floodplain dynamism increases significantly. Continuing farther downstream, channel and floodplain dynamism becomes even more pronounced with broad expanses of the channel and floodplain showing recent scour and deposition. This pattern generally continues until Pacheco Creek is confined by levees near Casa de Fruta.



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 17 Unit Name and Description.mxd

Figure 17. Unit Name and Description as Mapped by NRCS SSURGO

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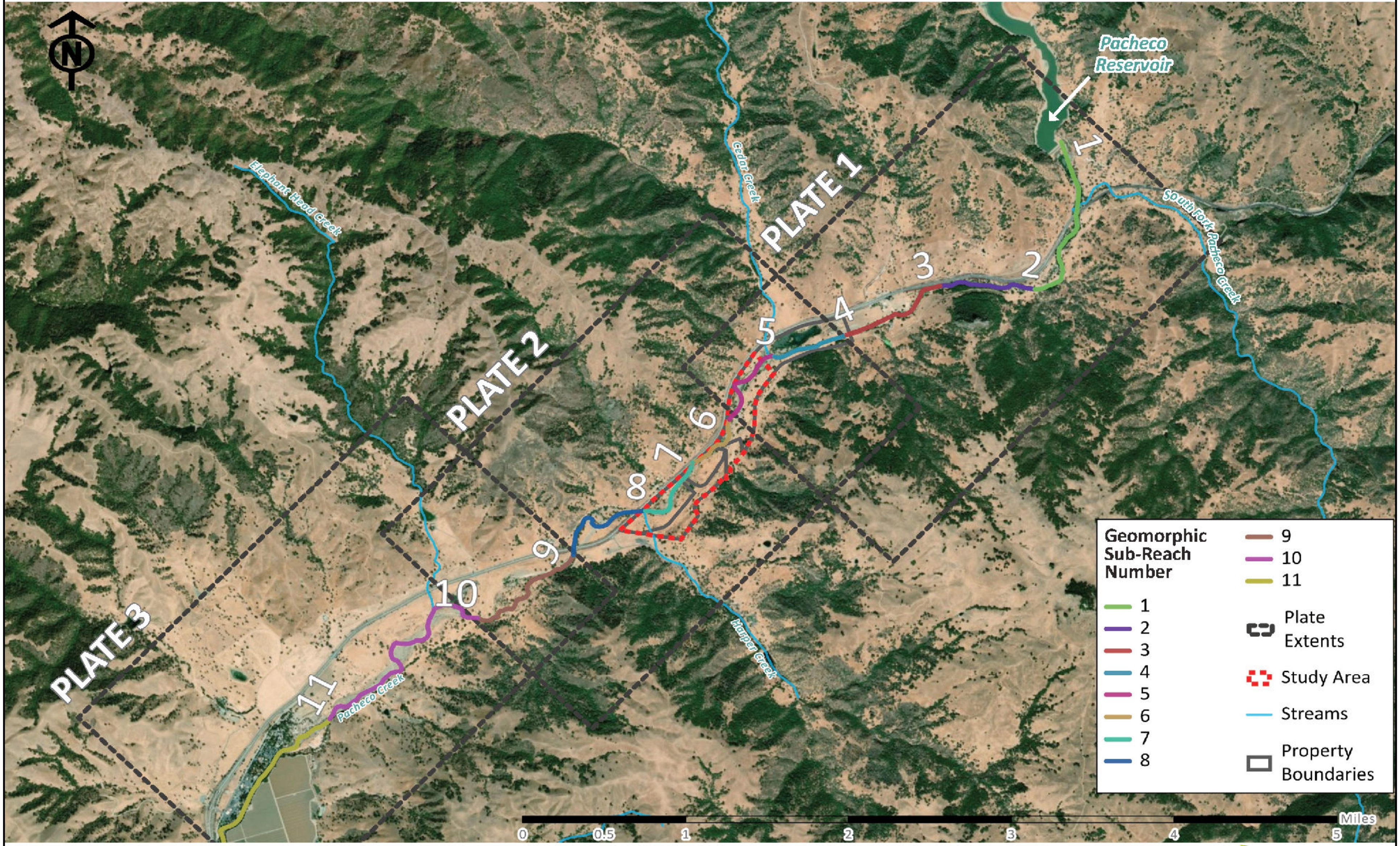

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 18a Geomorphic Overview.mxd

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Figure 18a. Geomorphic Overview of the Larger Reconnaissance Reach

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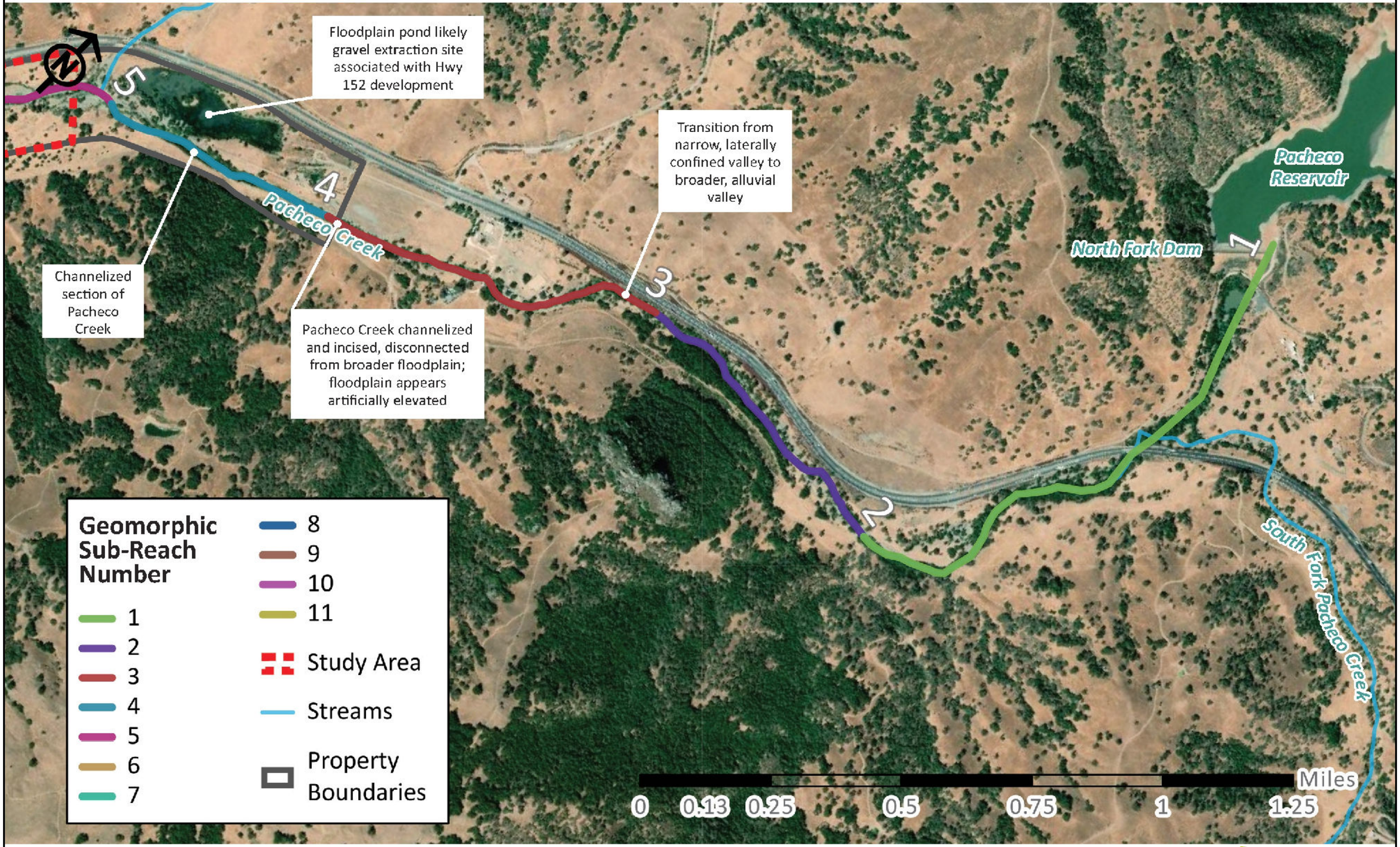

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N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 18b Geomorphic Overview - Plate 1.mxd

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Figure 18b. Geomorphic Overview of the Larger Reconnaissance Reach - Plate 1
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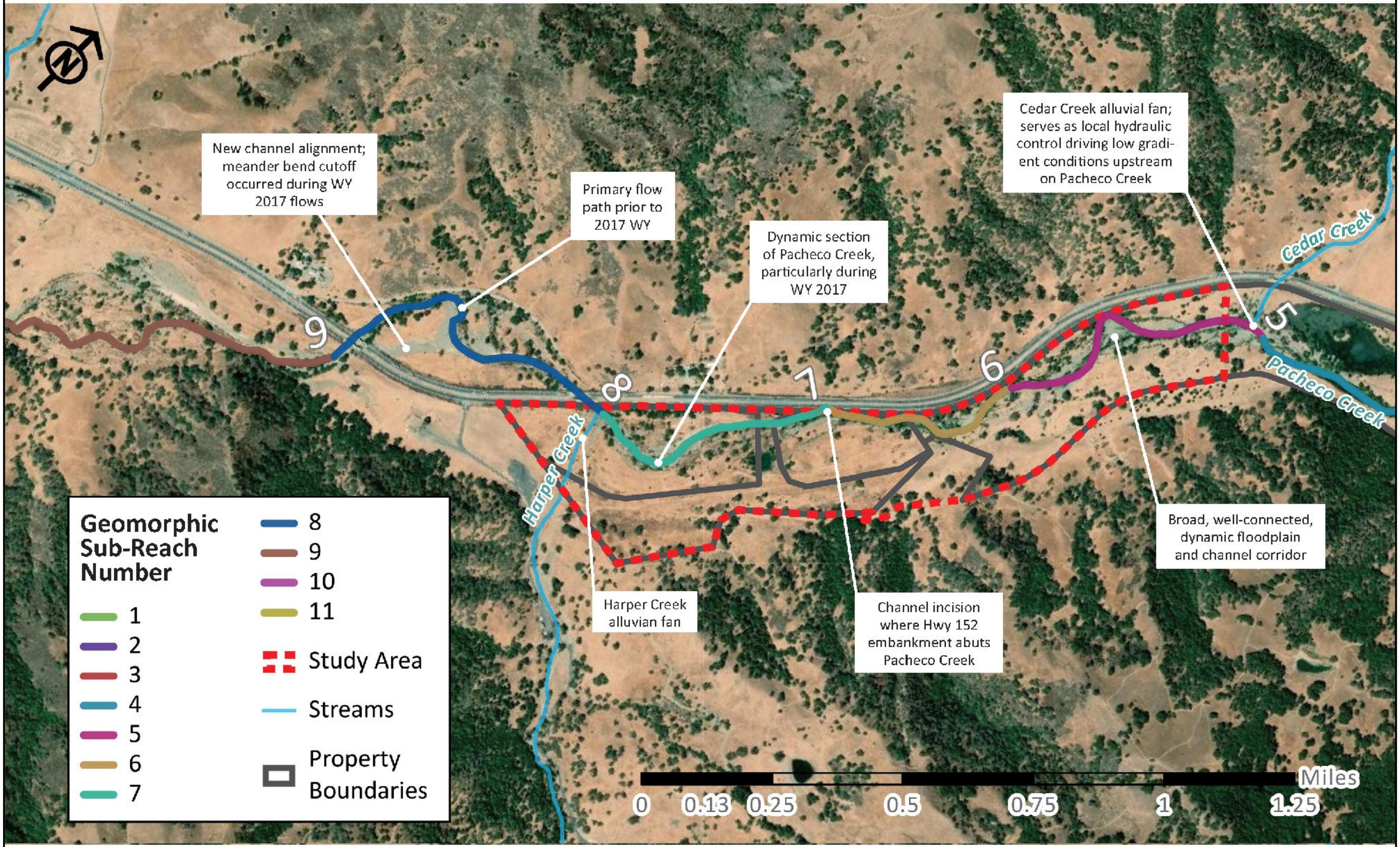

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Figure 18c. Geomorphic Overview of the Larger Reconnaissance Reach - Plate 2

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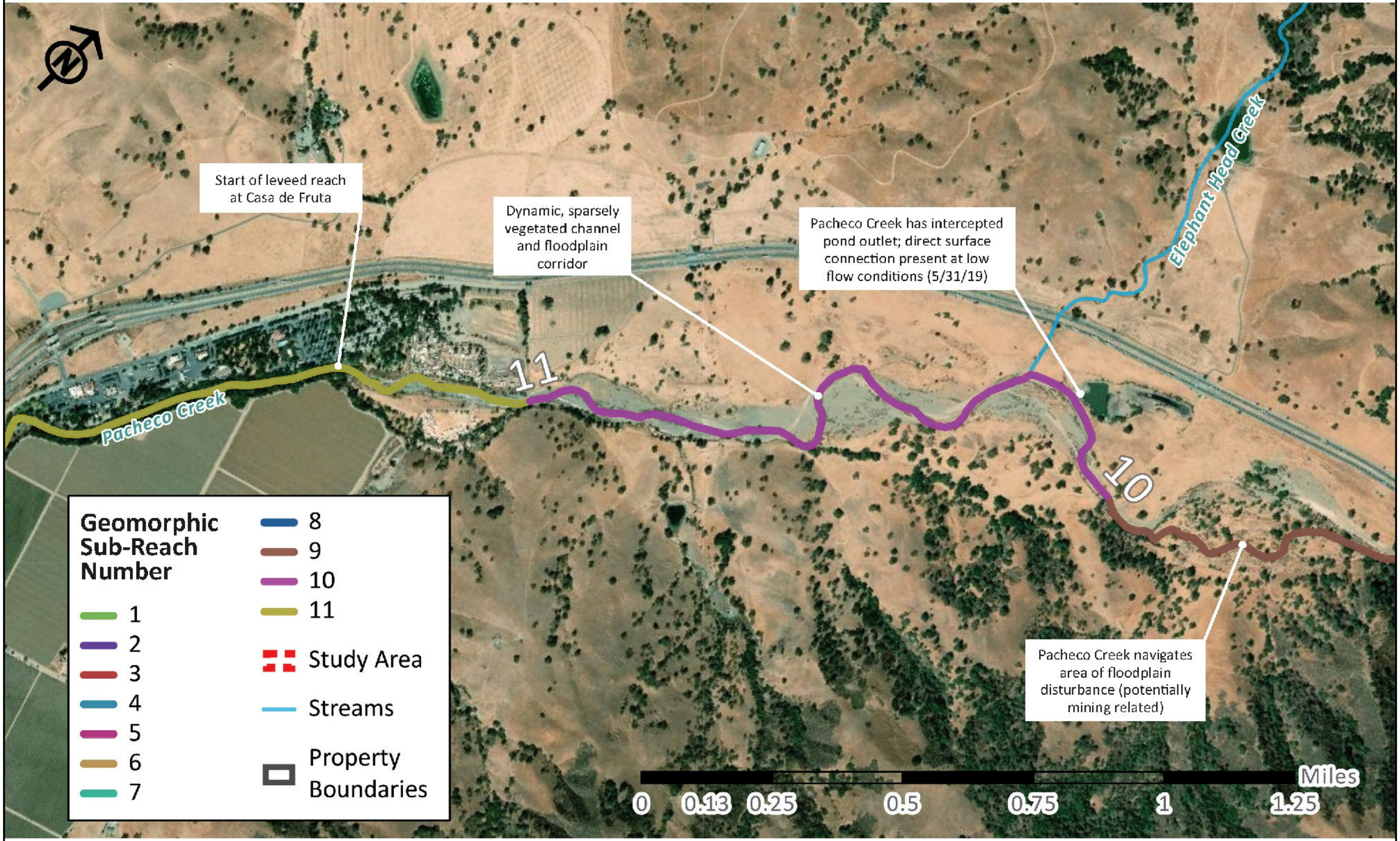

Start of leveed reach at Casa de Fruta

Dynamic, sparsely vegetated channel and floodplain corridor

Pacheco Creek has intercepted pond outlet; direct surface connection present at low flow conditions (5/31/19)

Pacheco Creek navigates area of floodplain disturbance (potentially mining related)

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 18d Geomorphic Overview - Plate 3.mxd

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Figure 18d. Geomorphic Overview of the Larger Reconnaissance Reach - Plate 3

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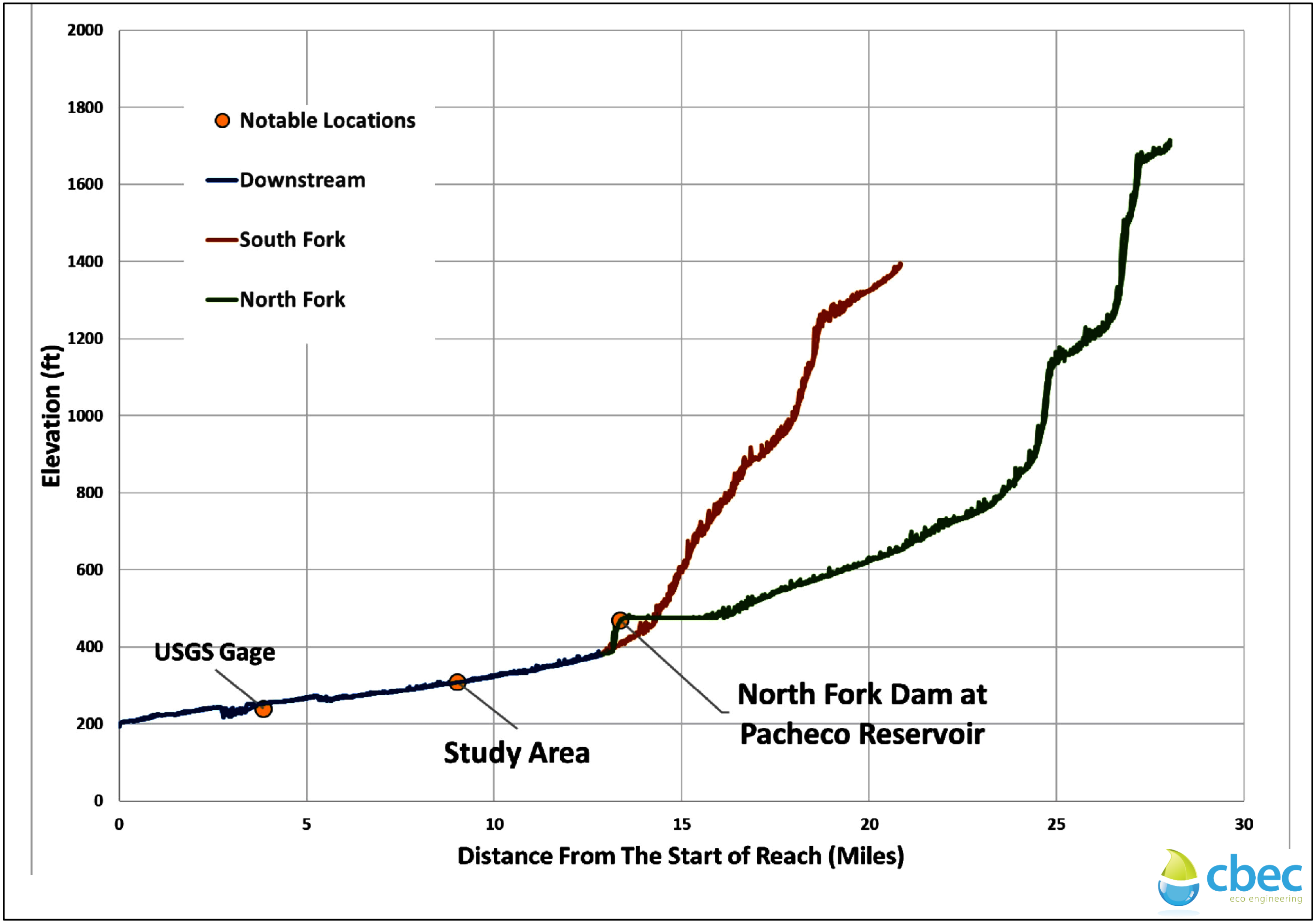

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 19 Longitudinal Profile.mxd

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Figure 19. Pacheco Creek Longitudinal Profile

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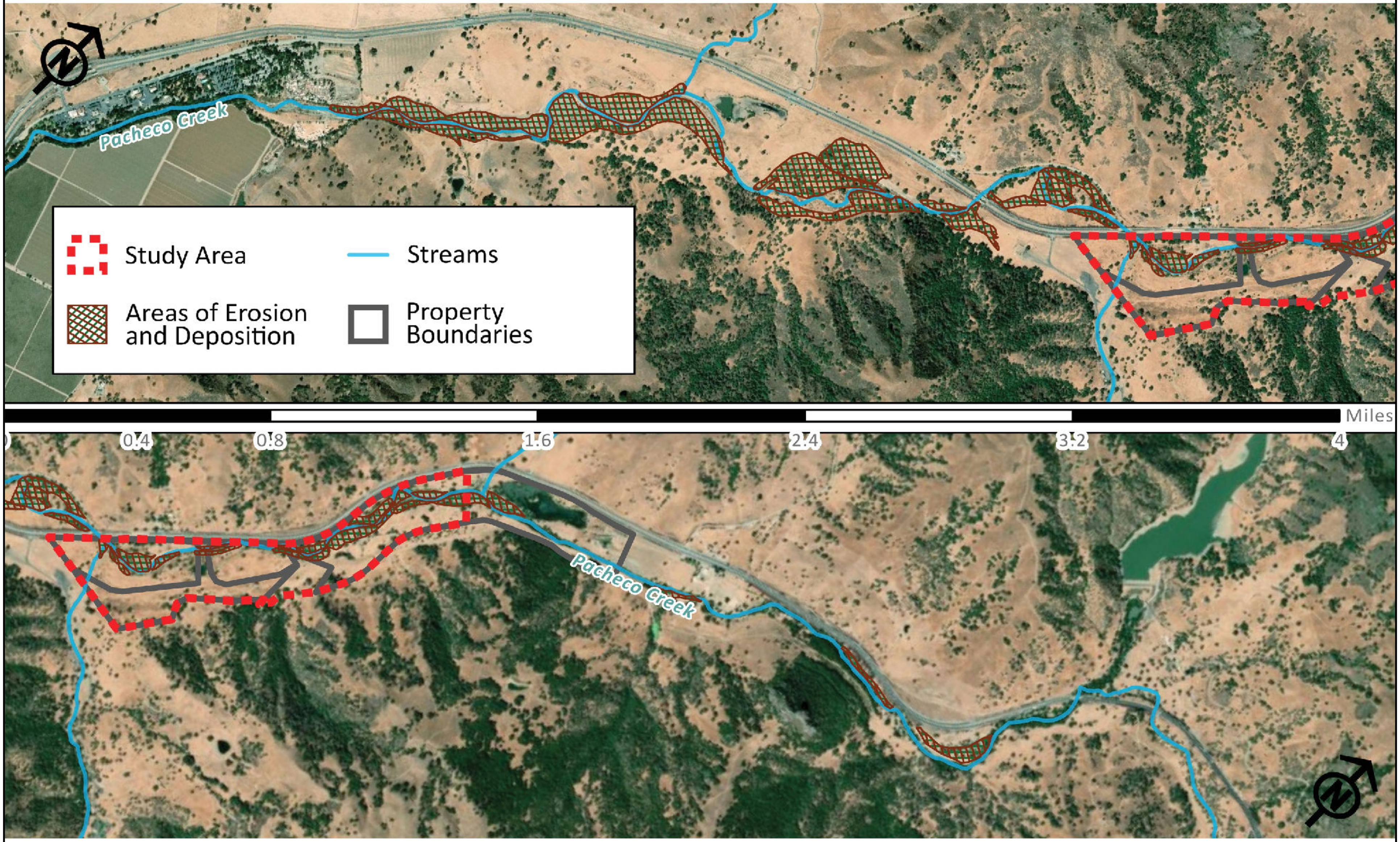

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Figure 20. Areas of Recent Scour and Deposition

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2.2.2.2 Disturbances to Physical Processes

The most significant disturbance to Pacheco Creek's physical process regime was the construction of the North Fork Dam to impound Pacheco Reservoir in 1939. As is typical with reservoirs and dams, Pacheco Reservoir captures all coarse sediment supply that is delivered to it. With 52% of the contributing watershed area (as measured at the downstream end of the study area) located above the reservoir, Pacheco Creek has experienced a significant reduction in the amount of sediment that was historically delivered to it. While Pacheco Creek does not appear to be highly sediment-limited along the study reach, historical and ongoing channel incision along some sections of the study area may be due in part to reduction in the coarse sediment load resulting from the dam. Additionally, the reservoir dampens peak flows along Pacheco Creek, specifically early in the winter season before the reservoir has filled, which can reduce the magnitude and duration of flood events and their associated capacity to perform geomorphic work (i.e., rework) the channel and floodplain. The summertime flow releases from the reservoir, that are used to support groundwater levels for irrigation pumping, result in higher summer base flows and have likely driven greater establishment, encroachment, and persistence of obligate riparian vegetation along the edge of the channel. In some areas, the density of this vegetation and the armoring it provides to the stream banks likely resist lateral channel migration and overall channel dynamism relative to historical conditions. The interaction of these processes is further described in Section 4 - Sycamore Regeneration Conceptual Model.

Another disturbance to Pacheco Creek's physical process regime includes the construction of SR 152. While the highway is generally located along the margins of the valley floor, it encroaches on Pacheco Creek's floodplain and its crossings over Pacheco Creek likely influence reach-scale hydraulics. In some instances, lateral migration of Pacheco Creek appears to be arrested by the armored embankment of the highway which in turn may be driving localized channel incision, particularly along sub-reach 6. Cattle grazing occurs along much of the larger reconnaissance reach and results in impacts to the channel banks and the composition of the riparian and floodplain vegetation. Gravel extraction from the Pacheco Creek floodplain is also evident where several persistent pond features remain on the landscape. The construction of an impoundment on Harper Creek approximately 1.3 miles upstream of the confluence reduces transport of coarse sediment to Pacheco Creek. Channel realignment, levee construction and floodplain disconnection are also present, particularly starting near Casa de Fruta where agricultural activities and land development within the floodplain are most prominent. These disturbances, particularly levee construction, have converted what was once likely a highly dynamic reach into a highly confined reach.

Within the vicinity of the study area, it appears that Pacheco Creek has incised since the construction of the existing reservoir and may be continuing to undergo incision in some reaches. Potential evidence of ongoing incision includes a tendency towards channel straightening in some portions of the study area (described below) as well as immediately downstream of the study area between the two Highway 152 bridge crossings where the primary channel exhibited a significant realignment during the WY 2017 winter flood events. The potential for ongoing and future incision, including in response to the potential reservoir expansion, should be considered in the development of any management and restoration opportunities.

2.2.3 Geomorphic Overview of Study Area

2.2.3.1 Historical Channel Alignment

The historical geomorphology of Pacheco Creek is well documented in the *South Santa Clara Valley Ecology Study* prepared by SFEI (2008). Many accounts describe Pacheco Creek as a braided channel with gravels and sparse sycamores across the entire valley near the study area. Pacheco Creek currently occupies a narrower riparian corridor. To understand the migration of the primary channel alignment in recent years, readily available historical imagery was used to delineate the location of the primary channel (Figure 21). The oldest available image is from 1939, which shows what appears to be a primary channel in a similar alignment to present yet a significantly less densely vegetated riparian corridor. The one major exception is that the pond at the northeast section of the Ciraulo property did not yet exist, and the stream likely passed through that location. This does come with the caveat that it is difficult to determine the exact location of the channel from the older imagery, as the riparian corridor was not densely vegetated at that point in time and the image resolution is limited. Imagery from 2001, 2006, 2012, 2016, and 2017 was also evaluated. Each of these images show that the primary channel operated in the same general corridor that it does today with minor meandering of the main channel. Major changes were observed after WY 2017 winter flows when the second highest peak flow on record was observed. In the area adjacent to P-6 (within sub-reach 5), Pacheco Creek cut off a significant meander bend thus realigning the channel over an 800 ft reach. As described above, downstream of the study area and SR 152 crossing, another major shift in the channel occurred realigning over 1,000 ft of channel (within sub-reach 8). The realignment would have been more significant if it had not been laterally confined by SR 152, where the channel is currently eroding riprap at the base of the highway.

2.2.3.2 Relative Elevation Model

A relative elevation model (REM) was developed to visualize the elevation of the floodplain relative to the stream channel prior to the development of the hydraulic model. The concept of a REM was developed from “stage 0” restoration, which is a recently popularized process-based restoration approach designed to create resilient, complex, and dynamic river systems (Cluer and Thorne 2014; Powers et al. 2019). The process relies on using a Geomorphic Grade Line (GGL) approach intended to approximate the pre-disturbance valley surface. The topographic data used in this analysis was the 2006 1/9 arc-second Santa Clara County USGS National Elevation Dataset[4]. The GGL is drawn parallel to the valley slope. Elevations are sampled along the GGL and a best-fit trend line is established to remove minor irregularities in topography. A surface based on the GGL best-fit trendline elevation is subtracted from the existing digital elevation model for the area of interest to calculate the relative elevation of the study area compared to the generalized valley surface. This analysis was applied to the study area with results displayed in Figure 22. Note that the blue areas do not indicate the expected WSE, but rather places that are lower than what was projected as the generalized valley surface. The actual base-flow water surface could be anywhere from -3 to -5 ft from the generalized valley surface. The

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[4] This 2006 topographic data set was selected for the feasibility study analysis because it is the highest resolution data set that was readily available for the study area at the time of the REM development. More recent yet lower resolution topographic data sets are also available, and the topographic data utilized in the hydraulic model consists largely of data acquired by cbec in 2019 and 2020.

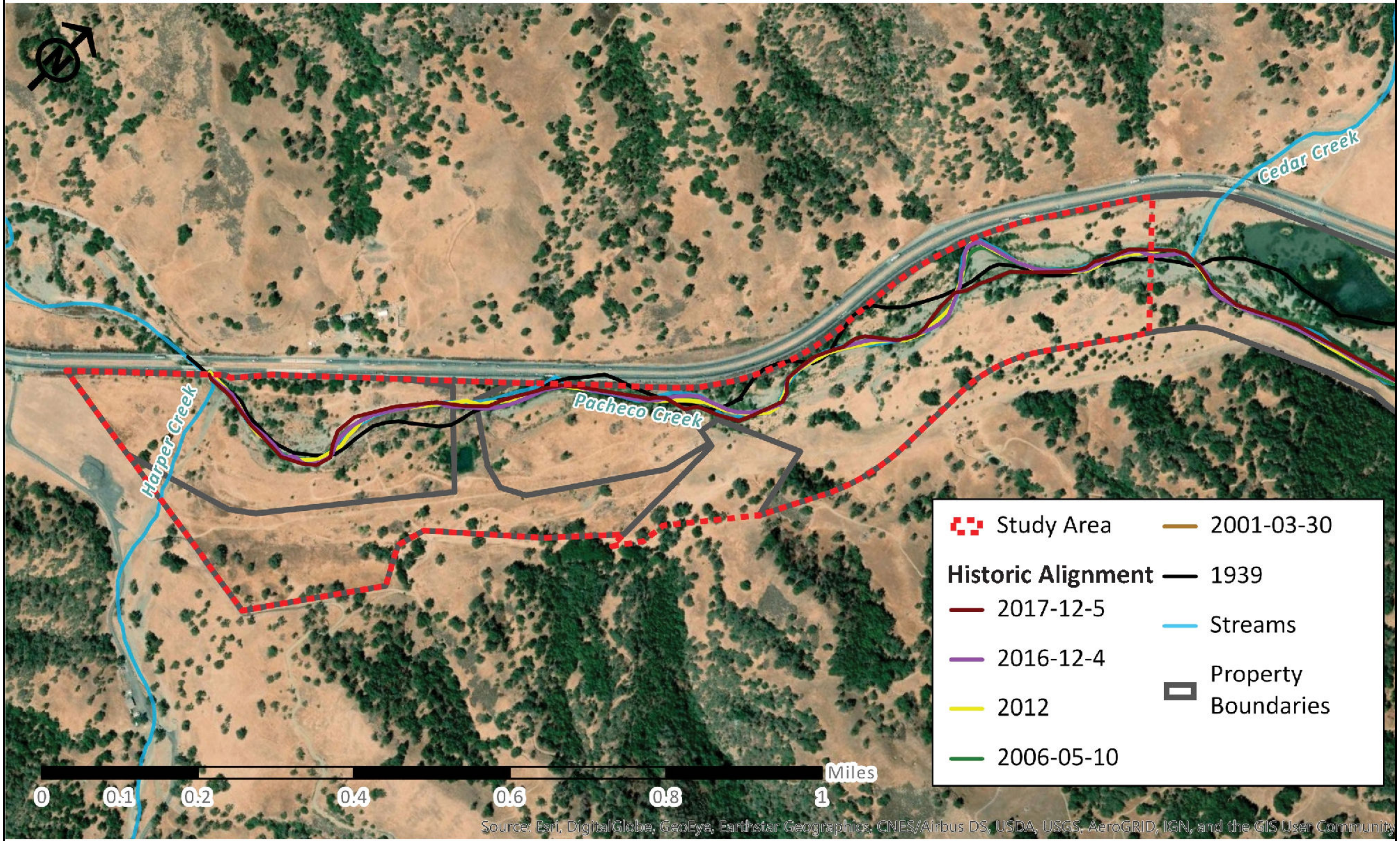
REM provides a useful tool at the feasibility study stage of the project to allow greater understanding of floodplain connectivity and to identify potential restoration measures.

2.2.3.3 Geomorphic Overview of Study Area Sub-Reaches

Within the study area, Pacheco Creek is an alluvial system with a dynamic channel and broad, well-connected floodplain at the upstream end generally trending towards a narrower, moderately connected floodplain downstream. Channel morphology is composed predominantly of pool-riffle sequences intermixed with slow-glide units. With some exceptions, spring and early summer base flows (when present) are confined to a single primary channel yet numerous secondary and tertiary channels are present (as visible in the REM in Figure 22 and hydraulic modeling inundation extent results in Figure 14). The better connected of these secondary channels likely begin activating after small precipitation events while the tertiary channels along the outer floodplain require more significant flows to activate. An abundance of recently activated depositional sediment bars are present within the main channel and inner floodplain. Substrate size generally ranges from sand and silt to cobble sized particles.

Channel complexity along the study reach ranges from complex, high-quality in-channel habitat in some areas to relatively straight sections with homogeneous bedforms and morphology offering relatively poor in-stream habitat. A limited amount of large wood, including dead mature sycamore trunks, is present within the channel and inner floodplain bar surfaces, and where it occurs, it drives localized topographic complexity of the channel bed and floodplain. We expect that today's levels of large wood within and along Pacheco Creek are lower than pre-disturbance levels due to reduced abundance of mature sycamores, land management and the presence of Pacheco Reservoir. Riparian vegetation is well established along the margins of much of the primary and secondary channels with some areas of canopy cover extending over the edges of the channel or even the full channel width. In some places, it appears that riparian vegetation and its associated root structure is armoring the stream banks and inhibiting lateral migration that may have otherwise naturally occurred prior to elevated reservoir-supported base flows during the dry season.

Sub-Reaches 4 and 5—At the upstream end of the study area, the unregulated Cedar Creek is tributary to Pacheco Creek. Above this confluence, Pacheco Creek appears to have been historically straightened and realigned with a relict pond (likely created by gravel extraction) occupying much of the floodplain. Cedar Creek's alluvial fan appears to function as a hydraulic control on Pacheco Creek, causing flatwater conditions and likely muting channel dynamism upstream of the confluence. Downstream of the confluence, the channel and floodplain character change dramatically. Channel and floodplain dynamism increase significantly as the stream moves into the relatively undisturbed sub-reach 5. As evident in the REM, the floodplain appears to be relatively well connected to the stream channel (i.e., the difference in elevation of the stream bed relative to the floodplain surface is low) and exhibits the greatest floodplain connectivity present within the study area. A number of regularly activated secondary channels are visible, including several that carry flow or are backwatered during base flow conditions (when Pacheco Creek is actually flowing). The combination of depositional processes and a broad, well-connected floodplain appear to drive dynamic channel and floodplain behavior with regular adjustments to channel alignment and flow paths.



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 21 Historical Channel Alignments.mxd

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Figure 21. Historical Channel Alignments
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N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 22 Relative Elevation Model for the Study Area.mxd

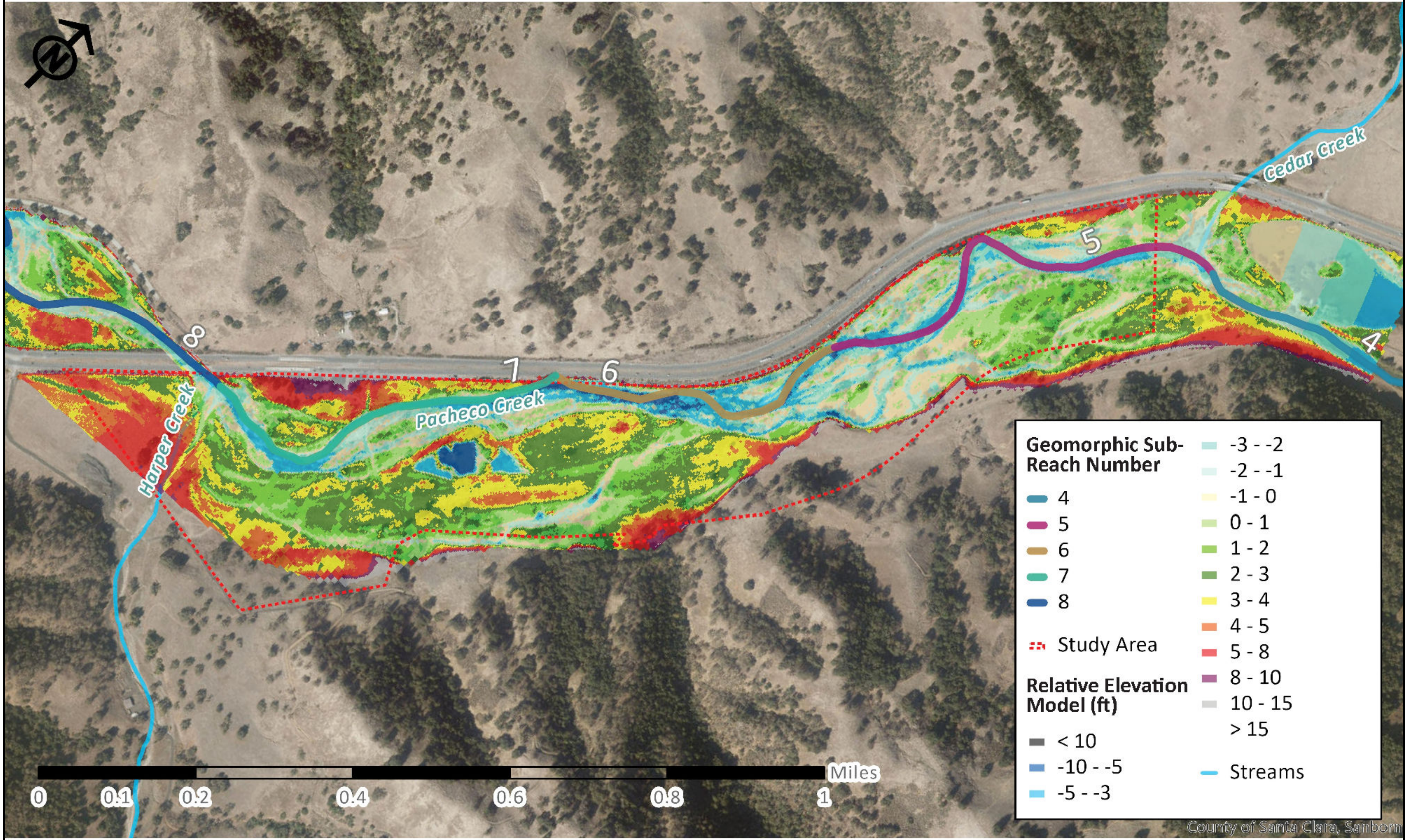

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Figure 22. Relative Elevation Model for the Study Area

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Sub-Reach 6—Continuing downstream to sub-reach 6, the valley walls (i.e., the adjacent hillsides) pinch down the width of valley floor and floodplain. At several points along this sub-reach, the embankment of SR 152 abuts the current alignment of the stream and likely resists lateral migration to the northwest. The channel appears somewhat incised and is substantially lower than the outer floodplain surface compared to the upstream sub-reach (Figures 14 and 22). It is likely that the stream energy from the lateral migration arrested by the SR 152 embankment may be driving, or at least contributing to, channel incision. Local bedrock outcrops and/or erosion-resistant soil layers may be helping to arrest further incision. Overall, the active channel corridor width is significantly less compared to the upstream sub-reach and channel dynamism and complexity are muted.

Sub-Reach 7—At the upstream end of sub-reach 7, the Pacheco Creek channel is straight and generally lacks morphological complexity. A narrow yet well-connected inner floodplain surface is present along the left bank while the right bank is tall, steep, unstable and actively eroding. Compared to the upstream extent of the study area (i.e., sub-reach 5), the stream channel is fairly disconnected from the outer floodplain. The outer floodplain also features a pond (i.e., Pond 1) ringed by a slight berm feature. This pond likely remains disconnected from surface flows except during large flood events. This portion of sub-reach 7 may be undergoing active incision processes.

Continuing downstream, channel dynamism and complexity increase significantly in the vicinity of the major meander bend upstream of the Harper Creek confluence and SR 152 crossing. This area, where there is a large bend, was subject to significant geomorphic adjustment during the WY 2017 winter flows. In particular, the large depositional bar and inner floodplain surface along the right bank experienced substantial erosion and reworking[5]. This surface also appears to have the greatest concentration of juvenile sycamores that have naturally established within the study area, with most of them occurring within areas of heightened dynamism or geomorphic adjustment. The outer (i.e., left when looking downstream) stream bank is also actively eroding at the apex of the meander bend. This erosion is converting what is currently a disconnected, high outer floodplain surface into a lower, well-connected inner floodplain area that is part of the dynamic active channel corridor.

The dynamism of this site is likely influenced by the Harper Creek alluvial fan and the SR 152 crossing. Both of these features likely drive reach-scale hydraulics and sediment dynamics. The SR 152 crossing holds static the stream channel alignment in the vicinity of the crossing and just upstream where buried riprap groynes[6] are located within the right bank and extend well into the floodplain to the base of the highway embankment. Dense, well-established riparian vegetation also dominates the right bank and further impedes channel adjustment immediately upstream of the crossing. While current flows and sediment loads from Harper Creek

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[5] The REM in Figure 22 is based on topographic data collected before WY 2017 flows and hence does not depict the geomorphic adjustments and current elevations of this feature.

[6] Groynes are rigid hydraulic structures, typically made of rip-rap or large rock, constructed in riverine or coastal settings to influence local hydraulics and sediment transport. In rivers, groynes are often constructed from the bank, extending perpendicularly into the channel. In this setting on Pacheco Creek, the observed groynes are buried in the stream bank and extend into the floodplain, rather than protruding into the channel. If the right (facing downstream) bank begins to erode, these buried groynes will likely resist lateral migration of the channel in the river right direction.

are likely diminished due to a privately owned and operated reservoir that impounds water roughly 1.3 mi upstream of the confluence, the alluvial fan maintains Pacheco Creek's alignment along the right side of the valley in this area.

2.3 Land Cover Types

Prior to conducting land cover mapping, H. T. Harvey plant ecologists reviewed current and historical aerial images (Google Inc. 2019; Nationwide Environmental Title Research 2019) of the project area; a USGS topographic map; the National Wetlands Inventory (National Wetlands Inventory 2019); and other relevant scientific literature and technical databases. Previous reports prepared for the project vicinity were also reviewed, including the *Pacheco Creek Reserve Vegetation Mapping Memorandum* (Prunuske Chatham Inc. 2018) and *The Definition and Location of California Sycamore Alluvial Woodland* (Keeler-Wolf et al. 1996).

Land cover mapping was conducted by H. T. Harvey plant ecologists on April 3, 2019. During the site visit, land cover data was recorded with the GIS Kit application (Garafa, LLC) on an Apple iPad. In the office, field data and observations were then used to map land cover types over aerial imagery in ArcMap (ESRI). A follow-up visit to further refine SAW mapping and perform a preliminary land cover survey of the Ciraulo property was conducted with H. T. Harvey's principal plant ecologist on April 26, 2019. A breakdown of the acreages of each land cover type is shown in Table 4 and their locations are depicted in Figure 23.

Table 4. Existing Surface Area of Land Cover Types

Land Cover Type	Surface Area (Acres)
California Annual Grassland	64.92
Mixed Oak Forest and Woodland	51.04
Willow Riparian Forest and Scrub	40.36
Central California Sycamore Alluvial Woodland	8.24
Mixed Riparian Forest and Woodland	7.08
Diablan Sage Scrub	1.34
Pond	0.78
Seasonal Wetland	0.42

2.3.1 California Annual Grassland

California annual grassland covers most of the study area, predominately to the east of Pacheco Creek (Figure 23). Vegetation in this land cover type is dominated by non-native annual grass species such as ripgut brome (*Bromus diandrus*), soft brome (*Bromus hordeaceus*), and foxtail barley (*Hordeum murinum*). Nonnative invasive forbs are also present and include yellow star thistle (*Centaurea solstitialis*) and milk thistle (*Silybum marianum*). However, this land cover type also includes lesser amounts of native forbs, including various lupine species (*Lupinus* spp.), common gumplant (*Grindelia camporum*), California goldfields (*Lasthenia gracilis*), narrow leaved owl's clover (*Castilleja attenuata*), and California golden violet (*Viola pendunculata*). Scattered, individual coast live oak (*Quercus agrifolia*) and valley oak (*Quercus lobata*) occur within areas mapped as California annual grassland.

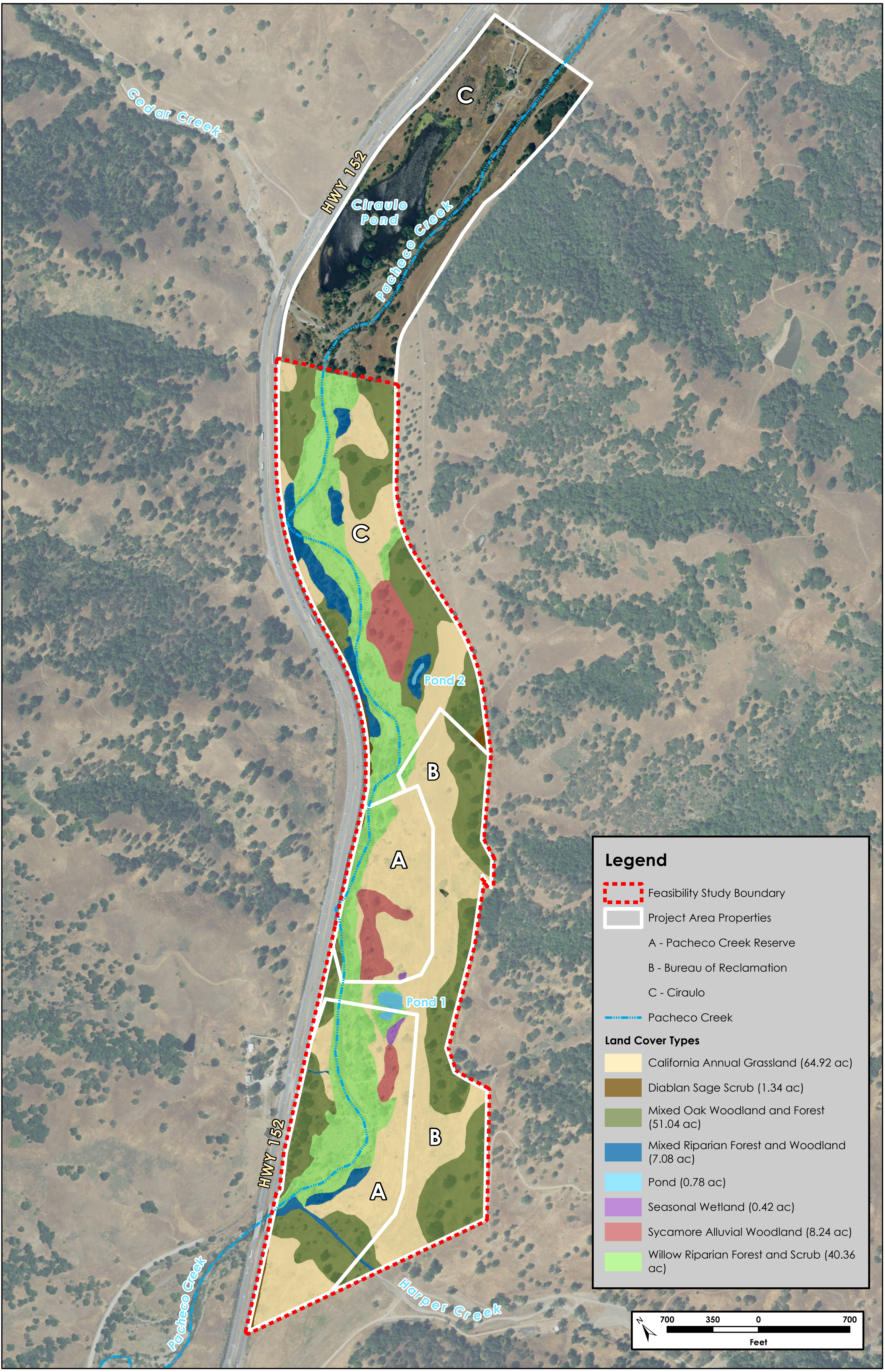

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Figure 23. Feasibility Study Area and Existing Land Cover Types

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Portions of the study area currently mapped as California annual grassland were historically part of the broad swath of SAW which dominated the now outer floodplain adjacent to Pacheco Creek (Keeler-Wolf et al. 1996). Numerous large, dead California sycamores are present within portions of the area currently mapped as California annual grassland. We hypothesize that the sycamore mortality may be due to declining shallow groundwater tables, reduced physical processes that historically resulted in more regular inundation of the outer floodplains, and/or recent longer-term drought cycles.

2.3.2 Mixed Oak Woodland and Forest

Mixed Oak Woodland and Forest occurs intermittently throughout the study area, and consists of a mix of widely spaced to closed-canopy mature coast live oak and valley oak in a matrix with the adjacent California annual grassland (Figure 23). The understory herbaceous vegetation is similar to that of the California annual grassland.

2.3.3 Willow Riparian Forest and Scrub

Willow riparian forest and scrub is extremely abundant along Pacheco Creek within the study area, and is the dominant riparian land cover type (Figure 23). The vegetation is generally dominated by a dense shrub layer consisting of arroyo willow (*Salix lasiolepis*) and mule fat (*Baccharis salicifolia*). Some larger tree species, including red willow (*Salix laevigata*), California sycamore, and coast live oak occur here, but they do not form dense or continuous stretches of canopy. In areas with understory development, vegetation consists of California poppy (*Eschscholzia californica*) and ruderal nonnative grasses such as ripgut brome and rattail sixweeks grass (*Festuca myuros*).

2.3.4 Central California SAW

Central California SAW historically occupied most of the study area along the east side of Pacheco Creek, as evident by historical floodplain channels, alluvial deposits, and the extensive distribution of both dead and living California sycamore individuals. Currently, the distribution of this land cover type is significantly reduced, and occurs in three small, district stands in the study area (Figure 23). Most of these areas lack a shrub layer, but in some areas the willow riparian forest and scrub land cover type intergrades along the historical flood channels, and mule fat and arroyo willow are present. Understory herbaceous vegetation consists of the components of California annual grassland land cover type.

2.3.5 Mixed Riparian Forest and Woodland

This land cover type is much less common than the adjacent willow riparian forest and scrub, and is differentiated by a mature and dense tree canopy of coast live oak, red willow, and California sycamore (Figure 23). Additionally, two intermittent tributaries to Pacheco Creek (Harper Creek and an unnamed creek in the Pacheco Creek Reserve) are mapped as this land cover type despite their lack of overstory vegetation, as this is the most appropriate land cover type per the definitions in the Habitat Plan.

2.3.6 Diablan Sage Scrub

Diablan sage scrub land cover exists as a narrow strip of shrub vegetation which borders the edge of SR 152 (Figure 23). Vegetation composition here primarily consists of California buckwheat (*Eriogonum fasciculatum*) and California sagebrush (*Artemisia californica*). This area was likely seeded with these species in the past as part of a California Department of Transportation (Caltrans) project associated with SR 152. This land cover type also occurs in a small area on the eastern edge of the study area, near the toe slope of the adjacent hills.

2.3.7 Seasonal Wetland

This land cover type occurs sporadically throughout the study area, and is generally associated with the historical secondary channels of Pacheco Creek or with large excavated depressions in the California annual grassland (Figure 23). Vegetation varies amongst the marshes, but generally consists of an herbaceous layer of wire rush (*Juncus balticus*), common bog rush (*Juncus effusus*), tall cyperus (*Cyperus eragrostis),* or spike rush (*Eleocharis macrostachya*). These marshes also vary in overstory, with some being entirely herbaceous, while those is the historical channels having a shrub layer of mule fat or an overstory canopy of large red willows.

2.3.8 Pond

Two significant ponds were observed in the study area. The largest is located in the southern half of the study area, to the east of Pacheco Creek; this is denoted as Pond 1 in Figure 23. This pond has significant depth, and is likely perennial in most years. This pond was apparently excavated by a previous landowner within the California annual grassland sometime in the past; the original purpose of this pond is unknown. Another smaller pond occurs near the center of the study area, and is obscured on aerial imagery by overhanging tree canopy; this is denoted as Pond 2 in Figure 23. Pond 2 is substantially shallower than Pond 1. The origin of this pond is unknown, although it is within a historical channel and may have been natural scoured, however it may have been further excavated by a previous landowner to enhance the water source for cattle. We observed that there was no surface ponding in Pond 2 in July 2019.

2.4 Habitat Plan Covered Wildlife Species and Steelhead

This section briefly describes the potential for occurrence of Habitat Plan covered wildlife species at the site to inform identification of habitat preservation, enhancement, restoration, and creation opportunities that could benefit covered species.

The Habitat Plan does not currently cover steelhead. However, we understand that the Habitat Agency is currently in discussions with the National Marine Fisheries Service (NMFS) regarding the current habitat value and potential for future restoration and enhancement of steelhead habitat at the site. Therefore, we have included a discussion of habitat suitability for steelhead herein.

Habitat Plan covered plant species are not discussed below because the site does not provide suitable habitat (i.e., serpentine soil types) for any of these species.

H. T. Harvey wildlife biologists reviewed pertinent background materials (e.g., Habitat Plan, other technical reports, California Natural Diversity Database [CNDDB]) to determine the potential for presence of covered species prior to conducting a site-wide reconnaissance of the study area on April 4, 2019.

2.4.1 California Red-Legged Frog

California red-legged frogs have been reported from the vicinity of the study area (CNDDB 2019; Figure 24. Specifically, two observations of adult California red-legged frogs in a large pond on the Ciraulo property, just upstream of the study area, were reported in the spring of 2004. This pond is located on the north side of Pacheco Creek, just east of its confluence with Cedar Creek, approximately 500 ft northeast of the study area boundary (Figure 23). In addition, individual California red-legged frogs have been observed approximately 4 mi upstream and 3 mi downstream of the site within the PCW (CNDDB 2019; Figure 24). The large pond on the Ciraulo property upstream of the study area, Pacheco Creek, and Pond 1 within the study area, provide perennial water, water depths greater than 3 ft, and emergent wetland vegetation and riparian vegetation such as willows and sycamores. These habitat elements provide high quality aquatic dispersal and foraging habitat, and may even provide breeding habitat for the California red-legged frog (Ford et al. 2013), and adjacent undeveloped grasslands and woodlands provide upland dispersal habitat (e.g., between the on-site aquatic habitats and off-site ponds). Pond 2 provides suitable aquatic foraging habitat (i.e., nonbreeding habitat) for red-legged frogs when it contains water, though its suitability for breeding depends primarily on hydroperiod (if it does not contain water at least through July in an average year, it is unsuitable for successful breeding by California red-legged frogs) and secondarily on the paucity of emergent vegetation or other potential egg mass attachment sites.

No California red-legged frogs were observed during reconnaissance visits in April and July 2019. A number of individuals of the American bullfrog (*Lithobates catesbeianus*), including adults, subadults, and larvae, were observed within Pacheco Creek (including the main channel and multiple off-channel pools) and Pond 1. Because American bullfrogs may compete with and prey on California red-legged frogs, the presence of this species could adversely affect the California red-legged frog (USFWS 1996, 2002). Also, if Pacheco Creek, the pond upstream on the Ciraulo property, and Pond 1 also contain nonnative predatory fish (centrarchid species), these fish may prey on tadpoles and small metamorphs, possibly precluding successful breeding of California red-legged frogs in these waterbodies (Fisher and Shaffer 1996). Therefore, due to high quality foraging and dispersal habitat and nearby records of observations, California red-legged frogs are expected to occur on site as at least dispersants, but they may not breed on the site due to the presence of bullfrogs and possible presence of nonnative predatory fish. Additional surveys would be needed to determine whether and how California red-legged frogs use this site.

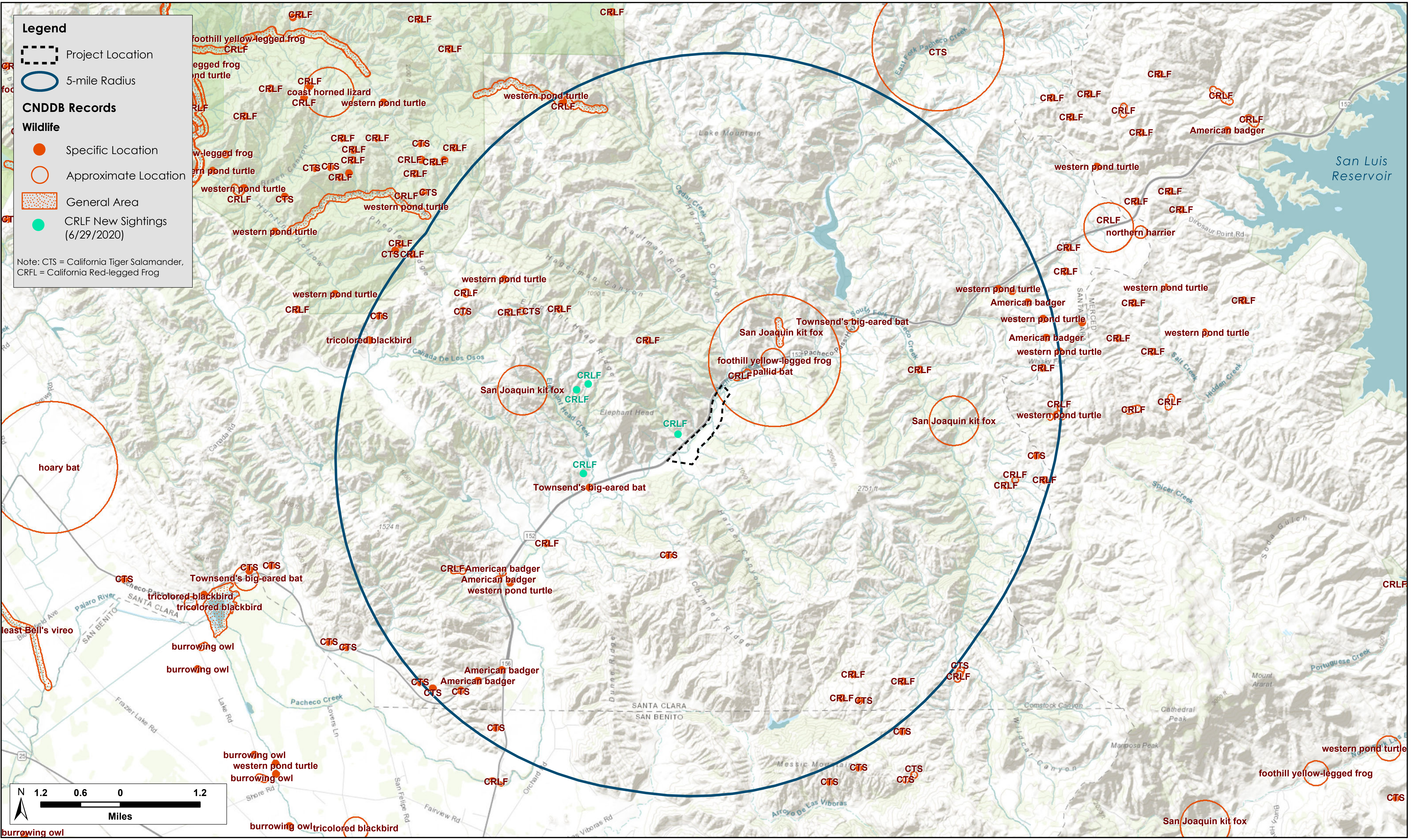
2.4.2 Foothill Yellow-Legged Frog

A foothill yellow-legged frog occurrence was recorded in the vicinity of the project site (CNDDB 2019; Figure 24). However, this record is 69 years old, and is nonspecific in location, described as "Highway 152, about 20 road miles east of Gilroy". Based on this description, we determined that this record alone does not establish that foothill yellow-legged frogs occur within or near the site. During the reconnaissance visits in April and July 2019, wildlife ecologists looked carefully for this species but detected no individuals, even though several individuals of the Pacific treefrog (*Pseudacris regilla*) and a number of bullfrogs were observed. The most suitable habitat for this species within the study area is present along Pacheco Creek, which provides potential habitat for dispersal and foraging required by the species in the form of cobble and sand banks, rock outcrops, and deeper pooling (van Hatton and Manor 2018). However, this reach of Pacheco Creek is downstream of Pacheco Reservoir, which would adversely affect the species by isolating any subpopulation downstream of the reservoir from any subpopulation upstream of the reservoir, and subjecting the subpopulation downstream to off-season flow regimes that would negatively affect breeding (Lind et al. 1996). Also, this reach of Pacheco Creek contains bullfrogs and possibly nonnative predatory fish, which would also negatively impact the species (Moyle 1973; Moyle and Nichols 1973). Given the lack of any detections during H. T. Harvey's April and July surveys, and the lack of any recent observations in the PCW, it is our opinion that foothill yellow-legged frogs are currently absent from the study area.

2.4.3 California Tiger Salamander

The nearest records of California tiger salamander occurrence are over 3 mi northwest of the site on the north side of SR 152 and over 4 mi east and south of the site on the south side of SR 152 (CNDDB 2019; H. T. Harvey 2015; Figure 24). Ponds 1 and 2 provide ostensibly suitable breeding habitat for the California tiger salamander, particularly if they hold standing water through June during a year of average rainfall (Ford et al. 2013). However, due to the occurrence of bullfrogs and possible occurrence of centrarchid fish in these ponds (at least in Pond 1), we do not consider them as high quality breeding habitat for the California tiger salamander, as the occurrence of fish and bullfrogs are thought to negatively affect successful breeding by this species (Fisher and Shaffer 1996). Therefore, if California tiger salamanders occur in the study area, they would likely be dispersants from other breeding ponds located off-site.

To the north of SR 152, the nearest CNDDB occurrence is more than twice the recognized dispersal capabilities of this species (1.36 mi per Orloff 2011) away from the site, and on the opposite side of SR 152 (an impediment to dispersal [USFWS 2017]). Therefore, we do not expect California tiger salamanders to be able to disperse to the site from the vicinity of that CNDDB occurrence. There are several potential breeding ponds between this occurrence and the site, with approximately six ponds within dispersal distance of the site, but also located on the opposite side of SR 152. If California tiger salamanders are currently breeding in these ponds, and if an individual could successfully cross SR 152, then the species could potentially disperse to the site from one of those ponds. However, it is more likely that if California tiger salamander occurs on the site it would be a dispersant from potential breeding ponds on the south side of SR 152. The nearest pond is a stock pond approximately 400 ft east of the site. There are an additional six ponds further away but within the dispersal distance of the species, with no apparent barrier to dispersal between these ponds and the site. If any of these ponds are currently being used by California tiger salamanders for breeding, then we would expect individuals of the species to disperse onto the site and use the upland of the site for refugia and above ground dispersal. Specifically, burrows of California ground squirrels (*Otospermophilus beecheyi*) and/or Botta's pocket gophers (*Thomomys bottae*) on the site could be used as refugia by California tiger salamanders.



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 24 CNDDB Wildlife Records 2.mxd

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Figure 24. California Natural Diversity Database Wildlife Records

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2.4.4 Western Pond Turtle

During visits to the study area by H. T. Harvey wildlife ecologists, 13 western pond turtles were observed in Pond 1 on April 4, 2019, and on July 27, 2019, six were observed in Pond 1 and six more were basking along the slow-moving reach of Pacheco Creek near the north end of the Pacheco Creek Reserve. This species has also been observed in the large pond upstream on the Ciraulo property (e.g., in 2004; CNDDB 2019; Figure 24). Pacheco Creek and Pond 1 provide high quality foraging and dispersal habitat, having over 3 ft deep of perennial ponding in the pond and deeper in-channel pools in the creek (Reese 1996), and the adjacent undeveloped grassland, scrub, and woodland provide dispersal and nesting habitat for this species.

2.4.5 Tricolored Blackbird

Tricolored blackbirds are known to nest in the vicinity of the study area (CNDDB 2019; Figure 24; Rottenborn 2007a). The nearest breeding records are from Tooth Lake at Cañada de los Osos Ecological Reserve, approximately 5 mi northwest of the site, where tricolored blackbirds nest in cattails around the lake edges (https://cdlo.org/content/documents/cdloer-tricolor-research.pdf), and from the vicinity of San Felipe Lake, approximately 7 mi southwest of the site, where tricolored blackbirds nest in emergent vegetation and upland thistles (*Cirsium* spp.) around the lake and in extensive emergent marsh to the southeast of the lake (Rottenborn 2007a). In Santa Clara County, tricolored blackbird colonies tend to be fairly small and occur primarily in emergent vegetation. However, nearby in San Benito County, large tricolored blackbird colonies have formed in grain fields that have been left fallow or allowed to be overgrown with mustard and other weeds. One such colony, located along Santa Ana Valley Road east of Hollister, supported more than 15,000 nesting tricolored blackbirds in 2016 (S. Rottenborn, pers. obs.).

The Habitat Plan's species modeling indicates that riparian habitat along Pacheco Creek in the study area provides primary habitat for the tricolored blackbird (ICF 2012). However, there are no records of tricolored blackbirds in Santa Clara County nesting in riparian habitat dominated by woody vegetation, and there are no documented tricolored blackbird colonies in Santa Clara County within habitat that would have been field-verified as one of the Habitat Plan's riparian land cover types at the time the colony was active. Under existing conditions, no suitable nesting habitat for tricolored blackbirds is currently present on or in the immediate vicinity of the site. Although some emergent vegetation is present around the edges of Pond 1 and other ponds on adjacent properties, this vegetation is much too limited in extent to support a tricolored blackbird colony. Similarly, no particularly extensive fields of mustard, thistle, or other upland vegetation capable of supporting a colony are present in the vicinity. Although tricolored blackbirds may forage on the site, they are not expected to nest there under current conditions.

2.4.6 Least Bell's Vireo

There are no known occurrences of least Bell's vireos in the study area and few in the vicinity. In Santa Clara County, the only record of the least Bell's vireo prior to 1997 was of a nest with eggs along the Pajaro River near "Sargent" (where State Highway 101 is currently located) on April 19, 1932 (Unglish 1937). In May 1997, a pair of least Bell's vireos was observed constructing a nest along lower Llagas Creek upstream from

Bloomfield Avenue, southeast of Gilroy (Rottenborn 2007b). This location is approximately 10 mi southwest of the project site. Subsequently, Valley Water conducted nearly annual surveys for the species, at least through 2010, along lower Llagas Creek from the Pajaro River confluence north to SR 152 (H. T. Harvey 2010; Padley 2010). These surveys detected at least one singing male least Bell's vireo both upstream and downstream from Bloomfield Avenue on May 17 and 18, 2001. Other surveys for this species have since been conducted along lower Llagas Creek (H. T. Harvey 2016), but no evidence of least Bell's vireo occurrence in potential breeding areas has been detected since 2001.

Least Bell's vireo recovery efforts, including riparian habitat restoration and cowbird trapping in core population areas, have resulted in increases in least Bell's vireo populations in some areas of southern California. Since 2005, the species has also occurred in a number of Central Valley locations where it had been absent for decades, suggesting that the species is expanding its range northward into portions of the Central Valley from which it had been extirpated. A pair of least Bell's vireos was confirmed breeding at the San Joaquin River National Wildlife Refuge in Stanislaus County from 2005 to 2007, providing the first confirmed breeding for the Central Valley in more than 50 years (PRBO Conservation Science 2006). Small numbers of singing males have also been detected in portions of the species' historical range in Tulare, Merced, Yolo, and Sacramento counties in recent years (Padley 2010). Up to three singing males established territories in the Yolo Bypass area in 2010 and 2011 (Rogers et al. 2010, 2011; Rottenborn et al. 2010). Near San Luis Reservoir in Merced County, approximately 18 mi northeast of the site, two least Bell's vireos were observed during the summer of 2010 (Rogers et al. 2010), and breeding was confirmed there in July 2011 (Rogers et al. 2011). These records collectively suggest that least Bell's vireos are attempting to reoccupy more northern portions of the species' breeding range. Although northward-expanding populations may result in occasional occurrence of birds (and possible nesting attempts) in areas that were historically at the edge of the species' range, such as southern Santa Clara County, the abundance of brood-parasitic brown-headed cowbirds (*Molothrus ater*) in the region limits the potential for successful nesting and establishment of a regular breeding population.

The Habitat Plan's species modeling indicates that riparian habitat along Pacheco Creek in the study area provides primary habitat for the least Bell's vireo (ICF 2012). Under existing conditions, the site provides ostensibly high-quality least Bell's vireo habitat in only a few limited areas where willow-dominated riparian vegetation supports a dense understory or is immediately adjacent to dense patches of mule fat, California rose (*Rosa californica*), poison hemlock (*Conium maculatum*), and other shrubby or herbaceous plants. A few patches of such vegetation are present along Pacheco Creek. In most areas, a combination of cattle grazing and scour from winter flooding has reduced the density of understory vegetation, a habitat component important to breeding least Bell's vireos (Kus 2002; Kus et al. 2010; Sharp and Kus 2006). Ideal least Bell's vireo nesting habitat consists of a riparian corridor at least 800 ft wide (Kus 2002; Kus et al. 2010); riparian habitat currently present on the project site is mostly less than 400 ft wide, reducing habitat quality. Although sporadic occurrence of least Bell's vireos on the site is possible, it is unlikely to support nesting pairs of this species.

2.4.7 San Joaquin Kit Fox

There are several older San Joaquin kit fox records from the project vicinity (CNDDB 2019; Figure 24). The most recent record, and the one closest to the study area, is of an adult reported from Henry Coe State Park near Bell Station, approximately 1.2 mi northeast of the site, on August 2, 2002. Two older records, of individuals detected sometime between 1972 and July 1975, are from about 3 miles west of the site near Elephant Head Creek, and near the South Fork of Pacheco Creek approximately 3.7 miles east of the site. Although there are few San Joaquin kit fox records from Santa Clara County, the species historically occurred more abundantly just to the south in the Hollister area of San Benito County. The most recent San Joaquin kit fox record in the Hollister area was from 1992, when an adult female kit fox and three of her pups were found dead at the San Juan Oaks Golf Course approximately 16 mi southwest of the site (CNDDB 2019). However, numerous San Joaquin kit fox surveys in the Hollister area in the 1980s and 1990s produced negative results. Detection dog surveys for San Joaquin kit foxes conducted in 2003 north of Hollister along SR 25 failed to detect the species (Endangered Species Recovery Program 2003). Collectively, this information suggests that San Joaquin kit foxes have always been scarce in southeastern Santa Clara County (with no confirmed records of dens or breeding), and the species has declined in or disappeared from nearby portions of San Benito County in the Hollister area. Currently, the nearest extant population occurs in the Los Banos area to the east. The species could potentially still occur in the project vicinity as an occasional dispersant from the Los Banos population (e.g., possibly using Pacheco Pass and the Pacheco Creek corridor as a dispersal pathway). The grasslands and other upland habitats on the site provide potential movement and foraging habitat for any San Joaquin kit fox that might disperse through the area, though there is a low potential for San Joaquin kit foxes to den or otherwise reside in or near the site.

2.4.8 Steelhead—SCCC DPS

In Pacheco Creek, the SCCC steelhead DPS is listed as threatened under the federal Endangered Species Act, and the reach of Pacheco Creek within the study area is designated as critical habitat (NMFS 2005). The critical habitat designation identified “Primary Constituent Elements” that are essential to support one or more life history stage(s) of SCCC Steelhead, the primary constituent elements that apply to Pacheco Creek are: 1) freshwater spawning sites with sufficient water quantity and quality as well as adequate substrate (i.e., spawning gravels of appropriate sizes) to support spawning, incubation and development; 2) freshwater rearing sites with sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions and allow development and mobility; sufficient water quality to support growth and development; food and nutrient resources such as terrestrial and aquatic invertebrates and forage fish; and natural cover such as shade, submerged and overhanging large wood, log jams, aquatic vegetation, large rocks and boulders, and; 3) freshwater migration corridors free of obstruction and excessive risk of predation with adequate water quantity to allow for juvenile and adult mobility; cover, shelter, and holding areas for juveniles and adults; and adequate water quality to allow for survival. The recovery plan identified critical recovery actions including water releases from Pacheco Dam, upstream of the project reach (NMFS 2013).

The project reach serves as a migration corridor for adult steelhead migrating to upstream spawning habitat, and for juveniles and smolts migrating downstream, and with appropriate discharge (and/or wet years), the project reach can provide rearing habitat. A reservoir release strategy to address steelhead (Micko and Smith 2019) was developed based on extensive stream habitat and water quality monitoring. The project reach can go subsurface in dry years, however, Micko and Smith (2019) determined that with sufficient flow releases from Pacheco Dam, juvenile rearing in the project reach could be supported.

Section 3. Primary Constraints to Restoration

This section identifies the primary constraints to potential habitat restoration actions at the site.

3.1 Valley Water Pipeline

An existing buried Valley Water pipeline runs parallel to the creek through much of the study area (Figure 25). The exact depth of the pipeline is unknown but ground disturbance (i.e., grading) within 50 ft of the pipeline should be avoided. However, if specific project elements are identified for potential implementation that include ground disturbance or would promote soil scour within 50 ft of the pipeline, then Valley Water should be consulted to determine what exactly would be allowed and appropriate pipeline protection measures that may be required.

3.2 SR 152

SR 152 runs along the north side of the study area (Figure 25). The current creek alignment includes some areas where the channel is directed towards the highway and Caltrans has constructed retaining walls to protect the road. Any proposed project elements that could alter creek hydraulics will need to be designed to ensure no additional pressures on road stability are created.

3.3 Habitat Agency Infrastructure

3.3.1 Legal Access and Parking Area

The Habitat Agency's main access point off SR 152 includes a fenced and gated area available to park vehicles (Figure 25). The Habitat Agency would like to keep this area available for parking; therefore, any proposed project elements in this vicinity should be designed such that the parking area is not altered from its existing condition.

3.3.2 Groundwater Wells

There are multiple groundwater wells on the Pacheco Creek Reserve property that will need to be protected (Figure 25). One well (EW-1) is in the immediate vicinity of the parking area described above and is currently being used by the Habitat Agency as an irrigation source to provide water to existing oak woodland restoration plantings. Another existing well (EW-2) on the opposite side of the creek is used as a domestic water source for an adjacent property owner. These two wells, along with all other existing wells within the study area will need to be protected and project elements designed to avoid impacts to these wells.

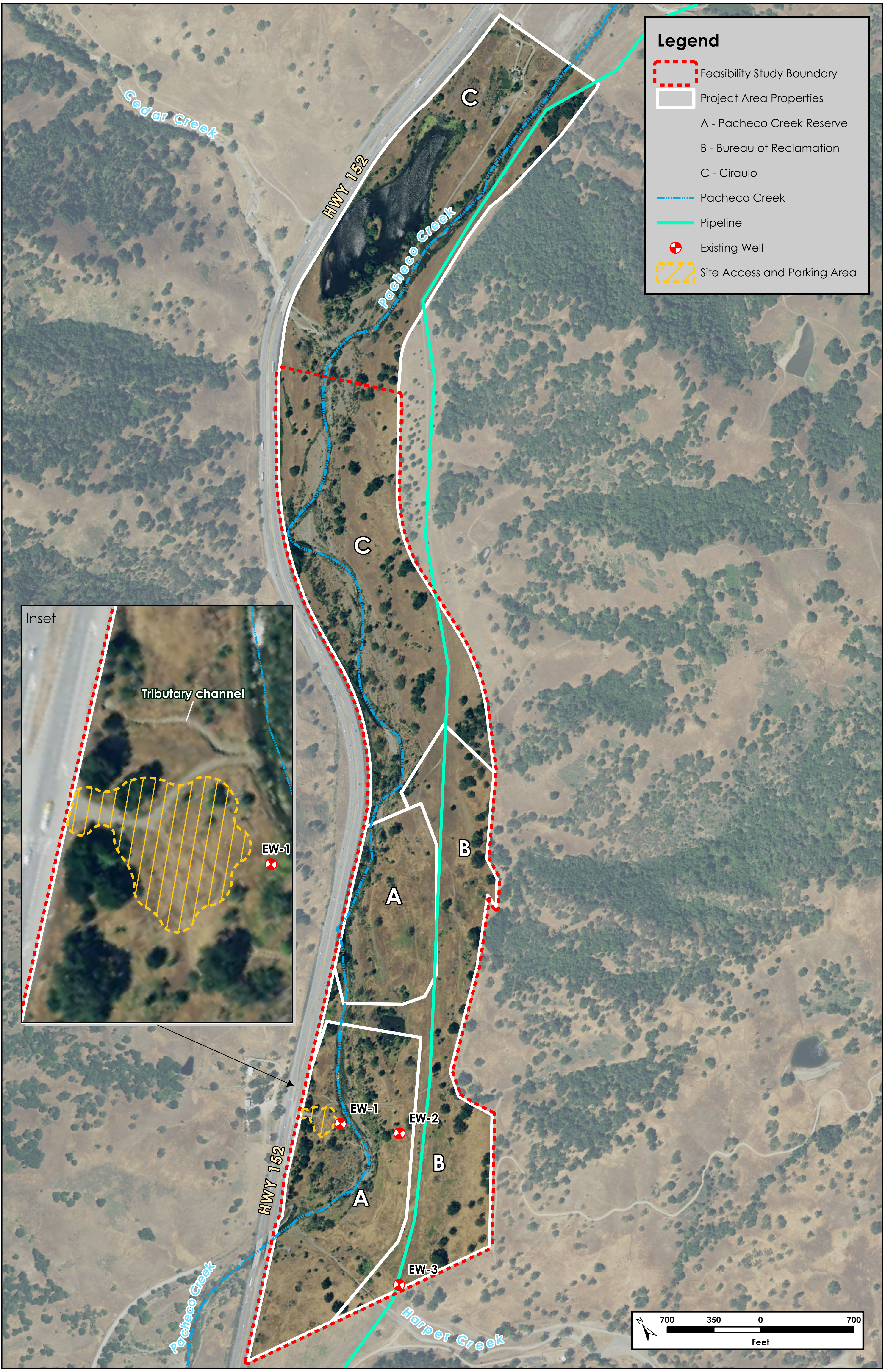

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Figure 25. Site Constraints

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3.4 Biotic Resources

3.4.1 Regulated Habitats

There are a number of existing habitats within the study area that are under the jurisdiction of local, state, and federal regulatory agencies. These include wetlands and other waters (stream, pond, seasonal wetland), riparian habitat (willow and mixed riparian), SAW, and upland habitats. All of these habitats could be subject to temporary disturbance or permanent conversion during project implementation. However, the project will be designed to minimize impacts to these habitats and to be self-mitigating, resulting in a significant ecological lift compared to existing conditions. Therefore, impacts to these regulated habitats are not expected to pose significant constraints to project implementation. In addition, all standard best management practices would be implemented to protect water quality (e.g., dewatering, silt fencing, and wattles) to further protect and limit impacts on regulated habitats.

3.4.2 Special-Status and Covered Wildlife Species

The study area supports several special-status wildlife species, including at least one Habitat Plan covered species (western pond turtle). The Habitat Plan provides the Habitat Agency with "take" coverage for covered species during enhancement and restoration activities, but these activities would need to comply with conditions intended to minimize adverse effects on habitat and water quality, as well as species-specific measures for several species, such as surveys for nesting least Bell's vireos and San Joaquin kit fox dens. For construction that occurs during the avian nesting season (roughly February 1 through August 31), preconstruction surveys for nesting birds, and buffers around active nests, should also be implemented.

Conditions on covered activities do not include species-specific measures for the western pond turtle, California red-legged frog, and California tiger salamander, however. Given the abundance of western pond turtles in the study area, we would recommend that enhancement and restoration activities incorporate preconstruction surveys and relocation of any detected western pond turtles to locations well outside the work area. Although such measures are not technically required by the Habitat Plan, they would minimize adverse effects on one of the species that is intended to benefit from these restoration activities. Similarly, measures to avoid and minimize impacts on steelhead, such as construction work windows and exclusion and/or relocation of steelhead from work areas, are likely to be required by NMFS approvals related to the project.

Although these wildlife-related conditions will need to be addressed during construction, none pose substantial constraints on implementation of the proposed habitat enhancements.

3.5 Cultural Resources

ICF's cultural resources specialists conducted a cultural resources assessment, which included a records search and literature review, a desktop geoarchaeological review, and an archaeological site reconnaissance, to determine the potential for occurrence of cultural resources within the study area. The assessment concluded that there are 2 previously recorded archaeological resources within or immediately adjacent to the study area. One is a historic-era building that is no longer present and the other is a pre-European contact midden deposit that is located partly within the southeastern corner of the study area. No evidence of the midden deposit was identified during the site reconnaissance. In general, the potential for disturbing cultural resources within the study are is low but, at a minimum, all workers should receive cultural resources sensitivity training prior to any ground disturbing activities. In addition, ground disturbance within the midden deposit area should be avoided, if possible. If ground disturbance in the midden deposit area is required then archaeological testing is recommended to verify whether additional studies are needed. ICF's complete cultural resources assessment is presented in Appendix C.

Section 4. Sycamore Regeneration Conceptual Model

4.1 Sexual Reproduction

Historically California sycamore was the dominant tree species along many ephemeral, braided stream networks throughout much of California. Sycamores occupied multi-thread stream reaches that were generally located along the longitudinal profile of streams below high-energy, laterally-confined canyon reaches and above single-thread reaches located farther downstream (Figure 26). These multi-thread reaches are often characterized by a reduction in slope (compared to upstream canyon reaches), a widened valley floor (i.e. reduced lateral confinement), substantial deposition of coarse sediment and significant channel dynamism. With their relatively coarse sediment geomorphic features, these multi-thread reaches, which may occur over an alluvial fan, often maintain surface flow for only a portion of the year. Declines in groundwater levels during the dry season likely limit establishment of phreatophytic woody riparian vegetation that requires a perennial groundwater depth that is shallower than that required by California sycamore (e.g., willows and cottonwoods). This phenomena reduces competition between willows/cottonwoods and California sycamore that would be detrimental to California sycamore regeneration.

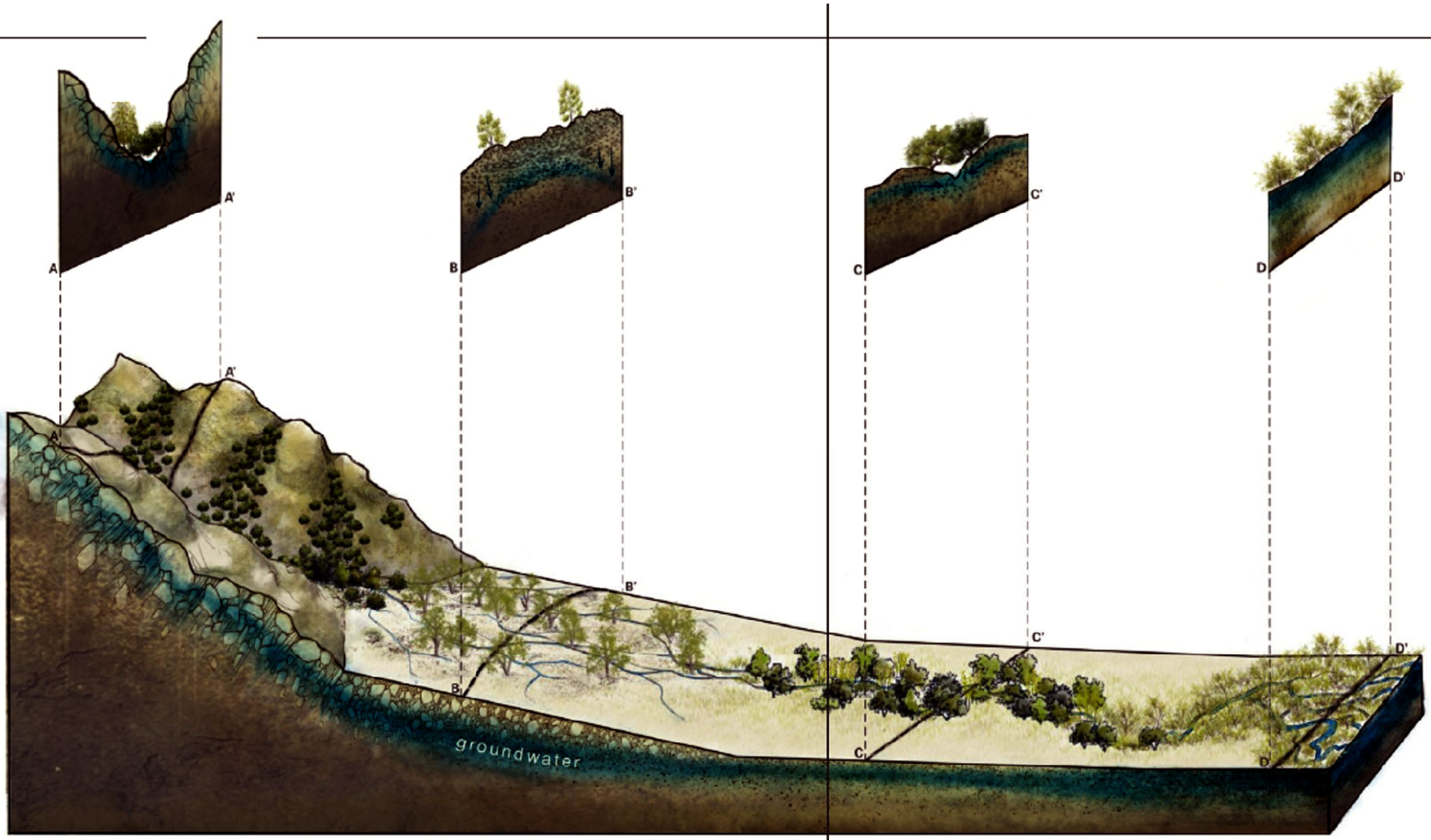
Successful regeneration of California sycamore requires the convergence of an array of abiotic and biotic factors over multi-year time scales. In order to describe these drivers and their interplay, we have developed a conceptual model that we refer to as the “Constellation of Drivers”. The conceptual model organizes the regeneration process into four stages, which include, 1) Setting the Physical Template, 2) Seed Source Development and Dispersal, 3) Establishment, and 4) Long-term Survival (Figure 27). Each of these stages include interrelated physical and ecological drivers, which must align spatially and temporally for the natural regeneration process to successfully occur (Figure 27). Additionally, the “stars” of this Constellation of Drivers must align frequently enough to ensure continued survival of the California sycamore population in a particular landscape area.

Setting the Physical Template. California sycamore regeneration from seed requires a large flood event that drives the necessary geomorphic processes that yield fresh alluvial surfaces (i.e., exposed mobile and permeable alluvium) to be colonized by sycamores. Streams that harbor SAW are generally subject to extended dry seasons and ephemeral winter flows punctuated by large episodic runoff events which rework the channels and floodplains, mobilizing sediment, creating morphological complexity, and exposing bare coarse alluvial surfaces (e.g., gravel and cobble). At the study area, a flow recurrence interval of approximately 20 years (from site observations and analyses described in this Feasibility Study) appears to be particularly effective in establishing substrate conditions that are suitable for sycamore regeneration from seed. It should be noted that the specific flow magnitude or recurrence interval event required to drive the necessary physical processes for sycamore regeneration is dependent on local valley and floodplain conditions specific to each stream reach, which include stream gradient, valley width, floodplain connectivity, dominant substrate grain sizes, soil properties and other factors. Additionally, different sized flood events (or different recurrence internal events) may drive the necessary physical processes to create fresh alluvial surfaces suitable for sycamore colonization across different extents of the floodplain. For example, at the study area a 10-year recurrence interval event may generate some new alluvial surfaces in a narrower band of floodplain closer to the primary channel when compared with the 20-year event. However, many of the fresh alluvial surfaces generated by more frequently occurring flows such as the 10-year event and smaller may favor obligate riparian trees, such as willows and cottonwoods. Conversely, a 50-year event would likely generate a greater extent of fresh alluvial surfaces within the study area compared with a 20-year event.

In addition to requiring a freshly established alluvial surface, sycamores require that the underlying substrate and soil conditions meet their water availability and/or soil moisture requirements. The underlying substrate and soil conditions, combined with the hydrologic conditions discussed below, must sustain sycamore seedlings and saplings while they establish their root network and attempt to persist through extended dry seasons. For example, if the substrate is very deep coarse alluvium then it is important that the seasonal groundwater table is near the surface during the early growing season and recedes slowly, allowing the newly establishing trees to send roots down quickly enough to access late dry season moisture. If the seasonal groundwater table recedes relatively quickly, then a soil profile that includes a higher percentage of fine-grained substrate is essential. Finer grained soil types can provide plant-available water later into the growing season simply by virtue of having a higher soil moisture holding capacity, and also through a higher capillary fringe above the groundwater table.

Seed Source, Development and Dispersal. This stage requires having a nearby, healthy stand of native sycamores (i.e., genetically pure and locally adapted) that provide a source of viable seed. Sycamores are prone to a particular fungal infection called anthracnose (*Colletotrichum,sp.*). Anthracnose is more common during wet, cool springs, and can completely defoliate trees of their first set of leaves. Anthracnose is not commonly known to kill trees and infected trees usually refoliate after temperatures increase, but it does sap the tree of vital resources and can jeopardize viable seed production. Native sycamores are also prone to hybridization with the London plane tree (*Platanus* × *acerifolia*), a common landscaping tree in urban and residential settings. Hybrid sycamores are known in wildland settings and may cause long-term impacts on genetic diversity. If there is a stand of healthy, native trees, it is then essential to have ripe seeds disperse, via wind and/or water, during or shortly after a large flow event and be deposited on fresh alluvial surfaces. Sycamores normally release seed between January and March, which typically coincides with higher flow events, but the exact timing needs to be closely aligned (Figure 28).

Establishment. This stage must provide the necessary hydrologic and biologic conditions to support successful germination and the survival of the growing sycamore seedling in its early years (i.e., 0-5 years). Streamflow must remain below the high energy scouring event thresholds that can remove the seed or recently germinated seedlings and saplings. Hydrologic conditions must also provide the required soil moisture for germination and initial establishment as the young tree develops its root structure.



CANYON REACH Within the bedrock canyon, the stream is confined to a single channel along most of its length and flows across a coarse substrate composed of boulders and cobble. Water is perched within the bedrock canyon and cannot easily sink into the ground. Combined with high groundwater, this typically results in perennial surface flow. Consistently available water supports a riparian forest, with a mix of oaks (*Quercus*), sycamores (*Platanus racemosa*), and more hydrophilic species such as alders (*Alnus*) and willows (*Salix*).

MULTI-THREAD REACH As the high energy stream exits the canyon, it is no longer confined. Due to a combination of the lack of confinement, decreased slope, and a change in bed materials, the stream loses transport capacity and begins to deposit coarse sediment (gravels and cobbles) to build a conical alluvial fan, often forming a multi-thread channel with braiding and distributaries among small islands and bars. At different stages of fan formation, this pattern can vary. Water begins to sink through the gravels to the underlying aquifers, and the stream enters a losing reach, which typically has surface flow for only a portion of the year. The typical riparian vegetation is sycamore alluvial woodland, or a mix of sycamores and oaks, which are able to thrive with intermittent surface flow and accessible groundwater, and help to stabilize the bars. Towards the bottom of this reach, as depth to groundwater increases, riparian trees typically become sparser.

SINGLE-THREAD REACH Further downstream, the stream reforms into a single stem channel as it loses power and sediment supply and experiences a decrease in slope. The stream begins to flow over finer gravels and sands. The stream bed and the ground surface slope to intersect groundwater levels, and the stream enters a gaining reach, which typically has water year round. Riparian vegetation is often mixed riparian forest.

DELTA DISTRIBUTARY REACH Finally, as the stream continues to decrease in slope and stream power, the substrate shifts to silts and clays. Many of these streams intercept groundwater as they flow through distributary channels into wetlands. Riparian vegetation typically consists of willows, transitioning to marsh species.

BOX 1.1. CONCEPTUAL STREAM TRANSECT

This drawing illustrates some of the habitat diversity historically found on local streams, and the physical controls that supported that diversity. Four reach types with distinct stream morphology, substrate, groundwater levels, surface flow, and riparian (or streamside) vegetation patterns can be identified. The reaches varied in length depending on slope and depth to groundwater, as well as the presence or absence of other creeks or geographic features. While this diagram does not represent any specific stream in the Alameda Creek watershed, components of these patterns are found here and in other nearby watersheds (e.g., Coyote Creek, upper Pajaro River), and the model can provide a helpful way of conceptualizing the connections between groundwater, substrate, and vegetation (Grossinger et al. 2006, 2008). See the detailed descriptions of Alameda Creek (both in Sunol Valley and on the Niles Cone), Arroyo Mocho, and Arroyo del Valle for more information on variations to this pattern.

One of the major factors shaping channel and riparian form on large streams in the study area is the alluvial fan pattern. Alluvial fans are formed as streams emerge from canyons and spread across an alluvial plain (Blair and McPherson 1994, Knighton 1998). Streams with a large source of sediment deposit a cone of this coarse sediment over time across the surrounding plain, creating a fan shape. Stream flows sink into the porous fan substrate, causing intermittent flow and distinct patterns of groundwater, riparian vegetation, and stream morphology. Although the dynamic processes of fans are not captured in the diagram at left, it shows an example of the reach types that can be created by a fan system. Understanding these patterns is critical to understanding how stream habitats were distributed along Arroyo del Valle, Arroyo Mocho, and Alameda Creek. (illustration by Jennifer Natali)

Source: Alameda Ck Historical Ecology Study, SFEI 2013

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Figure 26. Conceptual Longitudinal Profile
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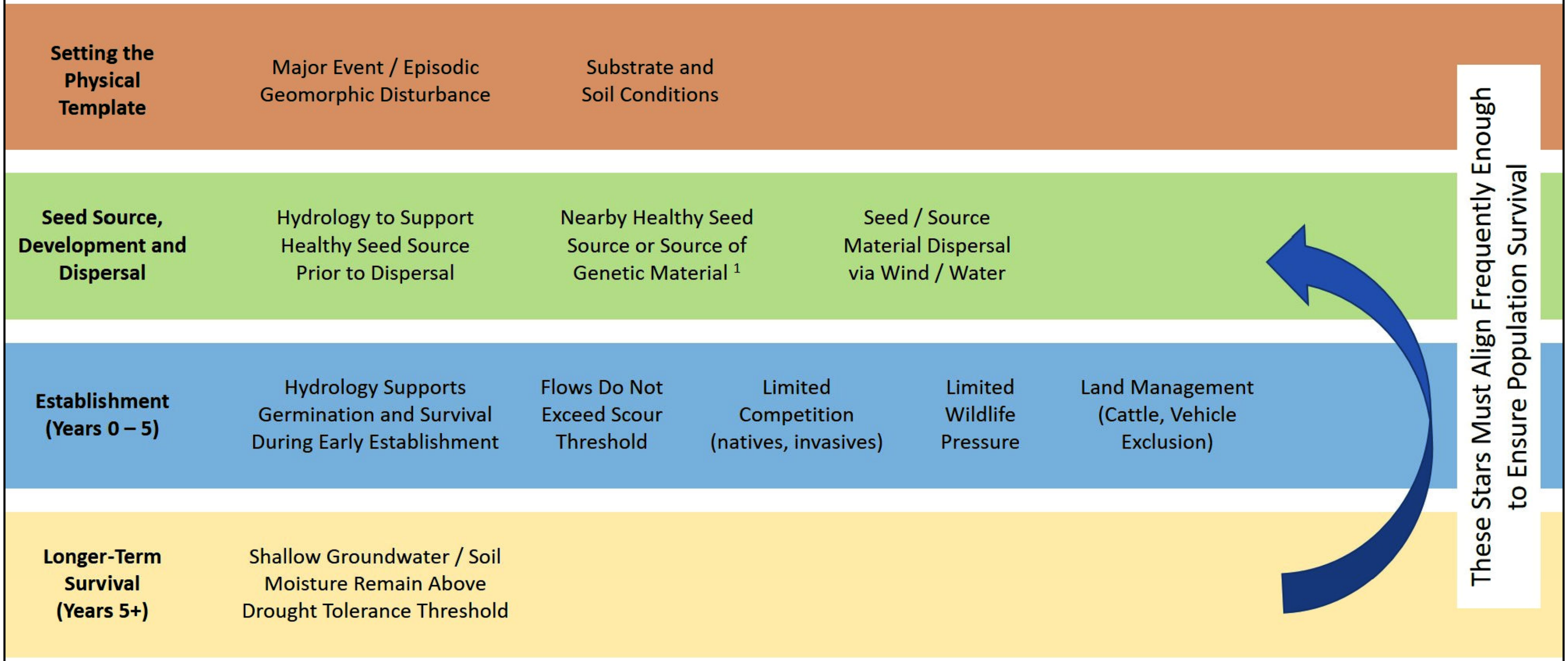
Sycamore Regeneration
"Constellation of Drivers"



Setting the Physical Template	Major Event / Episodic Geomorphic Disturbance	Substrate and Soil Conditions			
Seed Source, Development and Dispersal	Hydrology to Support Healthy Seed Source Prior to Dispersal	Nearby Healthy Seed Source or Source of Genetic Material [1]	Seed / Source Material Dispersal via Wind / Water		
Establishment (Years 0 – 5)	Hydrology Supports Germination and Survival During Early Establishment	Flows Do Not Exceed Scour Threshold	Limited Competition (natives, invasives)	Limited Wildlife Pressure	Land Management (Cattle, Vehicle Exclusion)
Longer-Term Survival (Years 5+)	Shallow Groundwater / Soil Moisture Remain Above Drought Tolerance Threshold				

These Stars Must Align Frequently Enough to Ensure Population Survival

[1] Source material includes clonal revegetation (e.g., vegetative resprouting)

Figure 27. Constellation of Drivers

Pacheco Creek Restoration Project: Feasibility Study (4291-01)

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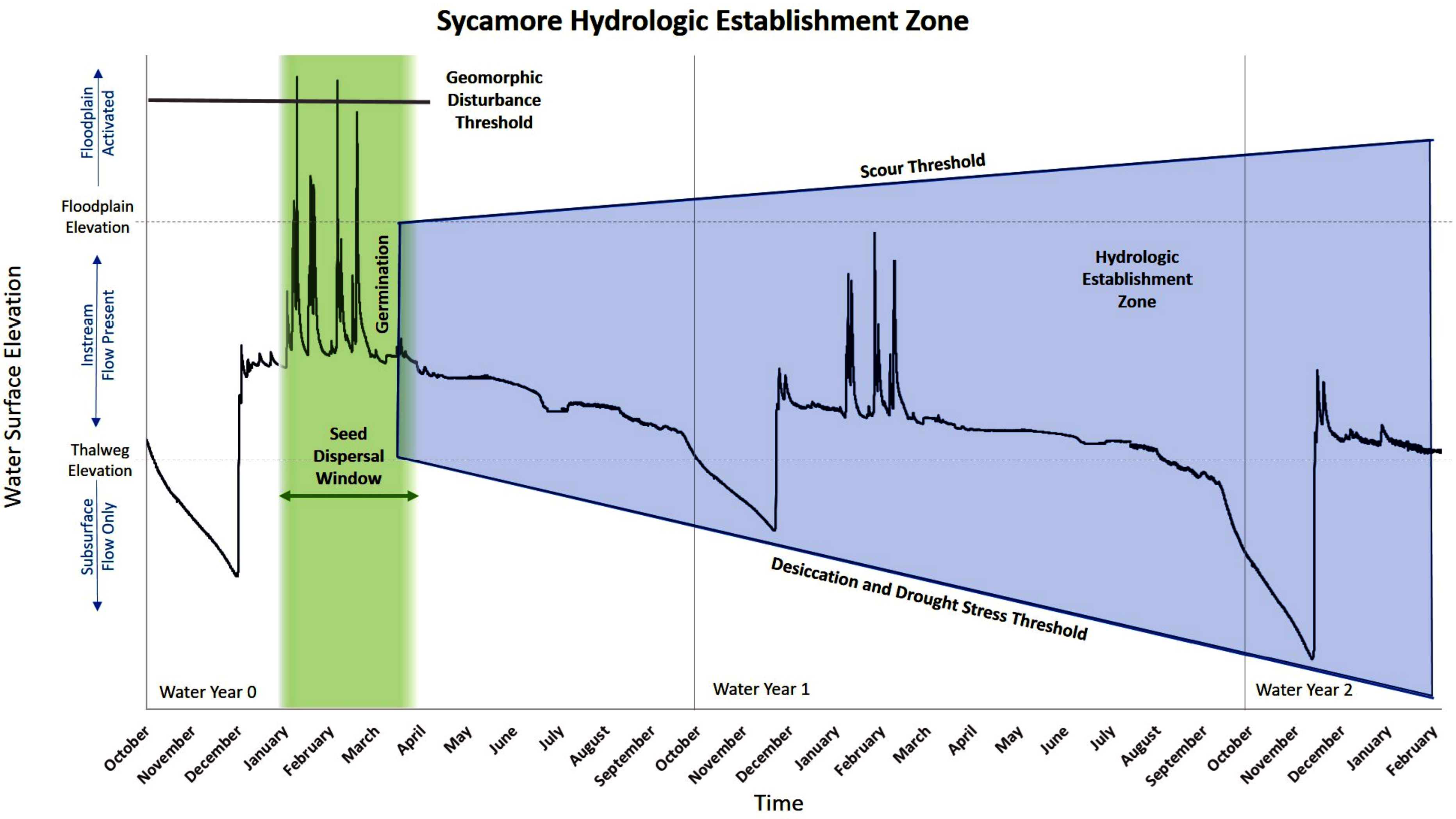

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Figure 28. Recruitment Box Concept

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To illustrate the temporal hydrologic requirements for sycamore regeneration, we have adapted Mahoney & Rood's (1998) recruitment box model for cottonwoods for application to the California sycamore. The recruitment box for cottonwoods refers to the flow range that exists between higher magnitude flows that can scour new seedlings and lower flows that maintain required moisture for roots during the seed dispersal period. The recruitment box concept has been adapted for sycamores as a Sycamore Hydrologic Establishment Zone which extends for multiple years following germination (Figure 28). Water surface elevation (including groundwater level when flow goes sub-surface) has been substituted for streamflow in the y-axis to account for the intermittent nature of streamflow in sycamore-supporting streams.

The sycamore regeneration process begins with a relatively large flood event that exceeds the Geomorphic Disturbance Threshold (Figure 28). As noted above, we have observed that an approximately 20-year flood event stimulated sycamore seedling regeneration within the study area. Such a flood event must occur within the sycamore seed dispersal window. Following the flood event and seed deposition and germination, hydrologic conditions must remain within the Hydrologic Establishment Zone. The upper limit of the establishment zone marks the Scour Threshold or the water surface elevations that correspond to streamflow with the capacity to scour new seedlings and saplings. As they grow and develop a more robust root structure, the young tree's capacity to withstand scouring flows increases and the upper extent of the hydrologic establishment zone trends upward in subsequent years to reflect this.

The Hydrologic Establishment Zone is also driven by subsurface hydrology, particularly during the transition from spring to the summer portion of the growing season. The groundwater table must be very near the surface during initial seedling establishment and then needs to draw down gradually during the growing season at a rate that allows roots of the establishing trees to chase the groundwater table as it recedes. This process also needs to be supported by direct precipitation and/or surface hydrology, where flows provide adequate moisture in the upper rooting zone while not scouring the surface and displacing the saplings. Moving later into the growing season, where direct precipitation and surface flows are not likely to provide adequate shallow soil moisture, it is important that the soil/substrate profile within the rooting zone has a water holding capacity that provides plants with available water late into the growing season. If the soil/substrate has a low soil moisture holding capacity, then slow rate of water table drawdown is of even greater importance. The lower extent of the Hydrologic Establishment Zone (Figure 28) represents the Desiccation and Drought Stress Threshold for the growing sapling, which becomes greater (lower or deeper) with time as the sapling's root depth increases. It is also important that the young trees do not have to compete with other plant species for resources (i.e., light, water and nutrients). Therein lies the importance of a flood event large enough to generate new bare ground alluvial surfaces. Sycamores do not necessarily prefer a fully saturated rooting zone and are adapted to drier conditions than many obligate riparian tree species, which limits the degree of competition. However, as newly germinated and young, establishing trees, competition with other woody and herbaceous species can pose challenges for the sycamores to access resources to thrive. Newly established sycamores require an absence of or limit to land use and animal browse/disturbance that threaten survival. For example, many of the ephemeral stream systems that are conducive to sycamore regeneration can be attractive to dry season off-road vehicle enthusiasts. Young trees can be inadvertently damaged or killed by off-road vehicles. Young trees in these environments are also often in areas actively grazed by cattle, which can browse and/or trample the trees. Additionally, local wildlife, such as deer and pigs can damage young trees by either browsing or disturbing the soil in the immediate vicinity of the rooting zone. If all the initial drivers align and these types of disturbances are limited or restricted there is a higher likelihood for successful establishment and long-term survival.

Long-term Survival. This stage requires a set of conditions that need to be met to support the growth and long-term survival of the young trees. A combination of precipitation events and streamflow are needed to provide adequate soil moisture and a seasonally accessible groundwater table, while not resulting in high energy, scouring events that can damage or remove the young trees. As the trees mature, they will be able to withstand higher flow events and begin to play a role in local geomorphic processes, such as creating depositional bars and scour features. Groundwater table levels need to continue to support the establishing trees by ideally being near the surface during larger winter flows and slowly drawing down during the growing season. A sudden decline in the groundwater table can cause drought stress that exceeds the tolerance of the trees which can result in significant die off.

Summary. In summary, successful California sycamore sexual reproduction requires the co-occurrence of a broad constellation of abiotic and biotic drivers (Figures 27 and 28). It is not often that all the stars of the constellation align in a way that supports all the stages of sycamore regeneration. Even when they do align, there are conditions that need to be met during the Long-term Survival stage to facilitate a positive feedback loop, such that when the Physical Template is again set then the subsequent stages can naturally progress. These include:

- a multi-year climatic pattern that does not subject the trees to severe drought cycles,
- an on-going need for adequate surface and/or sub-surface hydrology,
- lack of pathogens, such as anthracnose,
- limited impacts from land management activities, and
- limited competition from other plant species.

If all these conditions are met, then there is a higher likelihood that the existing sycamores will be healthy and able to produce viable seed for dispersal and once again initiate the establishment and long-term survival processes. Therefore, the processes of California sycamore regeneration and associated population sustainability are particularly sensitive to anthropogenic disturbances to hydrology and land use.

4.2 Clonal Revegetation or Resprouting

While sexual reproduction is necessary for the long-term maintenance of healthy sycamore populations and genetics, sycamores can use another regeneration pathway under particular conditions: vegetative or clonal reproduction. Sycamores utilize two methods of vegetative reproduction, 1) basal resprouting, and 2) resprouting from downed and partially buried trunks or large branches.

Basal resprouting is typically observed as new suckers growing off the rootcrown of a mother tree. Usually the mother tree is well past the peak of maturity and in general decline. We speculate that the trees may release hormones associated with dying that trigger the basal resprouting to facilitate regeneration. Given the prevalence of dams/reservoirs and associated flow regulation along many California streams, many areas that used to support natural sycamore regeneration from seed are now experiencing increased occurrences of basal resprouting as the main reproductive pathway. While the basal sprouts do have the mother tree's root network to support establishment, many of the same elements discussed for the Establishment and Long-term Survival stages above are still required for successful regeneration. For example, it is common to see basal sprouts heavily browsed in areas subject to cattle grazing and a multi-year drought can result in basal sprouts quickly dying, despite the mother tree's root network. However, having the mother tree's root network in place does provide basal sprouts a competitive edge over other establishing vegetation and provides a greater ability to withstand high energy flows or sub-optimal soil moisture and groundwater table levels.

Some woody riparian tree species (e.g., willows and cottonwoods) are well known for their ability to reproduce/resprout from trunks or branches that are displaced during floods. Sycamores also have the ability to regenerate from completely downed trees or large, somewhat intact trunks or branches, but do not use this reproductive strategy as readily as willow and cottonwood. This type of regeneration is often seen when a large tree or trunk is downed during a flood or other disturbance and subsequently partially buried in a location where hydrologic conditions described above for Establishment and Long-Term Survival remain in place (e.g., readily accessible groundwater table, adequate soil moisture in upper soil profile). Occasionally, a large branch of a healthy sycamore can fall in a location that provides the exact conditions needed for resprouting. However, typically this type of reproduction is more often associated with main trunks or large branches that are still completely or somewhat connected to the rootball. This connection provides access to essential belowground resources through the intact root network, similar to the basal resprouting process described above. It appears that the specific hormones that need to be triggered for rooting are only released under very specific circumstances, while resprouting from branches and trunks that still have an intact rootball is more common.

Asexual reproduction in the form of basal sprouting and to a lesser degree sprouting from downed trees or branches are both important reproductive strategies. However, genetic diversity and fitness would likely be compromised within sycamore populations located in landscapes where hydro-geomorphic conditions are altered in a manner that reduces the efficacy of sexual reproduction. Moreover, conditions that reduce sexual reproduction could eventually reduce sycamore population size and distribution because only a proportion of the individuals in a population is likely to successfully reproduce asexually.

Section 5. Opportunities for Habitat Preservation, Enhancement, Restoration, and Creation

In identifying habitat preservation, enhancement, restoration and creation opportunities for the study area, the H. T. Harvey team considered the historic character of Pacheco Creek and evaluated past, present and future drivers of change to the ecosystem. Our opportunities assessment was also founded on an understanding of the existing abiotic and biotic conditions summarized on Section 2, the constraints presented in Section 3, and our understanding of likely future conditions if/when the Pacheco Reservoir Expansion Project is implemented (Section 6). In the 1800s, the alluvial portion of Pacheco Creek supported a broad, braided, gravel- and cobble-bedded channel with seasonally intermittent flow (Grossinger et al. 2008). The creek sometimes occupied nearly the entire valley floor and its multiple channels and broad, gravelly bars were populated by sycamores and valley oaks (Grossinger et al. 2008). A.T. Herrmann, conducting a survey of Pacheco Pass Road in 1872, sketched upper Pacheco Creek and described it as: "very irregular wide and washed level bottom covers almost all ground up to base of hills." (Grossinger et al. 2008).

Since the historical accounts provided above, a number of disturbances have changed the character and evolution of Pacheco Creek and its floodplain. As described in Section 2, the construction of North Fork Dam for the Pacheco Reservoir constitutes the most significant physical disturbance. The dam captures upstream sediment supply, diminishes peak flows and geomorphic dynamism, and appears to be driving channel incision. Flow releases through the dry season have altered the stream's character from a more intermittent to perennial nature and caused shifts in the composition and density of riparian and floodplain vegetation. Other physical disturbances such as the construction of Highway 152 and floodplain gravel extraction have also altered the hydraulics and physical conditions. In addition, long-term cattle grazing has placed significant pressure on regeneration of riparian vegetation, including sycamores. Despite these disturbances, Pacheco Creek's physical process regime and ecological conditions within the study area appear generally healthy and capable of supporting a broad range of habitat types and natural regeneration of many species, including sycamores. Appropriate enhancement and restoration measures could provide meaningful uplift of physical processes and ecological conditions in the study area.

The most significant anticipated driver of future change is the proposed expansion of Pacheco Reservoir which could dramatically alter the physical processes, hydrology and ecology of Pacheco Creek and the study area. In addition, climate change is already altering precipitation and temperature patterns in the region and will continue to drive further changes to hydrologic conditions (e.g., streamflow, groundwater levels), dry season duration and variability, as well as other ecological functions.

This section describes the opportunities that the H. T. Harvey team identified as feasible for physical process restoration and habitat preservation, enhancement, restoration, and creation within the study area. Our team tailored these opportunities to achieve as many of the preliminary restoration goals as possible given the existing site conditions and primary constraints. This section was developed to present sufficient detail for the Habitat Agency's use in gathering input from stakeholders on the restoration opportunities and for the subsequent selection of opportunities to craft the project description for the Pacheco Creek Restoration Project. We understand that Valley Water is currently planning the Pacheco Reservoir Expansion Project, which would alter flows through the restoration project reach of Pacheco Creek. Therefore, based on our understanding and modeling results, included herein, our team identified opportunities that are likely to persist once the Pacheco Reservoir Expansion Project is built. We have also identified preliminary opportunities for reservoir flow regime management that would synergize with the Habitat Agency's goals for the study area (Section 7).

5.1 Physical Process Restoration Opportunities

The physical process restoration opportunities were identified to provide multiple, site-appropriate approaches for enhancing desirable physical processes (e.g., floodplain connectivity, channel dynamism) and morphological complexity. Implementing these actions can also improve habitat conditions for specific land cover types (e.g., willow riparian, SAW, freshwater marsh, pond) and Habitat Plan covered species (e.g., least Bell's vireo, California red-legged frog) that are targeted by the preliminary restoration goals. These opportunities involve elements that generally fall into two categories: earthwork measures and large wood placement. Earthwork measures may include floodplain lowering, channel bed aggradation, lateral bar placement, secondary channel enhancement, and seasonal wetland enhancement. Examples of large wood placement elements are bar apex jams, flow deflection jams, channel spanning jams, and wood augmentations. In addition, the restoration elements include biotechnical bank stabilization approaches such as, live brushlayering, live staking, and coir netting and also include large wood elements (e.g., root wads) in some instances. The physical process restoration elements are described in more detail in Appendix D.

Our team considered each of these general restoration element categories and identified specific (e.g., spatially explicit) physical process restoration opportunities (Figure 29). These opportunities typically combine two or more restoration elements. Table 5 summarizes the restoration opportunities and constituent restoration elements; it also includes scoring across key restoration goals, rough order of magnitude cost implications and a prioritization score for each opportunity. Many of these opportunities are aimed at promoting conditions that support existing and proposed SAW areas and potentially natural sycamore regeneration. Some of these measures are also aimed at slowing or inhibiting potential future channel incision processes and the associated reduction in floodplain connectivity within the study area.

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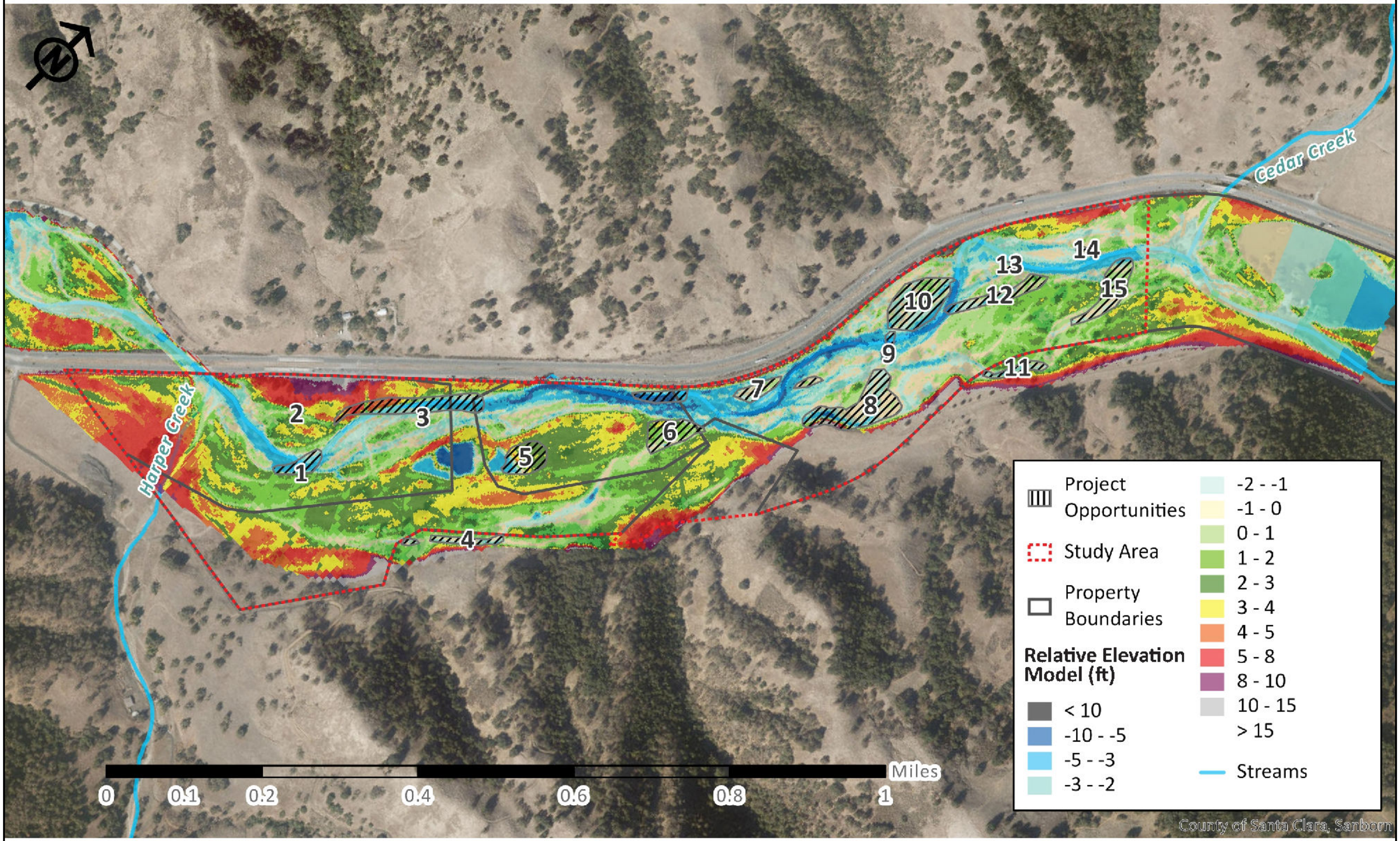

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Figure 29. Pacheco Creek Physical Process Restoration Opportunity Locations
Pacheco Creek Restoration Project: Feasibility Study (4291-01)
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Table 5. Pacheco Creek Physical Process Restoration Opportunities Matrix

ID	Geomorphic Zone(s)	Restoration Elements	Restoration Opportunity Description	Goals Addressed [1]											Rough Cost [3]	Priority (5 is highest)
				SAW	Willow Riparian/least Bell's vireo	Steelhead	Physical Processes/ Dynamism	Sycamore Regeneration	Seasonal Wetland	Freshwater Marsh (tri-colored blackbird)	CRLF, WPT [2]	Floodplain Connectivity	Groundwater Recharge	Infrastructure Protection (Habitat Agency-owned)		
1	Primary Channel Inner Floodplain	Flow Deflection Jam	Install flow deflection jam on interior point bar to promote continued migration of channel into the left bank. Remove electrical pole from eroding left bank and otherwise leave bank as is.	L	M-H	H	H	M-H	L	N/A	L-M	M-H	M	L	$$	5
2	Inner Floodplain	Log Step	Install individual logs along preferential flowpaths of large point bar surface, perpendicular to flow and partially embedded in the ground, to promote localized scour and topographic complexity that could provide sycamore recruitment sites and/or planting areas.	L	M	L	M	M-H	M	N/A	L	L	L	N/A	$	2
3	Primary Channel Inner Floodplain	Bank Layback Floodplain Lowering Point Bar Placement Biotech Bank Stabilization Flow Deflection Jam Armored Bank Heterogeneity Enhancement	Lay back, scallop and terrace right bank, place cut material in point bars along toe of right bank and install flow deflection jams to enhance heterogeneity of channel form along homogenous stream reach and encourage channel dynamism. Interrupt vegetative armoring of left bank by grading notches in bank to encourage lateral dynamism of stream channel, greater connectivity with secondary channel and inner floodplain, and enhancement of channel complexity. Active revegetation with willow and mixed riparian plantings.	N/A	H	H	H	H	N/A	N/A	L-M	M	L-M	M	$$/ $$$	4
4	Outer Floodplain Tertiary Channels	Floodplain Lowering Seasonal Wetland Enhancement	Lower floodplain surface along or near tertiary channel alignment to create scour pool analogs for sycamore recruitment or planting, creation of seasonal wetlands, as well as benefits to other species.	M	L-M	N/A	L	L	H	N/A	M	L	M-H	L	$$	3
5	Outer Floodplain	Construct Freshwater Marsh (1.2 acres)	Excavate outer floodplain area to daylight summer shallow groundwater table at design grade surface to create perennially saturated/shallowly inundated soils to support perennial tall emergent freshwater marsh vegetation for tri-colored blackbird breeding. Also include pockets of deeper ponding to provide additional CRLF habitat within the freshwater marsh.	N/A	N/A	N/A	L	N/A	L	H	H	L	L	N/A	$$	5
6	Primary Channel Inner Floodplain Tertiary Channels	Secondary Channel Enhancement Point Bar Placement/Channel Bed Aggradation	Lower inlet of secondary channel and place material (e.g., alluvium, rock, wood) in heavily incised primary channel to increase inundation frequency in the secondary channel in the proposed SAW restoration area. Configure material in point/lateral bars and/or aggrade the bed along the full channel width to improve instream habitat complexity.	H	M-H	M	H	M-H	L	N/A	L	M-H	H	M	$$/ $$$	4
7	Inner Floodplain	Floodplain Large Wood Complex Log Step	Install large wood complex and/or log steps along the inner floodplain surface to encourage scour, enhance topographic complexity and support natural recruitment of riparian vegetation	L	M	L	M-H	M-H	L	N/A	L	L	L-M	N/A	$/$$	4
8	Inner Floodplain Outer Floodplain	Secondary Channel Enhancement Floodplain Large Wood Complex Log Step	Install large wood complex and/or log steps along the inner floodplain surface to encourage scour, enhance topographic complexity and support natural recruitment of sycamores. Potentially lower secondary channel to promote greater connectivity with primary channel. Excavate and possibly expand Pond 2 to increase habitat value for CRLF.	H	M	H	M-H	M-H	L	N/A	M	H	H	N/A	$$/ $$$	5
9	Primary Channel	Transverse Cobble Bar Placement Channel Spanning Log Jam Secondary Channel Enhancement	Install a transverse cobble bar and/or channel spanning log jam and lower secondary channel inlet to enhancement floodplain connectivity within existing SAW and channel dynamism. Log jam will also enhance steelhead habitat and provide instream cover.	H	M-H	H	H	H	L	N/A	L	H	H	N/A	$$	5

				Goals Addressed [1]												
ID	**Geomorphic Zone(s)**	**Restoration Elements**	**Restoration Opportunity Description**	**SAW**	**Willow Riparian/least Bell's vireo**	**Steelhead**	**Physical Processes/ Dynamism**	**Sycamore Regeneration**	**Seasonal Wetland**	**Freshwater Marsh (tri-colored blackbird)**	**CRLF, WPT [2]**	**Floodplain Connectivity**	**Groundwater Recharge**	**Infrastructure Protection (Habitat Agency-owned)**	**Rough Cost [3]**	**Priority (5 is highest)**
10	Inner Floodplain	Floodplain Lowering Secondary Channel Enhancement Floodplain Large Wood Complex Log Step	Lower secondary channel inlet to promote connectivity. Selectively lower floodplain surface along right bank to encourage secondary flow paths and channel dynamism. Install floodplain large wood complexes and/or log steps to promote localized scour along inner floodplain and secondary channel features.	L	M	M	M-H	M-H	L	N/A	L	M	L-M	N/A	$$	4
11	Outer Floodplain Tertiary Channels	Seasonal Wetland Enhancement	Deepen and/or expand existing seasonal wetland habitats and enhance hydrologic conditions for SAW restoration.	L	L-M	L	L	L	H	N/A	M	L	M-H	N/A	$$	3
12	Inner Floodplain	Secondary Channel Enhancement	Lower secondary channel inlet and move existing large wood feature to downstream side of inlet to enhance secondary channel connectivity and/or lower full secondary channel or create an alcove at downstream end of secondary channel to enhance habitat value for steelhead and support natural recruitment of sycamores within proposed SAW restoration area.	M	M-H	H	M	M-H	M	N/A	M	M-H	M-H	N/A	$/$$	5
13	Primary Channel Inner Floodplain	Bar Apex Jam	Install bar apex jam immediately upstream of juvenile sycamore to encourage activation of secondary channel to river right of the jam and protect sycamore.	N/A	L	H	M-H	M-H	L	N/A	L	M	M	N/A	$$	2
14	Inner Floodplain	Secondary Channel Enhancement	Lower secondary channel to enhance steelhead rearing habitat.	N/A	L-M	M	M-H	M	L	N/A	L	L	L-M	N/A	$	3
15	Inner Floodplain Outer Floodplain Tertiary Channels	Secondary Channel Enhancement	Lower secondary channel inlet to promote connectivity.	H	M	M	M	M-H	L	N/A	L	H	H	N/A	$$	4

[1] H = High; M = Moderate; L = Low; N/A = Not Applicable

[2] CRLF = California red-legged frog; WPT = Western pond turtle

[3] $ < $10K; $$ = $10K to $100K; $$$ > $100K

The H. T. Harvey team and Habitat Agency selected the four most important preliminary restoration goals identified in Section 1 that could be pursued in the study area based on the biological resources present and likelihood of success. These goals are listed below and shaded in green in Table 5.

- **SAW Habitat**—enhance and restore SAW habitat through active planting, site management, and improving physical processes that support sustainable stands of sycamores. Increase the abundance (through active revegetation and natural regeneration) and fitness of sycamores on the site.
- **Willow Riparian/Least Bell's Vireo Habitat**—enhance existing willow riparian habitat, thus improving conditions to support least Bell's vireo, yellow warbler, yellow-breasted chat, and other riparian-associated avian species.
- **Steelhead**—enhance and restore in-stream, floodplain and riparian habitat supporting steelhead migration and juvenile rearing.
- **Physical Processes/Dynamism**—enhance physical processes and dynamism by removing impediments to natural processes or implementing measures that augment, accelerate, and/or amplify natural fluvial processes.

Additional secondary goals are also listed in Table 5. Every physical process restoration opportunity is ranked (e.g., L = low, M = moderate H = high) relative to each preliminary restoration goal. An overall prioritization score ranging from 1 (lowest priority) to 5 (highest priority) was then assigned by the H. T. Harvey team and the Habitat Agency. The prioritization score was established through a qualitative assessment of the degree of ecosystem enhancement relative to the goals, qualitative cost relative to ecosystem benefit, and environmental disturbance associated with implementation. Several lower priority opportunities were also eliminated following discussion with the Habitat Agency.

5.2 Restoration Opportunities Organized by Land Cover Type and Covered Species

The Habitat Plan establishes mitigation requirements by land cover type and covered species. Therefore, the following sections describe restoration opportunities by the land cover types and covered species that are targeted by the preliminary goals identified in Section 1. We also link the physical process restoration opportunities identified above to the specific land cover type and covered species restoration opportunities.

5.2.1 Preserve and Enhance Willow Riparian Forest and Associated Stream Habitat

The Habitat Plan calls for preservation and enhancement of 578 acres (ac) and restoration or creation of an additional 289 ac of riparian forest and scrub (ICF 2012). The Habitat Plan also requires the preservation of 28.3 mi of stream habitat and the restoration or creation of 9.4 mi of stream habitat (ICF 2012).

5.2.1.1 Preserve and Enhance Willow Riparian Forest and Stream Habitat via Cattle Exclusion

Opportunity Description—The distribution of willow riparian habitat within the study area is scattered along the mainstem of Pacheco Creek (Figure 30). However, site observations and groundwater data indicate that the majority of the streamside habitat should be suitable for willow riparian habitat. H. T. Harvey restoration ecologists observed evidence of substantial cattle browsing on the existing willow trees within the study area, particularly along the upstream reach on the recently acquired Ciraulo property that has been subjected to heavier grazing pressure. Moreover, on April 4, 2019 we observed a high abundance of new (i.e., 2019) willow seedlings that had naturally recruited onto low floodplains throughout the study area; they were not yet substantially browsed likely due to the abundance of the surrounding spring grasses and forbs. We therefore hypothesize that cattle grazing likely inhibits natural regeneration of willow riparian habitat and impacts the vertical structure of existing willow riparian habitat (including non-willow understory species), both of which reduce the quantity and quality of habitat for native riparian-associated birds (e.g., least Bell's vireo, yellow warbler), steelhead, California red-legged frog, and other aquatic species. Figure 30 shows the existing willow riparian and stream habitat and provides the surface area available for preservation and enhancement in the study area. Cattle exclusion or targeted flash grazing in streamside habitat would increase the overall cover and habitat quality of willow riparian habitat by promoting natural regeneration and increasing the vertical complexity of riparian vegetation. Cattle exclusion fencing could be strategically placed and maintained in riparian areas. Management of cattle grazing in willow riparian habitat should be integrated with a site-wide grazing management plan to include protection of all areas where preservation, enhancement, and restoration actions are implemented. This effort would likely include complete cattle exclusion for approximately 10 years and subsequently commencing limited flash grazing as part of the long-term management plan for the site.

Pros—This opportunity offers the following benefits:

- Preserve and enhance 40 ac of willow riparian and 7 ac of mixed riparian habitat.
- Preserve and enhance 7,591 linear ft (1.4 mi) of stream habitat.
- Increase cover of willow riparian habitat along Pacheco Creek's edge.
- Increase vertical complexity (and therefore habitat quality) of willow riparian habitat. This would restore habitat suitable for riparian-associated birds such as least Bell's vireo, which is typically associated with dense foliage within 6.6–9.8 ft of the ground (Kus et al. 2010), in areas devoid of such habitat and enhance existing suitable habitat by improving vertical structure.
- Improve freshwater rearing and migration habitat conditions for steelhead by increasing willow canopy cover over Pacheco Creek where appropriate. Additional willow riparian habitat along Pacheco Creek would increase shade over the channel, reduce water temperatures, provide cover, and increase nutrient and wood inputs to the creek.

- Improve riparian forest complexity and provide more shade and nutrient and wood inputs to increase instream and near-stream habitat complexity for California red-legged frog, western pond turtle, and other wildlife.
- Improve water quality by reducing cattle excrement inputs and increasing vegetation cover.
- Future conditions with expansion of Pacheco Reservoir would likely improve hydrologic conditions that support willow riparian habitat establishment and expansion.

Cons—The cons of this opportunity include:

- Potential reduction in sycamore natural recruitment close to the low-flow channel due to increased competition with willows within the willow riparian forest. However, this would not affect SAW habitat that occurs further from the stream and outside of willow riparian forest.
- Restricted cattle access to creek drinking water.

Cost—Moderate. The main cost would be installation and maintenance of cattle exclusion fencing. The fencing would be designed to protect the entire riparian corridor, including stream, willow riparian, mixed riparian, and SAW habitats. Gates would be installed at strategic locations to facilitate the potential for future flash grazing.

5.2.1.2 Install Willow Cuttings in Cattle Exclusion Zone

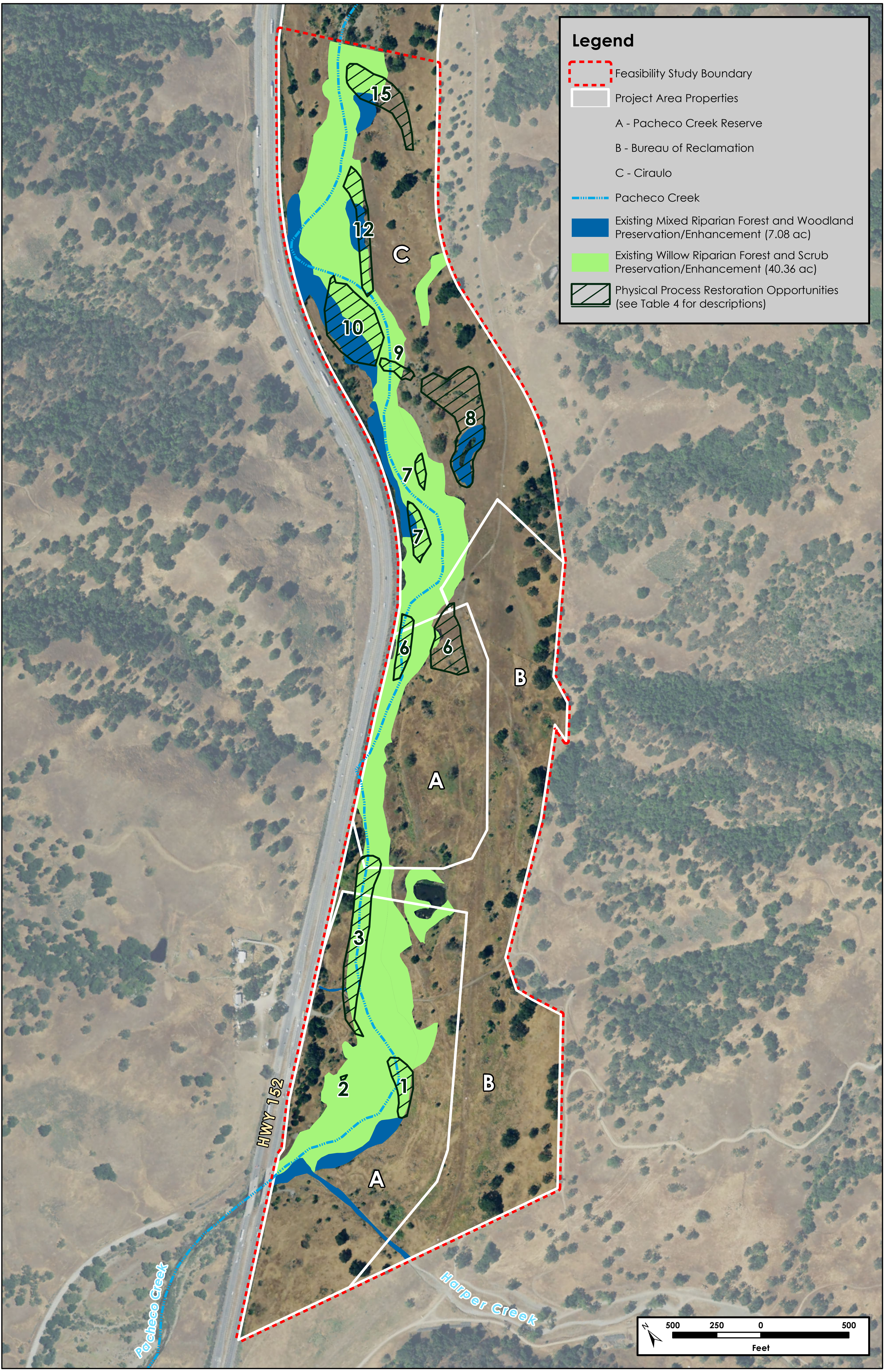
Opportunity Description—Natural willow recruitment from seed is episodic depending upon abiotic conditions during any given rainfall year. To increase the likelihood of rapid willow establishment, willow cuttings could also be installed in the streamside zone between December and January in areas protected from cattle grazing. This would be a low cost effort and would not require installation of an irrigation system.

Pros—This opportunity offers the following benefits:

- Increase rate of willow riparian habitat establishment to more quickly achieve the benefits in 5.2.1.1 above.

Cons—Other than a small additional cost, this opportunity has no disadvantage beyond that mentioned in 4.2.1.1.

Cost—Low



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 30 Enhancement of Riparian.mxd

Figure 30. Preservation and Enhancement of Willow and Mixed Riparian Forest

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5.2.1.3 Implement Physical Process Restoration Opportunities

Opportunity Description—Implementing many of the physical process restoration opportunities summarized in Table 5 and detailed in Appendix D would result in enhancing existing willow riparian forest habitat and stream habitat, as well as potentially creating abiotic conditions conducive to establishment of new willow riparian forest. Figure 29 shows the subset of physical process restoration opportunities that could be undertaken to enhance and/or restore willow riparian habitat. These opportunities provide improved hydrologic and ecological function under current and potential future, post-Pacheco Reservoir expansion, conditions. Table 5 includes relative rankings of the habitat benefits for each physical process opportunity connected to willow riparian forest.

Pros—These opportunities offer the following benefits:

- Improve near-stream (i.e., banks and lower floodplain) settings to facilitate recruitment and establishment of willow riparian forest.
- Improve secondary channel and floodplain connectivity and possibly expand/create new areas of willow riparian forest.
- Restore habitat suitable for riparian-associated birds such as least Bell's vireo in areas devoid of such habitat and enhance existing suitable habitat for riparian-associated birds by improving vertical structure.
- Improve riparian forest complexity, providing more shade, nutrient and wood inputs to increase instream and near-stream habitat complexity for California red-legged frog, western pond turtle, and other wildlife.
- Increase in-stream aquatic habitat complexity and enhance steelhead habitat.
- Physical process restoration opportunity #3 would stabilize and revegetate the scoured creek bank (right bank looking downstream) and thereby protect the Habitat Agency's site access/parking area and existing well/pump infrastructure (EW-1).

Cons—The cons of these opportunities include:

- Temporary impacts on and possible conversions of regulated habitats that would require regulatory agency permits and approvals.

Cost—Low to High. The costs associated with earthwork to implement the physical process restoration opportunities shown on Figure 24 are described in Table 4.

5.2.2 Restore Central California SAW

The Habitat Plan calls for preservation and enhancement of 40 ac and restoration or creation of an additional 14 ac of SAW (ICF 2012). Below we first provide an overview of the existing research on the historical ecology of SAW in the region and at the site, as well as a summary of the factors limiting SAW regeneration. This section further compliments the Sycamore Regeneration Conceptual Model (Section 4), briefly summarizing parts of the conceptual model and providing site specific observations. The historical ecology summary is then followed by the identification of opportunities to approach or meet the Habitat Plans requirements for SAW preservation, enhancement and restoration and creation.

5.2.2.1 Overview of Historical Ecology and Factors Limiting Natural Regeneration of SAWs within the Study Area

SAW is relatively rare in California. The historical distribution and habitat regeneration of SAW has been greatly limited over the past 200 years, largely as a result of changes to flow and sediment dynamics from dam installations and the removal of floodplains from the influence of regular flooding (Keeler-Wolf et al. 1996). SAW has been mapped in just 17 occurrences along intermittent streams in California that encompass a total of approximately 2,000 ac (Keeler-Wolf et al. 1996). The Central California SAW habitat type is identified in the Habitat Plan conservation strategy as a "very rare and threatened land cover type" (ICF 2012).

Historical data indicate that on the mainstems of Uvas-Carnadero, Llagas, and Pacheco Creeks there was a total of at least 22 mi of braided channel with California sycamore as the dominant riparian tree. About 6 mi of the historical sycamore-dominated braided channel was made up of large stands that could be considered to meet the criteria of Keeler-Wolf et al. (1996) for SAW (i.e., greater than 10 ac). Most of this SAW was found along Pacheco Creek, which is still one of the largest intact SAW sites in California (Grossinger et al. 2008).

Natural flood events are critical for SAW to thrive; they deposit fresh alluvial sediment, carry and deposit seeds, and recharge groundwater levels that are drawn down over time (Keeler-Wolf et al. 1996). These conditions are necessary for the successful sexual reproduction of sycamores (e.g., viable seed production, dispersal, germination, and seedling establishment) (Keeler-Wolf et al. 1996). In most California watersheds, dams have cut off peak flows, thus limiting substantial flood events, coarse sediment deposition, and scour, and resulting in altered hydrographs. Dams and other water management practices have often transformed intermittent streams into perennial streams (Kamman Hydrology 2009). Furthermore, groundwater pumping alters natural draw-down rates and affects the subsurface conditions to which the California sycamore likely adapted (Gilles 1998; King 2004). Grazing, vegetation management, and land use changes such as road encroachments and habitat conversion can further impede conditions that support SAW.

The Pacheco Creek California sycamore stands are hindered by the alteration of natural hydrologic and physical processes from Pacheco Reservoir operations and gravel mining excavations, as well as pressure from grazing (Keeler-Wolf et al. 1996). The construction of Pacheco Reservoir in 1939 has limited the natural flooding, scouring, and sediment deposition on Pacheco Creek alluvial bars and terraces, and therefore affected the conditions that support sycamore regeneration. The capture of sediment behind the Pacheco Reservoir dam has also likely produced sediment-starved water, which can cause the mainstem channel to incise, further reducing flooding of adjacent floodplain surfaces. In addition, the release of stored water during the dry season for groundwater recharge and agricultural use appears to be gradually causing conversion of SAW to willow riparian forest in a manner similar to that observed on other local streams (Beagle et al. 2017; Grossinger et al. 2008). The widening of SR 152 caused the removal of some stands and confines the creek under multiple bridge crossings.

Development of a comprehensive understanding of the patterns and timing of SAW regeneration is an ongoing field of discovery. The primary components are understanding the distribution, age, and health of SAW communities and observing patterns of SAW regeneration. SFEI researchers conducted an inventory of California sycamore trees at the Pacheco Creek site in 2015. They observed that although the ages of the sycamores were relatively evenly distributed, the reproduction within the stands appeared to be limited and concentrated near the active channel, in areas mapped as willow riparian.

In the 2017 WY, Pacheco Creek experienced its largest flood year on record since 1998, experiencing two greater than 10-year recurrence interval events (greater than 11,000 cfs). As a result of the hydrologic activity, major geomorphic change was observed on site. These events scoured new floodplain areas, depositing coarse cobble and establishing what looked like an active channel in a previous grassy area. Similarly, side channels were activated or initiated, and new surfaces near and around the channel were scoured, forming new bars. After WY 2017, SFEI researchers documented several types of regeneration on site and mapped the locations. These observations, which are summarized below, could be used for planning appropriate locations, elevations, and ages of expected sycamore natural recruitment and/or active revegetation (Beagle et al. 2017, 2018).

1. **Vegetative Resprouting from Downed Trees—**Several trees along the active channel had been knocked over in the downstream direction and partially buried. These downed trees then sent multiple, large shoots upward from the prone trunks, similar to the growth strategies of other disturbance-adapted floodplain species such as willows (*Salix* spp.) and California bays (*Umbellularia* spp.). This appears to be an additional resprouting strategy different than vegetative resprouting from ground level trunks (of intact, vertical trees) observed during non-flood years (see Beagle et al. 2017).
2. **Seedling Recruitment—**Sycamores reproduce sexually as well as asexually. Successful sexual reproduction by seed is thought to be controlled by the presence of suitable substrate, access to baseflow or groundwater, and seed production and dispersal (Bock and Bock 1989). During field observations on November 8, 2017, we mapped seedlings in 28 locations at the Pacheco Creek site. We observed these seedlings within the geomorphic locations described below.
    a. **Point Bars—**Seedlings were observed growing on freshly sorted point bars, in locations that were protected from high velocities on downstream ends of point bars, or in backwater areas of upstream ends of point bars.
    b. **New Depositional Bars—**Seedlings were observed on newly scoured or recently reworked lateral- bars. In particular, they were observed in fresh cobble gravel bars about one foot above the low-flow channel, and situated such that groundwater was still accessible. These bars were typically flat or of low grade. When grain size was fine or embedded, we did not see regeneration. Seedlings were associated with young mule fat, tall cyperus, and water smartweed (*Polygonum* sp.).

Bars with seedlings were in areas where no sign of grazing was observed. We observed sapling sycamores (5–6.5 ft tall) on bars of slightly higher elevations that appear to have established prior to the 2017 WY.

c. **Side Channel Oxbow Lake Features—**We also observed several saplings 3–4 ft tall, most likely 1–3 years old, located along a side channel which has become a series of small oxbow "lakes" or isolated pools. These saplings were located in a similar position as the new seedlings, in protected or lower-velocity sides of channels in flood stage.

d. **Persistent Bar Formations—**We observed a bar along the channel that had persisted through the most recent flooding event and that may have formed in another large event. This higher elevation bar has become vegetated with a several similar-sized sycamores in a patch of mature, 5-ft-high mule fat. These sycamores are estimated to be 20 years old based on tree coring. Though the age of the mature mule fat was only an estimate, we speculate that these mule fat and sycamores may have established together around the time the fresh gravel bar was formed. The last "threshold" event (1998) may have scoured this bar alongside the channel, beginning the cycle of succession.

5.2.2.2 Preserve and Enhance Existing SAWs via Cattle Exclusion

Opportunity Description—H. T. Harvey plant ecologists mapped a total of 8.24 ac of existing SAW habitat within the study area that could be preserved (Figure 31). However, the historical SAW ecology presented above, historical aerial photographs, and remnants of old sycamores confirm that SAW previously occupied a much larger proportion of the study area. We hypothesize that a combination of recent prolonged drought cycles, declining ground water levels, and cattle grazing have likely influenced the regional decline in overall health and sustainability of SAW habitat, and have reduced natural regeneration at the site. Therefore, we believe the exclusion of cattle from the existing SAW habitat would result in a significant enhancement to the existing SAW habitat to be preserved. The approach to cattle exclusion and management would be similar to that described above for willow riparian and stream habitats. Cattle would be completely excluded for approximately 10 years via construction of cattle exclusion fencing. However, flash grazing would be allowed and could facilitate long-term weed control efforts following the initial decade of exclusion.

Pros—This opportunity offers the following benefits:

- Provide 8.24 ac of the 40 ac of SAW preservation required by the Habitat Plan.
- Ensure the long-term ecological connectivity between existing and restored SAW within the study area (see below for SAW restoration opportunities).

Cons—We see no detriments to this opportunity from the ecological perspective.

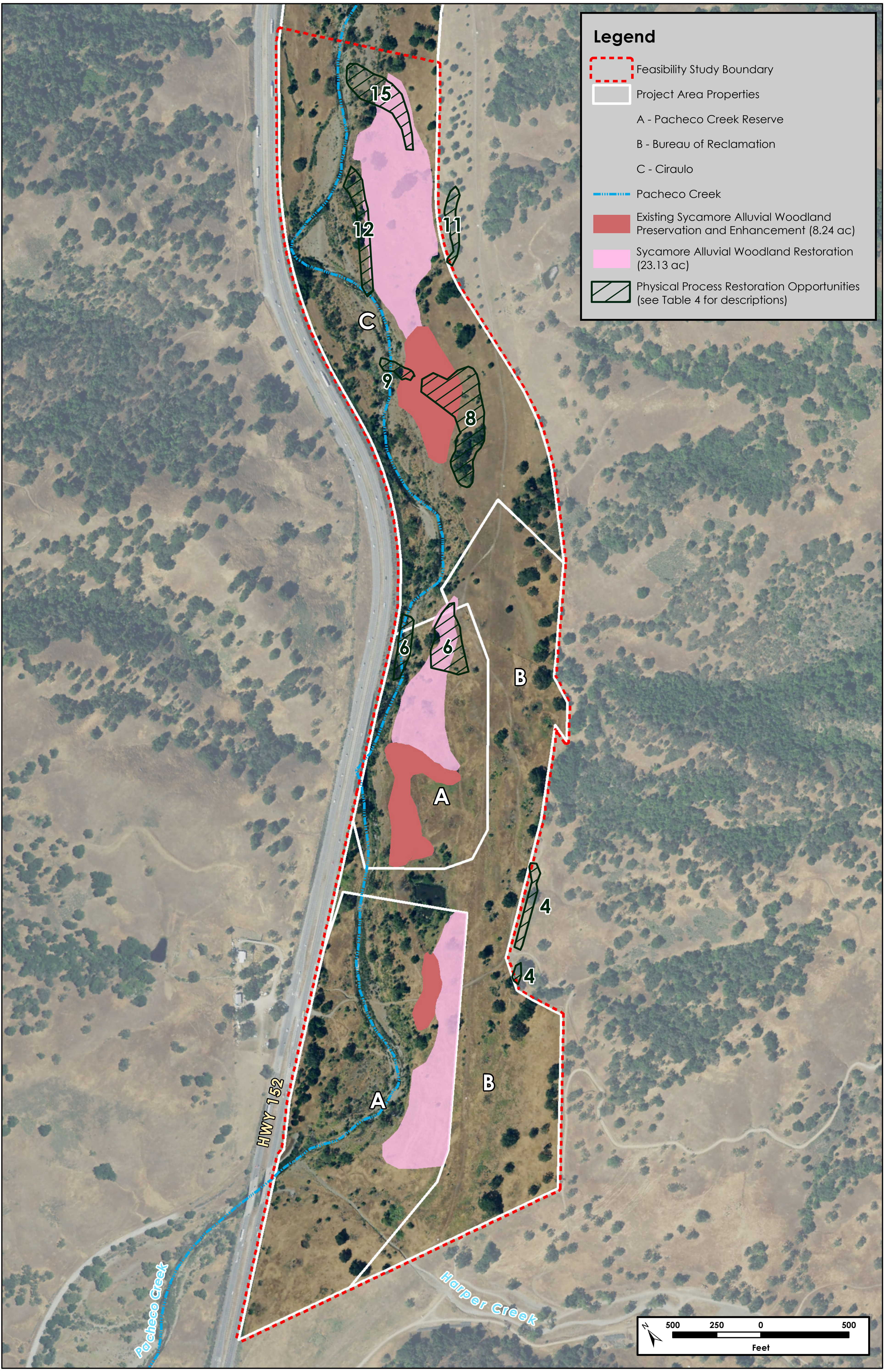

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Figure 31. Preservation, Enhancement and Restoration of Sycamore Alluvial Woodland

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Cost—Moderate. The primary cost would be installation and maintenance of cattle exclusion fencing. The fencing would be designed to protect the entire riparian corridor, including stream, willow riparian, mixed riparian and SAW habitats.

5.2.2.3 Restoration of SAWs through Active Revegetation

Opportunity Description—H. T. Harvey restoration ecologists have identified a total of approximately 23 ac within the study area that would likely support restoration of SAW habitat (Figure 31). We identified SAW restoration areas by integrating information on the estimated historical footprint of SAW habitat, existing SAW distribution, existing soil conditions, preliminary data on groundwater from recently installed piezometers, and anticipated restoration of particular physical processes. SAW habitat restoration would entail active revegetation, short-term irrigation (approximately 5 years), and managed grazing. Cattle would likely need to be completely excluded for approximately 10 years. However, once the trees are established to the point they can tolerate periodic disturbance from livestock, flash grazing would be allowed and could facilitate long-term weed control efforts. Implementing specific physical process restoration opportunities within different geomorphic zones would complement the active revegetation. These opportunities are described in the next section.

Pros—This opportunity offers the following benefits:

- Provide up to 23 ac of SAW which exceeds the 14 ac of SAW restoration required by the Habitat Plan. We recommend that the SAW revegetation footprint exceed the Habitat Plan minimum acreage requirement by at least 20% to provide a contingency to accommodate for the modest level of uncertainty inherent in SAW restoration. Restoration of the entire 23 ac area would benefit SAW in the region and goes well beyond the Habitat Plan requirements.
- Restore SAW habitat that will be contiguous with existing SAW habitat.

Cons—The cons of this opportunity include:

- We see no detriments to this opportunity from the ecological perspective.

Cost—Moderate to High. Cost would include collection, propagation, planting and maintenance of planted sycamores, as well as cattle exclusion fencing described above.

5.2.2.4 Implement Physical Process Restoration Opportunities

Opportunity Description—Implementation of the subset of physical process restoration opportunities shown on Figure 29 would enhance existing SAW habitat. Moreover, in certain locations physical process restoration could restore abiotic conditions conducive to sustaining existing SAW and establishing new SAW within the restoration areas (e.g. reconnecting existing or historical swales to restore braided system, lowering floodplains to spread flows and encourage scouring of surfaces, increasing mobility of channel bed materials and reworking channel bed forms, encouraging scour pools). Table 4 provides a description of these physical process opportunities.

Pros—These opportunities offer the following benefits:

- Improve physical processes needed to sustain existing and restored SAW habitat, which would also benefit downstream reaches of Pacheco Creek that support existing SAW.
- Support Habitat Plan goals for preserving 40 ac and restoring 14 ac of SAW.

Cons—The cons of these opportunities include:

- We see no detriments to this opportunity from the ecological perspective.

Cost—Low to High. The costs associated with earthwork to implement physical process restoration opportunities shown on Figure 29 are provided in Table 5.

5.2.3 Preserve and Enhance Existing Pond Habitat

The Habitat Plan requires preservation and enhancement of 52 ac of pond habitat (ICF 2012). The following section identifies opportunities relative to these requirements.

5.2.3.1 Cattle Exclusion at Ponds 1 and 2

Opportunity Description—The exclusion of cattle from Ponds 1 and 2 will reduce browse pressure and facilitate the expansion of freshwater marsh and seasonal wetland habitats along the fringe of the ponds (Figure 32). The restoration of a freshwater marsh/seasonal wetland fringe would benefit California red-legged frog, western pond turtle, and the broader pond ecosystem. Cattle should be excluded from all or at least the majority of the pond to enhance this valuable edge habitat type. It is feasible to consider having limited cattle access to a portion of the ponds for use as a water source. However, it would be recommended to allow at least 5 years for the fringe habitat to reestablish prior to allowing some restricted cattle access.

Pros—This opportunity offers the following benefits:

- Improve habitat suitable for California red-legged breeding by improving conditions for frog egg mass attachment to emergent wetland vegetation in Pond 1. Note that more hydroperiod monitoring data would be needed to determine whether the hydroperiod at Pond 2 is suitable for California red-legged frog breeding.
- Improve habitat suitable for foraging by metamorphic California red-legged frog and hatchling western pond turtle.
- Reduce habitat suitability for bullfrogs along the pond fringe by increasing emergent wetland cover and thereby potentially reducing predation on California red-legged frog.
- Increase native plant community diversity.

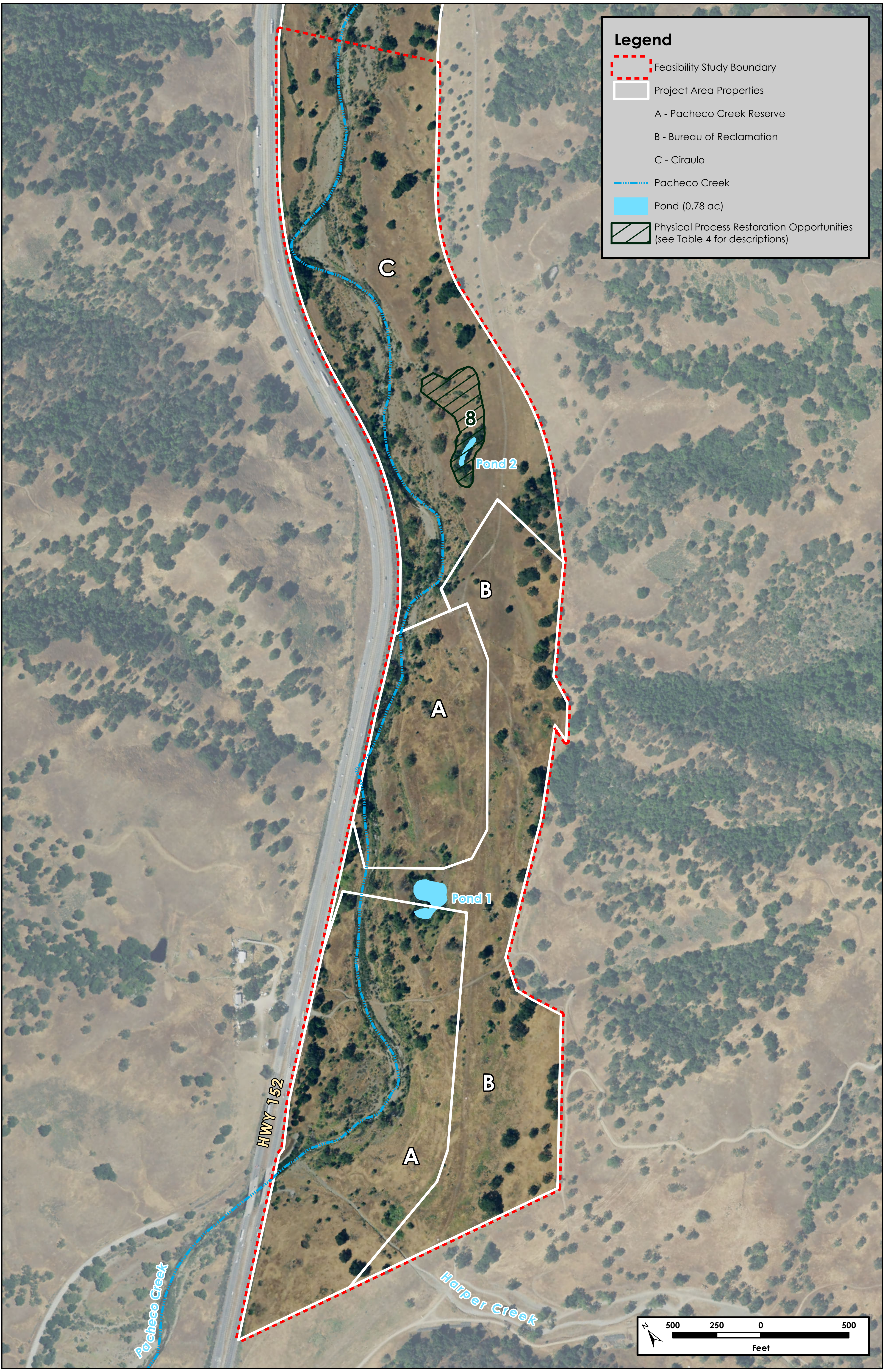

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Figure 32. Preservation and Enhancement of Existing Ponds

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Cons—The cons of this opportunity include:

- Restricted cattle access to drinking water.
- Would require an access agreement with BOR to install fence on their property.

Cost—Low. The above sections put forth the opportunity to enhance willow riparian forest and SAW by excluding cattle from the riparian corridor. Because Ponds 1 and 2 are located close to the existing willow and SAW land cover types, exclusion of cattle from Ponds 1 and 2 would only nominally increase the cost of fencing.

5.2.3.2 Control Bullfrog Abundance at Pond 1 and Stream

Opportunity Description—The H. T. Harvey herpetologist observed a relatively high abundance of adult bullfrogs at Pond 1 and within the stream corridor during the April and July 2019 site reconnaissance surveys. Because bullfrogs may compete with, and prey on, California red-legged frogs, the presence of bullfrogs is considered a substantial adverse effect on the California red-legged frog (Cook 2002; Cook and Currylow 2014; Cook and Jennings 2001; Kiesecker et al. 2001; Moyle 1973). A bullfrog eradication or reduction program could be initiated and maintained in Pond 1 and the adjacent Pacheco Creek. At a minimum, a reduction in bullfrog abundance may allow for both species to occupy Pond 1 and the adjacent Pacheco Creek if the habitats are diverse enough to allow for segregation of individuals into these different habitats (Cook and Currylow 2014).

Pros—This opportunity offers the following benefits:

- A reduction in bullfrog abundance will reduce the negative impact of competition and predation on the California red-legged frog.

Cons—The cons of this opportunity include:

- Because the site is part of an open system and bullfrogs may continuously enter the site from offsite sources, a bullfrog eradication or reduction program may be required into perpetuity to sustain the benefits.

Cost—Moderate

5.2.3.3 Eradicate Exotic Fish from Pond 1

Opportunity Description—H. T. Harvey's qualitative visual observations indicate the high likelihood that there are exotic predatory fish (i.e., centrarchid fish species) present at Pond 1. If present, these fish species may prey on tadpoles and newly metamorphic California red-legged frogs. Therefore, the presence of these fish species are considered a major negative impact on the California red-legged frog (USFWS 1996). A survey to determine the presence of exotic predatory fish followed by an eradication program, if found to be present, would remove this negative impact on the California red-legged frog, if present.

Pros—This opportunity offers the following benefits:

- Eradication of exotic predatory fish, if present, would reduce the negative impact of predation on the California red-legged frog.

Cons—We see no detriments to this opportunity from the ecological perspective.

Cost—Moderate

5.2.3.4 Install Floating Turtle Basking Platforms at Pond 1

Opportunity Description—As noted in the existing conditions section above, H. T. Harvey's wildlife ecologists observed numerous western pond turtles at Pond 1 and identified a paucity of basking sites within Pond 1 (most turtles were concentrated on small logs or were basking on the bank, where predation risk is higher than on in-water structures). Therefore, western pond turtle basking habitat could be improved via installation of four floating turtle basking platforms. The platform design should emulate platforms that our herpetologist has observed to provide effective pond turtle basking habitat and would include the following attributes: stationary position in deeper portions of the pond, increased basking area to accommodate several turtles, easy access for turtles to basking area from surrounding water.

Pros—This opportunity offers the following benefits:

- Increases the basking sites available to western pond turtles.
- Provides safe basking sites to western pond turtles in the deeper portions of Pond 1.

Cons—We see no detriments to this opportunity from the ecological perspective.

Cost—Low

5.2.3.5 Deepen and Expand Area of Pond 2 to Improve Conditions for California Red-Legged Frogs and Western Pond Turtles

Opportunity Description—The estimated hydroperiod at Pond 2 is not likely suitable for California red-legged frog breeding or substantial use by western pond turtle; however, additional water level monitoring would be needed to confirm the actual hydroperiod of Pond 2. Pond 2 could be excavated to increase ponding depths and expand the pond footprint to enhance the existing conditions and create new pond habitat for California red-legged frogs and western pond turtle (Figure 32, location #8). The deepened and expanded pond could be revegetated with native seasonal and perennial wetland vegetation. During the design, the footprint of pond deepening would need to be informed via test pit/trench excavation because bedrock may be close to the surface in certain locations.

Pros—This opportunity offers the following benefits:

- Provision of California red-legged frog breeding habitat and improved pond habitat for western pond turtle.

Cons—We see no detriments to this opportunity from the ecological perspective.

Cost—Moderate cost due to the need for earthwork.

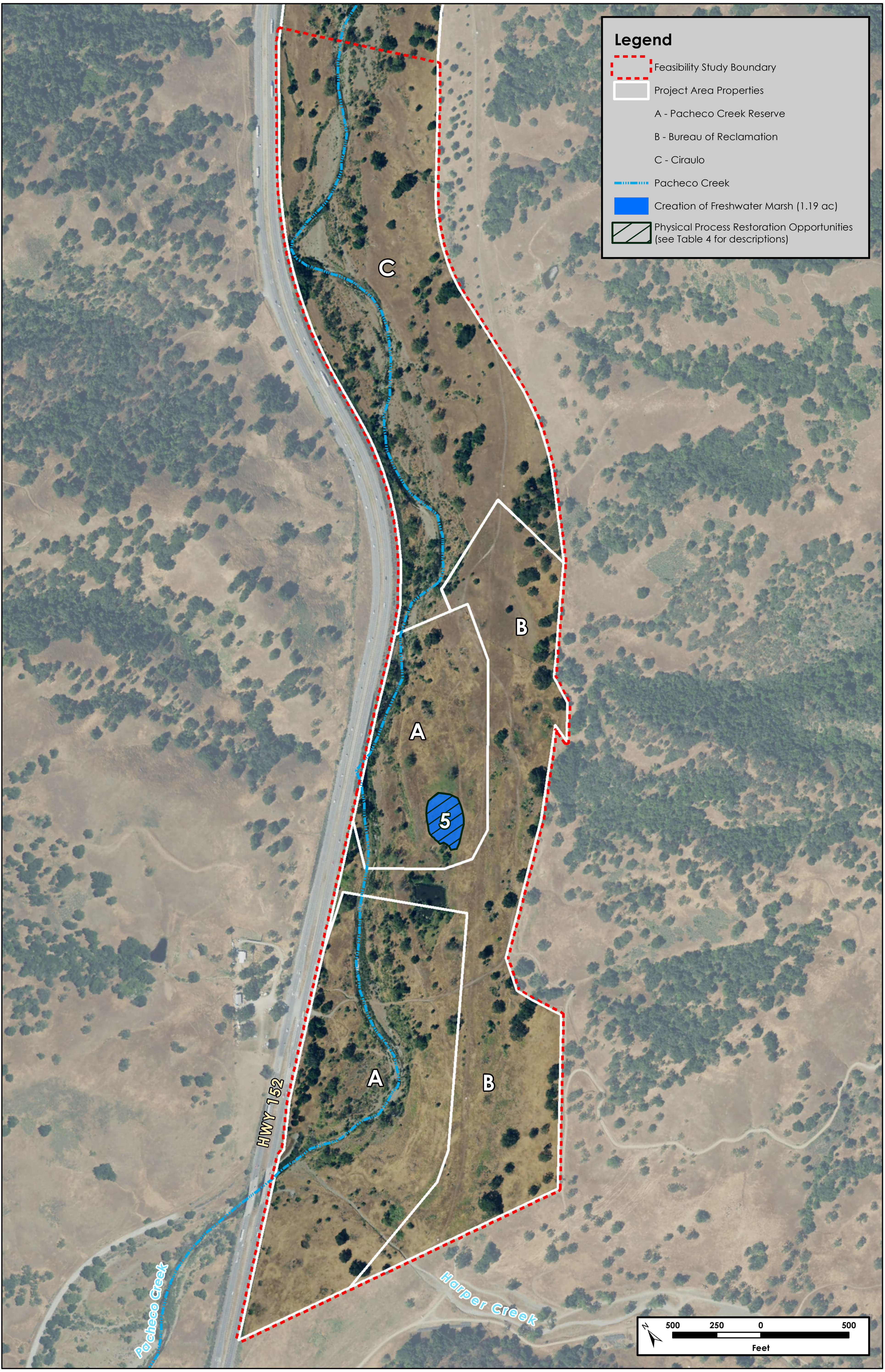
5.2.4 Create New Freshwater Marsh and Seasonal Wetland Habitats

The Habitat Plan requires restoration or creation of 25 ac of coastal and valley freshwater marsh (perennial wetland), restoration or creation of 30 ac of seasonal wetlands, and restoration or creation of 52 ac of pond habitat (ICF 2012). The following section identifies opportunities relative to these requirements.

5.2.4.1 Create New Freshwater Marsh/Pond and Seasonal Wetland Habitat via Floodplain Excavation

Opportunity Description—Ponds 1 and 2 are likely inundated perennially or near-perennially by shallow groundwater (Figure 33). This hypothesis is supported both by visual observations, vegetation types and preliminary groundwater data, which show that WSEs both in Pacheco Creek and the existing ponds track closely with groundwater levels measured in the newly installed piezometers. The existence of groundwater driven perennial pond/wetland habitat on the floodplain supports the notion that additional similar ponds/wetlands could be constructed via floodplain excavation into the shallow groundwater table. This could be accomplished via expansion of the existing seasonal wetland depression immediately northeast of Pond 1 (Figure 27, location #5); this depression could be deepened and enlarged to support perennial freshwater marsh. A contiguous patch of perennial freshwater marsh spanning at least 1 ac would provide suitable breeding habitat for tricolored blackbird. This species may use areas of habitat no greater than a few square meters, and many colonies occupy habitat less than 1 ac in extent (CDFW 2018). However, larger patches of suitable habitat can support larger colonies, and we recommend that the created marsh be at least one ac in extent to provide suitable breeding habitat for a sizeable tricolored blackbird colony. The created freshwater marsh could also be designed with some deeper pockets of open water to provide additional pond habitat beneficial to California red-legged frog and western pond turtle. However, suitable tricolored blackbird breeding habitat requires contiguous emergent marsh with few or no trees within the marsh or on the marsh perimeter. Therefore, a freshwater marsh design should incorporate elements to minimize willow tree establishment and long-term management would be required to prevent willow tree establishment.

There are other existing low points within the historical floodplain channel network that could be excavated to reduce the depth to seasonal groundwater to enhance existing and possibly create new seasonal wetland habitat (Figure 33, locations 4 and 11). The design for any floodplain excavations would need to include measures to minimize the potential for stranding/trapping steelhead.



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 33 Creation of Freshwater Marsh and Seasonal Wetland.mxd

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Ecological Consultants

Figure 33. Creation of Freshwater Marsh and Seasonal Wetlands

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Pros—This opportunity offers the following benefits:

- Creation of freshwater marsh habitat suitable for tricolored blackbird breeding.
- Creation or expansion of breeding habitat for the California red-legged frog and enhancement/ expansion of western pond turtle aquatic foraging/refugial habitat.
- Creation of seasonal wetland habitat.

Cons—The cons of this opportunity include:

- Willows will likely recruit around the edge of the freshwater marsh and require long-term control to maintain tricolored blackbird breeding habitat.
- Floodplain wetlands/ponds, if not designed properly, could increase the potential to trap steelhead when floods recede.
- Additional perennial freshwater marsh and pond habitat could improve breeding habitat for invasive aquatic predators such as bullfrogs, which threaten California red-legged frogs.

Cost—Moderate to High. The cost associated with this opportunity would vary based on the extent of the actual grading implemented.

Section 6. Potential Effects of Proposed Reservoir Expansion

6.1 Proposed Reservoir Expansion

The Pacheco Reservoir Expansion Project has proposed to significantly expand the existing 5,500 acre-feet reservoir to a 140,800 acre-feet active storage capacity (DOI et al. 2019). The expanded reservoir would nearly double Valley Water's overall storage capacity of approximately 165,000 acre-feet distributed across ten other reservoirs. In 2018, $484.5 million of the estimated $1.3 billion required project funding was conditionally secured by Valley Water, PPWD and San Benito County Water District (Valley Water 2020). The expanded reservoir would be filled by local inflows and water imported from the Central Valley Project (CVP). Proposed project benefits include flexibility in water allocation and management, improved drinking water supply resilience, reduced reliance on groundwater pumping during droughts, improved downstream steelhead habitat, and incidental flood risk reduction along Pacheco Creek and the Pajaro River. These benefits are intended to include reduced reliance by the Santa Clara Valley on Delta water during drought conditions and the ability to allocate greater amounts of water to wildlife refuges in the San Joaquin River watershed and Delta during below normal water years (DOI et al. 2019).

In addition to constructing a taller new earthen dam approximately 0.5 miles upstream of the existing dam, the Pacheco Reservoir Expansion Project would include installation of a new two-way pump station and a pipeline to move water into and out of the new reservoir. The new pump station would be connected to the Pacheco Conduit, an existing water pipeline operated by Valley Water that facilitates transport of water to Santa Clara Valley from the CVP's San Luis Reservoir. In addition to capturing inflows from the contributing watershed, the expanded reservoir would be designed to store imported CVP water and would have the ability to release that water into the Pacheco Conduit. The Pacheco Reservoir Expansion Project is one of the alternatives presented in the San Luis Reservoir Low Point Project EIS/EIR (DOI et al. 2019) and is intended to address some of the water allocation constraints that currently exist due to differences in timing of water availability at San Luis Reservoir and demand (or storage capacity) within Santa Clara Valley and other areas. Without the additional storage capacity of the proposed reservoir, storage or transfer of this additional imported CVP water may not be feasible (DOI et al., 2019).

Of the total 140,800 acre-feet of storage capacity, the lower 55,000 acre-feet of capacity would be reserved for habitat releases with exception of public health and safety emergency situations (to be designated by Valley Water). The habitat releases are intended to maintain wetted channel habitat and cool water temperatures to support steelhead within Pacheco Creek and the Pajaro River downstream. As currently planned, CVP water would be imported in the early portion of the calendar year prior to when San Luis Reservoir is drawn down. Average monthly releases would target flow rates between 10-20 cfs as measured at the confluence of the North and South Forks of Pacheco Creek, below the reservoir (Table 6). In the event that flows from the South Fork meet or exceed the flow target, flow releases from the expanded reservoir may be reduced or eliminated (DOI et al. 2019).

Table 6. Proposed Release Targets and Associated Flow Volumes from the Pacheco Reservoir Expansion Project[1]

Month	Average Monthly Release Targets to Pacheco Creek (cfs)[2]	Volume Released Per Month (Acre-Feet)[3]
January	10	615
February	10	555
March	20	1,230
April	20	1,190
May	12	738
June	13	774
July	14	861
August	14	861
September	14	833
October	14	861
November	10	595
December	10	615
Annual		9,727

[1] All monthly flow release targets are from Table 2.2 of the San Luis Low Point Improvement Project Draft Environmental Impact Statement (DOI et. al. 2019).

[2] Pacheco Reservoir releases are reduced during higher flows in the South Fork of Pacheco Creek

[3] Volume Released per Month is calculated by multiplying the discharge target by the number of days in a month and converting to acre-days.

Based on the limited information available, all runoff from the North Fork would be captured and stored except when the reservoir is at full capacity and additional water is released beyond the proposed habitat release flow targets shown in Table 6.

6.2 Potential Effects on Pacheco Creek Hydrology

The proposed reservoir expansion would significantly alter the hydrology of Pacheco Creek by changing the magnitude and timing of streamflow and the system's overall water balance. It should be noted that the hydrologic regime of Pacheco Creek has already been modified by the existing reservoir and its operations as described in Section 2 (Effects of Reservoir Operations on Unimpaired Flows).

6.2.1 Potential Changes to Peak Flow Regime

With a proposed capacity of 140,800 acre-feet, the new reservoir's potential storage volume would be approximately an order of magnitude larger than the estimated average annual inflow to the North Fork of 12,200 acre-feet[7]. Even during the wettest of winters, the reservoir's storage capacity is significantly greater than the annual runoff generated from the North Fork watershed. The capture of this runoff would reduce the

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[7] Annual flow accumulation refers to the total volume of streamflow that passes through a specific location during a water year. The average flow accumulation was calculated by scaling flow accumulation observed at the USGS Pacheco Creek gage to the location of the North Fork Dam. Results are based on daily discharge from WY 1940-1981 and 2007-2019. Estimates are conservative in that they do not include reduction of flow accumulation due to evaporative losses from the North Fork Dam or streamflow percolation.

magnitude of peak flow events observed downstream at the study area by removing the North Fork sub-watershed contribution unless flows were released from the reservoir during the event.

To more quantitatively assess the magnitude of these effects, the average daily discharge and annual flow accumulation were evaluated for three of the water years with highest peak flows within the USGS gage record for Pacheco Creek: 1956, 1969 and 2017 (Figures 34, 35 and 36). While the proposed reservoir would not experience these exact winter flow conditions, this analysis provides an example of how the expanded reservoir capacity and operations could alter Pacheco Creek's peak flow regime. In 1956, 1969 and 2017, the estimated annual flow accumulation at the reservoir location of 36,700, 45,000 and 56,300 acre-feet, respectively, is significantly lower than the total storage capacity of the proposed reservoir. Unless the reservoir started the WY 2017 winter season at or more than 83,700 acre-feet of storage and no other losses (e.g., evaporation) or gains (e.g., CVP imports) are assumed, there would be no contribution of streamflow during a peak flow event from the North Fork to Pacheco Creek, unless discretionary releases were made from the reservoir. While it is possible that a "perfect storm" of conditions could occur such that the reservoir's storage capacity is exceeded during a winter season, the probability of this occurring during a large high flow event is relatively low. Therefore, the magnitude of the greatest peak flow events observed at the Pacheco Creek study area would generally see a full loss of the North Fork's contribution. Figure 37 also shows the estimated flow accumulation below the North Fork and at the study area for both existing and proposed reservoir conditions for WY 2017 to show how the proposed reservoir expansion would significantly reduce the peak flow regime during this historical very wet winter.

6.2.2 Potential Changes to Base Flow Regime

The proposed flow targets shown in Table 6 and associated reservoir releases would further transition Pacheco Creek from an intermittent to a perennial stream. As mentioned above, Section 2.1.2.4 discusses the shift in flow regime caused by the existing North Fork Dam. With the proposed reservoir's lower 55,000 acre-feet of storage capacity reserved for habitat releases and emergency water supply use, it is likely that the reservoir will be capable of maintaining streamflow in accordance with the average monthly release targets (which cumulatively yield less than 10,000 acre-feet per year), through most multi-year droughts. Although the existing reservoir releases have augmented Pacheco Creek flows below the reservoir through a substantial portion of the dry season in many years, there are often still periods of zero flow, especially during drier water years (see discussion in Section 2.1.2 and Figure 6 regarding average daily flow distribution).

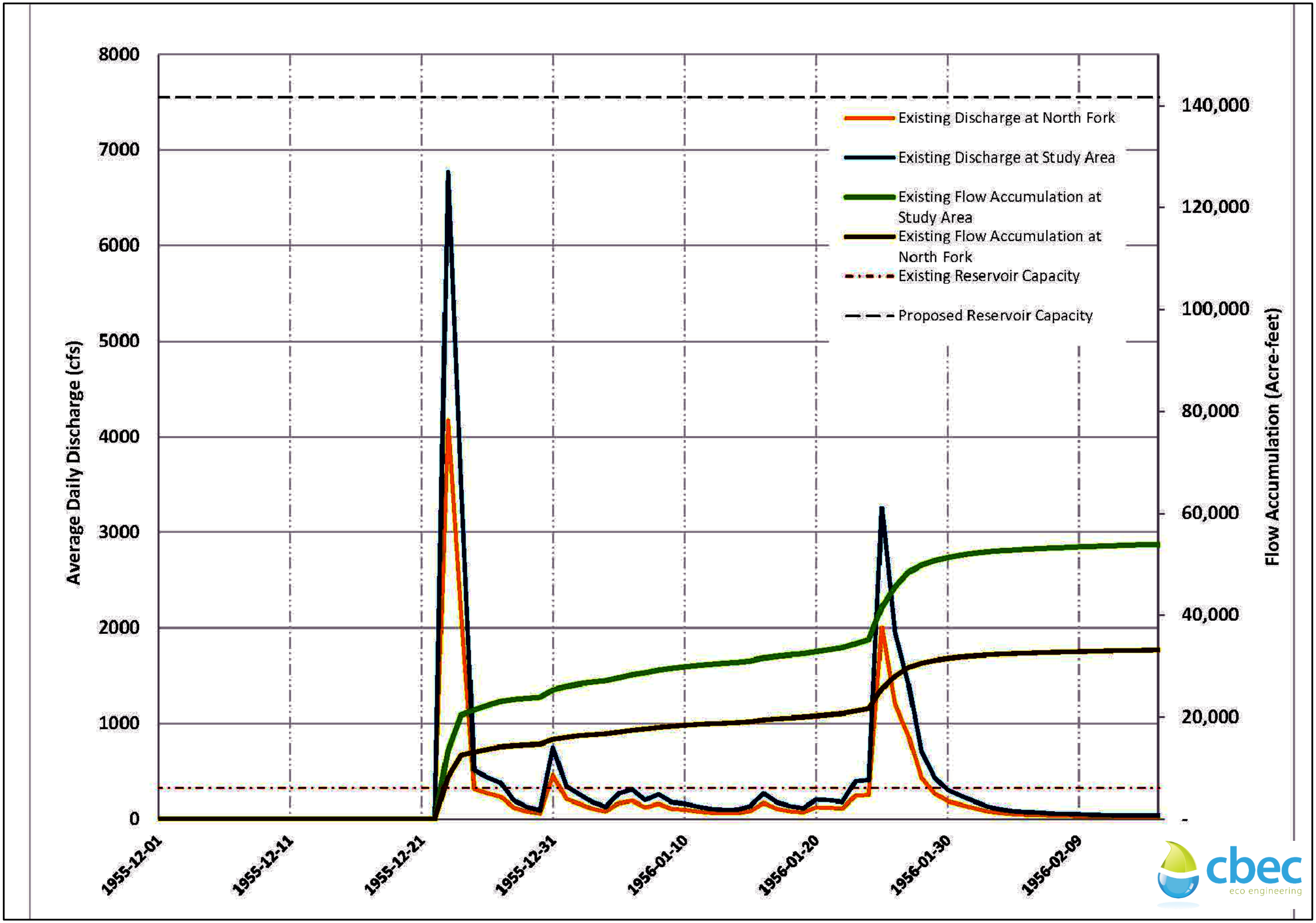
The proposed reservoir release targets also shift the timing and magnitude of typical streamflow. Figure 38 presents discharge and flow accumulation for WY 2016, which had an estimated North Fork flow accumulation of 11,000 acre-feet which is comparable to the long-term annual average for the North Fork of 12,200 acre-feet. This figure shows how the steady, perennial reservoir releases for the proposed condition (dashed blue line) would likely compare with the estimated existing North Fork flows (solid blue line), essentially smoothing out a flashy intermittent stream hydrograph to create a fairly flat and consistent base flow. The flow accumulation for the proposed reservoir flow releases also demonstrates the differences in the timing of the flow accumulation being driven predominantly by a few short runoff events in the existing hydrologic condition to a steady accumulation over the year in the proposed hydrologic condition. Figure 39 presents discharge and flow accumulation for WY 2013 which was a particularly dry year. The difference between the dashed and solid red and green lines shows how much greater the proposed annual flow accumulation will be for a dry year compared to the existing hydrologic condition. As referenced above, Figure 37 provides a comparison of WY 2017, one of the wettest years on record as measured by flow accumulation, for the proposed reservoir releases with the existing North Fork flows. While contributions from the South Fork would remain unregulated in all of these cases, providing flashy contributions to streamflow during heavy rain events, the effect of the proposed reservoir expansion and operations on the base flow regime is illustrated in these examples.

This conversion of Pacheco Creek to a perennial stream will also raise the minimum groundwater surface elevation in the study area. As described in Section 2 (Surface-Water and Groundwater Monitoring), groundwater levels in the study area typically decline shortly after the cessation of flow releases from the existing reservoir and continue to drop while no surface flow is present. As a perennial stream, the pronounced dry-season decline in groundwater levels would be eliminated and a more consistent minimum depth to groundwater would be maintained within the study area.

6.2.3 Potential Changes to Water Balance

The expansion of the reservoir and its associated operations would alter the existing water balance (i.e., the change in storage and movement of water into and out of a system) of the Pacheco Creek watershed. With the significant increase in storage capacity and intended carryover storage volume, the proportion of annual runoff from the North Fork that is lost to evaporation would increase significantly. To provide a rough estimate of potential evaporation losses from the proposed reservoir, the proposed surface area of the reservoir at full pool (1,385 acres per DOI et al. 2019) was multiplied by the annual evaporation rate. Monthly evaporation rates near the Pacheco Watershed have been reported in other planning efforts. Micko (2014c) reported 48.6 in/year from data provided by the City of Hollister and 44.5 in/year from data obtained from Valley Water. The 1954 Bureau of Reclamation Reconnaissance Report stated an annual evaporation rate of 51.6 in/year. Applying these rates to the reservoir full pool surface area yielded annual evaporation estimates ranging from 5,136 to 5,955 acre-feet/year. Using these same evaporation rates and assumption of full pool storage, the existing reservoir yields 731 to 847 acre-feet/year of evaporation. While it is unlikely that either the existing or proposed reservoir will be maintained at full pool throughout the year and some of the stored water in the proposed reservoir will be imported CVP water, these estimates are intended to provide an order-of-magnitude estimate of evaporation losses which are significantly greater than the losses expected from the existing reservoir.

The release targets for the proposed reservoir cumulatively yield 9,700 acre-feet/year while the average annual flow accumulation for the North Fork over the period of record at the USGS gage is estimated at 12,200 acre-feet/year. Flows from the North Fork may be further reduced based on potential contributions from the South Fork (Table 6). This reduction in total releases of 2,484 acre-feet/year suggests a minimum 20% reduction in annual streamflow volume from the North Fork in a condition where the South Fork contributes zero flow in meeting the proposed confluence habitat release targets. With any contribution from the South Fork, the magnitude of reduction in North Fork contribution would be even greater.



N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 34 Peak Flows WY 1956.mxd

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Figure 34. Peak Flows WY 1956
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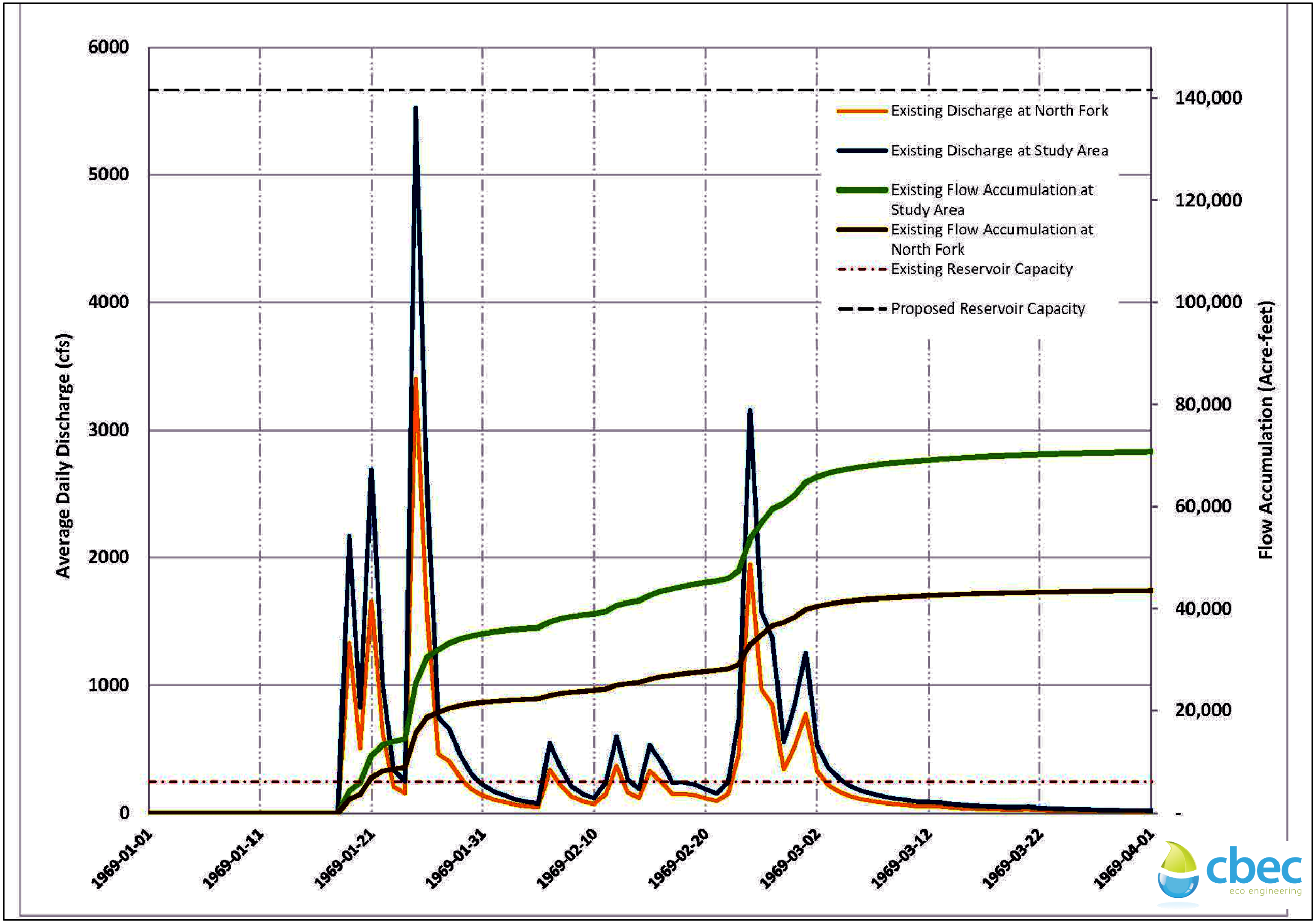

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Figure 35. Peak Flows WY 1969

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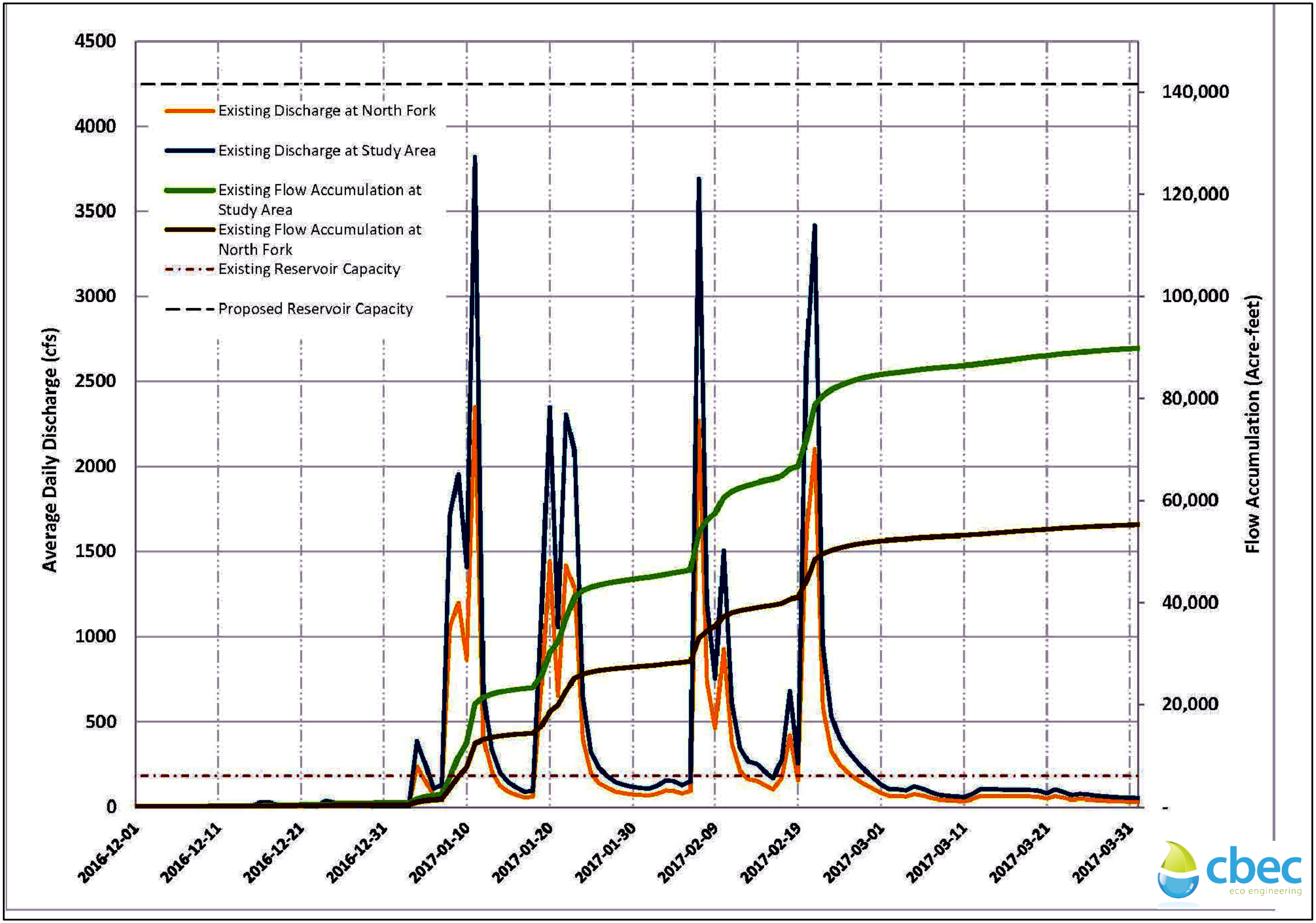

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Figure 36. Peak Flows WY 2017

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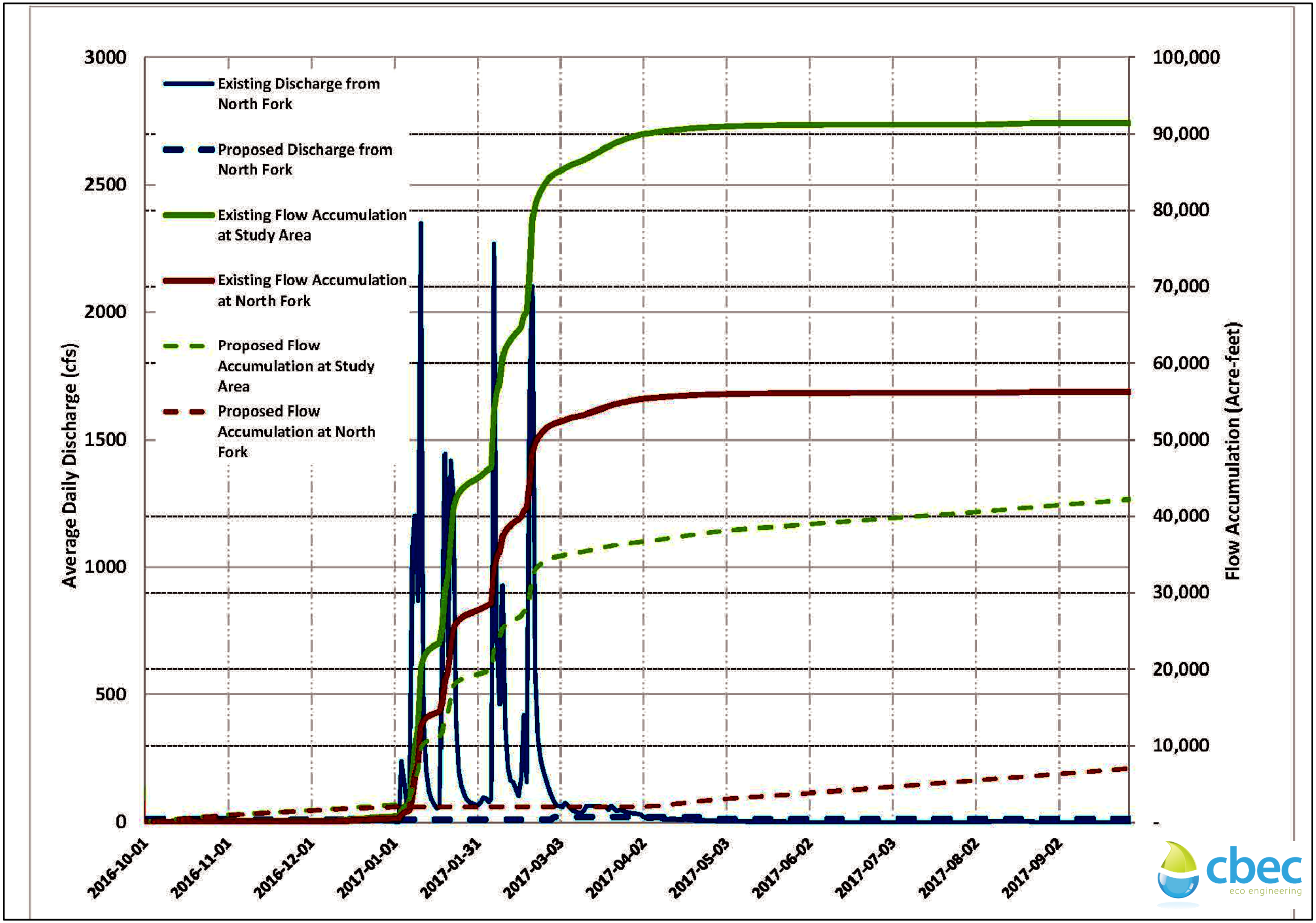

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 37 Flow Accumulation WY 2017.mxd

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Figure 37. Flow Accumulation WY 2017

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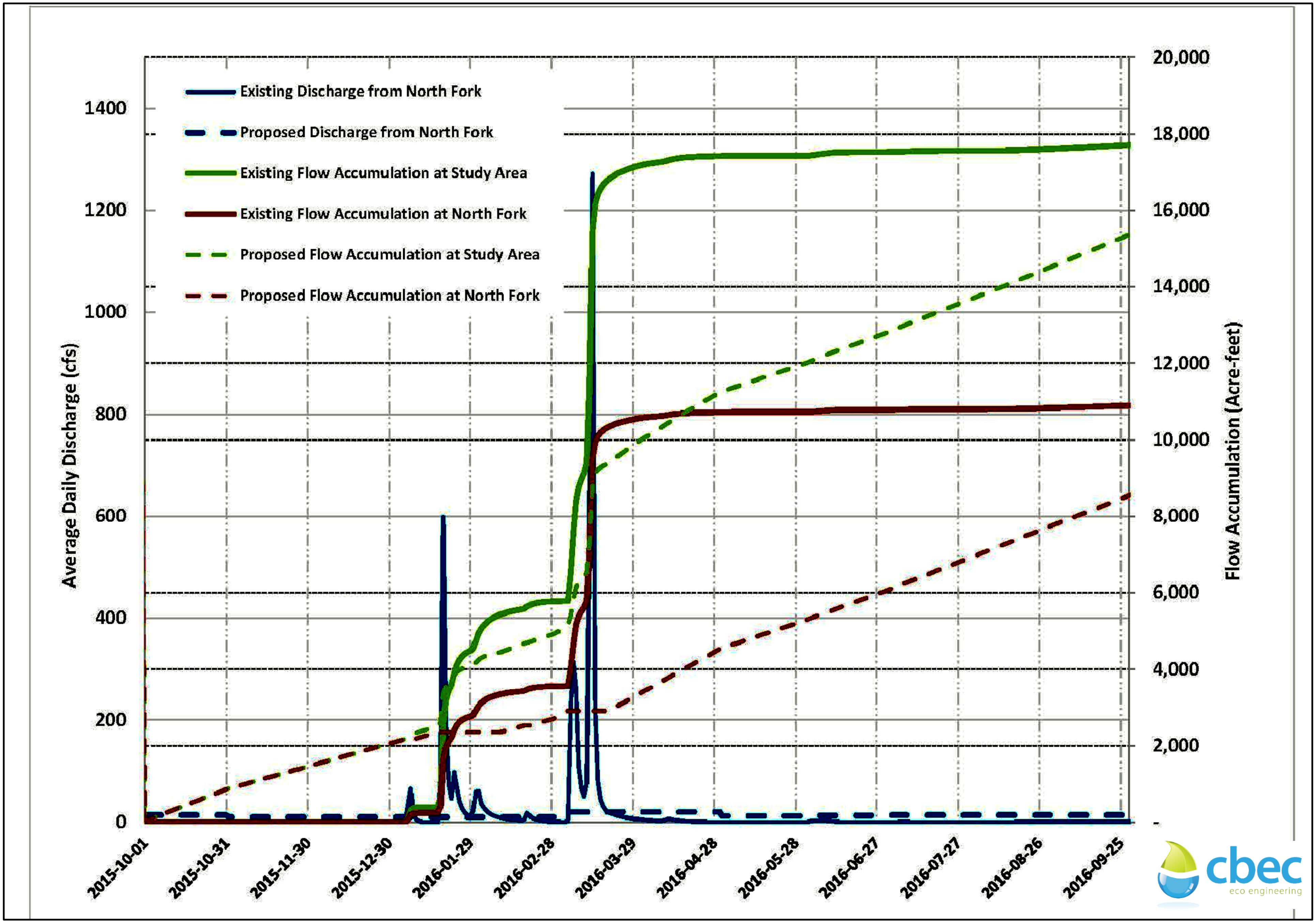

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Figure 38. Flow Accumulation WY 2016

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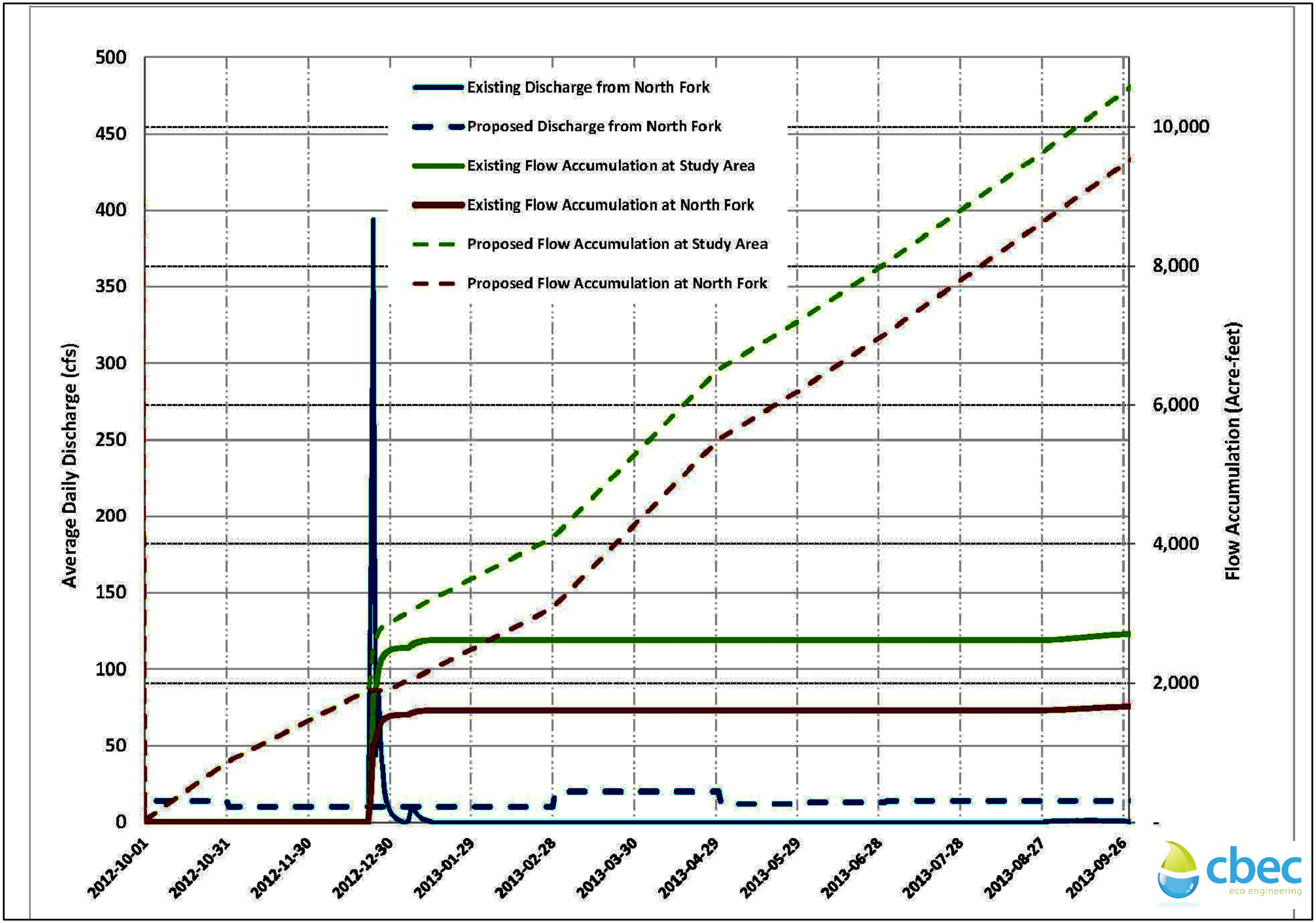

N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 39 Flow Accumulation WY 2013.mxd

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Figure 39. Flow Accumulation WY 2013

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6.3 Potential Effects on Riparian Vegetation, Physical Processes and Sycamore Regeneration at the Study Area

6.3.1 Effects of Increased Base Flows on Existing Willow Riparian Forest and Channel Dynamism

This section is focused on proposed reservoir effects upon the Willow Riparian Forest and Scrub Habitat area shown in Figure 23. Since construction of the North Fork Dam and subsequent flow releases through much of the summer growing season, the creek has changed from an intermittent stream to nearly perennial through the project reach. This change in the timing and distribution of flows has likely altered the character of the system from a sparsely vegetated, highly dynamic channel, floodplain and valley floor to a more densely vegetated riparian corridor with muted dynamism. Stands of dense riparian vegetation along sections of the channel margins, dominated by willow and mule fat, likely impede lateral migration of the stream channel. While the current reservoir provides significant flow augmentation through much or all of the summer growing season, there are still periods of zero streamflow, which likely limits further establishment of willow riparian vegetation. California sycamore seedling regeneration was observed at the site within the Willow Riparian Forest and Scrub land cover type. The degree of sycamore regeneration that H. T. Harvey and SFEI observed as a consequence of the 2017 flood was likely substantial enough to support the sustainability of the scattered distribution of sycamores within the site's willow riparian forest. The current flow regime likely reduces interspecific competition between willows and regenerating sycamore seedlings/saplings within the willow riparian forest, allowing sycamore regeneration along the channel margins and inner floodplain.

The proposed reservoir expansion and operations would likely increase dry season baseflow in the study area from approximately 0 to 5 cfs supplied by the current reservoir to approximately 10 to 20 cfs (DOI et al. 2019). This increase in dry season streamflow along with the elimination of periods of zero streamflow would increase the shallow groundwater elevation along the channel and promote further willow establishment in locations that are currently sparsely vegetated with woody vegetation including mature sycamores and sycamore seedlings/saplings. In particular, the perennial streamflow would likely raise the minimum groundwater surface elevation significantly and reduce or eliminate one of the current constraints on willow riparian vegetation establishment. With even greater streamflow releases through the dry season, the riparian corridor close to the low-flow channel would likely become more heavily vegetated with willow riparian vegetation, thereby reducing sycamore regeneration.

The more densely vegetated riparian corridor resulting from increased baseflows would likely drive vegetative armoring of the stream banks which could further impede the dynamism of the stream channel and floodplain. Vegetative armoring of the stream banks may also increase the potential for stream channel incision. This reduced channel dynamism and potential reduction in floodplain connectivity due to incision may further reduce the potential for sycamore regeneration along the channel margins and inner floodplain.

6.3.2 Effects of Increased Base Flows on Existing and Proposed Sycamore Alluvial Woodland

Increased summer base flows would likely increase shallow groundwater elevations within existing SAW and proposed SAW restoration areas further from the main channel. Given that the shallow groundwater table is well connected to surface water in the channel, it is expected that future summer DTG would remain similar to the values displayed in Figure 10. In the proposed SAW planting areas, the average DTG generally ranges between 5-8 ft when surface water is flowing in Pacheco Creek. Under potential future conditions the interannual variability in the dry season DTG will be substantially reduced. For the piezometers adjacent the proposed SAW planting areas (P-2, P-3, P4, P-6, P-7), the DTG dropped an average of 5 ft between observations when surface water was present (Figure 10) to the seasonal low observed in the piezometers on 12/1/2019 (Figure 11). The increased perennial baseflow from the expanded reservoir would provide relatively constant minimum DTG, compared to historical conditions where the DTG would increase when reservoir releases stopped. This increased stability of the shallow groundwater table could increase survival and growth of existing California sycamore and proposed sycamore plantings by reducing the potential for shallow groundwater to recede below tolerable depths during future drought years. There is also some potential for decreased summer groundwater table depths to support expansion of the footprint of willow riparian forest in the lowest lying areas within the existing and proposed SAW. However, this phenomena is unlikely to affect a substantial proportion of the SAW areas given the greater frequency of flood inundation and depth to groundwater throughout the majority of the SAW areas.

6.3.3 Effects of Reduced Peak Flows on Physical Processes and Sycamore Regeneration

Physical processes and the potential for sycamore regeneration would be significantly affected by the reduction in peak flows resulting from the proposed reservoir expansion and operations. As described above, large flow events are responsible for driving dynamic channel behavior and are essential for creating conditions conducive to natural sycamore regeneration. The velocities and broad inundation extents of these high flow events, particularly events of the 5-year recurrence interval or greater, drive reworking of the stream channel and floodplain by scouring, mobilizing and depositing sediment. These processes create new channel forms and alignments which create the physical template for new areas that facilitate California sycamore regeneration. This is because sycamore regeneration relies on freshly scoured and/or deposited bar surfaces to facilitate new seedling recruitment.

The proposed reservoir expansion and operations would largely eliminate peak flow contributions from the North Fork. The loss of contributions from Pacheco Creek's largest sub-watershed in nearly all flood events (see examples in Figures 34, 35 and 36) would mute the peak flow regime and associated physical process regime. In order to quantitatively assess the effects of this reduction in peak flows on physical processes and sycamore regeneration, a more detailed evaluation was performed by way of analyzing differences in a future 20-year recurrence interval runoff event. This event was selected because it, 1) is large enough to drive physical processes that create reworked floodplain and near-channel surfaces that support sycamore regeneration and 2) occurs frequently enough relative to sycamore longevity to provide seed-generating individuals with multiple opportunities during their lifetimes for seed dispersal and establishment[8]. As previously described, the 20-year runoff event has a peak streamflow of 10,550 cfs at the study area, which activates the full width of the valley bottom. Under the proposed reservoir expansion and operations, it is likely that most 20-year runoff events would no longer experience flow contributions from the North Fork. This would reduce the observed flows at the study area by 36% to approximately 6,750 cfs.

To evaluate the effects of this potential reduction in peak flows on the physical process regime and the potential for sycamore regeneration in the study area, a velocity range expected to be capable of mobilizing much of the floodplain surface sediment was identified. The velocity magnitude that is needed to mobilize various substrates or vegetation classes is well documented in the scientific literature (Chang 1988; Gerstraser 1998; Fischenich 2001). Literature-based velocity threshold values were compared for the existing condition and the expanded reservoir condition estimated flow rates to assess differences in the velocity patterns that are predicted.

Dominant grain sizes and soil character were evaluated based on field observations and boring logs obtained during the piezometer installations. The boring logs characterized most surface and near-surface soils as “Sand with Silt”, “Silty Sand with Gravel”, “Poorly Graded Sand” and “Silty Gravel with Sand”. Vegetation presence and root density across the floodplain also varies spatially, though much of the floodplain has established grassland vegetation with some areas of dense, woody vegetation. At the lower end of the velocity range, a velocity of 1.75 ft/second was selected as the critical velocity capable of mobilizing “Sandy Loam and Silty Loam (non-colloidal)” or the more readily erodible material on the floodplain surface. At the upper end of the velocity range, a velocity of 3.75 ft/second was selected as the critical velocity based on its capacity to mobilize “graded loam to cobbles”, “alluvial silt (colloidal)” and “short native and bunch grass” land cover (Gerstraser 1998; Chang 1988; Fischenich 2001). This velocity is considered capable of mobilizing less easily erodible material on the floodplain, yet there are features on the floodplain, such as more densely vegetated areas and coarser grained material that would be unlikely to mobilize at this velocity.

Velocity results from hydraulic model simulation of the 20-year runoff event were analyzed with respect to exceedance of these lower and upper velocity magnitude thresholds of 1.75 and 3.75 ft/second, respectively. For the purposes of this analysis, the velocity thresholds were applied universally across the stream channel and floodplain. While this simplification does not account for the spatial heterogeneity in sediment grain sizes and properties, vegetative cover and critical velocity for sediment mobilization, it provides a first-order approximation of the changes in Pacheco Creek’s capacity for geomorphic work within the study area. It should also be noted that this analysis also focuses on scour or erosion processes, while sediment deposition is also a process associated with the geomorphic reworking of a stream channel and floodplain during higher flow events and the resulting creation of new floodplain and bar surfaces that can serve as the physical template for sycamore recruitment and establishment.

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[8] As described in the conceptual model in Section 4, successful sycamore regeneration requires alignment of a number of abiotic and biotic factors including a significant geomorphic event.

Under the existing hydrologic conditions, the 20-year runoff event (10,550 cfs) velocities exceed 1.75 and 3.75 ft/second across 99.9 and 39.3 acres (Table 7), respectively, within the study area (Figure 40 top panel). By contrast, under the proposed hydrologic conditions of the expanded reservoir, the muted 20-year runoff event (6,750 cfs) velocities only exceed 1.75 and 3.75 ft/second across 68.0 and 23.6 acres of the study area, respectively (Figure 40 bottom panel). This represents a 32% and 40% decrease in the area subject to velocities of 1.75 and 3.75 ft/second or greater, respectively, within the floodplain.

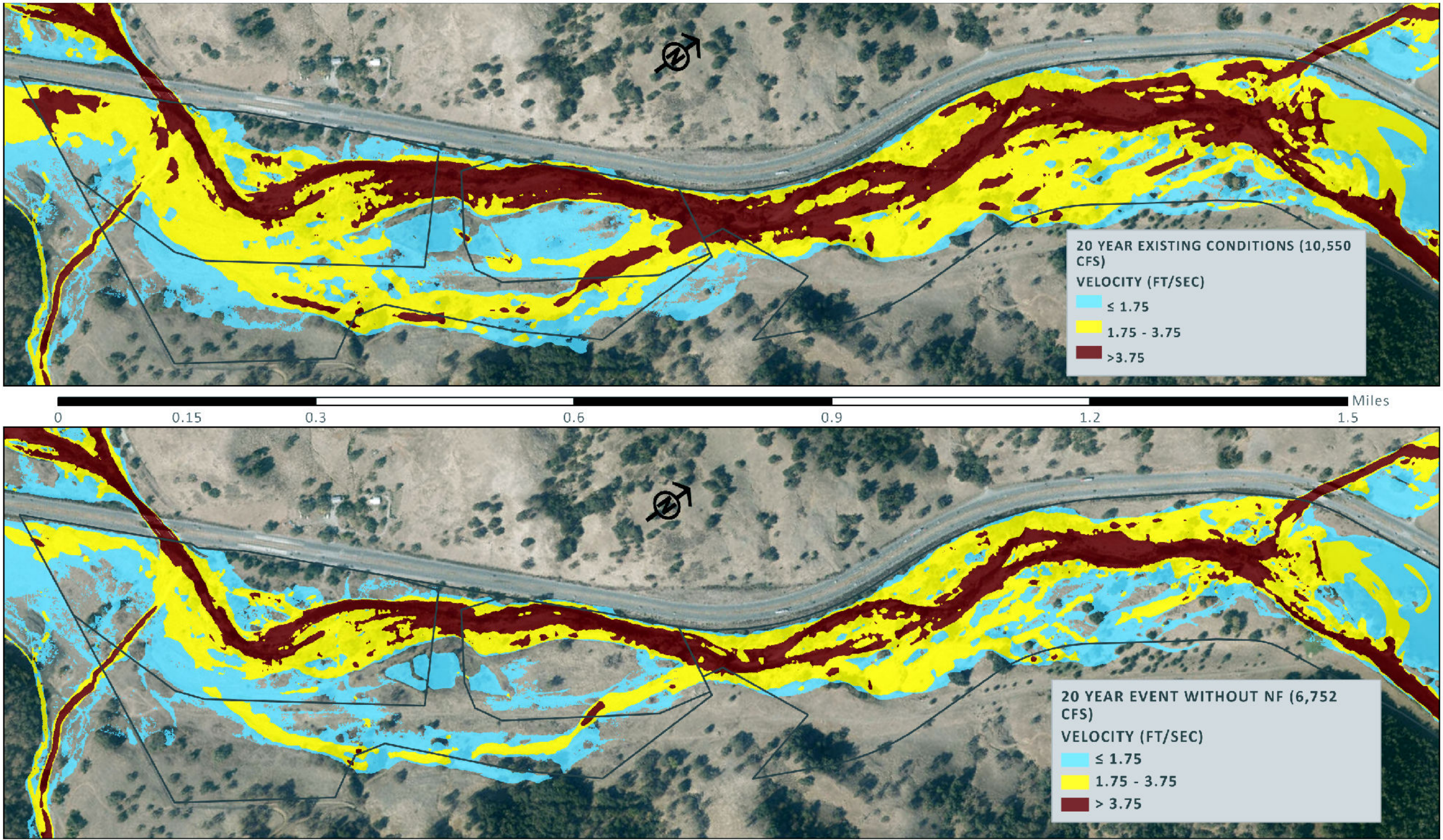
Table 7. Acreage within Study Area that Exceeds Velocity Thresholds Required to Mobilize Floodplain Material With and Without Proposed Reservoir

Velocity Thresholds [1]	Areal Extent That Exceeds Velocity Threshold with North Fork (acres)	Areal Extent That Exceeds Velocity Threshold without North Fork Contribution (acres)	Change in Areal Extent (acres)	% Change
0-1.75 ft/second	35.3	36.8	1.6	4%
1.75 - 3.75 ft/second	60.6	44.4	-16.3	-27%
> 3.75 ft/second	39.3	23.6	-15.7	-40%
Total Inundated Area	135.3	104.8	-30.4	-23%

[1] The area that experiences velocities above 1.75 ft/second as referenced in the text, is the sum of the 1.75 to 3.75 ft/second and > 3.75 ft/second rows in the table.

The reduction in areas that exceed this velocity range during a 20-year runoff event is indicative of a significant loss in Pacheco Creek's capacity for geomorphic work and its ability to drive natural regeneration of sycamores within the study area under the proposed hydrologic regime. The changes in spatial extents of the lower and upper velocity threshold values in the study area that would result from the proposed reduction in streamflow are shown in Figure 41. Figure 41 differs from Figure 40 in that it provides layered velocity exceedance mapping for a single velocity threshold for both hydrologic conditions in the same panel, while the panels in Figure 40 show the velocity ranges for a single hydrologic condition.

California sycamore seedling regeneration was observed during the growing season after the floods in the study area in WY 2017, which included two, greater than 10-year recurrence interval runoff events (Beagle et al. 2018). Overall, the proposed reservoir expansion and operations would likely have a negative effect on the potential for natural sycamore regeneration along channel margins and the inner floodplain (within the willow riparian forest and scrub) by driving increased willow riparian vegetation density and muting and/or inhibiting the physical processes and channel dynamism that are required for sycamore regeneration. The interaction of these factors is depicted in Figure 42, a conceptual model of the effects of the existing reservoir and proposed reservoir expansion on hydrology, physical processes, riparian vegetation communities and sycamores. The reservoir expansion is expected to intensify many of these effects with the exception of disruption of coarse sediment supply. Discussion of potential measures to reduce these effects are described in Section 7.



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N:\Projects4200\4291-01\Reports\Feasibility Study\Fig 40 Floodplain Velocity.mxd

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Figure 40. Floodplain Velocity
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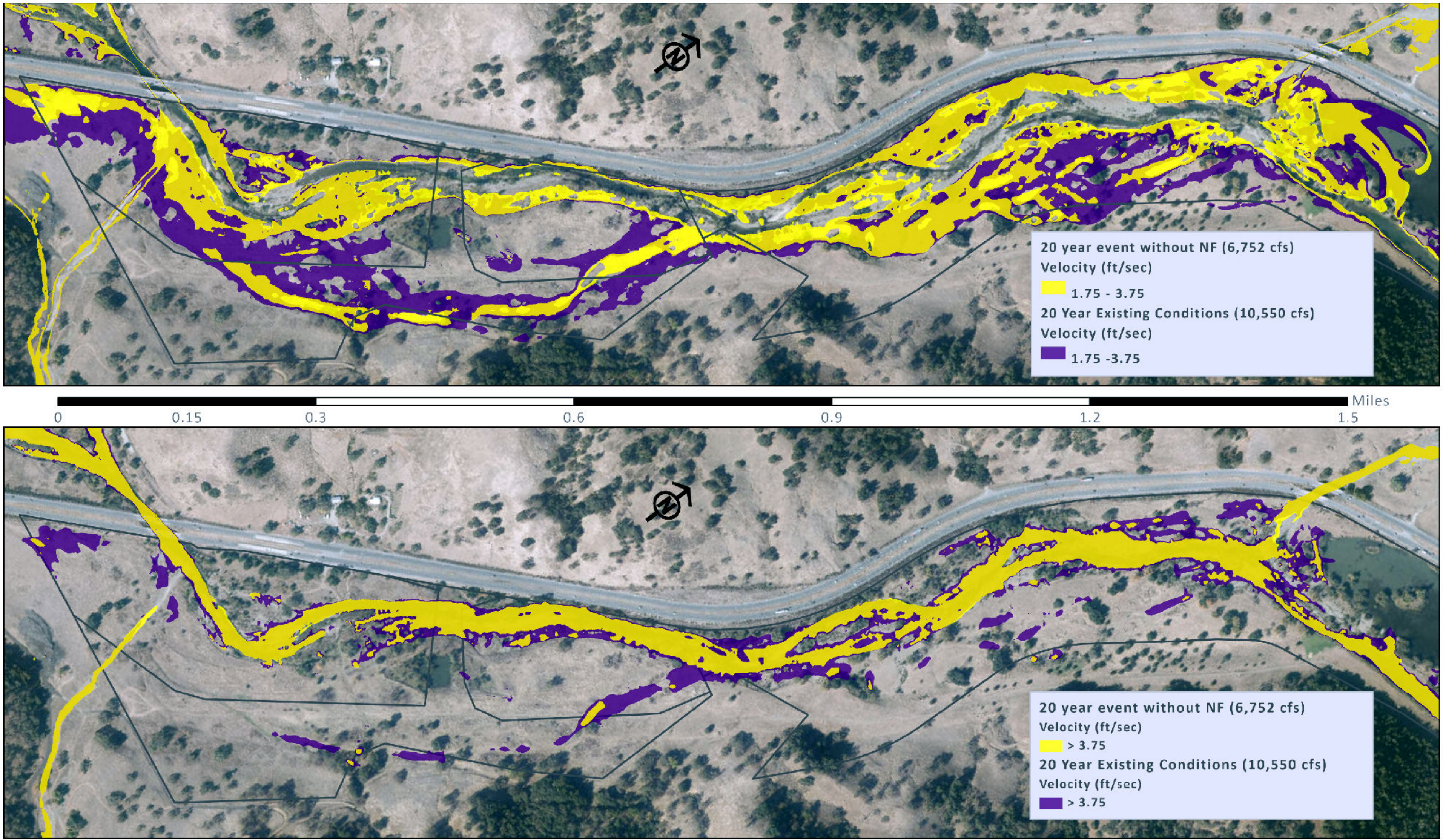

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Figure 41. Floodplain Velocity Difference

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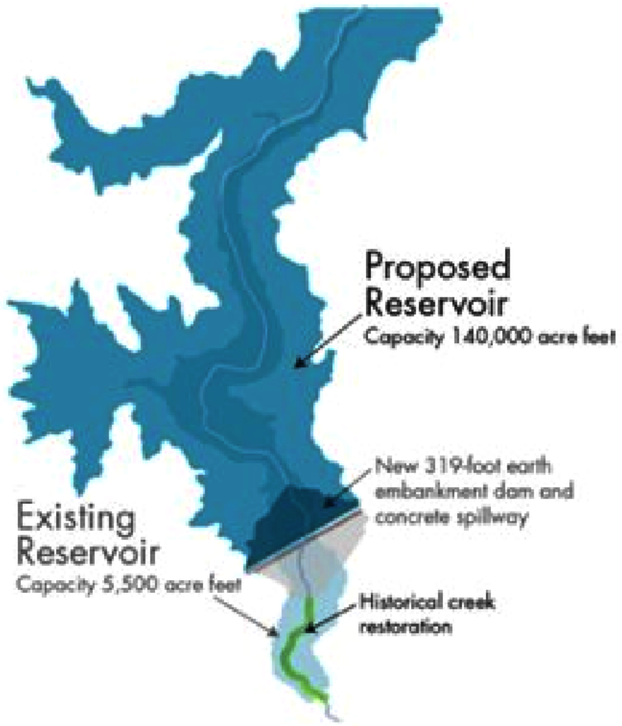
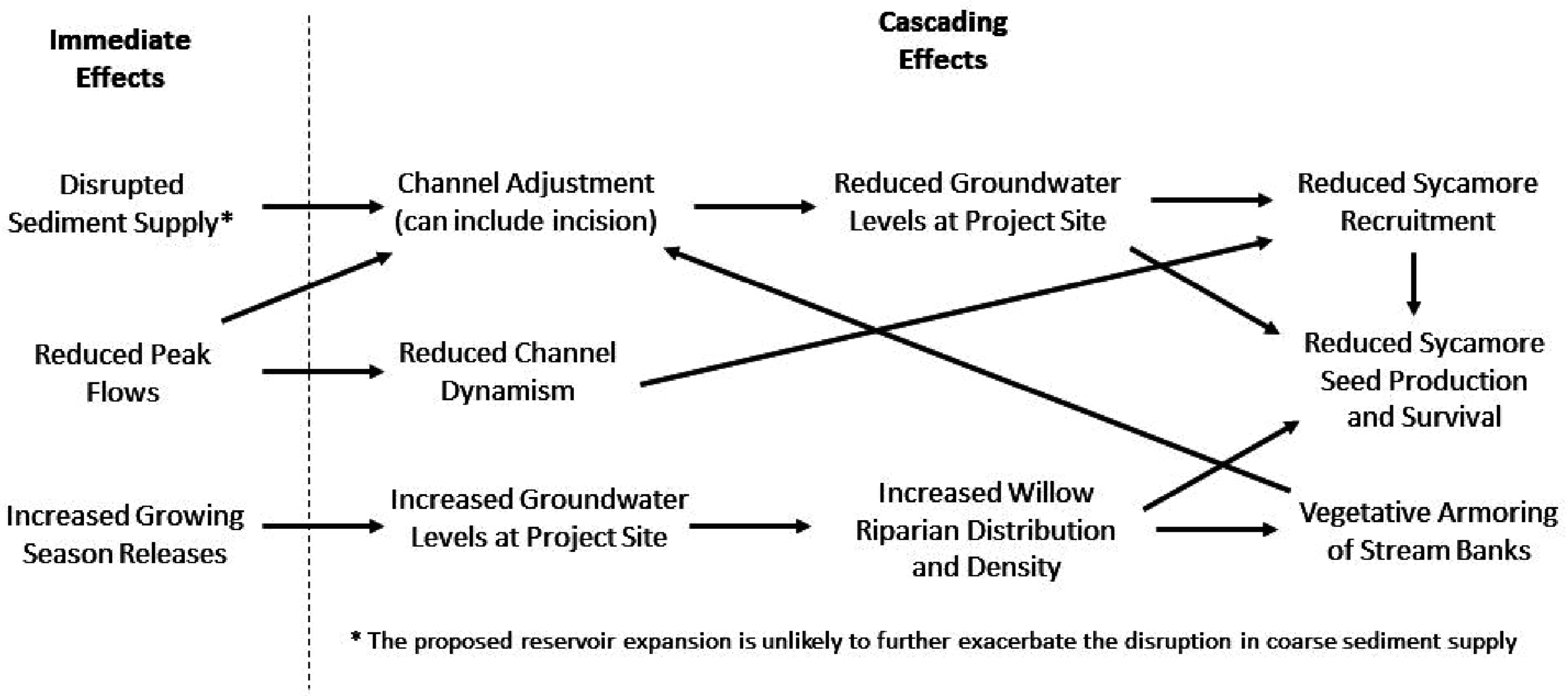
Reservoir Effects Conceptual Model



Valley Water 2020



Immediate Effects

Cascading Effects

Disrupted Sediment Supply*

Reduced Peak Flows

Increased Growing Season Releases

Channel Adjustment (can include incision)

Reduced Channel Dynamism

Increased Groundwater Levels at Project Site

Reduced Groundwater Levels at Project Site

Increased Willow Riparian Distribution and Density

Reduced Sycamore Recruitment

Reduced Sycamore Seed Production and Survival

Vegetative Armoring of Stream Banks

* The proposed reservoir expansion is unlikely to further exacerbate the disruption in coarse sediment supply

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Figure 42. Reservoir Effects Conceptual Model
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Section 7. Pacheco Reservoir Expansion Project Flow Regime Management Opportunities

As described in Section 6, the proposed Pacheco Reservoir expansion, if implemented, would provide substantially greater water storage capacity and significantly greater potential for alterations to Pacheco Creek's flow and thermal regimes. The multi-purpose reservoir expansion is primarily intended to serve as a water supply and storage project that also provides a perennial cold-water pool source to benefit steelhead in the Pajaro River Watershed. However, the Habitat Agency has expressed an interest in considering other ecological benefits and in reducing the potential for negative effects associated with the reservoir on the proposed Pacheco Creek Restoration Project. The following concepts summarize several opportunities to reduce the potential negative effects of the reservoir expansion.

7.1 Provide Releases during High Flow Events to Maintain Key Geomorphic Processes

As described in Section 6 the proposed reservoir's dramatically expanded storage capacity will vastly exceed the average annual runoff flowing into the reservoir. If flows during significant rainfall events are completely captured by the expanded reservoir, Pacheco Creek will experience reduced peak flows. In turn, these reduced peak flows would likely diminish the creek's capacity for geomorphic work and dynamic behavior, especially during the large flow events that are responsible for driving channel and floodplain form. As noted in the above sycamore regeneration conceptual model, California sycamore natural regeneration from seed appears to be driven by relatively large and infrequent flood events which generate bare coarse alluvium surfaces on floodplains relatively close to groundwater. For example, sycamore seedling regeneration was observed during the growing season after the floods at the site in WY 2017, which included two, greater than 10-year recurrence interval runoff events (Beagle et al. 2018). Therefore, the muted dynamism that could be caused by the reservoir expansion would likely diminish the creek's ability to drive natural sycamore regeneration from seed in all areas downstream of the dam. In light of the Habitat Agency's goals for preserving, enhancing, and restoring SAW in the study area, the Habitat Agency should consider requesting reservoir operations that include geomorphically significant reservoir flow releases during major runoff events (i.e. 10-20-year runoff events) designed to substantially augment flow in the study area and help maintain Pacheco Creek's physical and biological processes, including California sycamore regeneration. Specific criteria could be established for the magnitude, volume, and timing of releases from the reservoir specifically intended for continuation of significant flow contributions from the North Fork of Pacheco Creek and healthy physical processes that would support SAW regeneration.

7.2 Maintain Intermittent Character of Pacheco Creek Base Flows

Pacheco Creek historically went dry during the summer and, since construction of the North Fork Dam and subsequent flow releases through much of the dry season, the creek has been changed from an intermittent stream to a nearly perennial system. The proposed reservoir expansion and associated perennial flow release schedule would likely eliminate all periods of zero flow, hence increasing the shallow groundwater elevation along the channel and promoting willow establishment in locations that are currently sparsely vegetated with woody vegetation including mature sycamores and sycamore seedlings/ saplings. With even greater flow releases through the dry season, the riparian corridor close to the low-flow channel will likely become more heavily vegetated with willow riparian forest, which could potentially further impede the dynamism of the stream channel and floodplain, encourage incision and reduce the potential for sycamore regeneration along the channel and inner floodplains. The Habitat Agency's ecological goals for the study area include the preservation, enhancement and restoration of habitat for multiple biotic resources including steelhead, willow riparian forest, and SAW. Therefore, the Habitat Agency may consider recommending periods of reduced or no flow releases from the new reservoir to maintain some aspect of Pacheco Creek's historical intermittent nature, limit further riparian vegetation establishment and allow for continued channel and floodplain dynamism.

Section 8. Habitat Agency Site Access Improvement Opportunities

Currently, the Habitat Agency has a single legal entrance point from SR 152 on the west side of the property (Figure 25). This entrance provides limited access to the study area during times when the creek is flowing. There is a remnant road associated with this entrance that was used as a dry-season low water crossing for many years but the approach from the right bank was washed out as the bank retreated during the 2016–2017 winter flows. In its current condition, the right bank of Pacheco Creek is nearly vertical and no longer provides a viable vehicular access point. However, there is a small ephemeral drainage that enters Pacheco Creek immediately adjacent (upstream) to this former access area that could be utilized as an alternative right (when looking downstream) bank access to the former stream crossing and thus provide on-going dry season access. The downstream (right) bank of this ephemeral drainage could be laid back to provide a shallower slope, and stabilized with biotechnical materials to enable 4WD access to the bed of the main channel and to the remaining road segment on the left bank. This ephemeral drainage likely only carries flow during and immediately following rain events. Because the drainage ties into the Pacheco Creek stream bed, it should provide a relatively stable access point that has minimal impacts on the dynamism, physical processes and habitat value of Pacheco Creek.

For the time being, the Habitat Agency has a verbal agreement with the Bourdet family, who own much of the property surrounding the study area to the south and west, to use their existing access road to enter the site from the southwest. The Habitat Agency is currently negotiating with the Bourdet family to secure a long-term agreement for access through their property.

Section 9. Preliminary Restoration Opportunities on Ciraulo Property Upstream of Study Area Boundary

The H. T. Harvey team conducted a brief field reconnaissance survey along the Pacheco Creek channel on the Ciraulo Property upstream of the feasibility study boundary. The purpose of our reconnaissance was to qualitatively assess existing conditions and provide a bullet list of habitat restoration opportunities for possible future consideration.

The low-flow channel along this reach appears to have been realigned and straightened along the south side of the property. Just north of the channel and upstream of the confluence with Cedar Creek there is a large floodplain pond, likely excavated as part of a historical gravel mining operation (Figure 23). It appears a berm was constructed between the pond and the low-flow channel that likely limits the surface water connectivity between the floodplain and creek in this area. The adjacent floodplain is situated at relatively high elevation compared to the channel bottom and the low-flow channel has steep earthen banks and low connectivity to the floodplain. We observed very low in-stream channel habitat complexity; there was little apparent variation channel form and depositional features and low coarse wood abundance. Woody riparian habitat quantity and quality was also low, with narrow, scattered patches of willow riparian and mixed riparian forest growing on the steep channel banks. However, we did not observe substantial stands of invasive vegetation.

The confluence of Cedar Creek and Pacheco Creek is a dynamic area that certainly warrants further investigation for preservation, enhancement and restoration.

Our team identified the following preliminary restoration opportunities:

- Revegetate the creek banks and top of banks with mixed riparian and woodland habitat to increase riparian corridor continuity, width and structure.
- Install large wood structures to drive physical processes and increase in-stream habitat complexity for steelhead and other aquatic species including California red-legged frog.
- Establish inset floodplain terraces (could be coupled with large wood structures) to provide more frequently inundated areas and greater habitat complexity.
- Cedar Creek is known to be an important native fish stream and was historically important for steelhead, with perennial flows upstream of the intermittent reach near its confluence with Pacheco Creek (Smith 2002). Therefore, we recommend assessing the degree of flow connectivity for steelhead passage between Cedar Creek and Pacheco Creek and determine if improvements in connectivity are warranted and/or possible.
- The Cedar Creek confluence area currently supports some sycamores and could be further assessed to determine of conditions are suitable for SAW habitat restoration.

- Consider control of bullfrogs in the large floodplain pond. Bullfrog control would benefit downstream California red-legged frog restoration activities by reducing downstream dispersal of bullfrogs from the large pond.
- Consider methods of eradicating nonnative fish from the large pond such as the use of rotenone; the ability to permit the use of rotenone would need to be explored to determine the feasibility of this option.

Section 10. References

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Appendix A. Pacheco Creek Hydraulic Model Development Technical Memorandum

Hydrology | Hydraulics | Geomorphology | Design | Field Services

TECHNICAL MEMORANDUM

Date:	7/14/2020
To:	Ed Sullivan and Gerry Haas, Santa Clara Valley Habitat Agency
From:	Michael Founds, Jai Singh and Chris Hammersmark, cbec eco engineering
Project:	19-1011 Pacheco Creek Restoration Project
Subject:	Pacheco Creek Hydraulic Model Development

1 INTRODUCTION

In support of the Pacheco Creek Restoration Project Feasibility Study (Feasibility Study) being performed for the Santa Clara Valley Habitat Agency (Habitat Agency), cbec Inc., eco engineering (cbec) developed a two-dimensional (2D) hydraulic model using the Hydraulic Engineering Center River Analysis System (HEC-RAS) 2D hydrodynamic modeling software. The hydraulic model covers a 3.2 mile length of Pacheco Creek that includes the three properties of interest to the feasibility study: Pacheco Creek Reserve (owned by the Habitat Agency), Bureau of Reclamation (BOR) property, and the Ciraulo property (recently acquired by the Habitat Agency). The hydraulic model was developed to simulate hydraulic conditions (i.e., depth and velocity) for the existing topography for a range of stream flows as part of the Feasibility Study. The model will be utilized in future phases of the Pacheco Creek Restoration Project to support the restoration design process. The following sections detail the development of the hydraulic model including inputs, domain, assumptions and results.

2 MODEL DEVELOPMENT

2.1 TOPOGRAPHIC DATA SOURCES AND SURFACE DEVELOPMENT

Bathymetric and topographic survey data collected by cbec were combined with LiDAR data to create the existing conditions topographic surface. cbec collected bathymetric and topographic survey data for the primary areas of interest (i.e., the stream channel and floodplain within the project area) as summarized in Table 1. These data were supplemented with 2006 LiDAR from the USGS for hillslope areas and portions of the model domain outside of the project area (e.g., Harper Creek, Cedar Creek, upper portions of the Ciraulo property, etc.). The approximate spatial coverage of each of these datasets is shown in Figure 1. Topographic data derived from Structure from Motion (SfM) processing of drone imagery were used for the majority of the floodplain as well as portions of the main channel corridor where the stream bed was dry and unobscured by dense vegetation.

Ground-based topographic and bathymetric survey data, obtained either by RTK-GPS or total station, were used to fill in areas where SfM derived data was limited. Over 2,750 ground survey points were collected to represent bridge and culvert crossings, submerged sections of the channel and densely vegetated areas in the hydraulic model. Interpolation techniques were used to integrate the ground survey points and SfM data. The pond located on Parcels A and B was also surveyed using a combination of RTK-GPS and bathymetric surveys conducted with a single beam echo sounder mounted on a remote control Hydrone survey boat. Where ground-based topographic and bathymetric data were utilized, manual breaklining was performed in Autodesk Civil3D to best approximate the stream bed and floodplain topography between surveyed data points. The composite surface was prepared in Autodesk Civil3D and exported for incorporation in the hydraulic model.

Expected accuracy of the surface varies by location and type of survey data utilized. In general, a high level of accuracy can be expected in areas with less vegetation obscuring the surface, and where a dense group of ground survey points was collected. The median error between 2,750 surveyed points and the final surface was less than 0.1 ft. However, the surveyed points were used to calibrate the surface so a high level of accuracy should be expected in locations where ground survey data are available. Additional surveying may be performed in subsequent design phases to enhance surface accuracy and model resolution in areas of interest for restoration design (e.g., secondary channel inlets, engineered riffle locations, seasonal wetland creation areas, etc.).

Table 1. Summary of Topographic Data Included in Hydraulic Model

Data Source	Location	Project Utility	Collection Dates
cbec Structure from Motion Upstream	Entire Project Area from Cedar Creek confluence to the Hwy 152 crossing	Used to create 1 ft resolution DEM and Orthoimagery	November 2019
cbec Structure from Motion Downstream	Extends from Upper Hwy 152 crossing / Harper Creek confluence to the downstream boundary of the hydraulic model	Used to create 1 ft resolution DEM and Orthoimagery	January 2020
cbec Ground Based RTK and Total Station Survey	Primarily within the primary channel and inner floodplain corridor where ground was obscured by vegetation or water	Used to correct SfM data and for surface development and breaklining in key areas	November 2019 - January 2020
cbec Pond Bathymetry Survey	Pond on parcels A and B	Used to establish pond bottom surface	March 2019
USGS Santa Clara County LiDAR	Used to fill areas primarily outside of the Project Area	Used to fill areas outside the primary area of interest including hillslopes and tributary floodplains	April 2006 - May 2006

2.2 MODEL DOMAIN

The HEC-RAS 2D hydraulic model domain spans 3.2 miles of Pacheco Creek from 1.0 miles upstream of the Cedar Creek confluence downstream to the CalFire Station on Highway 152 (Figure 2). The model domain incorporates the lower reaches of Cedar Creek and Harper Creek near their confluences with Pacheco Creek. The model domain also includes three Highway 152 crossings: two over Pacheco Creek and one over Cedar Creek. Bridges and culverts were represented within the 2D model domain using surveyed geometry since the simulated flows did not reach the bridge decks or the tops of culverts.

2.3 BOUNDARY CONDITIONS

Boundary conditions for the hydraulic model include streamflow at the upstream extents of the model domain for Pacheco, Cedar and Harper Creeks and a normal depth stage boundary at the model domain’s downstream extent for Pacheco Creek. USGS stream gage data for Pacheco Creek and Cedar Creek were analyzed to develop recurrence interval estimates for flood events using the USGS Bulletin No. 17-B methodology (Interagency Committee on Water Data 1982). The primary USGS gage on Pacheco Creek is located 3.3 miles downstream of the downstream model boundary and incorporates flow accretion from an additional 25 square miles of watershed. Streamflow values for flood events were downscaled to the project site based on percent flow contribution estimates derived from an uncalibrated hydrologic model developed for the Feasibility Study (described in greater detail in the Feasibility Study report). These stream flow values were then proportionately divided among the Pacheco Creek, Cedar Creek and Harper Creek boundary conditions also using outputs from the hydrologic model. The percentage flow contribution estimated by the hydrologic model was similar to the results obtained by weighting each catchment’s contribution by area, but did estimate a slightly higher flow contribution from the higher elevation catchments of the North Fork and South Fork of Pacheco Creek.

Table 2 summarizes the stream flows that were simulated including contributions from each tributary and the recurrence internal of each flow rate, when appropriate. Note that no inflow is estimated for Cedar and Harper Creeks below the 100 cfs condition, based on observations in the field. The “20-yr No NF” flow scenario is a special case simulated with no flow contribution from the North Fork of Pacheco Creek included, but maintains inflow from the other tributaries. Each of the upstream boundary conditions were set as steady state flows. The downstream boundary condition was set using a normal depth stage boundary with a slope of 0.001. Each model boundary condition was located over ½ mile from the feasibility area and tested to ensure that model results in the Project Area were not influenced boundary effects.

Table 2. Simulated Flows Summary

Event Recurrence Interval or Flow Amount	Flow at USGS Gage (cfs)	Flow at Project Location (cfs)	Pacheco Creek Proportion	Cedar Creek Proportion	Harper Creek Proportion	Pacheco Creek Flow (cfs)	Cedar Creek Flow (cfs)	Harper Creek Flow (cfs)
100-year	16,597	14,439	78%	17%	5%	11,302	2,415	722
20-year	12,127	10,550	78%	17%	5%	8,258	1,765	528
20-yr No NF	6,549	5,697	66%	26%	8%	4,459	1,765	528
10-year	8,704	7,572	78%	17%	5%	5,927	1,267	379
5-year	5,149	4,480	78%	17%	5%	3,506	749	224
2-year	1,222	1,063	78%	17%	5%	832	178	53
500 cfs	500	500	78%	19%	3%	391	94	15
100 cfs	100	100	78%	19%	3%	78	19	3
50 cfs	50	50	100%	0%	0%	50	0	0
20 cfs	20	20	100%	0%	0%	20	0	0
10 cfs	10	10	100%	0%	0%	10	0	0
5 cfs	5	5	100%	0%	0%	5	0	0

2.4 HYDRAULIC ROUGHNESS

Hydraulic roughness values, or Manning's coefficient (*n*), are used by hydrodynamic models to describe the efficiency of flow conveyance in channel and floodplain areas. Higher values indicate "rougher" conditions that result in slower flow velocities and greater flow depths. Roughness values are used in the 2D model to describe both the type/density of vegetation as well as channel sediment grain size and bed forms at the sub-grid scale. Roughness values were estimated using professional judgment, based on field observations and visual inspection of vegetation and ground cover patterns in aerial imagery obtained during drone flights in late 2019 and early 2020 (Table 3 and Figure 3). Values were selected based upon guidance provided in published literature (Chow, 1988) and by best professional judgement gained from developing and applying hydraulic models in comparable environments.

Table 3. Manning's roughness coefficient (n) for Pacheco Creek

Classification	Manning's Roughness
Highway	0.015
Pond	0.025
Gravel	0.035
Grasses	0.04
Shrubs 2 - 6ft	0.06
Small Trees 6 - 15 ft	0.08
Med Trees 15 - 25 ft	0.08
Tall Trees > 25 ft	0.07
General Vegetation	0.07

2.5 MODELING PARAMETERS AND ASSUMPTIONS

The HEC-RAS 2D model mesh used for this project consists of mostly square elements in a 15-ft grid. The model mesh was refined along the primary channel and inner floodplain corridor of Pacheco Creek to improve model calculation resolution for lower flow events. The inner floodplain was refined to an 8-ft grid, and the primary channel (approximately 50 cfs inundation extent) was further refined to a 3-ft mesh as shown in Figure 4. The mesh was further refined with breaklines along bridge piers, culverts, and road crests. The breaklines ensure that the model mesh was enforced along topographic features that direct or prevent flow paths (e.g., a road crest or bridge pier). In addition, the cell spacing along the bridge piers was reduced to approximately 2 ft (i.e., smaller sizes to increase resolution of calculations). Table 4 provides an overview of the model parameters applied.

Table 4. HEC-RAS 2D Model Parameters

Parameter	Value	Notes
HEC-RAS	Version 5.0.7	-
Flow Module	2D unsteady	-
Equation Set	Full Momentum	-
Theta (0.6 – 1.0)	1.0	-
Initial Condition	Dry bed with warmup period	-
Inflows	Constant, sub-critical	EG slope = 0.001 (same as bed slope)
Outflows	Normal depth	Slope set to 0.001
Eddy Viscosity	-	Default

While preliminary model results were evaluated with respect to the observed stream flow record at instream stage recorders at four locations along Pacheco Creek for the WY 2020 flow season, the model was not formally calibrated and validated due to a lack of long-term measured streamflow data at the project site for higher flow conditions and concerns about inaccuracy in streamflow gains and/or losses between the project area and USGS gage downstream.

2.6 EXISTING CONDITIONS MODEL RESULTS

To date, only existing topographic conditions have been simulated with the hydraulic model. Inundation extents for a range of flow conditions are provided in Figure 5. Flows are largely contained within the main channel and inner floodplain through the 2-year recurrence interval event. The 5-year recurrence interval event activates a number of secondary channel features on the broader (outer) floodplain while the 20-year recurrence interval event largely inundates the full floodplain extent (i.e., extending to the valley wall on the left and Highway 152 embankment on the right, when looking downstream). Longitudinal profiles of water surface elevation (WSE) for the simulated flows also help characterize hydraulic conditions throughout the Study Area (Figure 6). At lower flows, WSE is driven by local, in-channel topographic controls (i.e. riffle crests). At higher flows such as the 20- and 100-year recurrence interval events, larger valley-wide controls or limitations on flow conveyance capacity such as the Highway 152 crossing become more apparent. Additional results and discussion are provided in the main body of the Pacheco Creek Restoration Project Feasibility Study (to which this technical memorandum is an appendix).

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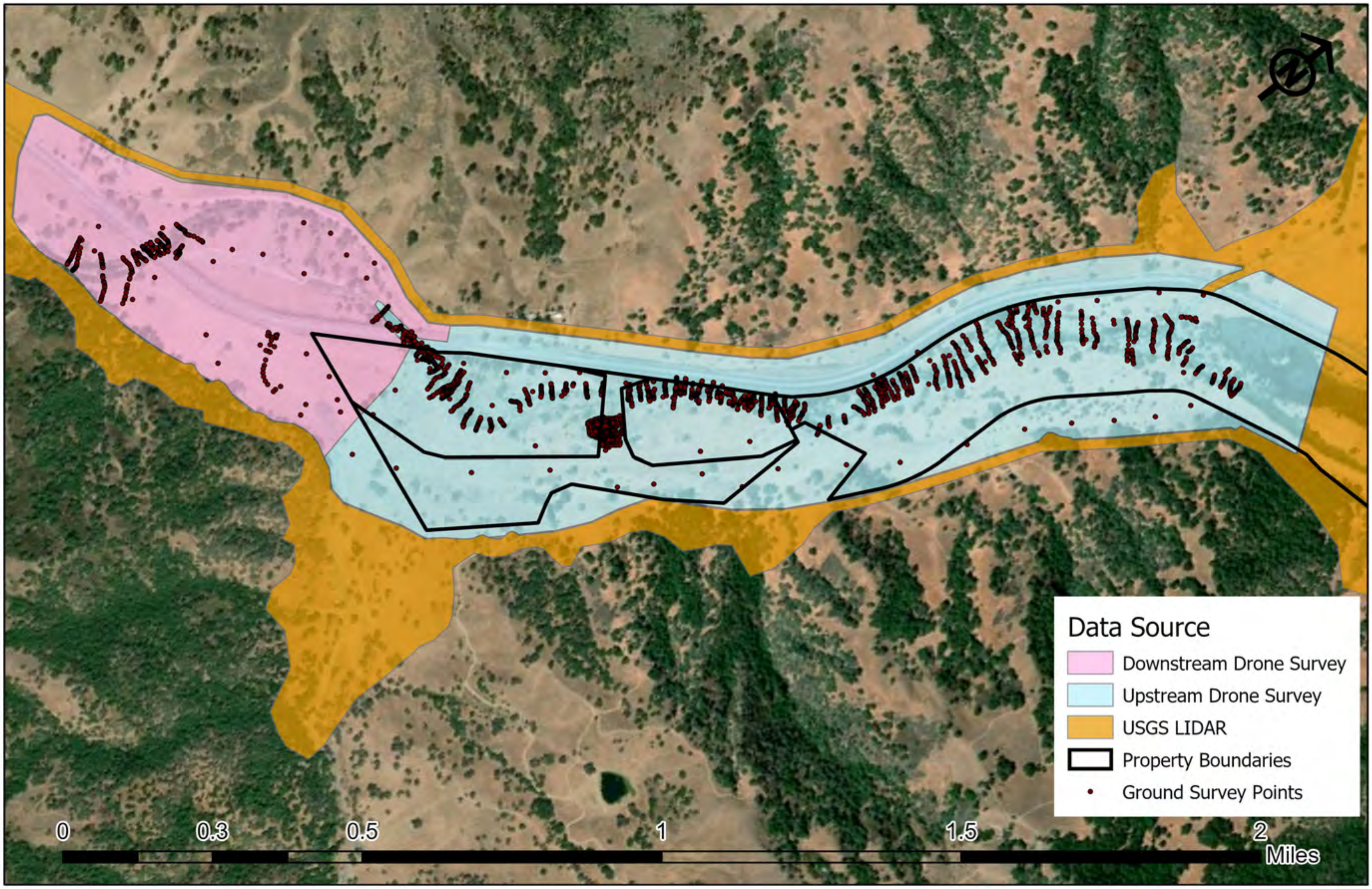


Notes:

Pacheco Creek Restoration Project

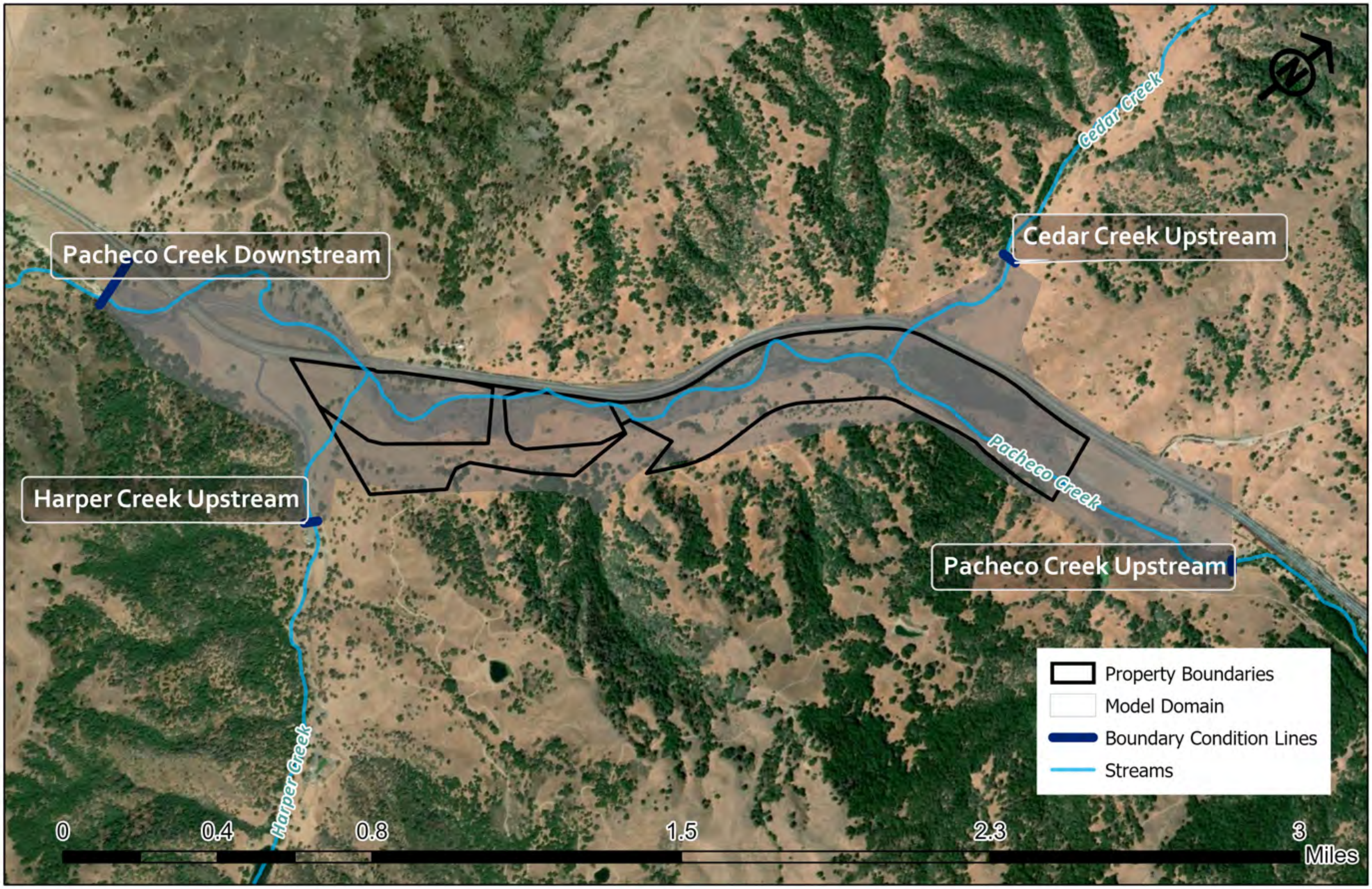
Data Sources for Topographic Surface Development

Project No. 19-1011

Created by: MF

Figure 1

7/14/2020



Notes:

Pacheco Creek Restoration Project

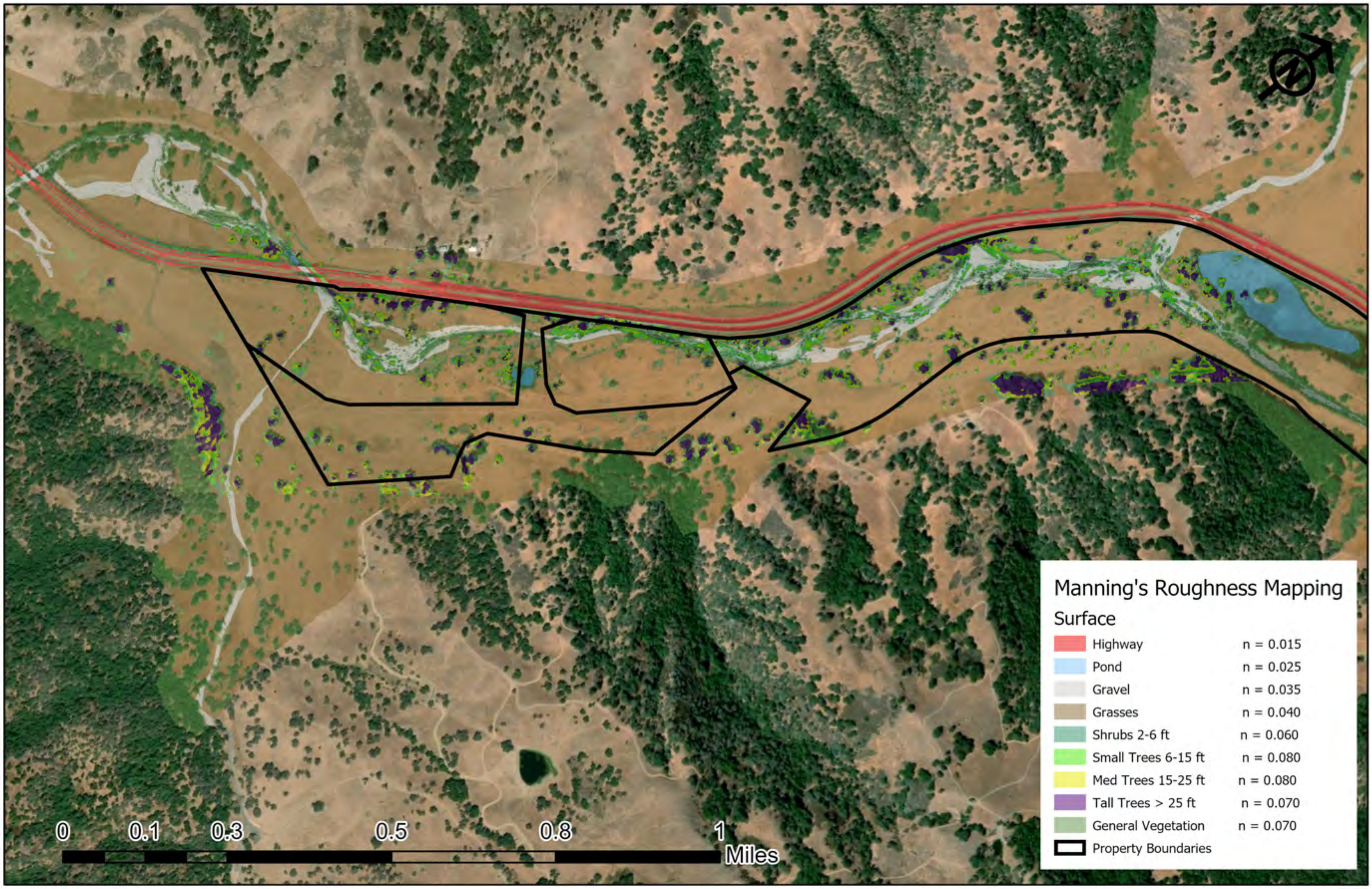
Model Domain

Project No. 19-1011

Created by: MF

Figure 2

7/14/2020



Notes:

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Pacheco Creek Restoration Project

Hydraulic Model Roughness Mapping

Project No. 19-1011

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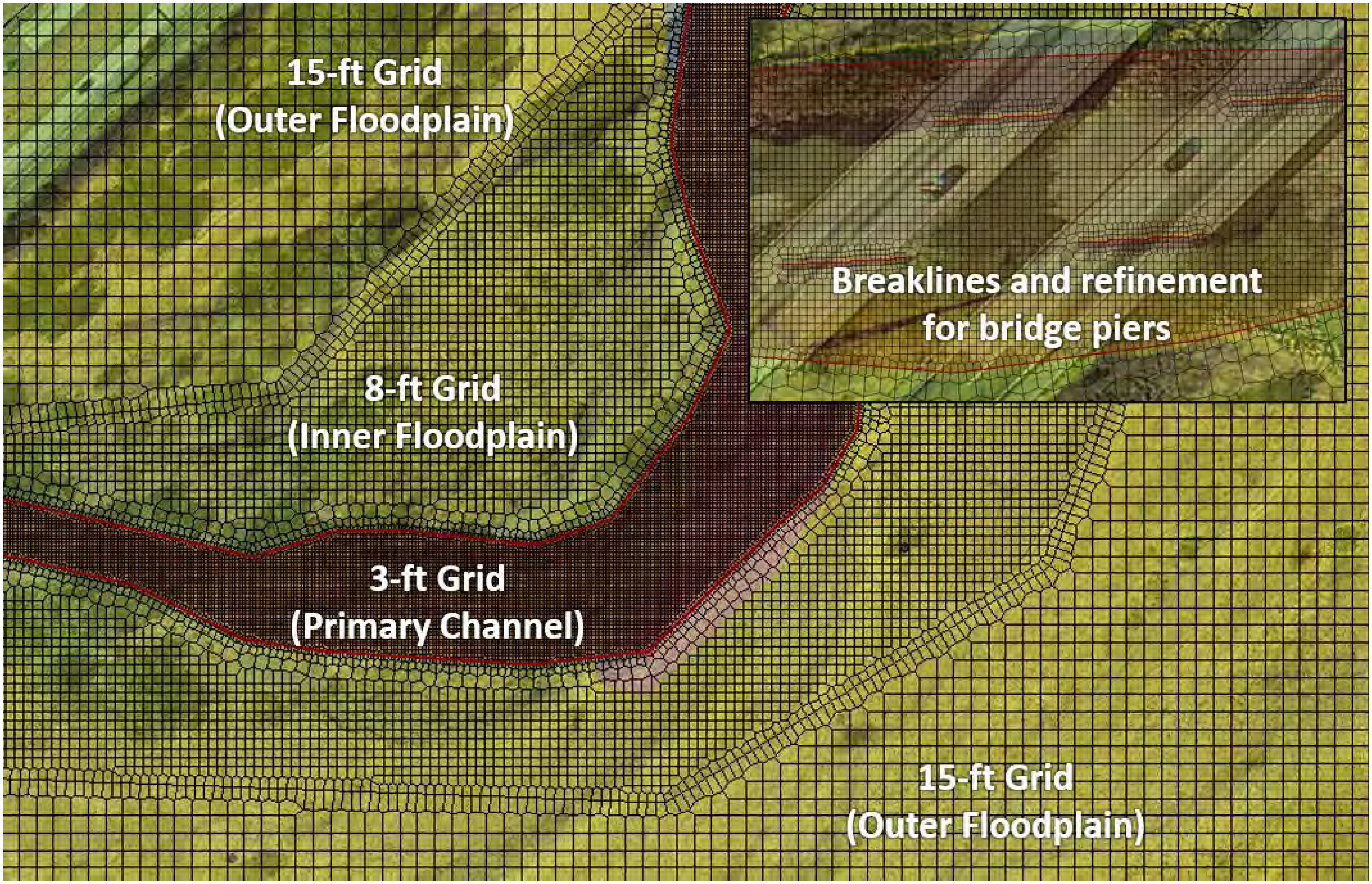
Figure 3

7/14/2020



Notes:

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Pacheco Creek Restoration Project

Model Mesh Refinement within Primary Channel and Inner Floodplain

Project No. 19-1011

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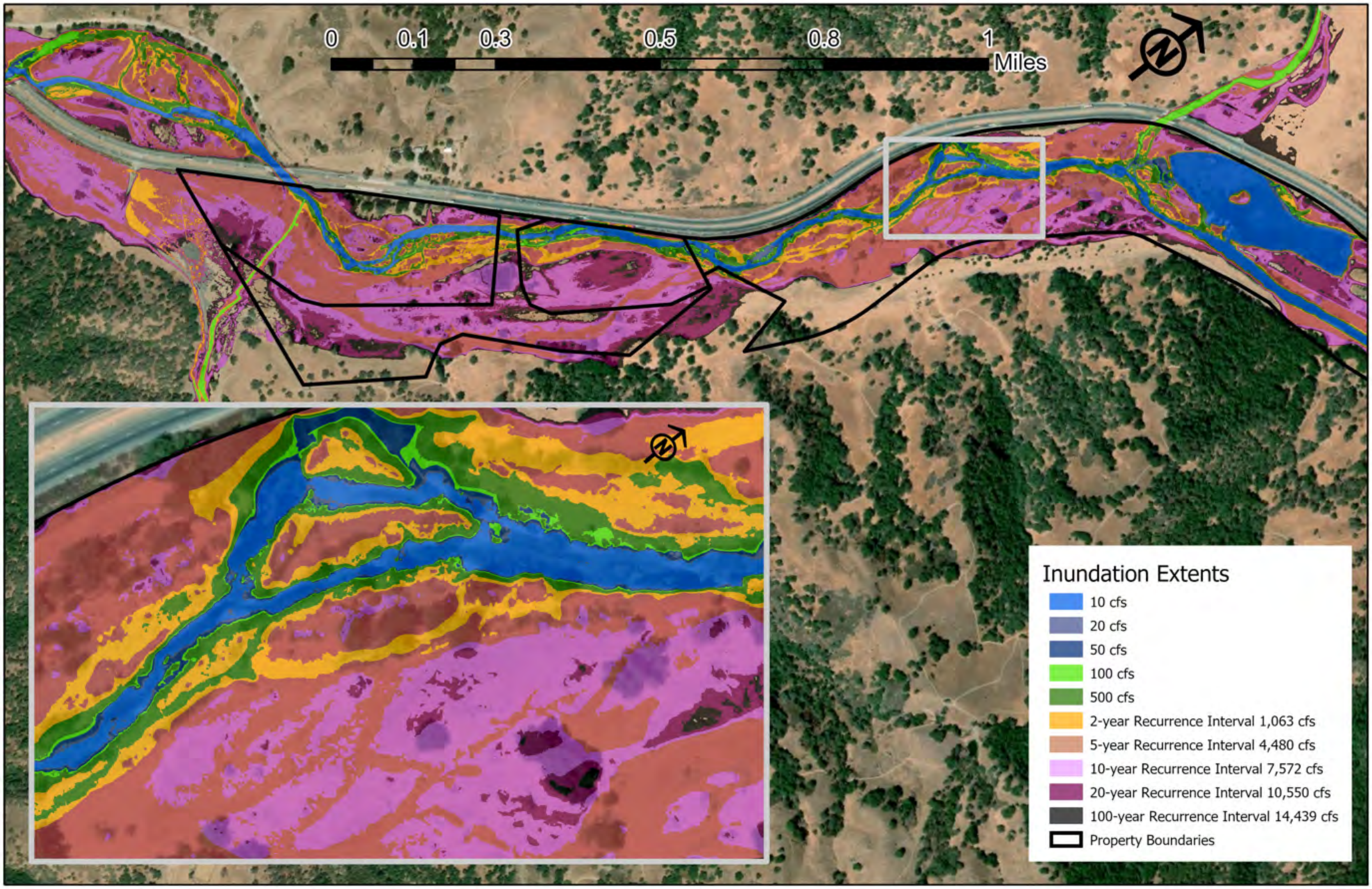
Figure 4

7/14/2020



Notes:

Pacheco Creek Restoration Project

Inundation Extent Results

Project No. 19-1011

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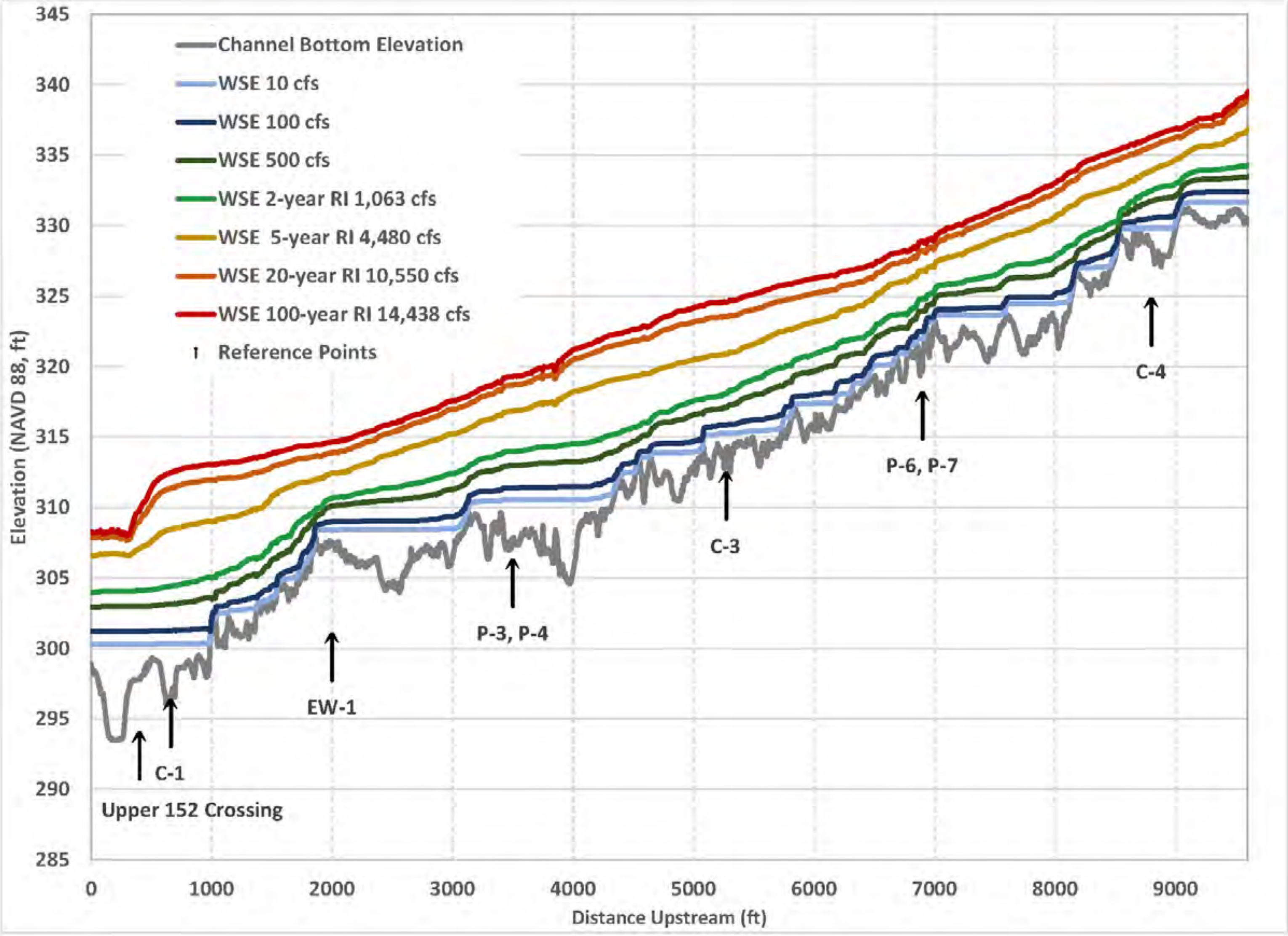
Figure 5

7/14/2020



Notes:

Pacheco Creek Restoration Project

Water Surface Elevation Longitudinal Profiles

Project No. 19-1011

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Figure 6

7/14/2020

Appendix B. Piezometer Installation Report

PIEZOMETER INSTALLATION REPORT

PACHECO CREEK RESTORATION PROJECT
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FOR
cbec, inc. eco engineering
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June 24, 2019 Project No. 1929

Mr. Jai Singh
j.singh@cbecoeng.com
cbec, inc. eco engineering
2544 Industrial Avenue
West Sacramento, CA 95691

Subject: **Piezometer Installation Report**
Pacheco Creek Restoration Project
12163 & 14610 Pacheco Pass Highway
Santa Clara County, California

Dear Mr. Singh,

Pacific Crest Engineering Inc. (PCEI) is pleased to submit this report on the installation of seven piezometers located at 12163 and 14610 Pacheco Pass Highway in the unincorporated area of Gilroy, Santa Clara County, California.

The accompanying report presents our methods and findings for the subject project. If you have any questions concerning the information presented in this report, please call our office.

Very truly yours,

PACIFIC CREST ENGINEERING INC.

Prepared by:

Cara AlLami

Cara Al-Lami
Staff Geologist

Reviewed by:

REGISTERED PROFESSIONAL ENGINEER
JAMES FRED WALKER
No. C 62120
Exp. 9/30/19
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STATE OF CALIFORNIA

Jim F. Walker, PE
Vice-President/Principal Chemical Engineer
C 62120, Expires 9/30/2019
CH 4664, Expires 6/30/2021
FP 1601, Expires 6/30/2021

Electronic Copies: 1 to Mr. Jai Singh, cbec, inc. eco engineering

444 AIRPORT BLVD., SUITE 106 | WATSONVILLE, CA 95076 | PHONE 831-722-9446 | WWW.4PACIFIC-CREST.COM

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PIEZOMETER INSTALLATION REPORT
Pacheco Creek Restoration Project
Pacheco Pass Highway, Santa Clara County, California

I. INTRODUCTION

PURPOSE AND SCOPE

This report describes the installation for seven new piezometers at 12163 and 14610 Pacheco Pass Highway and presents our methods and findings. The piezometers were installed in order to monitor and characterize groundwater elevations beneath the southern floodplain of Pacheco Creek. Subject information will be used to determine the influence of the groundwater levels on Sycamore Alluvial Woodland health as well as determine appropriate floodplain plantings to restore this section of Pacheco Creek.

Our scope of services for this project has consisted of:

1. Site reconnaissance to observe the existing conditions and mark the proposed piezometer locations.
2. Review of the following published maps:
   - Geologic Map of the Pacheco Creek Quadrangle, Santa Clara County, California, Dibblee Jr., 2007.
   - United States Geological Survey Topographic Map: Pacheco Creek Quadrangle, California, Santa Clara County, 7.5 Minute Series, 2018.
3. Completion of Santa Clara Valley Water District's "Well Construction Application" for each of the seven piezometers.
4. The drilling, logging and installation of seven piezometers to depths ranging between 20 and 25 feet below ground surface.
5. Locating each piezometer location using a handheld Trimble Geoexplorer 6000 Series device.
6. Coordination of field activities with personnel from cbec, inc., HT Harvey & Associates, Santa Clara Valley Habitat Agency and Santa Clara Valley Water District.
7. Uploading Well Completion Reports for each of the seven piezometers to the Department of Water Resources (DWR).
8. Preparation of this report documenting our investigation and presenting our methods and findings.

PROJECT LOCATION

The project site is situated in an area that is currently undeveloped in the unincorporated area of Gilroy in Santa Clara County. It is roughly situated between Harper Canyon to the south and Cedar Canyon to the north and is located on the southeast side of Pacheco Creek which runs roughly parallel to the southeast side of Pacheco Pass Highway. Piezometers P-1, P-2, P-3 and P-4 were installed on land owned by the Santa Clara Valley Habitat Agency located at 12163 Pacheco Pass Highway. Piezometers P-5, P-6 and P-7 were installed on private property, with the permission of the landowner, located at 14610 Pacheco Pass Highway. The piezometers are located at the following coordinates:

Table No. 1 – Piezometer Locations

Piezometer	Latitude	Longitude
P-1	37.01559970	-121.33547714
P-2	37.01496646	-121.33445758
P-3	37.02036837	-121.33031693
P-4	37.01992158	-121.32955354
P-5	37.02388265	-121.32680531
P-6	37.02781820	-121.32531771
P-7	37.02747599	-121.32405231

Please refer to Figure No. 1, Regional Site Map presented within Appendix A, for the general location of the project site.

II. INVESTIGATION METHODS

PRE-FIELD ACTIVITIES

Well construction permits were obtained from the Santa Clara Valley Water District (Valley Water) and are presented within Appendix B. PCEI marked the proposed piezometer locations and notified Underground Service Alert (USA) of the scheduled date and time of the proposed ground disturbing activities. Valley Water was notified at least two days in advance of the field activities.

FIELD INVESTIGATION

Four, 8-inch diameter test borings were drilled at the site on April 10th, 2019, and three, 8-inch diameter test borings were drilled at the site on May 30th, 2019. All borings were advanced by the drilling subcontractor, Exploration Geoservices, Inc. (EGI). The approximate locations of the piezometer borings shown on the Site Map Showing Well Location, Figure No. 2, in Appendix A. The drilling method used was hydraulically operated continuous flight augers on a truck mounted drill rig equipped with 8-inch outside diameter augers. A geologist from PCEI was present during the drilling operations to log the soil encountered.

Relatively undisturbed soil samples were obtained approximately every five feet by driving a split spoon sampler 18 inches into the ground. This was achieved by dropping a 140 pound hammer a vertical height of 30 inches. The hammer was actuated with a wire winch. The number of blows required to drive the sampler each six-inch increment and the total number of blows required to drive the last 12-

inches was recorded by the field geologist. The outside diameter of the samplers used was 2-inches and is designated on the Boring Logs as "T".

The soils encountered in the borings were continuously logged in the field and visually described in accordance with the Unified Soil Classification System (ASTM D2488) as described in the Boring Log Explanation, Figures No. 3 and 4, in Appendix A.

Appendix A contains a regional site map, a site map showing the locations of the test boring, an explanation of the soil classification system used and our borings logs. Stratification lines on the boring logs are approximate as the actual transition between soil types may be gradual.

PIEZOMETER CONSTRUCTION

PCEI supervised the construction of the 2-inch diameter piezometers at the locations shown in Figure 2. Each well was constructed using 2-inch diameter, 0.010-inch slotted, Schedule 40 Polyvinyl Chloride (PVC) screen and 2-inch diameter, Schedule 40 PVC well casing. An additional three feet of well casing was left above ground so that each piezometer could be easily located. For each piezometer, the well casing was sealed with a water tight, locking cap and the well head was encapsulated by a stovepipe cover. The annulus of the piezometers was filled with #3 sand, 3/8" hydrated bentonite chips and Portland cement to the ground surface: Piezometer Construction Diagrams are presented in Appendix A. The table below lists the specifications of each piezometer:

Table No. 2 – Piezometer Construction Details

Piezometer	Total Depth (Feet)	Well Casing (feet bgs)	Screened Casing (feet bgs)	Portland Cement Well Seal (feet bgs)	3/8" Bentonite Chips (feet bgs)	#3 Sand Filter Pack (feet bgs)
P-1	20	0-5	5-20	0-4	4-5	5-20
P-2	25	0-5	5-25	0-4	4-5	5-25
P-3	20	0-5	5-20	0-4	4-5	5-20
P-4	25	0-5	5-25	0-4	4-5	5-25
P-5	20	0-5	5-20	0-3	3-5	5-20
P-6	20	0-5	5-20	0-3	3-5	5-20
P-7	25	0-5	5-25	0-3	3-5	5-25

Installation of the well seals was witnessed by an inspector from Valley Water on April 10th, 2019, and May 30th, 2019.

PIEZOMETER SAMPLING

The piezometers were installed to monitor groundwater elevations not groundwater quality. As a result, groundwater sampling was beyond PCEI's scope of services for this project and not completed.

III. FINDINGS

GEOLOGIC SETTING

The surficial geology in the area of the project site is mapped as Alluvium (Dibblee Jr., 1997). The Alluvium is described by Dibblee Jr. as "*alluvial gravel, sand and clay of valley areas*." The hummocky hills surrounding the project site are mapped as Franciscan Assemblage and includes deposits of Graywacke sandstone, Melange, Greenstone, Conglomerate and Chert. The soils encountered within the test borings are generally consistent with alluvium derived from the adjacent hills.

SURFACE CONDITIONS

The piezometers were installed within the floodplain along the south to southeast side of Pacheco Creek. The ground surface of the floodplains is relatively flat. The ground is terraced as it moves away from the floodplain and towards the toes of the surrounding undulating slopes. The site is vegetated with grasses and young to mature trees are scattered along the creek, floodplain and hills. An approximately 12-inch veneer of silty sand was consistently encountered at each of the seven piezometer locations.

SUBSURFACE CONDITIONS

The borings for all seven piezometers were drilled and sample to depths ranging between 20 to 25 feet below ground surface. In general, the subsurface lithology consists of interbedded sandy to gravelly soils with varying amounts of clay and silt. The sand was typically very fine to coarse grained, quartz, sandstone and chert rich, sub-angular to rounded shaped. The density of the sand ranged from loose to very dense. Gravels were generally angular to well rounded shaped, sandstone, quartz and chert rich and were ¼ to 2 inches in diameter. Cobbles as large as 3 inches in diameter were observed in the drilling cuttings. The density of the gravel soils ranged from dense to very dense. A bed of weathered conglomerate was encountered at depths ranging between 19 and 19½ feet below ground surface within piezometers P-3, P-4, P-5, P-6 and P-7. The conglomerate bed had weathered to soils described as sandy lean clay, clayey sand, clayey sand with gravel and silty gravel and had densities/consistencies described as very dense to very hard. Gley colored soils, indicative of anaerobic environments, were encountered within P-2, P-4, P-5, P-6 and P-7 approximately 19 to 24½ feet below ground surface.

Please refer the Logs of Piezometer Boring in Appendix A, for a more detailed description of the subsurface conditions encountered in each of our test borings at the subject site.

GROUNDWATER

Groundwater was encountered in each of the seven piezometers during the time of construction. As previously discussed, the piezometers were located using a handheld, Trimble Geoexplorer 6000 GPS device using the WGS84 Horizontal Datum. The device does not accurately measure elevations, and therefore, the groundwater elevations were not calculated for the newly constructed piezometers. The depth to groundwater measurements are summarized below:

Table No. 3 – Depths to Groundwater

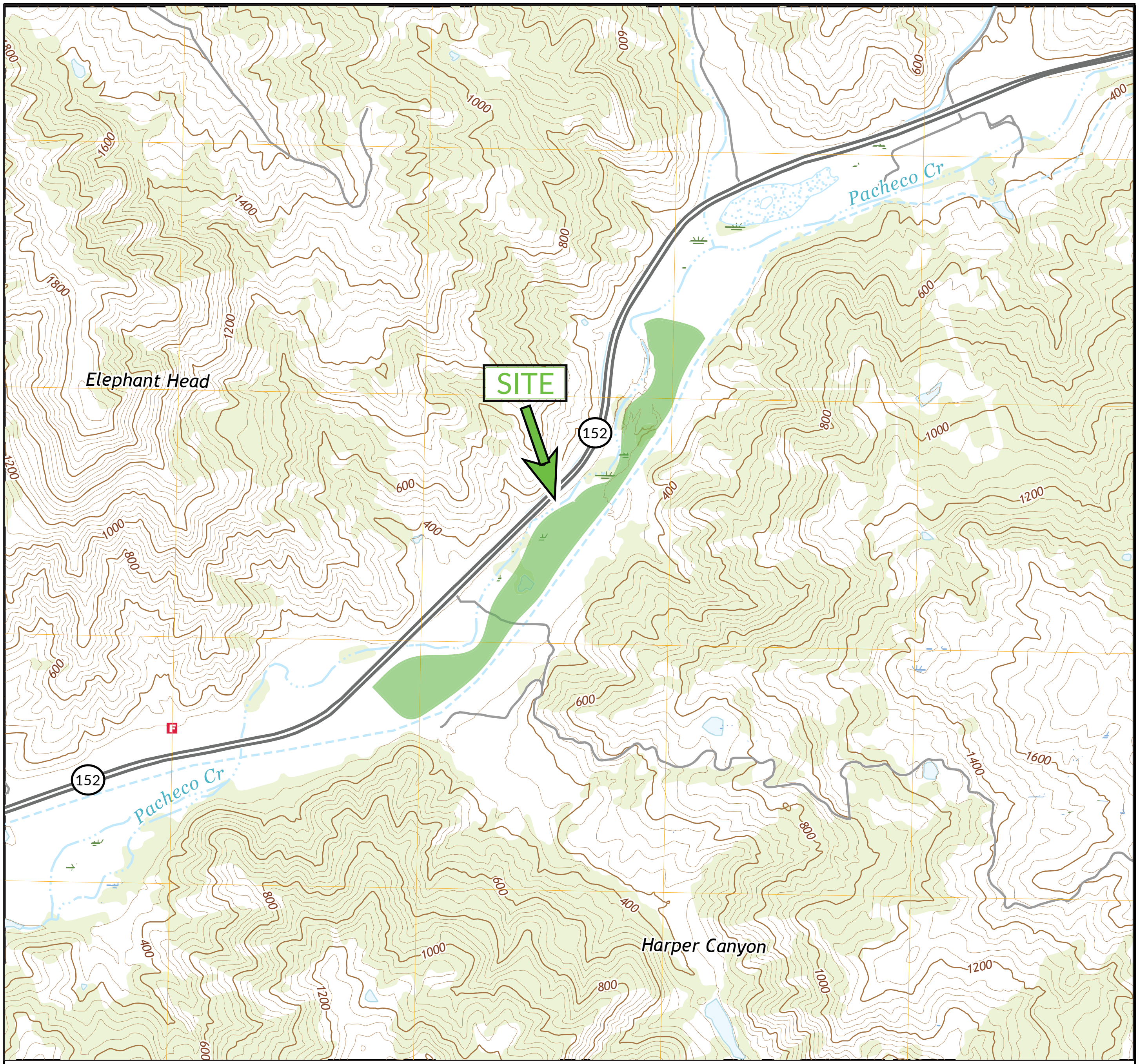
Piezometer	Date	Groundwater Depth (ft. below top of casing)
P-1	4/10/19	6.75
P-2	4/10/19	7.7
P-3	4/10/19	7.2
P-4	4/10/19	7.2
P-5	5/30/19	6.0
P-6	5/30/19	6.0
P-7	5/30/19	6.0

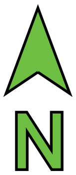
IV. LIMITATIONS

PCEI has used the customary standard of care and skill in performing its environmental services. PCEI cannot and will not certify whether or not a certain property is or is not free of environmental impairment. This is in lieu of all other warranties, express or implied. We appreciate the opportunity to be of service. Please contact our office at (831) 722-9446, should you have any questions regarding this report.

APPENDIX A

Regional Site Map
Site Map Showing Piezometer Location
Key to Soil Classification
Logs of Piezometer Borings
Piezometer Construction Details





Base Map: United States Geological Survey
Pacheco Creek Quadrangle, California
Santa Clara County, 7.5 Minute Series, 2018

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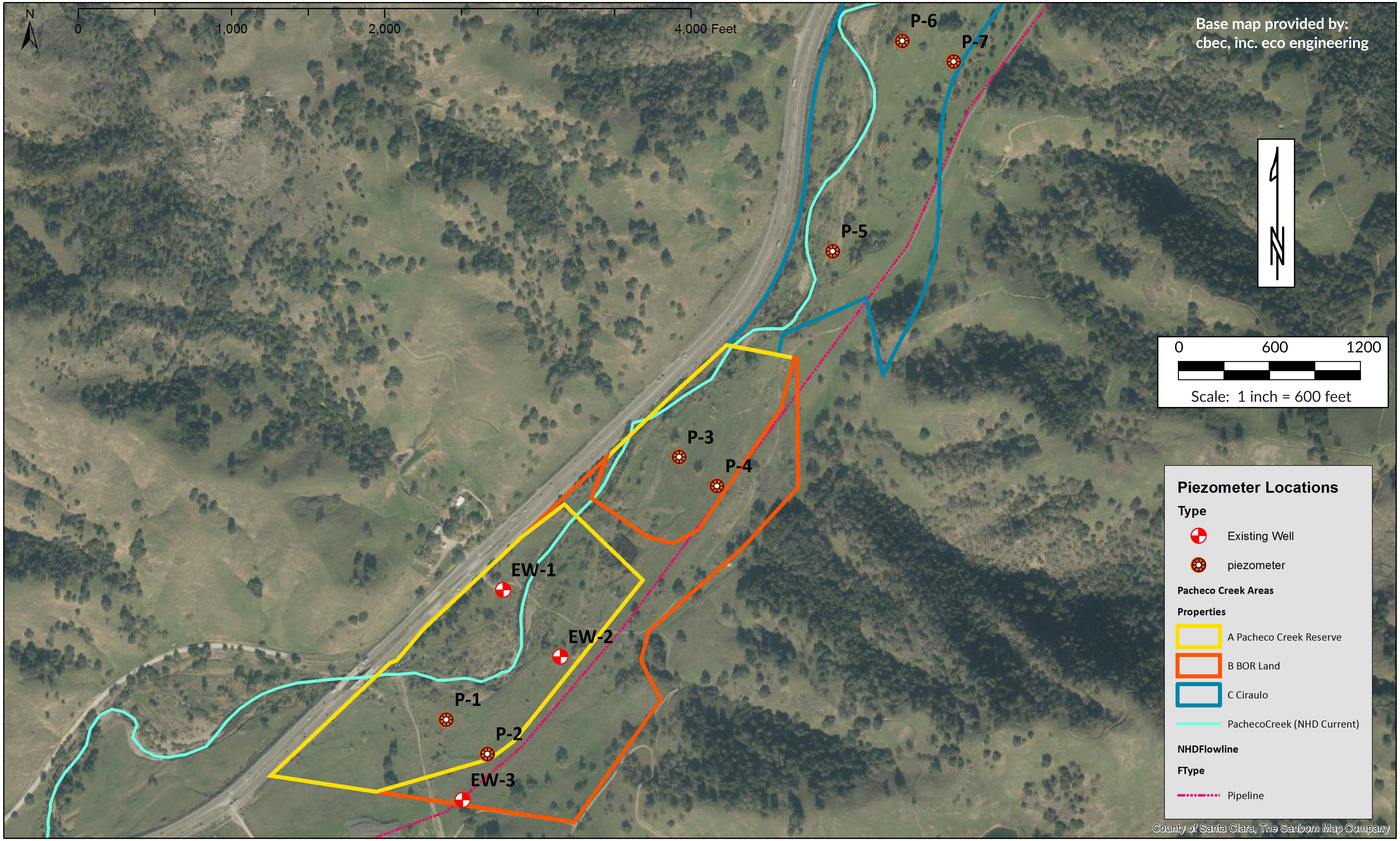
Regional Site Map
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 1
Project No. 1929
Date: 6/24/19



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Site Map Showing Piezometer Locations
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 2
Project No. 1929
Date: 6/24/19

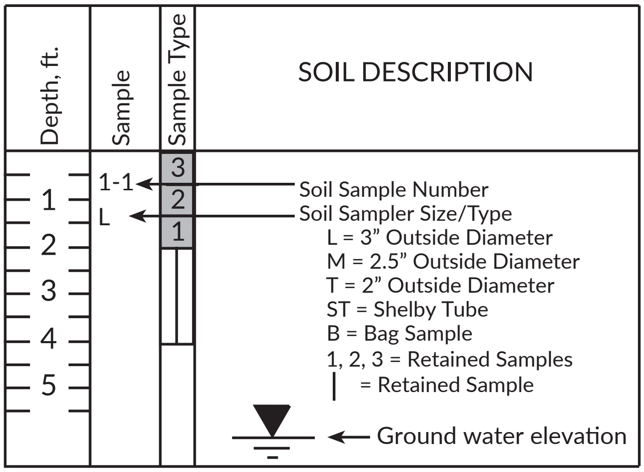
KEY TO SOIL CLASSIFICATION - FINE GRAINED SOILS (FGS)
UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2487 (Modified)

MAJOR DIVISIONS		SYMBOL	FINES	COARSENESS	SAND/GRAVEL	GROUP NAME
SILT AND CLAY	*LL < 35% Low Plasticity	**CL** Lean Clay PI > 7 Plots Above A Line -OR- **ML** Silt PI > 4 Plots Below A Line	<30% plus No. 200	<15% plus No. 200		Lean Clay / Silt
				15-30% plus No. 200	% sand ≥ % gravel	Lean Clay with Sand / Silt with Sand
					% sand < % gravel	Lean Clay with Gravel / Silt with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Lean Clay / Sandy Silt
					≥ 15% gravel	Sandy Lean Clay with Gravel / Sandy Silt with Gravel
				% sand < % gravel	< 15% sand	Gravelly Lean Clay / Gravelly Silt
					≥ 15% sand	Gravelly Lean Clay with Sand / Gravelly Silt with Sand
		CL - ML 4 < PI < 7	<30% plus No. 200	<15% plus No. 200		Silty Clay
				15-30% plus No. 200	% sand ≥ % gravel	Silty Clay with Sand
					% sand < % gravel	Silty Clay with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Silty Clay
					≥15% gravel	Sandy Silty Clay with Gravel
				% sand < % gravel	< 15% sand	Gravelly Silty Clay
					≥15% sand	Gravelly Silty Clay with Sand
	35% ≤ *LL < 50% Intermediate Plasticity	**CI**	<30% plus No. 200	<15% plus No. 200		Clay
				15-30% plus No. 200	% sand ≥ % gravel	Clay with Sand
					% sand < % gravel	Clay with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Clay
					≥ 15% gravel	Sandy Clay with Gravel
				% sand < % gravel	< 15% sand	Gravelly Clay
					≥ 15% sand	Gravelly Clay with Sand
	*LL > 50% High Plasticity	**CH** Fat Clay Plots Above A Line -OR- **MH** Elastic Silt Plots Below A Line	<30% plus No. 200	<15% plus No. 200		Fat Clay or Elastic Silt
				15-30% plus No. 200	% sand ≥ % gravel	Fat Clay with Sand Elastic Silt with Sand
					% sand < % gravel	Fat Clay with Gravel / Elastic Silt with Gravel
			≥30% plus No. 200	% sand ≥ % gravel	< 15% gravel	Sandy Fat Clay / Sandy Elastic Silt
					≥ 15% gravel	Sandy Fat Clay with Gravel / Sandy Elastic Silt with Gravel
				% sand < % gravel	< 15% sand	Gravelly Fat Clay / Gravelly Elastic Silt
					≥ 15% sand	Gravelly Fat Clay with Sand / Gravelly Elastic Silt with Sand

* LL = Liquid Limit

* PI = Plasticity Index

BORING LOG EXPLANATION



MOISTURE

DESCRIPTION	CRITERIA
DRY	Absence of moisture, dusty, dry to the touch
MOIST	Damp, but no visible water
WET	Visible free water, usually soil is below the water table

CONSISTENCY

DESCRIPTION	UNCONFINED SHEAR STRENGTH (KSF)	STANDARD PENETRATION (BLOWS/FOOT)
VERY SOFT	< 0.25	< 2
SOFT	0.25 - 0.5	2 - 4
FIRM	0.5 - 1.0	5 - 8
STIFF	1.0 - 2.0	9 - 15
VERY STIFF	2.0 - 4.0	16 - 30
HARD	> 4.0	> 30

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Piezometer Log Explanation - FGS
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 3
Project No. 1929
Date: 6/24/19

KEY TO SOIL CLASSIFICATION - COARSE GRAINED SOILS
UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2487 (Modified)

MAJOR DIVISIONS		FINES	GRADE/TYPE OF FINES	SYMBOL	GROUP NAME *
GRAVEL	More than 50% of coarse fraction is larger than No. 4 sieve size	<5%	Cu ≥ 4 and 1 ≤ Cc ≤ 3	**GW**	Well-Graded Gravel/ Well-Graded Gravel with Sand
			Cu < 4 and/or 1 > Cc > 3	**GP**	Poorly Graded Gravel/Poorly Graded Gravel with Sand
		5-12%	ML or MH	**GW - GM**	Well-Graded Gravel with Silt / Well- Graded Gravel with Silt and Sand
				GP - GM	Poorly Graded Gravel with Silt / Poorly Graded Gravel with Silt and Sand
			CL, CI or CH	**GW - GC**	Well-Graded Gravel with Clay / Well-Graded Gravel with Clay and Sand
				GP - GC	Poorly Graded Gravel with Clay / Poorly Graded Gravel with Clay and Sand
		>12%	ML or MH	**GM**	Silty Gravel / Silty Gravel with Sand
			CL, CI or CH	**GC**	Clayey Gravel/ Clayey Gravel with Sand
			CL - ML	**GC - GM**	Silty, Clayey Gravel/ Silty, Clayey Gravel with Sand
SAND	50% or more of coarse fraction is smaller than No. 4 sieve size	<5%	Cu ≥ 6 and 1 ≤ Cc ≤ 3	**SW**	Well-Graded Sand / Well-Graded Sand with Gravel
			Cu < 6 and/or 1 > Cc > 3	**SP**	Poorly Graded Sand / Poorly Graded Sand with Gravel
		5-12%	ML or MH	**SW - SM**	Well-Graded Sand with Silt / Well- Graded Sand with Silt and Gravel
				SP - SM	Poorly Graded Sand with Silt / Poorly Graded Sand with Silt and Gravel
			CL, CI or CH	**SW - SC**	Well-Graded Sand with Clay / Well-Graded Sand with Clay and Gravel
				SP - SC	Poorly Graded Sand with Clay / Poorly Graded Sand with Clay and Gravel
		>12%	ML or MH	**SM**	Silty Sand / Silty Sand with Gravel
			CL, CI or CH	**SC**	Clayey Sand / Clayey Sand with Gravel
			CL - ML	**SC - SM**	Silty, Clayey Sand / Silty, Clayey Sand with Gravel

* The term “with sand” refers to materials containing 15% or greater sand particles within a gravel soil, while the term “with gravel” refers to materials containing 15% or greater gravel particles within a sand soil.

US STANDARD SIEVE SIZE: 3 inch ¾ inch No. 4 No. 10 No. 40 No. 200 0.002 µm

	COARSE	FINE	COARSE	MEDIUM	FINE		
COBBLES AND BOULDERS	GRAVEL		SAND			SILT	CLAY

RELATIVE DENSITY

DESCRIPTION	STANDARD PENETRATION (BLOWS/FOOT)
VERY LOOSE	0 - 4
LOOSE	5 - 10
MEDIUM DENSE	11 - 30
DENSE	31 - 50
VERY DENSE	> 50

MOISTURE

DESCRIPTION	CRITERIA
DRY	Absence of moisture, dusty, dry to the touch
MOIST	Damp, but no visible water
WET	Visible free water, usually soil is below the water table

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Piezometer Log Explanation - CGS
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 4
Project No. 1929
Date: 6/24/19

LOGGED BY CLA
DATE DRILLED 4/10/19
BORING DIAMETER 8" HS
BORING NO. P-1
DRILL RIG EGI Truck Mounted Mobile B40
HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1											
2											
3											
4	P1-1 T		**SAND WITH SILT:** Brown (7.5YR 4/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, poorly indurated, sub-angular to sub-rounded shaped gravels up to 1 inch in diameter, moist, medium dense	SP	5 10 15	19					
5											
6			▽ **SILTY GRAVEL WITH SAND:** Yellowish brown (10YR 5/4), fine to very coarse grained, angular to rounded shaped quartz and sandstone sand, angular to to well rounded shaped sandstone and quartz gravels up to 2 inches in diameter, wet, dense	GM							
7											
8	P1-2 T				7 23 24	47					
9											
10											
11											
12											
13	P1-3 T		**SILTY SAND WITH GRAVEL GRADING TO SILTY GRAVEL WITH SAND:** Yellowish brown (10YR 5/4), coarse to very coarse grained sand, angular to well rounded shaped sand and gravel, sandstone, quartz and chert rich, gravels up to 2 inches in diameter, fine to medium grained, **CLAYEY SAND** lens at 15 feet, wet, very dense	SM/ GM	25 35 50/4”	50/4”					
14											
15											
16											
17			Cobbles in the cuttings between 15’ and 18’								
18											
19	P1-4 T		**Interbedded SILTY SAND WITH GRAVEL/SILTY GRAVEL WITH SAND, CLAYEY SAND WITH GRAVEL** lens from 19½ to 20 feet, wet, very dense		20 26 49	75					
20			Boring terminated at 20 feet. Groundwater encountered at 6’9”.								
21											
22											
23											

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Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 5
Project No. 1929
Date: 6/24/19

LOGGED BY CLA DATE DRILLED 4/10/19 BORING DIAMETER 8" HS BORING NO. P-2

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1											
2											
3											
4	P2-1 T		**SILTY SAND:** Brown (10YR 4/3), very fine to fine grained, poorly graded, quartz rich, poorly indurated, trace sub-rounded shaped gravels up to ½ inch, slightly moist loose	SM	2 2 3	5					
5											
6											
7			Increase in drilling resistance at 6½ feet								
8			▽ **SILTY GRAVEL WITH SAND/SILTY SAND WITH GRAVEL:** Dark yellowish brown (10YR 4/4), angular to sub-rounded shaped, poorly graded, quartz and sandstone rich, coarse to very coarse grained sand, very fine to fine grained gravel, wet, medium dense	GM/ SM							
9	P2-2 T				7 7 15	22					
10											
11											
12											
13											
14	P2-3 T		**Interbedded SILTY GRAVEL WITH SAND/SILTY SAND WITH GRAVEL:** rounded 2-inch diameter sandstone gravels at 15 feet and in the shoe, wet, very dense		22 46 50/5”	50/5”					
15											
16											
17											
18											
19	P2-4 T				20 26 50/6”	50/6”					
20			**SANDSTONE:** Light olive brown (2.5Y 5/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, well cemented, moist to wet, very dense, (likely sampled through a boulder)								
21											
22											
23			Dense, slow drilling								

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Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 6
Project No. 1929
Date: 6/24/19

LOGGED BY CLA DATE DRILLED 4/10/19 BORING DIAMETER 8" HS BORING NO. P-2

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
24	P2-5 T		**SAND:** Light olive brown (2.5Y 5/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded,fine grained gravel lens at 24 feet, wet, very dense	SP	24 27						
25			**CLAYEY SAND:** Dark bluish gray (GLEY 2 4/5B), very fine to very fine grained, poorly graded, quartz rich, poorly indurated, very moist, very dense	SC	37	64					
26			Boring terminated at 25 feet. Groundwater encountered at 7'8".								
27											
28											
29											
30											
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											
41											
42											
43											
44											
45											
46											

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ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 7
Project No. 1929
Date: 6/24/19

LOGGED BY CLA
DATE DRILLED 4/10/19
BORING DIAMETER 8" HS
BORING NO. P-3

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline
HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1 2 3											
4 5 6	P3-1 T		**SILTY SAND WITH GRAVEL:** Brown (10YR 4/3) very fine to fine grained, quartz rich, poorly graded, poorly indurated, angular to rounded shaped quartz and sandstone gravels up to 1 inch in diameter, slightly moist, medium dense	SM	5 6 13	19					
7			▽								
8 9 10 11 12	P3-2 T		**SILTY SAND WITH GRAVEL:** Dark brown (10YR 3/3), fine to very coarse grained, well graded, quartz, sandstone and chert rich, angular to well rounded shaped sand and gravel, wet, dense	SM	7 18 13	31					
13 14	P3-3 T		**SILTY SAND:** Dark brown (10YR 3/3), fine to medium grained, grading to coarse to very coarse grained with depth, poorly graded, quartz, sandstone and chert rich, angular to well rounded shaped, wet, very dense	SM	35 27						
15 16 17			**WEATHERED CONGLOMERATE: WEATHERED TO SILTY GRAVEL WITH SAND:** Olive brown (2.5Y 4/4), very fine to fine coarse grained sand, sand and gravel are angular to well rounded shaped and sandstone, quartz and chert rich, very moist to wet, very dense	GM	50/6”	50/6”					
18 19	P3-4 T		**SAND:** Dark brown (10YR 3/3), interbedded fine to medium grained and coarse to very coarse grained, gravel lens at 19’, wet, very dense	SP	21						
20 21			**CLAYEY SAND WITH GRAVEL:** Light olive brown (2.5Y 5/4), result of weathered conglomerate, very fine to fine grained with trace medium to coarse grains, sub-angular to sub-rounded shaped, poorly graded, sub-rounded sandstone gravels up to 1 inch in diameter, very moist, very dense	SC	19 45	64					
22 23			Boring terminated at 20 feet. Groundwater encountered at 7’2”.								

Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 8
Project No. 1929
Date: 6/24/19

LOGGED BY CLA
DATE DRILLED 4/10/19
BORING DIAMETER 8" HS
BORING NO. P-4

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline
HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1											
2											
3											
4	P4-1 T		**SILTY SAND:** Dark brown (10YR 3/3), fine grained coarsening to fine to medium grained with depth, poorly graded, quartz rich, trace sub-angular to well rounded chert and sandstone gravels up to 1 inch at 5 feet, slightly moist, medium dense	SM	6 7 9	16					
5											
6			▽								
7											
8											
9	P4-2 T		**SAND:** Dark brown (10YR 3/3), fine grained coarsening to coarse to very coarse grained with depth, sub-angular to well rounded shaped, quartz, chert and sandstone rich, poorly graded, very poorly indurated, trace rounded to well rounded sandstone gravels up to 1 inch in diameter, wet, medium dense	SP	5 7 16	23					
10											
11			Cobbles encountered near 9 feet								
12											
13											
14	P4-3 T		Interbedded medium grained and coarse to very coarse grained sand, wet, very dense		19 25 48	73					
15			**SILTY SAND:** Olive brown (2.5Y 4/4), fine to coarse grained, angular to rounded shaped, poorly graded, quartz, sandstone and chert rich, trace rounded sandstone gravels up to 1 inch in diameter, wet, very dense	SM							
16											
17											
18											
19	P4-4 T		**SAND:** Dark brown (10YR 3/3), coarse to very coarse grained, wet, very dense	SP	18 32 50/5”	50/5”					
20			**WEATHERED CONGLOMERATE: WEATHERED TO SILTY GRAVEL:** Olive brown (2.5Y 4/4), sub-angular to well rounded, sandstone gravels up to 1 inch in diameter, trace very fine to fine grained sand, moist, very dense								
21											
22											
23											

Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 9
Project No. 1929
Date: 6/24/19

LOGGED BY CLA DATE DRILLED 4/10/19 BORING DIAMETER 8" HS BORING NO. P-4

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
24 25	P4-5 T		**CLAYEY SAND WITH GRAVEL:** Dark greenish gray (GLEY 2 4/10G), result of completely weathered conglomerate, very fine to fine grained with trace medium to coarse grains, sub-angular shaped, poorly graded, sub-rounded sandstone gravels up to 1 inch in diameter, moist to wet, dense	SC	25 15 33	48					
26			Boring terminated at 25 feet. Groundwater encountered at 6'2".								
27											
28											
29											
30											
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Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 10
Project No. 1929
Date: 6/24/19

LOGGED BY CLA DATE DRILLED 5/30/19 BORING DIAMETER 8" HS BORING NO. P-5

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1 2			**SILTY SAND:** Brown (10YR 4/3), fine to medium grained with trace coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, scattered rootlets, trace binder, slightly moist,	SM							
3 4 5 6 7	P5-1 T		**SILTY SAND WITH GRAVEL:** Brown (10YR 4/3), fine to medium grained with trace coarse to very coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz, sandstone and chert rich, poorly indurated, sub-angular to well rounded shaped gravels up to 1 inch in diameter, slightly moist, medium dense ▽	SM	19 11 15	26					
8 9 10 11 12	P5-2 T		**SILTY GRAVEL WITH SAND:** Brown (10YR 4/3), sub-angular to well rounded shaped, predominately fine grained gravels ranging from ¼ to ½ inch in diameter with a trace amount of gravels up to 2 inches in diameter, quartz, siltstone and sandstone rich, poorly graded, poorly indurated, fine to medium grained **SILTY SAND** lens near 9½ feet, wet, very dense	GM	12 15 38	53					
13 14	P5-3 T		**SILTY SAND:** Brown (10YR 4/3), fine to medium grained grading to coarse to very coarse grained near 14 feet, sub-angular to well rounded shaped, quartz, sandstone and chert rich, wet, very dense	SM	40 50/6"	50/6"					
15 16 17			**COMPLETELY WEATHERED CONGLOMERATE; WEATHERED TO CLAYEY SAND WITH GRAVEL:** Light olive brown (2.5Y 5/3), very fine to medium grained with trace coarse to very coarse grains, sub-angular to well rounded shaped, quartz, sandstone and chert rich, poorly indurated, gravels up to 2 inches in diameter, wet, very dense	SC							
18	P5-4 T		**SAND:** Brown (10YR 4/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, poorly indurated, wet, medium dense	SP	28						
19 20 21			**WEATHERED CONGLOMERATE; WEATHERED TO CLAYEY SAND WITH GRAVEL:** Bluish gray (GLEY2 5/5B), very fine to fine grained with trace medium to coarse grains, poorly graded, moderately indurated, sub-angular to well rounded shaped gravels up to 2 inches in diameter, very moist, very dense	SC	29 50/6"	50/6"					
22 23			Boring terminated at 20 feet. Groundwater encountered at 6 feet.								

Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 11
Project No. 1929
Date: 6/24/19

LOGGED BY CLA DATE DRILLED 5/30/19 BORING DIAMETER 8" HS BORING NO. P-6

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
1 2			**SILTY SAND:** Dark brown (10YR 3/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, scattered rootlets, slightly moist	SM							
3 4 5 6 7	P6-1 T		**SILTY SAND WITH GRAVEL:** Brown (10YR 4/3), fine to coarse grained with trace very coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz, sandstone and chert rich, sub-angular to rounded shaped gravels up to 2 inches in diameter, poorly indurated, slightly moist, medium dense ▽	SM	7 8 11	19					
8 9 10 11 12	P6-2 T		**SILTY GRAVEL WITH SAND:** Brown (10YR 4/3), sub-angular to well rounded shaped, predominately fine grained gravels ranging from ¼ to ½ inch in diameter with a trace amount of gravels up to 2 inches in diameter, quartz, siltstone, sandstone and quartz rich, poorly graded, poorly indurated, fine to medium grained quartz rich **SILTY SAND** lens near 8½ feet, wet, very dense	GM	16 18 38	56					
13 14 15 16 17	P6-3 T		Wet, very dense		50/6"	50/6"					
18 19	P6-4 T		**SILTY SAND:** Very dark gray (10YR 3/1), medium to coarse grained with trace fine grains, angular to rounded shaped, poorly graded, quartz, sandstone and chert rich, wet, very dense	SM	33 40						
20 21			**WEATHERED CONGLOMERATE; WEATHERED TO CLAYEY SAND WITH GRAVEL:** Bluish gray (GLEY2 5/5B), very fine to fine grained with trace medium to coarse grains, poorly graded, moderately indurated, sub-angular to well rounded shaped gravels up to 2 inches in diameter, very moist, very dense	SC	48	88					
22 23			Boring terminated at 20 feet. Groundwater encountered at 6 feet.								

Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 12
Project No. 1929
Date: 6/24/19

LOGGED BY CLA
DATE DRILLED 5/30/19
BORING DIAMETER 8" HS
BORING NO. P-7

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline
HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
0–3			**SILTY SAND WITH GRAVEL:** Dark brown (10YR 3/3), fine to medium grained with trace coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, sub-angular to well rounded shaped gravels up to 3 inches in diameter, scattered rootlets, moist	SM							
4	P7-1 T		Lack of rootlets, slightly moist, medium dense		9 11 19	30					
6			▽								
9	P7-2 T		Increase in coarseness of sand, quartz, sandstone and chert rich, wet, loose		6 8 8	16					
9–12			**SILTY GRAVEL WITH SAND:** Brown (10YR 4/3), sub-angular to well rounded shaped, predominately fine grained gravels ranging from ¼ to ½ inch in diameter with a trace amount of gravels up to 1 inch in diameter, fine to very coarse grained sand, sand and gravel are sub-angular to well rounded shaped, quartz, sandstone and chert rich, poorly graded, poorly indurated, wet, medium dense	GM							
13	P7-3 T		Silt content increases with depth, coarse grained sand lense near 13½ feet, severely weathered fine grained sandstone gravel at 14 feet, wet, very dense		50/6"	50/6"					
18–20	P7-4 T		**SILTY SAND:** Grayish brown (2.5Y 5/2), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, wet, very dense	SM	26 41 37	78					
20–23			**WEATHERED CONGLOMERATE; WEATHERED TO SANDY LEAN CLAY/CLAYEY SAND:** Bluish gray (GLEY2 5/5B) and light olive brown (2.5Y 5/6), fine to medium grained sand, sub-angular to sub-rounded shaped, poorly graded, angular to rounded shaped gravels up to ½ inch in diameter in a clay matrix, moist to very moist, very hard/very dense	CL/ SC							

Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 13
Project No. 1929
Date: 6/24/19

LOGGED BY CLA   DATE DRILLED 5/30/19   BORING DIAMETER 8" HS   BORING NO. P-7

DRILL RIG EGI Truck Mounted Mobile B40 with Wireline   HAMMER TYPE 140 lb Down-Hole Safety Hammer

Depth (feet)	Sample	Sample Type	Soil Description	USCS	Field Blow Counts	SPT "N" Value	Pocket Pen. (tsf)	% Passing #200 Sieve	Dry Density (pcf)	Moisture Content (%)	Additional Lab Results
24	P7-5 T		**CLAY WITH GRAVEL:** Very dark gray (2.5Y 3/1), clay appears to exhibit intermediate plasticity, sub-rounded shaped gravels up to 1 inch in diameter in a clay matrix, moist, very hard	CI	10 42 50/3”	50/3”					
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46			Boring terminated at 25 feet. Groundwater encountered at 6 feet.								

Pacific Crest
ENGINEERING INC

Log of Piezometer Borings
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 14
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME: Pacheco Creek Restoration Project

WELL NUMBER: P-1

PROJECT NUMBER: 1929

PERMIT AGENCY: Santa Clara Valley Water District

LOCATION: 37.01559970, -121.33547714

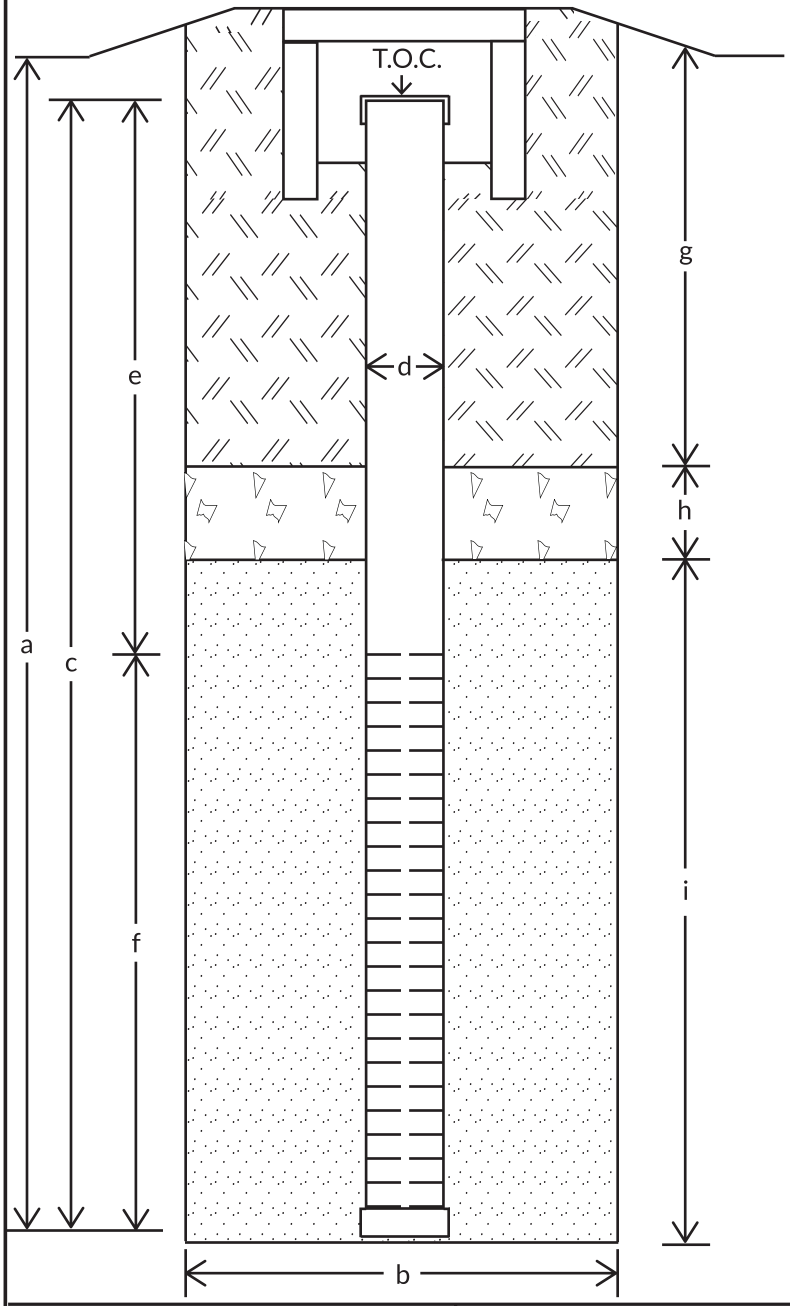
DATUM: WGS 1984

WELL PERMIT NO.: C20190326003

WELL COVER: Stovepipe

DATE INSTALLED: 4/10/2019

DRILL RIG: Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 20 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 20 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 20 feet

Screened Length: 15 feet

Screen Size: 0.010

g. Annular Seal: 0 to 4 feet

Material: Neat Cement

h. Bentonite Seal: 4 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 20 feet

Material: #3 Sand

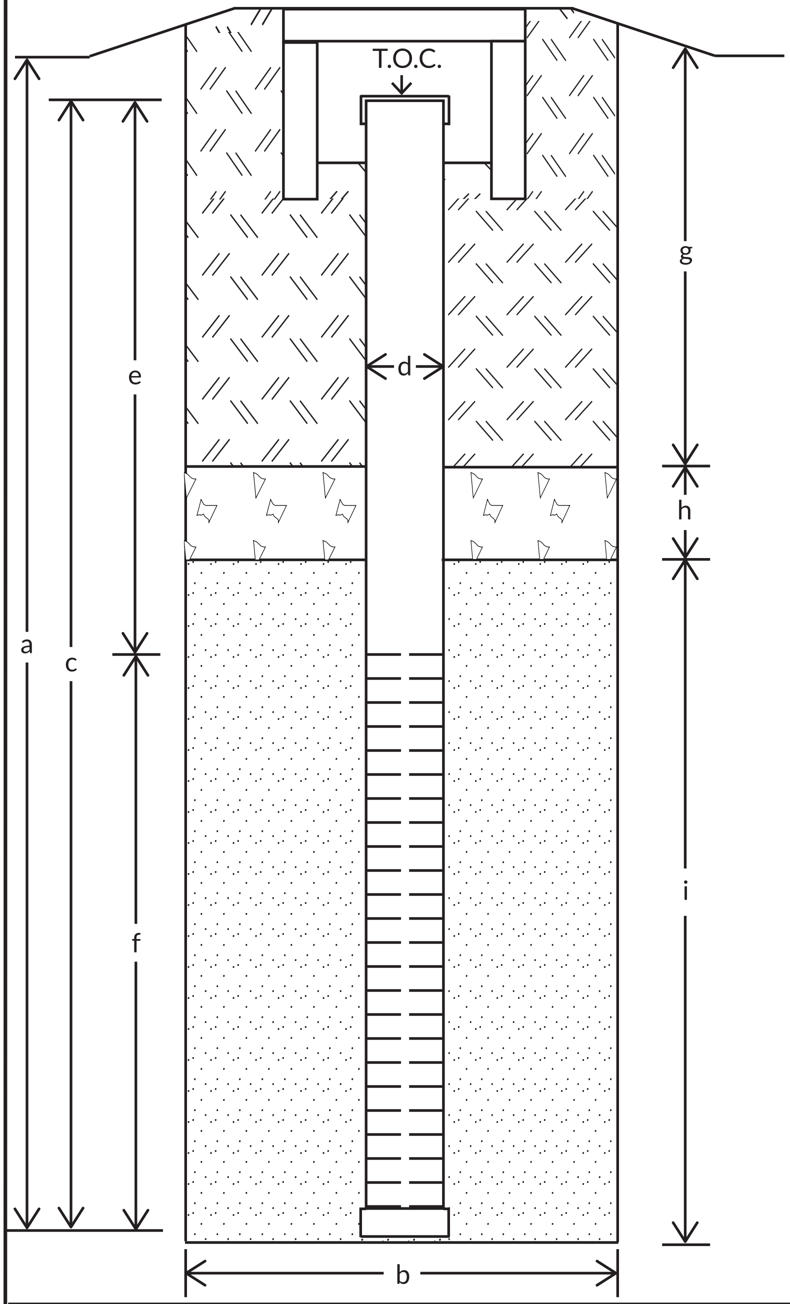
Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 15
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME:	Pacheco Creek Restoration Project	WELL NUMBER:	P-2
PROJECT NUMBER:	1929	PERMIT AGENCY:	Santa Clara Valley Water District
LOCATION:	37.01496646, -121.33445758	DATUM:	WGS 1984
WELL PERMIT NO.:	C20190326004	WELL COVER:	Stovepipe
DATE INSTALLED:	4/10/2019	DRILL RIG:	Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 25 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 25 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 25 feet

Screened Length: 20 feet

Screen Size: 0.010

g. Annular Seal: 0 to 4 feet

Material: Neat Cement

h. Bentonite Seal: 4 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 25 feet

Material: #3 Sand

Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 16
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME: Pacheco Creek Restoration Project

WELL NUMBER: P-3

PROJECT NUMBER: 1929

PERMIT AGENCY: Santa Clara Valley Water District

LOCATION: 37.02036837, -121.33031693

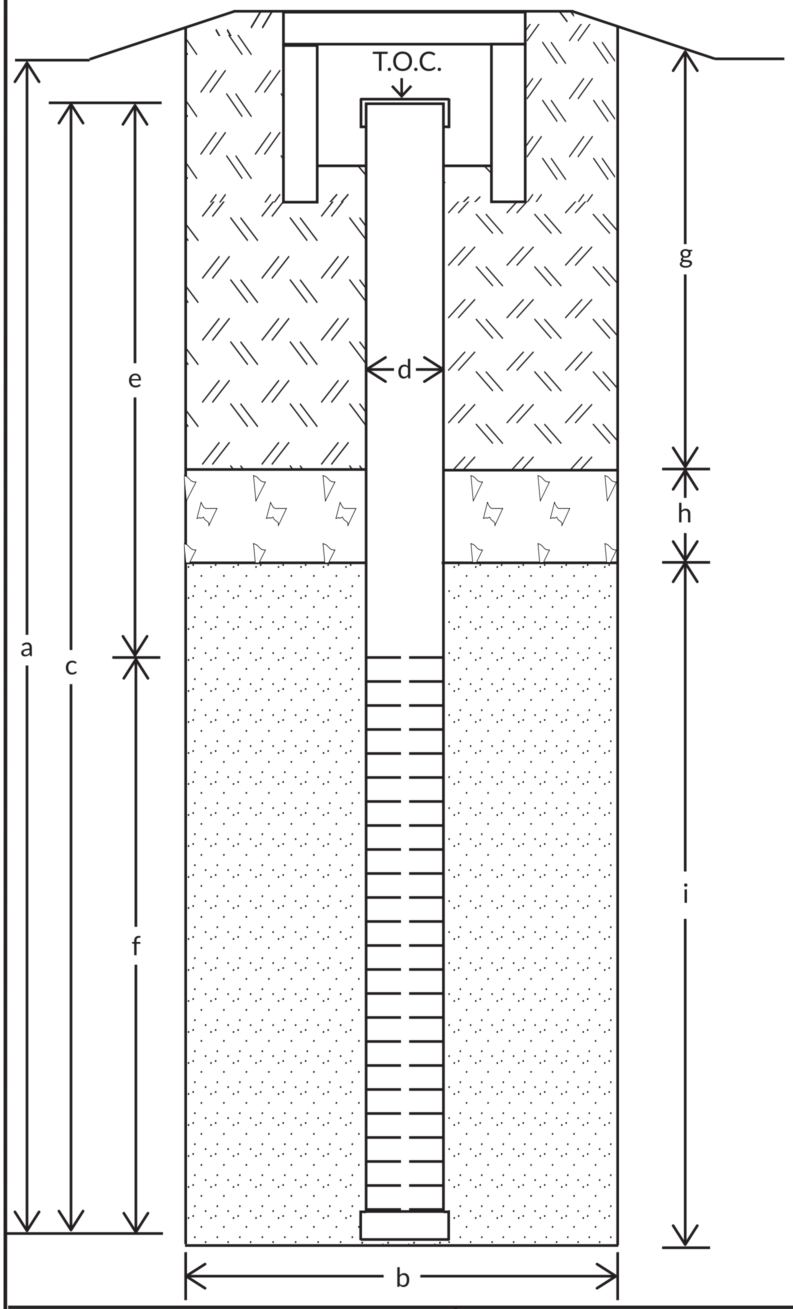
DATUM: WGS 1984

WELL PERMIT NO.: C20190326001

WELL COVER: Stovepipe

DATE INSTALLED: 4/10/2019

DRILL RIG: Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 20 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 20 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 20 feet

Screened Length: 15 feet

Screen Size: 0.010

g. Annular Seal: 0 to 4 feet

Material: Neat Cement

h. Bentonite Seal: 4 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 20 feet

Material: #3 Sand

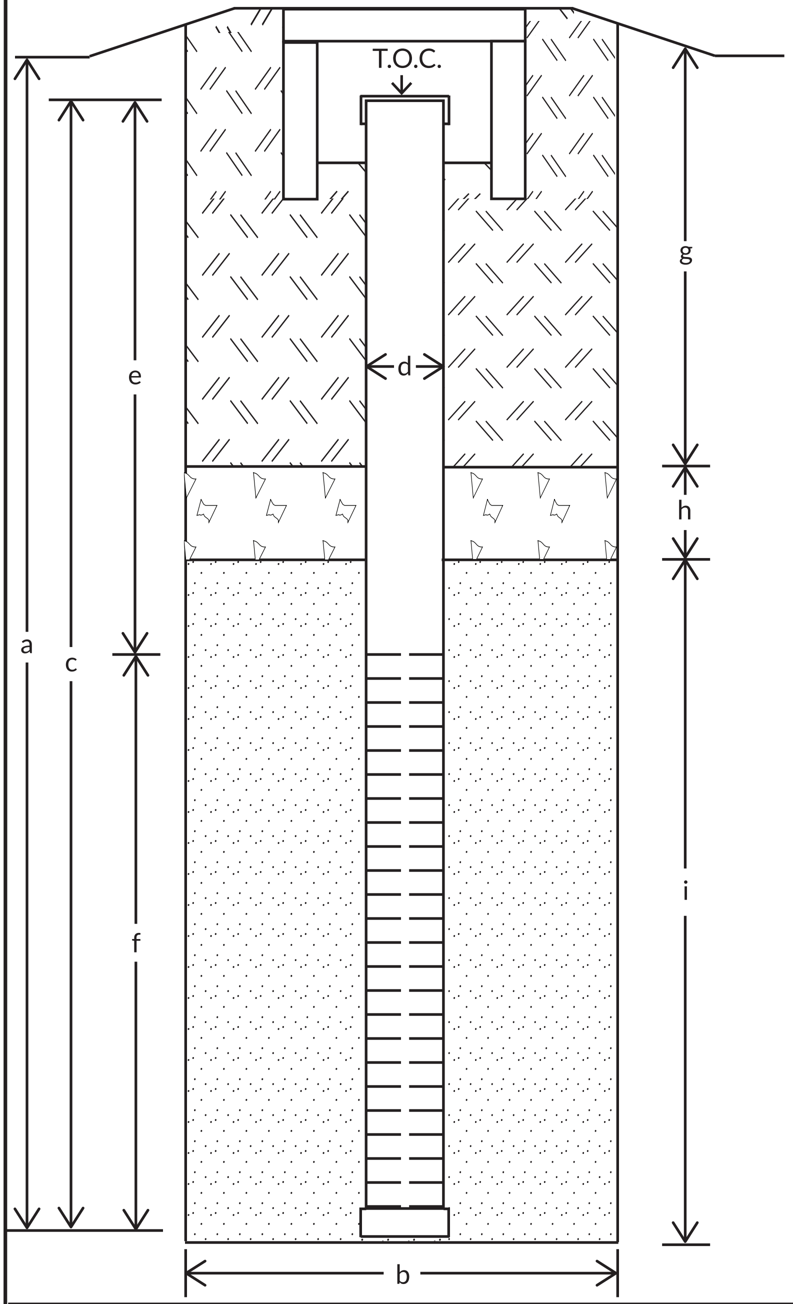
Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 17
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME:	Pacheco Creek Restoration Project	WELL NUMBER:	P-4
PROJECT NUMBER:	1929	PERMIT AGENCY:	Santa Clara Valley Water District
LOCATION:	37.01992158, -121.32955354	DATUM:	WGS 1984
WELL PERMIT NO.:	C20190326002	WELL COVER:	Stovepipe
DATE INSTALLED:	4/10/2019	DRILL RIG:	Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 25 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 25 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 25 feet

Screened Length: 20 feet

Screen Size: 0.010

g. Annular Seal: 0 to 4 feet

Material: Neat Cement

h. Bentonite Seal: 4 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 25 feet

Material: #3 Sand

Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 18
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME: Pacheco Creek Restoration Project

WELL NUMBER: P-5

PROJECT NUMBER: 1929

PERMIT AGENCY: Santa Clara Valley Water District

LOCATION: 37.02388265, -121.32680531

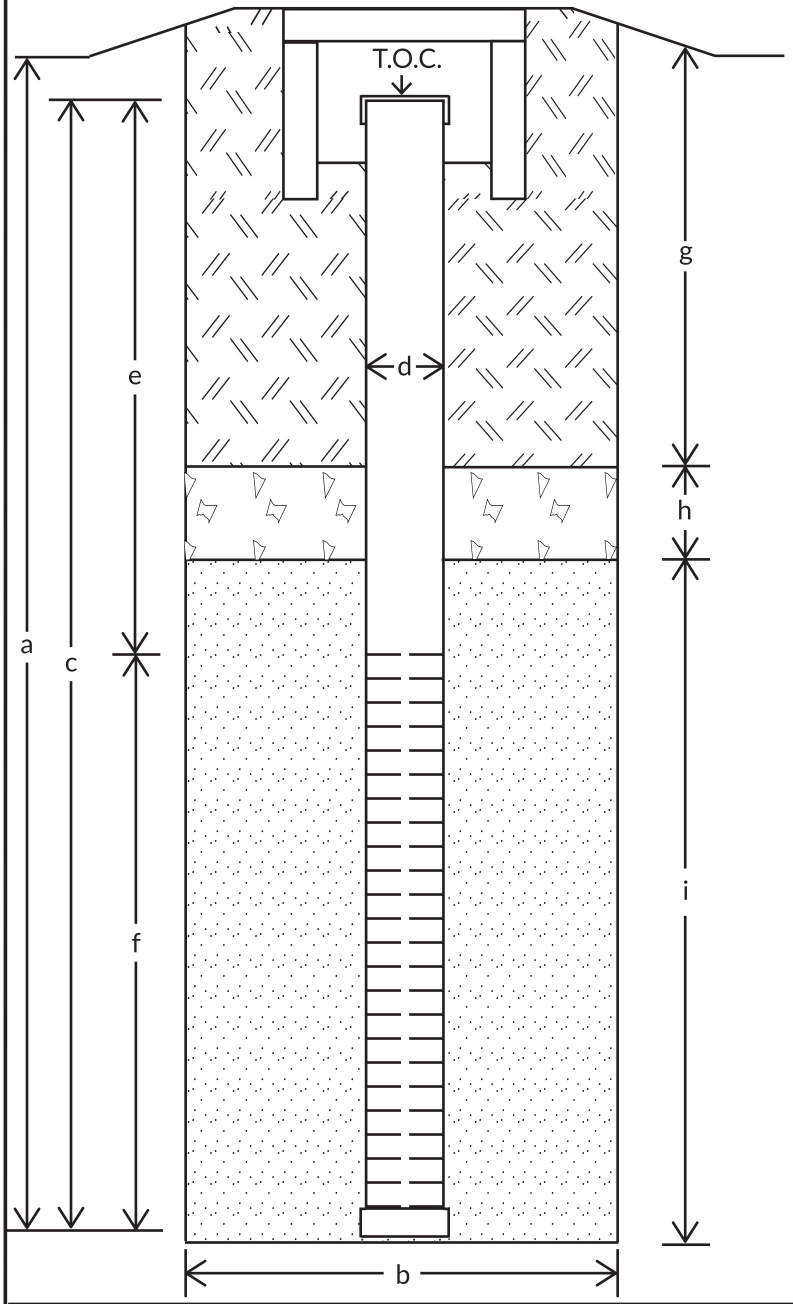
DATUM: WGS 1984

WELL PERMIT NO.: C20190513004

WELL COVER: Stovepipe

DATE INSTALLED: 5/30/2019

DRILL RIG: Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 20 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 20 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 20 feet

Screened Length: 15 feet

Screen Size: 0.010

g. Annular Seal: 0 to 3 feet

Material: Neat Cement

h. Bentonite Seal: 3 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 20 feet

Material: #3 Sand

Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 19
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME: Pacheco Creek Restoration Project

WELL NUMBER: P-6

PROJECT NUMBER: 1929

PERMIT AGENCY: Santa Clara Valley Water District

LOCATION: 37.02781820, -121.32531771

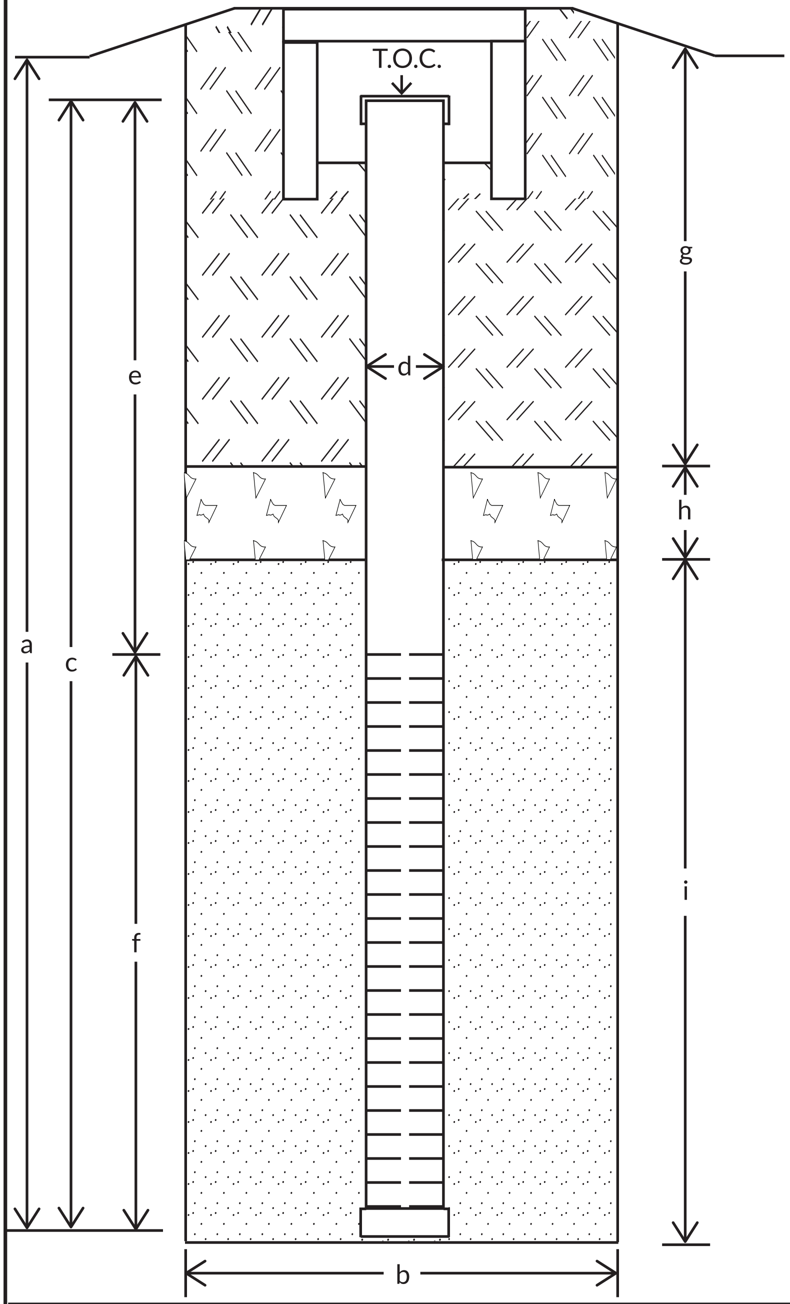
DATUM: WGS 1984

WELL PERMIT NO.: C20190513003

WELL COVER: Stovepipe

DATE INSTALLED: 5/30/2019

DRILL RIG: Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 20 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 20 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 20 feet

Screened Length: 15 feet

Screen Size: 0.010

g. Annular Seal: 0 to 3 feet

Material: Neat Cement

h. Bentonite Seal: 3 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 20 feet

Material: #3 Sand

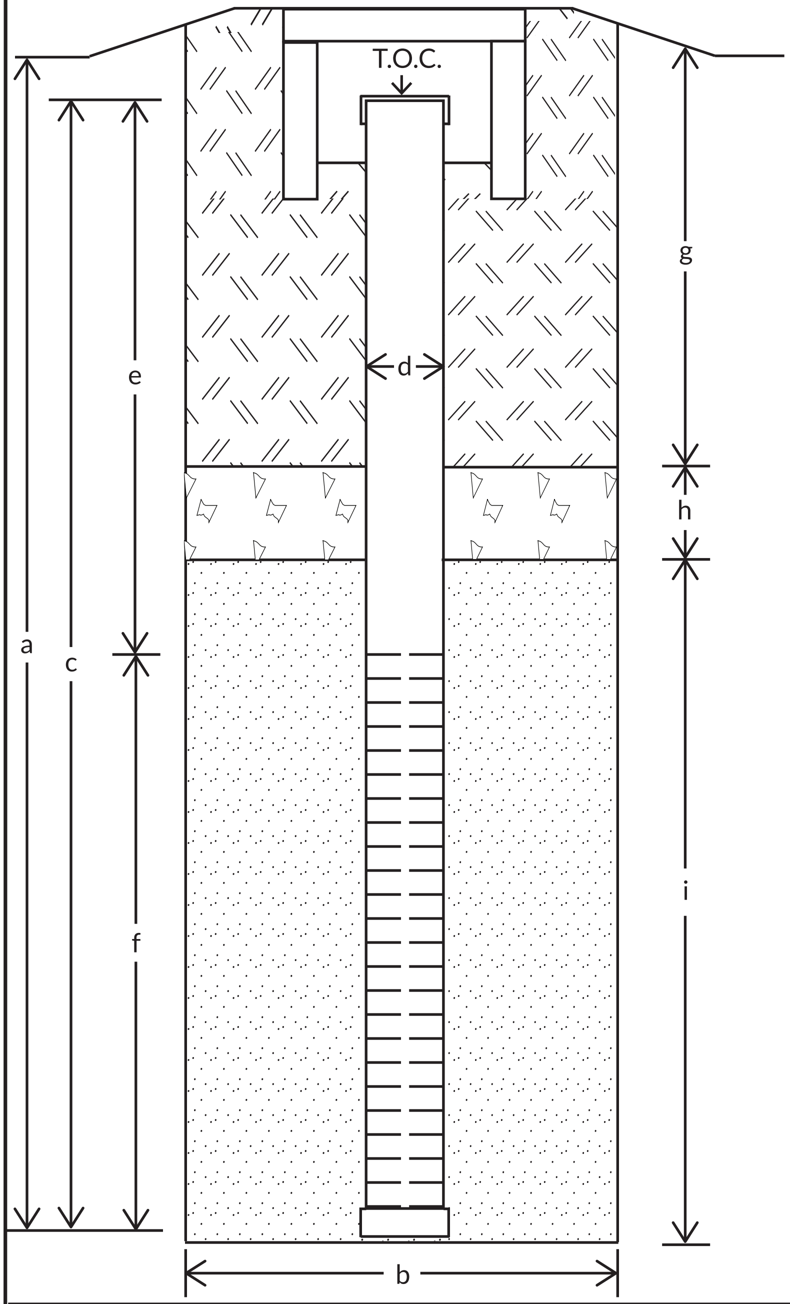
Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 20
Project No. 1929
Date: 6/24/19

PIEZOMETER CONSTRUCTION DETAILS

PROJECT NAME:	Pacheco Creek Restoration Project	WELL NUMBER:	P-7
PROJECT NUMBER:	1929	PERMIT AGENCY:	Santa Clara Valley Water District
LOCATION:	37.02747599, -121.32405231	DATUM:	WGS 1984
WELL PERMIT NO.:	C20190513002	WELL COVER:	Stovepipe
DATE INSTALLED:	5/30/2019	DRILL RIG:	Exploration Geoservices B-40



EXPLORATORY BORING

a. Total Depth: 25 feet

b. Diameter: 8 inch

Drilling Method: Hollow Stem Auger

WELL CONSTRUCTION

c. Total Casing Length: 25 feet

Material: Schedule 40 PVC

d. Diameter: 2 inches

e. Depth of Blank Screen: 0 to 5 feet

Blank Screen Length: 5 feet

f. Depth of Screen: 5 to 25 feet

Screened Length: 20 feet

Screen Size: 0.010

g. Annular Seal: 0 to 3 feet

Material: Neat Cement

h. Bentonite Seal: 3 to 5 feet

Material: 3/8” Chips

i. Gravel Pack: 5 to 25 feet

Material: #3 Sand

Pacific Crest
ENGINEERING INC

Piezometer Construction Details
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 21
Project No. 1929
Date: 6/24/19

APPENDIX B

Santa Clara County Well Construction Applications
Department of Water Resources Well Completion Reports

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No.: C20190326003
Date Issued: 3/26/2019
Well Registration No:
Geologic Setting: 4
Expiration Date: 3/26/2020
Driller's Log No.:

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner: Santa Clara Valley Habitat Agency
Well Owner's Mailing Address: 535 Alkire Avenue
City, State, Zip: Morgan Hill, CA 95037
Telephone No. & Contact Name: 669-253-6127 Gerry Haas

Property Owner: Santa Clara Valley Habitat Agency
Property Owner's Mailing Address: 535 Alkire Avenue
City, State, Zip: Morgan Hill, CA 95037
Telephone No. & Contact Name: 669-253-6127 Gerry Haas

Name of Business at Well Site: Pacheco Creek Reserve
Address of Well Site: 12163 Pacheco Pass Highway
City, State, Zip: Gilroy, CA 95020
Telephone No.:

Owner's/Consultant's Well No: P-1
Assessor's Parcel No. of Well Site: Book 898 Page 38 Parcel 006 (001)

Consultant (Company): Pacific Crest Engineering Inc.
Address: 444 Airport Boulevard Suite 106
City, State, Zip: Watsonville, CA 95076
Telephone No.: 831-722-9446
☐ Check if address or phone number has changed

Drilling Company: Exploration Geoservices Inc.
Address: 1535 Industrial Avenue
City, State, Zip: San Jose, CA 95112
Telephone No.: 408-280-6822
C-57 License No.: 484288
☐ Check if address or phone number has changed

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No.: Pacheco Creek Restoration Project
Caseworker Name: N/A
Oversight Agency: Santa Clara Valley Habitat Agency
Caseworker Telephone No.: 408-779-7261

Signature of Responsible Professional
Date: 2/22/19
Print Name: Jim F. Walker
(No substitution of signature will be accepted)

Civil Engineer Registration No.: 62120 62120
OR
Geologist Registration No.:

Estimated Depth of Completed Well: ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other:

Well is to be constructed: ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*
*See General Condition F, page 2

WELL TYPE/USE

☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
☐ Agricultural ☐ Domestic ☐ Industrial ☐ Municipal	☒ GW Level ☐ GW Quality ☐ Inclinometer ☐ Vapor ☐ Other	☐ Air Sparge ☐ GW Extraction ☐ Material Emplacement ☐ Vapor Extraction ☐ Other	☐ Permanent ☐ Temporary	☐ Closed Loop ☐ Open Loop	☐ Groundwater Cleanup Reinjection ☐ Stormwater ☐ Water Supply Recharge ☐ Other		

Other wells exist on this property? ☒ Yes ☐ No If yes, status: ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90-1, the District Well Standards, and the conditions of this permit (see page 2). I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable. I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ. I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application.

Signature of Property Owner/Agent: Date: 3/21/19 Print Name of Property Owner/Agent: Gerry Haas
Signature of Well Owner/Agent: Date: 3/21/19 Print Name of Well Owner/Agent: Gerry Haas
Signature of Well Driller/Agent: Date: 3/22/19 Print Name of Driller/Agent: John Coll
Signature of Consultant/Agent: Date: 3/22/19 Print Name of Consultant/Agent: Jim Walker

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
S.C.V.W.D.
WELLS

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 2 of 2

DISTRICT WELL PERMIT NO.: C2019 0326 003

Based on information on this application and attachment(s) hereto (if any) and subject to approval noted below, permission is hereby granted to construct (drill) the described well. Permission to start work may be withheld until a field check verifies all statements made on application by permittee and is also subject to the "General" and "Special" Conditions stated below.

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH APPROVAL (Water Supply Well Only)

NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted
☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan **must** be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
2. North arrow and scale
3. Location of proposed well with dimensions in feet from well to nearest cross streets.

GENERAL CONDITIONS

A. **District** (telephone 408-265-2607, ext. 2660) **must be notified a minimum of one working day before construction of the annular seal.** An authorized District representative must be on site to witness the construction of the annular seal. This requirement may be waived by an authorized District representative. If the District waives the inspection requirement, the District may request the permittee(s) to furnish certification, under penalty of perjury, that the well was constructed in accordance with the District Well Standards and with the permit conditions.

B. Permittee agrees to construct, operate, and maintain the well according to provisions of the latest District Ordinance and the latest published revisions of District Well Standards to the end that this well will not cause pollution or contamination of groundwater or otherwise jeopardize the health, safety, or welfare of the people of the District.

C. This permit is valid only for the purpose specified herein. Well construction methods authorized under this permit may not be changed except by written approval of an authorized District representative, and only if the District believes that such a change will result in equal or superior compliance with the District and State Well Standards (e.g., if the District representative finds that site conditions warrant such a change).

D. This permit is only valid for the Assessor's Parcel No. indicated on it.

E. This permit may be voided if it contains incorrect information. If the permit is voided after work has begun, the well or boring that was constructed under this permit must be destroyed in accordance with District and State Well Standards.

F. If any work associated with this permit will take place on District property/easement, an encroachment or construction permit must be granted by the District's Community Projects Review Unit (telephone 408-265-2607, ext. 2589).

G. Before the well constructed under this permit can be used as a drinking water source, its use must be approved by the regulatory agency with authority over such use (typically the Santa Clara County Department of Environmental Health or the State of California Department of Public Health). A completed Well Inventory Form must also be approved.

H. If the well constructed under this permit cannot be or is not being used for its intended purpose, permittee is hereby required to destroy the well according to the District Well Standards and under permit from the District. Any test holes drilled under this permit must be destroyed within 24 hours of completion of testing activities. Destruction activities must be completed according to District standards. District must be notified a minimum of 24 hours prior to destruction.

I. Within 30 days of the completion of the well construction activities, the driller or consultant identified on this permit shall fully complete State of California DWR Form 188 and mail the original to the District's Wells and Water Production Unit.

J. The permittee(s) shall assume entire responsibility for all activities and uses under this permit and shall indemnify, defend, and hold the District, its officers, agents, and employees, free and harmless from any and all expense, cost, and liability in connection with or resulting from the granting or exercise of this permit including, but not limited to, property damage, personal injury, and wrongful death.

K. Permittees are required to be in full compliance with Cal/OSHA California Labor Code Section 6300.

L. A current C-57 Water Well Drilling Contractor's License is required for the construction of all wells.

M. Permittee, permittee's contractors, consultants, or agents shall be responsible to assure that all materials or waters generated during drilling, well construction, well development, pump testing, or other activities associated with this permit will be safely handled, properly managed, and disposed of according to all applicable federal, state, and local statutes regulating such. In no case shall these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed.

N. The driller and consultants (if applicable) shall have an active copy of their Worker's Compensation Insurance on file with District.

O. This permit shall expire if not exercised within 180 calendar days of its approval, unless an extension of the permit expiration date is granted by an authorized District representative.

P. This permit must be kept on site during all activities associated with it and shall immediately be presented to an authorized District representative upon request.

Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

Please see attached addendum for zone #4.
Disregard per phone conversation with Alexis, 4/8/19

Community Projects Review Unit Approval (if needed):

CPRU Permit No.:

Approved by: Alexis

Date: 3/26/2019

Please allow 10 working days to process this application.

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

ANNULAR SEAL REQUIREMENTS

All wells constructed in Zone 4 must have an annular seal at least 50 feet deep with a radial thickness of at least 2 inches. Other seal requirements may be required by the District based on site specific or regional conditions.

If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

0 200 400

Scale: 1 inch = 200 feet

Base Map Provided by: cbec, inc. eco engineering

Pacific Crest
ENGINEERING INC

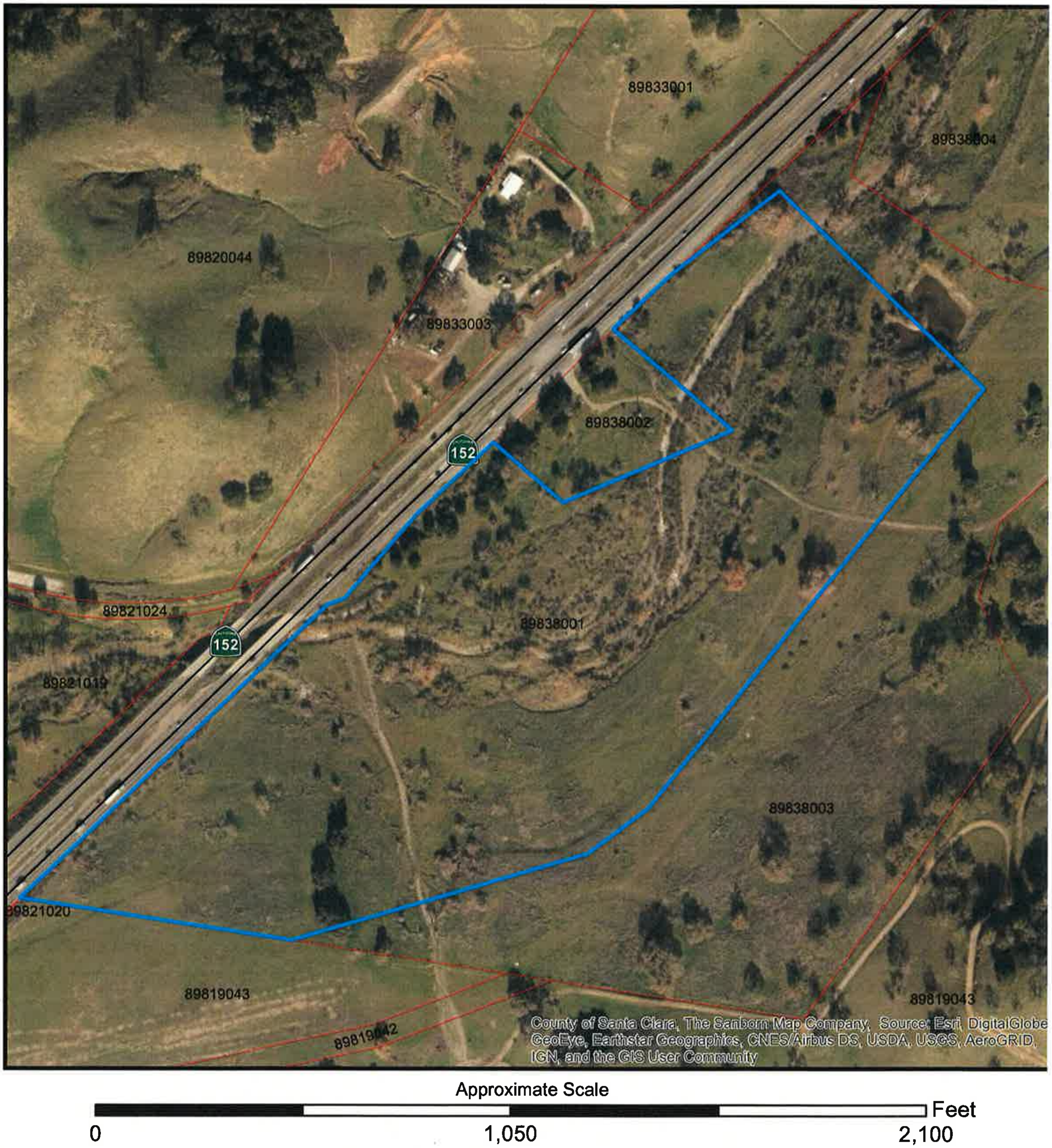
Site Map Showing Proposed Piezometer Locations - P-1 & P-2
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 1
Project No. PR 19-025
Date: 3/22/19

SANTA CLARA VALLEY HABITAT AGENCY

APN 898-38-006 (001)
12163 PACHECO PASS HIGHWAY
GILROY, CA 95020

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614



County of Santa Clara, The Sanborn Map Company, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Wells

⊕ A01: Water Supply - Active

■ S: Water Supply - Standby

⊕ A02: Extraction (Env) - Active

■ I02: Extraction (Env) - Inactive

⊕ A: Other - Active

✱ B: Abandoned

⊕ D: Destroyed

▲ Undet: Status Undetermined

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No. C20190326004	Date Issued 3/26/2019	Well Registration No.
Geologic Setting 4	Expiration Date 3/26/2020	Driller's Log No.:

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner: Santa Clara Valley Habitat Agency	Property Owner: Santa Clara Valley Habitat Agency	Name of Business at Well Site: Pacheco Creek Reserve
Well Owner's Mailing Address 535 Alkire Avenue City, State, Zip Morgan Hill, CA 95037	Property Owner's Mailing Address 535 Alkire Avenue City, State, Zip Morgan Hill, CA 95037	Address of Well Site 12163 Pacheco Pass Highway City, State, Zip Gilroy, CA 95020
Telephone No. & Contact Name 669-253-6127 Gerry Haas	Telephone No. & Contact Name 408-461-0239 Peter Ciraulo	Telephone No.: 408-461-0239 (001)

Owner's/Consultant's Well No. P-2 | Assessor's Parcel No. of Well Site Book 898 Page 38 Parcel 006

Consultant (Company): Pacific Crest Engineering Inc.	Drilling Company Exploration Geoservices Inc.
Address: 444 Airport Boulevard Suite 106 City, State, Zip Watsonville, CA 95076	Address: 1535 Industrial Avenue City, State, Zip San Jose, CA 95112
Telephone No. 831-722-9446	Telephone No.: 408-280-6822 C-57 License No. 484288
☐ Check if address or phone number has changed	☐ Check if address or phone number has changed

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No.: Pacheco Creek Restoration Project	Caseworker Name N/A
Oversight Agency: Santa Clara Valley Habitat Agency	Caseworker Telephone No.: 408-779-7261

Signature of Responsible Professional

Date 3/22/19

Print Name Jim F. Walker

(No substitution of signature will be accepted)

Civil Engineer Registration No. 62120 62120

OR

Geologist Registration No.

Estimated Depth of Completed Well: ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other

Well is to be constructed: ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*

*See General Condition F, page 2

WELL TYPE/USE

☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
☐ Agricultural ☐ Domestic ☐ Industrial ☐ Municipal	☒ GW Level ☐ GW Quality ☐ Inclinometer ☐ Vapor ☐ Other	☐ Air Sparge ☐ GW Extraction ☐ Material Emplacement ☐ Vapor Extraction ☐ Other	☐ Permanent ☐ Temporary	☐ Closed Loop ☐ Open Loop	☐ Groundwater Cleanup Reinjection ☐ Stormwater ☐ Water Supply Recharge ☐ Other		

Other wells exist on this property? ☒ Yes ☐ No If yes, status: ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90-1, the District Well Standards, and the conditions of this permit (see page 2). I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable. I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ. I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application.

Signature of Property Owner/Agent:	Date 3/21/19	Print Name of Property Owner/Agent: Gerry Haas
Signature of Well Owner/Agent:	Date 3/26/19	Print Name of Well Owner/Agent Gerry Haas
Signature of Well Driller/Agent	Date 3/22/19	Print Name of Driller/Agent John Coll
Signature of Consultant/Agent	Date 3/22/19	Print Name of Consultant/Agent Jim Walke

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
MAR 26 2019
S.C.V.W.D.
WELLS

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)

DISTRICT WELL PERMIT NO.: C20190326004

Based on information on this application and attachment(s) hereto (if any) and subject to approval noted below, permission is hereby granted to construct (drill) the described well. Permission to start work may be withheld until a field check verifies all statements made on application by permittee and is also subject to the "General" and "Special" Conditions stated below.

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH APPROVAL (Water Supply Well Only)

NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted

☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan **must** be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
2. North arrow and scale
3. Location of proposed well with dimensions in feet from well to nearest cross streets.

GENERAL CONDITIONS

A. **District** (telephone 408-265-2607, ext. 2660) **must be notified a minimum of one working day before construction of the annular seal.** An authorized District representative must be on site to witness the construction of the annular seal. This requirement may be waived by an authorized District representative. If the District waives the inspection requirement, the District may request the permittee(s) to furnish certification, under penalty of perjury, that the well was constructed in accordance with the District Well Standards and with the permit conditions.

B. Permittee agrees to construct, operate, and maintain the well according to provisions of the latest District Ordinance and the latest published revisions of District Well Standards to the end that this well will not cause pollution or contamination of groundwater or otherwise jeopardize the health, safety, or welfare of the people of the District.

C. This permit is valid only for the purpose specified herein. Well construction methods authorized under this permit may not be changed except by written approval of an authorized District representative, and only if the District believes that such a change will result in equal or superior compliance with the District and State Well Standards (e.g., if the District representative finds that site conditions warrant such a change).

D. This permit is only valid for the Assessor's Parcel No. indicated on it.

E. This permit may be voided if it contains incorrect information. If the permit is voided after work has begun, the well or boring that was constructed under this permit must be destroyed in accordance with District and State Well Standards.

F. If any work associated with this permit will take place on District property/easement, an encroachment or construction permit must be granted by the District's Community Projects Review Unit (telephone 408-265-2607, ext. 2589).

G. Before the well constructed under this permit can be used as a drinking water source, its use must be approved by the regulatory agency with authority over such use (typically the Santa Clara County Department of Environmental Health or the State of California Department of Public Health). A completed Well Inventory Form must also be approved.

H. If the well constructed under this permit cannot be or is not being used for its intended purpose, permittee is hereby required to destroy the well according to the District Well Standards and under permit from the District. Any test holes drilled under this permit must be destroyed within 24 hours of completion of testing activities. Destruction activities must be completed according to District standards. District must be notified a minimum of 24 hours prior to destruction.

I. Within 30 days of the completion of the well construction activities, the driller or consultant identified on this permit shall fully complete State of California DWR Form 188 and mail the original to the District's Wells and Water Production Unit.

J. The permittee(s) shall assume entire responsibility for all activities and uses under this permit and shall indemnify, defend, and hold the District, its officers, agents, and employees, free and harmless from any and all expense, cost, and liability in connection with or resulting from the granting or exercise of this permit including, but not limited to, property damage, personal injury, and wrongful death.

K. Permittees are required to be in full compliance with Cal/OSHA California Labor Code Section 6300.

L. A current C-57 Water Well Drilling Contractor's License is required for the construction of all wells.

M. Permittee, permittee's contractors, consultants, or agents shall be responsible to assure that all materials or waters generated during drilling, well construction, well development, pump testing, or other activities associated with this permit will be safely handled, properly managed, and disposed of according to all applicable federal, state, and local statutes regulating such. In no case shall these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed.

N. The driller and consultants (if applicable) shall have an active copy of their Worker's Compensation Insurance on file with District.

O. This permit shall expire if not exercised within 180 calendar days of its approval, unless an extension of the permit expiration date is granted by an authorized District representative.

P. This permit must be kept on site during all activities associated with it and shall immediately be presented to an authorized District representative upon request.

Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

Please see attached addendum for zone #4.

Disregard per phone conversation with Alexis, 4/8/19

Community Projects Review Unit Approval (if needed):

CPRU Permit No.:

Approved by:

Date: 3/26/2019

Please allow 10 working days to process this application.

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

ANNULAR SEAL REQUIREMENTS

All wells constructed in Zone 4 must have an annular seal at least 50 feet deep with a radial thickness of at least 2 inches. Other seal requirements may be required by the District based on site specific or regional conditions.

If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

Scale: 1 inch = 200 feet

Base Map Provided by: cbec, inc. eco engineering

Pacific Crest
ENGINEERING INC

Site Map Showing Proposed Piezometer Locations - P-1 & P-2
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 1
Project No. PR 19-025
Date: 3/22/19

SANTA CLARA VALLEY HABITAT AGENCY

APN 898-38-006 (001)
12163 PACHECO PASS HIGHWAY
GILROY, CA 95020

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614

County of Santa Clara, The Sanborn Map Company, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Approximate Scale

0 1,050 2,100 Feet

Wells

- ⊕ A01: Water Supply - Active
- ■ S: Water Supply - Standby
- ⊕ A02: Extraction (Env) - Active
- ■ I02: Extraction (Env) - Inactive
- ⊕ A: Other - Active
- ✱ B: Abandoned
- ⊕ D: Destroyed
- ▲ Undet: Status Undetermined

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No. C20190326001	Date Issued: 3/26/2019	Well Registration No.:
Geologic Setting: 4	Expiration Date: 3/26/2020	Driller's Log No.:

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner: Santa Clara Valley Habitat Agency	Property Owner: Santa Clara Valley Habitat Agency	Name of Business at Well Site: Pacheco Creek Reserve
Well Owner's Mailing Address: 535 Alkire Avenue	Property Owner's Mailing Address: 535 Alkire Avenue	Address of Well Site: 12163 Pacheco Pass Highway
City, State, Zip Morgan Hill, CA 95037	City, State, Zip Morgan Hill, CA 95037	City, State, Zip Gilroy, CA 95020
Telephone No. & Contact Name 669-253-6127 Gerry Haas	Telephone No. & Contact Name 669-253-6127 Gerry Haas	Telephone No. (004)

Owner's/Consultant's Well No. P-3

Assessor's Parcel No. of Well Site: Book 898 Page 38 Parcel 007

Consultant (Company): Pacific Crest Engineering Inc.	Drilling Company: Exploration Geoservices Inc
Address: 444 Airport Boulevard Suite 106	Address: 1535 Industrial Avenue
City, State, Zip Watsonville, CA 95076	City, State, Zip San Jose, CA 95112
Telephone No. 831-722-9446	Telephone No. 408-280-6822 C-57 License No. 484288
☐ Check if address or phone number has changed	☐ Check if address or phone number has changed

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No.: Pacheco Creek Restoration Project	Caseworker Name: N/A
Oversight Agency: Santa Clara Valley Habitat Agency	Caseworker Telephone No. 408-779-7261

Signature of Responsible Professional

Date: 3/22/19

Print Name: Jim F. Walker

(No substitution of signature will be accepted)

Civil Engineer Registration No.: 62120 42120

OR

Geologist Registration No.:

Estimated Depth of Completed Well: ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other

Well is to be constructed: ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*

*See General Condition F, page 2

WELL TYPE/USE	☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
	☐ Agricultural	☒ GW Level	☐ Air Sparge	☐ Permanent	☐ Closed Loop	☐ Groundwater Cleanup Reinjection		
	☐ Domestic	☐ GW Quality	☐ GW Extraction	☐ Temporary	☐ Open Loop	☐ Stormwater		
	☐ Industrial	☐ Inclinometer	☐ Material Emplacement			☐ Water Supply Recharge		
	☐ Municipal	☐ Vapor	☐ Vapor Extraction			☐ Other		
		☐ Other	☐ Other					

Other wells exist on this property? ☒ Yes ☐ No   If yes, status: ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90-1, the District Well Standards, and the conditions of this permit (see page 2). I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable. I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ. I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application.

Signature of Property Owner/Agent	Date 3/21/19	Print Name of Property Owner/Agent Gerry Haas
Signature of Well Owner/Agent	Date 3/21/19	Print Name of Well Owner/Agent Gerry Haas
Signature of Well Driller/Agent	Date 3/22/2019	Print Name of Driller/Agent John Collins
Signature of Consultant/Agent	Date 3/22/19	Print Name of Consultant/Agent Jim Walker

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
MAR 26 2019
S.C.V.W.D.
WELLS

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 2 of 2

DISTRICT WELL PERMIT NO.: C20190326001

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NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted
☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan **must** be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
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Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

Please see Attached addendum for zone #4.
Disregard per A phone conversation with Alexis, 4/8/19

Community Projects Review Unit Approval (if needed):

CPRU Permit No.:

Approved by: Alexis Shields

Date: 3/26/2019

Please allow 10 working days to process this application.

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

ANNULAR SEAL REQUIREMENTS

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If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

Scale: 1 inch = 200 feet

Base Map Provided by: cbec, inc. eco engineering

Pacific Crest
ENGINEERING INC

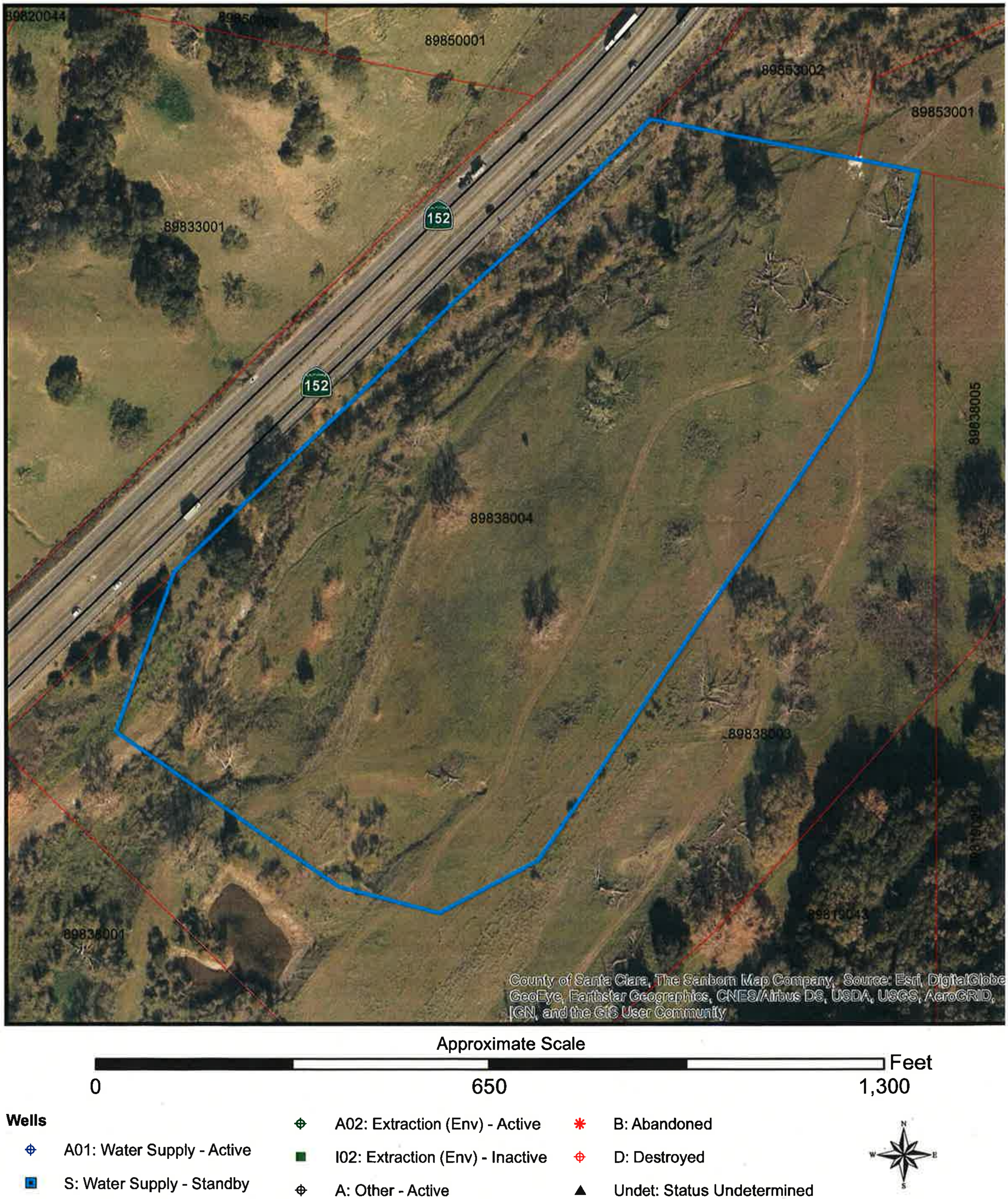
Site Map Showing Proposed Piezometer Locations - P-3 & P-4
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 1
Project No. PR 19-025
Date: 3/22/19

SANTA CLARA VALLEY HABITAT AGENCY

APN 898-38-007 (004)
12163 PACHECO PASS HIGHWAY
GILROY, CA 95020

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614



County of Santa Clara, The Sanborn Map Company, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No C20190326002	Date Issued: 3/26/2019	Well Registration No.:
Geologic Setting: 4	Expiration Date: 3/26/2020	Driller's Log No.:

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner: Santa Clara Valley Habitat Agency	Property Owner: Santa Clara Valley Habitat Agency	Name of Business at Well Site: Pacheco Creek Reserve
Well Owner's Mailing Address: 535 Alkire Avenue	Property Owner's Mailing Address 535 Alkire Avenue	Address of Well Site: 12163 Pacheco Pass Highway
City, State, Zip Morgan Hill, CA 95037	City, State, Zip Morgan Hill, CA 95037	City, State, Zip Gilroy, CA 95020
Telephone No. & Contact Name 669-253-6127 Gerry Haas	Telephone No. & Contact Name 669-253-6127 Gerry Haas	Telephone No.:

Owner's/Consultant's Well No.: P-4

Assessor's Parcel No. of Well Site Book 898 Page 38 Parcel 007 (004)

Consultant (Company): Pacific Crest Engineering Inc.	Drilling Company Exploration Geoservices Inc.	
Address: 444 Airport Boulevard Suite 106	Address 1535 Industrial Avenue	
City, State, Zip Watsonville, CA 95076	City, State, Zip San Jose, CA 95112	
Telephone No.: 831-722-9446	Telephone No.: 408-280-6822	C-57 License No.: 484288
☐ Check if address or phone number has changed	☐ Check if address or phone number has changed	

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No.: Pacheco Creek Restoration Project	Caseworker Name: N/A
Oversight Agency: Santa Clara Valley Habitat Agency	Caseworker Telephone No.: 408-779-7261

Signature of Responsible Professional

Date 3/22/19

Print Name Jim F. Walker

(No substitution of signature will be accepted)

62120 42120
Civil Engineer Registration No.

OR

Geologist Registration No.

Estimated Depth of Completed Well: ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other:

Well is to be constructed ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*

*See General Condition F, page 2

WELL TYPE/USE

☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
☐ Agricultural	☒ GW Level	☐ Air Sparge	☐ Permanent	☐ Closed Loop	☐ Groundwater Cleanup Reinjection		
☐ Domestic	☐ GW Quality	☐ GW Extraction	☐ Temporary	☐ Open Loop	☐ Stormwater		
☐ Industrial	☐ Inclinometer	☐ Material Emplacement			☐ Water Supply Recharge		
☐ Municipal	☐ Vapor	☐ Vapor Extraction			☐ Other		
	☐ Other	☐ Other					

Other wells exist on this property? ☒ Yes ☐ No If yes, status ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90-1, the District Well Standards, and the conditions of this permit (see page 2). I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable. I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ. I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application.

Signature of Property Owner/Agent:	Date: 3/21/19	Print Name of Property Owner/Agent: Gerry Haas
Signature of Well Owner/Agent:	Date: 3/21/19	Print Name of Well Owner/Agent: Gerry Haas
Signature of Well Driller/Agent:	Date: 3/22/2019	Print Name of Driller/Agent: John Collins
Signature of Consultant/Agent:	Date: 3/22/19	Print Name of Consultant/Agent: Jim Walker

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
MAR 26 2019
S.C.V.W.D.
WELLS

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 2 of 2

DISTRICT WELL PERMIT NO.: C20190326002

Based on information on this application and attachment(s) hereto (if any) and subject to approval noted below, permission is hereby granted to construct (drill) the described well. Permission to start work may be withheld until a field check verifies all statements made on application by permittee and is also subject to the "General" and "Special" Conditions stated below.

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH APPROVAL (Water Supply Well Only)

NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted
☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan **must** be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
2. North arrow and scale
3. Location of proposed well with dimensions in feet from well to nearest cross streets.

GENERAL CONDITIONS

A. **District** (telephone 408-265-2607, ext. 2660) **must be notified a minimum of one working day before construction of the annular seal**. An authorized District representative must be on site to witness the construction of the annular seal. This requirement may be waived by an authorized District representative. If the District waives the inspection requirement, the District may request the permittee(s) to furnish certification, under penalty of perjury, that the well was constructed in accordance with the District Well Standards and with the permit conditions.

B. Permittee agrees to construct, operate, and maintain the well according to provisions of the latest District Ordinance and the latest published revisions of District Well Standards to the end that this well will not cause pollution or contamination of groundwater or otherwise jeopardize the health, safety, or welfare of the people of the District.

C. This permit is valid only for the purpose specified herein. Well construction methods authorized under this permit may not be changed except by written approval of an authorized District representative, and only if the District believes that such a change will result in equal or superior compliance with the District and State Well Standards (e.g., if the District representative finds that site conditions warrant such a change).

D. This permit is only valid for the Assessor's Parcel No. indicated on it.

E. This permit may be voided if it contains incorrect information. If the permit is voided after work has begun, the well or boring that was constructed under this permit must be destroyed in accordance with District and State Well Standards.

F. If any work associated with this permit will take place on District property/easement, an encroachment or construction permit must be granted by the District's Community Projects Review Unit (telephone 408-265-2607, ext. 2589).

G. Before the well constructed under this permit can be used as a drinking water source, its use must be approved by the regulatory agency with authority over such use (typically the Santa Clara County Department of Environmental Health or the State of California Department of Public Health). A completed Well Inventory Form must also be approved.

H. If the well constructed under this permit cannot be or is not being used for its intended purpose, permittee is hereby required to destroy the well according to the District Well Standards and under permit from the District. Any test holes drilled under this permit must be destroyed within 24 hours of completion of testing activities. Destruction activities must be completed according to District standards. District must be notified a minimum of 24 hours prior to destruction.

I. Within 30 days of the completion of the well construction activities, the driller or consultant identified on this permit shall fully complete State of California DWR Form 188 and mail the original to the District's Wells and Water Production Unit.

J. The permittee(s) shall assume entire responsibility for all activities and uses under this permit and shall indemnify, defend, and hold the District, its officers, agents, and employees, free and harmless from any and all expense, cost, and liability in connection with or resulting from the granting or exercise of this permit including, but not limited to, property damage, personal injury, and wrongful death.

K. Permittees are required to be in full compliance with Cal/OSHA California Labor Code Section 6300.

L. A current C-57 Water Well Drilling Contractor's License is required for the construction of all wells.

M. Permittee, permittee's contractors, consultants, or agents shall be responsible to assure that all materials or waters generated during drilling, well construction, well development, pump testing, or other activities associated with this permit will be safely handled, properly managed, and disposed of according to all applicable federal, state, and local statutes regulating such. In no case shall these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed.

N. The driller and consultants (if applicable) shall have an active copy of their Worker's Compensation Insurance on file with District.

O. This permit shall expire if not exercised within 180 calendar days of its approval, unless an extension of the permit expiration date is granted by an authorized District representative.

P. This permit must be kept on site during all activities associated with it and shall immediately be presented to an authorized District representative upon request.

Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

~~Please see attached addendum for zone #4~~

Disregard per phone conversation with Alexis, 4/8/19

Community Projects Review Unit Approval (if needed):

CPRU Permit No.:

Approved by:

Date: 3/26/2019

Please allow 10 working days to process this application.

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

ANNULAR SEAL REQUIREMENTS

All wells constructed in Zone 4 must have an annular seal at least 50 feet deep with a radial thickness of at least 2 inches. Other seal requirements may be required by the District based on site specific or regional conditions.

If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

Scale: 1 inch = 200 feet

Base Map Provided by: cbec, inc. eco engineering

Pacific Crest
ENGINEERING INC

Site Map Showing Proposed Piezometer Locations - P-3 & P-4
Pacheco Creek Restoration Project
Santa Clara County, California

Figure No. 1
Project No. PR 19-025
Date: 3/22/19

SANTA CLARA VALLEY HABITAT AGENCY

APN 898-38-007 (004)
12163 PACHECO PASS HIGHWAY
GILROY, CA 95020

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614

County of Santa Clara, The Sanborn Map Company, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Approximate Scale

0 — 650 — 1,300 Feet

Wells

- ⊕ A01: Water Supply - Active
- ■ S: Water Supply - Standby
- ⊕ A02: Extraction (Env) - Active
- ■ I02: Extraction (Env) - Inactive
- ⊕ A: Other - Active
- ✱ B: Abandoned
- ⊕ D: Destroyed
- ▲ Undet: Status Undetermined

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No. C201905l3004
Geologic Setting: 4
Date Issued 5/13/19
Expiration Date 5/13/20
Well Registration No
Driller's Log No

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner: Santa Clara Valley Habitat Agency
Well Owner's Mailing Address: 535 Alkire Avenue
City, State, Zip: Morgan Hill, CA 95037
Telephone No & Contact Name: 669-253-6127 Gerry Haas

Property Owner: Peter Ciraulo
Property Owner's Mailing Address: ~~14610 Pacheco Pass Highway~~ PO Box 2416
City, State, Zip: Gilroy, CA ~~95020~~ 95021
Telephone No & Contact Name: 408-461-0239 Peter Ciraulo

Name of Business at Well Site: N/A
Address of Well Site: 14610 Pacheco Pass Highway
City, State, Zip: Gilroy, CA 95020
Telephone No: 408-461-0239

Owner's/Consultant's Well No: P-5
Assessor's Parcel No. of Well Site: Book 898 Page 53 Parcel 002

Consultant (Company): Pacific Crest Engineering Inc.
Address: 444 Airport Boulevard Suite 106
City, State, Zip: Watsonville, CA 95076
Telephone No: 831-722-9446
☐ Check if address or phone number has changed

Drilling Company: Exploration Geoservices Inc
Address: 1535 Industrial Avenue
City, State, Zip: San Jose, CA 95112
Telephone No: 408-280-6822
C-57 License No: 484288
☐ Check if address or phone number has changed

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No.: Pacheco Creek Restoration Project
Oversight Agency: Santa Clara Valley Habitat Agency
Caseworker Name: N/A
Caseworker Telephone No: 408-779-7261

Signature of Responsible Professional
Date
Print Name: Jim F. Walker
(No substitution of signature will be accepted)

Civil Engineer Registration No: 62120
OR
Geologist Registration No

Estimated Depth of Completed Well: ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other
Well is to be constructed: ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*
*See General Condition F, page 2

WELL TYPE/USE

☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
☐ Agricultural ☐ Domestic ☐ Industrial ☐ Municipal	☒ GW Level ☐ GW Quality ☐ Inclinometer ☐ Vapor ☐ Other	☐ Air Sparge ☐ GW Extraction ☐ Material Emplacement ☐ Vapor Extraction ☐ Other	☐ Permanent ☐ Temporary	☐ Closed Loop ☐ Open Loop	☐ Groundwater Cleanup Reinjection ☐ Stormwater ☐ Water Supply Recharge ☐ Other		

Other wells exist on this property? ☒ Yes ☐ No If yes, status: ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90-1, the District Well Standards, and the conditions of this permit (see page 2). I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable. I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ. I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application.

Signature of Property Owner/Agent — Date 05/01/19 — Print Name of Property Owner/Agent: Peter Ciraulo - See ATTACHMENT
Signature of Well Owner/Agent — Date 5/01/19 — Print Name of Well Owner/Agent: Gerry Haas
Signature of Well Driller/Agent — Date 5/1/2019 — Print Name of Driller/Agent: John Collins
Signature of Consultant/Agent — Date — Print Name of Consultant/Agent: Jim Walker

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
MAY 09 2019
S.C.V.W.
WELLS

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 2 of 2

DISTRICT WELL PERMIT NO.: C20190513004

Based on information on this application and attachment(s) hereto (if any) and subject to approval noted below, permission is hereby granted to construct (drill) the described well. Permission to start work may be withheld until a field check verifies all statements made on application by permittee and is also subject to the "General" and "Special" Conditions stated below.

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH APPROVAL (Water Supply Well Only)

NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted
☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan must be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
2. North arrow and scale
3. Location of proposed well with dimensions in feet from well to nearest cross streets.

GENERAL CONDITIONS

A. **District** (telephone 408-265-2607, ext. 2660) **must be notified a minimum of one working day before construction of the annular seal.** An authorized District representative must be on site to witness the construction of the annular seal. This requirement may be waived by an authorized District representative. If the District waives the inspection requirement, the District may request the permittee(s) to furnish certification, under penalty of perjury, that the well was constructed in accordance with the District Well Standards and with the permit conditions.

B. Permittee agrees to construct, operate, and maintain the well according to provisions of the latest District Ordinance and the latest published revisions of District Well Standards to the end that this well will not cause pollution or contamination of groundwater or otherwise jeopardize the health, safety, or welfare of the people of the District.

C. This permit is valid only for the purpose specified herein. Well construction methods authorized under this permit may not be changed except by written approval of an authorized District representative, and only if the District believes that such a change will result in equal or superior compliance with the District and State Well Standards (e.g., if the District representative finds that site conditions warrant such a change).

D. This permit is only valid for the Assessor's Parcel No. indicated on it.

E. This permit may be voided if it contains incorrect information. If the permit is voided after work has begun, the well or boring that was constructed under this permit must be destroyed in accordance with District and State Well Standards.

F. If any work associated with this permit will take place on District property/easement, an encroachment or construction permit must be granted by the District's Community Projects Review Unit (telephone 408-265-2607, ext. 2589).

G. Before the well constructed under this permit can be used as a drinking water source, its use must be approved by the regulatory agency with authority over such use (typically the Santa Clara County Department of Environmental Health or the State of California Department of Public Health). A completed Well Inventory Form must also be approved.

H. If the well constructed under this permit cannot be or is not being used for its intended purpose, permittee is hereby required to destroy the well according to the District Well Standards and under permit from the District. Any test holes drilled under this permit must be destroyed within 24 hours of completion of testing activities. Destruction activities must be completed according to District standards. District must be notified a minimum of 24 hours prior to destruction.

I. Within 30 days of the completion of the well construction activities, the driller or consultant identified on this permit shall fully complete State of California DWR Form 188 and mail the original to the District's Wells and Water Production Unit.

J. The permittee(s) shall assume entire responsibility for all activities and uses under this permit and shall indemnify, defend, and hold the District, its officers, agents, and employees, free and harmless from any and all expense, cost, and liability in connection with or resulting from the granting or exercise of this permit including, but not limited to, property damage, personal injury, and wrongful death.

K. Permittees are required to be in full compliance with Cal/OSHA California Labor Code Section 6300.

L. A current C-57 Water Well Drilling Contractor's License is required for the construction of all wells.

M. Permittee, permittee's contractors, consultants, or agents shall be responsible to assure that all materials or waters generated during drilling, well construction, well development, pump testing, or other activities associated with this permit will be safely handled, properly managed, and disposed of according to all applicable federal, state, and local statutes regulating such. In no case shall these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed.

N. The driller and consultants (if applicable) shall have an active copy of their Worker's Compensation Insurance on file with District.

O. This permit shall expire if not exercised within 180 calendar days of its approval, unless an extension of the permit expiration date is granted by an authorized District representative.

P. This permit must be kept on site during all activities associated with it and shall immediately be presented to an authorized District representative upon request.

Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

Community Projects Review Unit Approval (if needed):

CPRU Permit No.:

Approved by:

Date: 5/13/19

Please allow 10 working days to process this application.

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

ANNULAR SEAL REQUIREMENTS

All wells constructed in Zone 4 must have an annular seal at least 50 feet deep with a radial thickness of at least 2 inches. Other seal requirements may be required by the District based on site specific or regional conditions.

If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

Attachment to Well Construction Application

Property Owner: Peter Ciraulo
Owner's/Consultant's Well No.: P-5
Assessor's Parcel No. of Well Site: Book 898 Page 53 Parcel 002

Pete Ciraulo, property owner, Agreement to this permit and right of entry/encroachment is with the understanding with Edmund Sullivan that the Santa Clara County Habitat Agency will be purchasing the property and with that understanding is signing the consent forms.

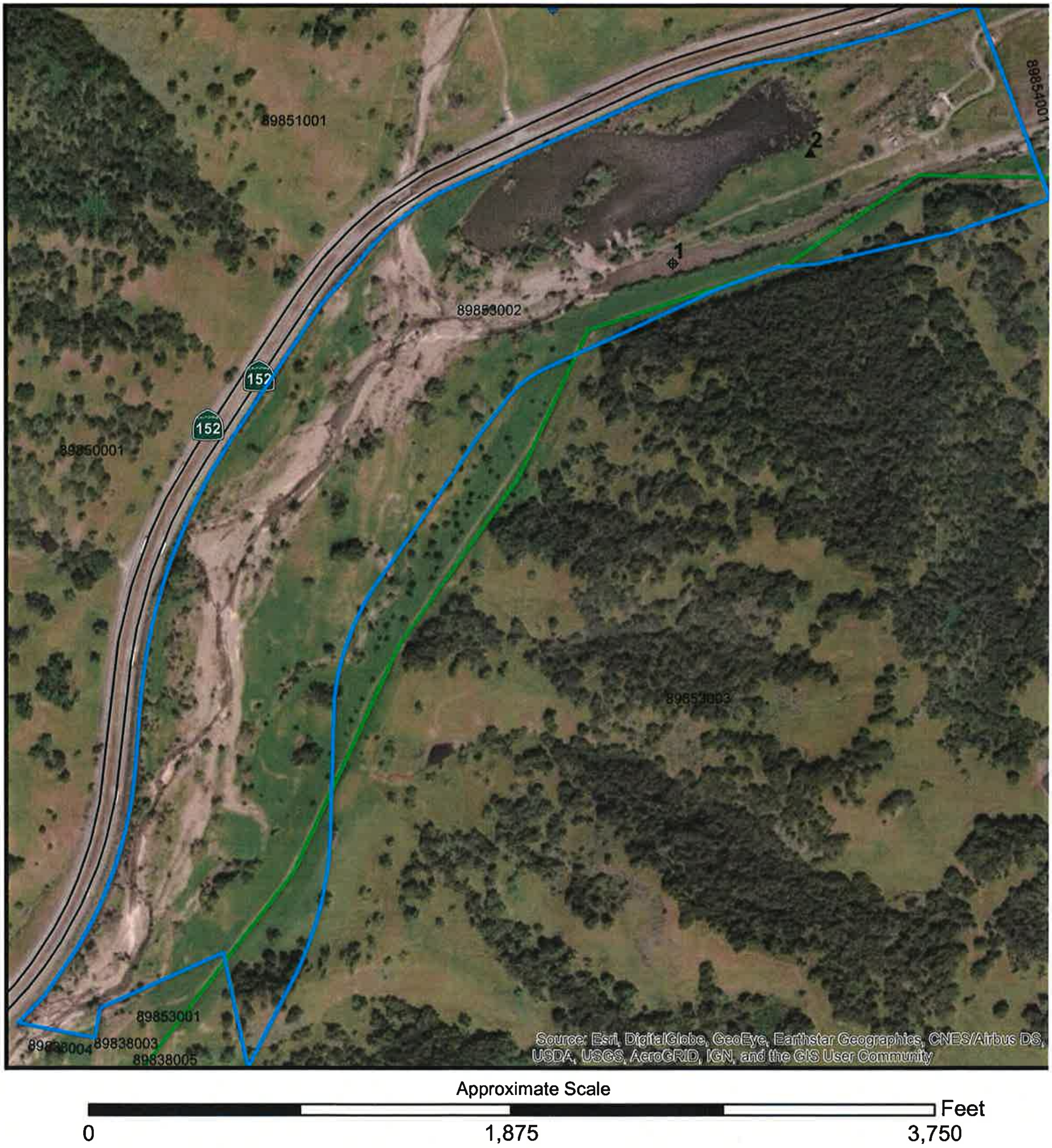
Given the fact that the Habitat Agency will be the sole owner of the property Pete Ciraulo is signing the consent form with no contingencies.

If the sale of the property does not take place per the agreement and in a reasonable amount of time, Peter Ciraulo and/or Karen Ciraulo has the right to terminate the permit and right of entry/encroachment.

Dated May 1, 2019

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614

APN 898-53-002
14610 PACHECO PASS HIGHWAY
GILROY, CA 95020



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Wells

- ⊕ A01: Water Supply - Active
- ■ S: Water Supply - Standby
- ⊕ A02: Extraction (Env) - Active
- ■ I02: Extraction (Env) - Inactive
- ⊕ A: Other - Active
- ✱ B: Abandoned
- ⊕ D: Destroyed
- ▲ Undet: Status Undetermined

ID	CONSULTANT	PERMIT	WELLID	WELLSTATUS
1	VAULT #26	C20170726003-1	10S06E28P001	A
2		NO PERMIT111		Undet

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No C201905130003
Geologic Setting 4
Date Issued 5/13/19
Expiration Date 5/13/20
Well Registration No
Driller's Log No :

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner: Santa Clara Valley Habitat Agency
Well Owner's Mailing Address: 535 Alkire Avenue
City, State, Zip Morgan Hill, CA 95037
Telephone No & Contact Name 669-253-6127 Gerry Haas

Property Owner Peter Ciraulo
Property Owner's Mailing Address ~~14610 Pacheco Pass Highway~~ PO Box 2465
City, State, Zip Gilroy, CA ~~95020~~ 95021
Telephone No & Contact Name: 408-461-0239 Peter Ciraulo

Name of Business at Well Site N/A
Address of Well Site 14610 Pacheco Pass Highway
City, State, Zip Gilroy, CA 95020
Telephone No 408-461 0239

Owner's/Consultant's Well No.: P-6
Assessor's Parcel No. of Well Site Book 898 Page 53 Parcel 002

Consultant (Company) Pacific Crest Engineering Inc
Address: 444 Airport Boulevard Suite 106
City, State, Zip Watsonville, CA 95076
Telephone No : 831-722-9446
☐ Check if address or phone number has changed

Drilling Company Exploration Geoservices Inc
Address, 1535 Industrial Avenue
City, State, Zip San Jose, CA 95112
Telephone No. 408-280-6822
C-57 License No 484288
☐ Check if address or phone number has changed

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No Pacheco Creek Restoration Project
Oversight Agency Santa Clara Valley Habitat Agency
Caseworker Name N/A
Caseworker Telephone No 408 779 7261

Signature of Responsible Professional
Date
Print Name Jim F. Walker
(No substitution of signature will be accepted)

Civil Engineer Registration No 62120
OR
Geologist Registration No

Estimated Depth of Completed Well ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other

Well is to be constructed: ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*

*See General Condition F, page 2

WELL TYPE/USE

☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
☐ Agricultural	☒ GW Level	☐ Air Sparge	☐ Permanent	☐ Closed Loop	☐ Groundwater Cleanup Reinjection		
☐ Domestic	☐ GW Quality	☐ GW Extraction	☐ Temporary	☐ Open Loop	☐ Stormwater		
☐ Industrial	☐ Inclinometer	☐ Material Emplacement			☐ Water Supply Recharge		
☐ Municipal	☐ Vapor	☐ Vapor Extraction			☐ Other		
	☐ Other	☐ Other					

Other wells exist on this property? ☒ Yes ☐ No If yes, status: ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90 1, the District Well Standards, and the conditions of this permit (see page 2) I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application

Signature of Property Owner/Agent	Date 05/01/19	Print Name of Property Owner/Agent Peter Ciraulo - See ATTACHMENT
Signature of Well Owner/Agent	Date 5/01/19	Print Name of Well Owner/Agent Gerry Haas
Signature of Well Driller/Agent	Date 5/1/2019	Print Name of Driller/Agent John Collins
Signature of Consultant/Agent	Date	Print Name of Consultant/Agent Jim Walker

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
S.C.V.W.D.
WELLS

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 2 of 2

DISTRICT WELL PERMIT NO. C20190513003

Based on information on this application and attachment(s) hereto (if any) and subject to approval noted below, permission is hereby granted to construct (drill) the described well. Permission to start work may be withheld until a field check verifies all statements made on application by permittee and is also subject to the "General" and "Special" Conditions stated below.

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH APPROVAL (Water Supply Well Only)

NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted
☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan must be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
2. North arrow and scale
3. Location of proposed well with dimensions in feet from well to nearest cross streets

GENERAL CONDITIONS

A. **District (telephone 408-265-2607, ext. 2660) must be notified a minimum of one working day before construction of the annular seal.** An authorized District representative must be on site to witness the construction of the annular seal. This requirement may be waived by an authorized District representative. If the District waives the inspection requirement, the District may request the permittee(s) to furnish certification, under penalty of perjury, that the well was constructed in accordance with the District Well Standards and with the permit conditions.

B. Permittee agrees to construct, operate, and maintain the well according to provisions of the latest District Ordinance and the latest published revisions of District Well Standards to the end that this well will not cause pollution or contamination of groundwater or otherwise jeopardize the health, safety, or welfare of the people of the District.

C. This permit is valid only for the purpose specified herein. Well construction methods authorized under this permit may not be changed except by written approval of an authorized District representative, and only if the District believes that such a change will result in equal or superior compliance with the District and State Well Standards (e.g., if the District representative finds that site conditions warrant such a change).

D. This permit is only valid for the Assessor's Parcel No. indicated on it.

E. This permit may be voided if it contains incorrect information. If the permit is voided after work has begun, the well or boring that was constructed under this permit must be destroyed in accordance with District and State Well Standards.

F. If any work associated with this permit will take place on District property/easement, an encroachment or construction permit must be granted by the District's Community Projects Review Unit (telephone 408-265-2607, ext. 2589)

G. Before the well constructed under this permit can be used as a drinking water source, its use must be approved by the regulatory agency with authority over such use (typically the Santa Clara County Department of Environmental Health or the State of California Department of Public Health). A completed Well Inventory Form must also be approved.

H. If the well constructed under this permit cannot be or is not being used for its intended purpose, permittee is hereby required to destroy the well according to the District Well Standards and under permit from the District. Any test holes drilled under this permit must be destroyed within 24 hours of completion of testing activities. Destruction activities must be completed according to District standards. District must be notified a minimum of 24 hours prior to destruction.

I. Within 30 days of the completion of the well construction activities, the driller or consultant identified on this permit shall fully complete State of California DWR Form 188 and mail the original to the District's Wells and Water Production Unit.

J. The permittee(s) shall assume entire responsibility for all activities and uses under this permit and shall indemnify, defend, and hold the District, its officers, agents, and employees, free and harmless from any and all expense, cost, and liability in connection with or resulting from the granting or exercise of this permit including, but not limited to, property damage, personal injury, and wrongful death.

K. Permittees are required to be in full compliance with Cal/OSHA California Labor Code Section 6300

L. A current C-57 Water Well Drilling Contractor's License is required for the construction of all wells.

M. Permittee, permittee's contractors, consultants, or agents shall be responsible to assure that all materials or waters generated during drilling, well construction, well development, pump testing, or other activities associated with this permit will be safely handled, properly managed, and disposed of according to all applicable federal, state, and local statutes regulating such. In no case shall these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed.

N. The driller and consultants (if applicable) shall have an active copy of their Worker's Compensation Insurance on file with District.

O. This permit shall expire if not exercised within 180 calendar days of its approval, unless an extension of the permit expiration date is granted by an authorized District representative.

P. This permit must be kept on site during all activities associated with it and shall immediately be presented to an authorized District representative upon request.

Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

Community Projects Review Unit Approval (if needed):

CPRU Permit No.:

Approved by:

Date: 5/13/19

Please allow 10 working days to process this application.

Attachment to Well Construction Application

Property Owner: Peter Ciraulo
Owner's/Consultant's Well No.: P-6
Assessor's Parcel No. of Well Site: Book 898 Page 53 Parcel 002

Pete Ciraulo, property owner, Agreement to this permit and right of entry/encroachment is with the understanding with Edmund Sullivan that the Santa Clara County Habitat Agency will be purchasing the property and with that understanding is signing the consent forms.

Given the fact that the Habitat Agency will be the sole owner of the property Pete Ciraulo is signing the consent form with no contingencies.

If the sale of the property does not take place per the agreement and in a reasonable amount of time, Peter Ciraulo and/or Karen Ciraulo has the right to terminate the permit and right of entry/encroachment.

Dated May 1, 2019

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

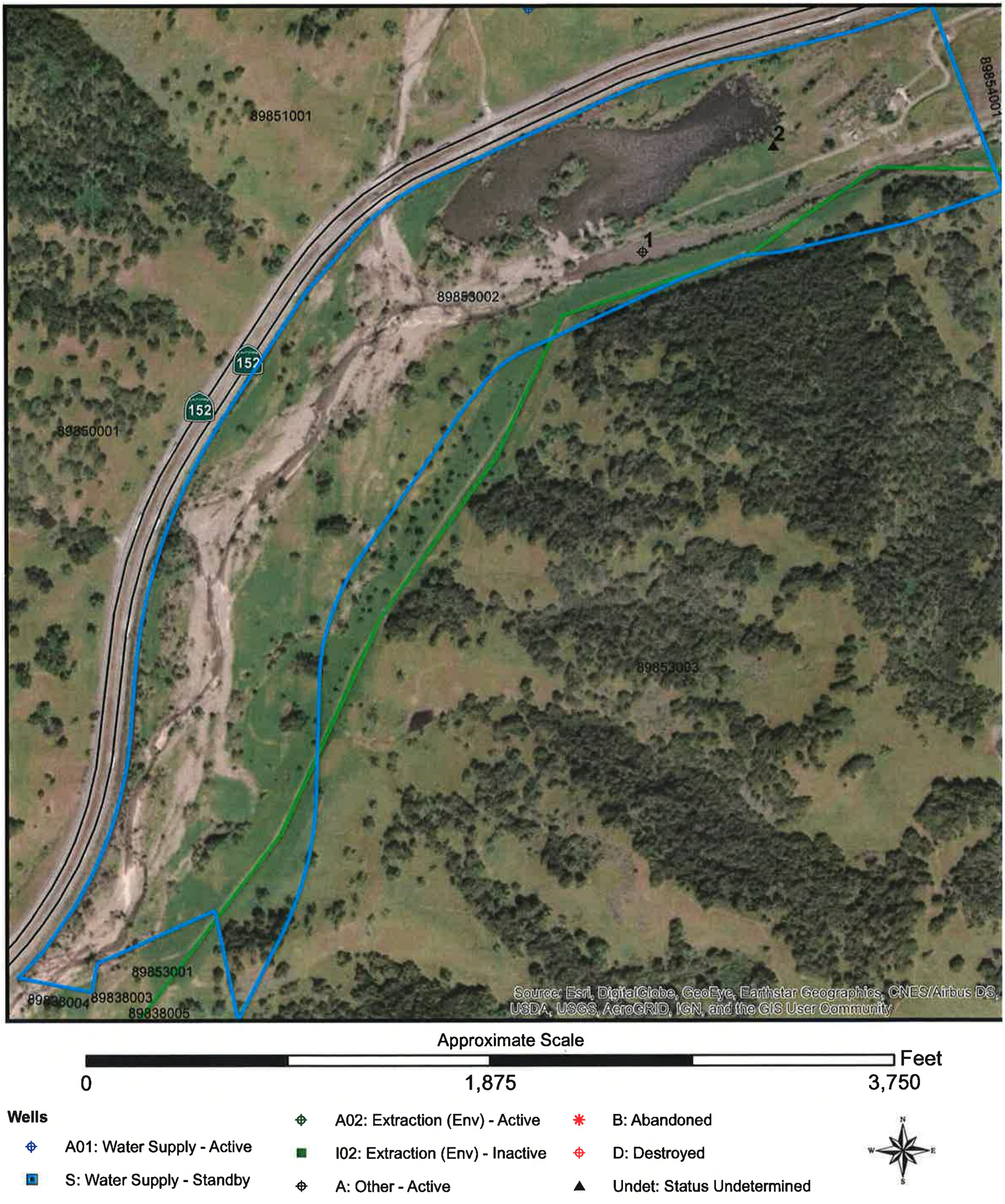
ANNULAR SEAL REQUIREMENTS

All wells constructed in Zone 4 must have an annular seal at least 50 feet deep with a radial thickness of at least 2 inches. Other seal requirements may be required by the District based on site specific or regional conditions.

If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

APN 898-53-002
14610 PACHECO PASS HIGHWAY
GILROY, CA 95020

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ID	CONSULTANT	PERMIT	WELLID	WELLSTATUS
1	VAULT #26	C20170726003-1	10S06E28P001	A
2		NO PERMIT111		Undet

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 1 of 2

TO BE COMPLETED BY DISTRICT

District Permit No C201905130002
Geologic Setting 4
Date Issued 5/13/19
Expiration Date 5/13/20
Well Registration No
Driller's Log No

TO BE COMPLETED BY OWNER AND DRILLER

Well Owner
Santa Clara Valley Habitat Agency
Well Owner's Mailing Address
535 Alkire Avenue
City, State, Zip
Morgan Hill, CA 95037
Telephone No & Contact Name
669 253-6127 Gerry Haas

Property Owner
Peter Ciraulo
Property Owner's Mailing Address
~~14610 Pacheco Pass Highway~~ PO Box 2465
City, State, Zip
Gilroy CA ~~[illegible]~~ 95021
Telephone No & Contact Name
408-461 0239 Peter Ciraulo

Name of Business at Well Site
N/A
Address of Well Site
14610 Pacheco Pass Highway
City State Zip
Gilroy, CA 95020
Telephone No
408 461 0239

Owner's/Consultant's Well No P-7
Assessor's Parcel No of Well Site Book 898 Page 53 Parcel 002

Consultant (Company)
Pacific Crest Engineering Inc
Address
444 Airport Boulevard Suite 106
City, State, Zip Watsonville, CA 95076
Telephone No
831-722-9446
☐ Check if address or phone number has changed

Drilling Company
Exploration Geoservices Inc
Address
1535 Industrial Avenue
City, State, Zip San Jose, CA 95112
Telephone No
408-280-6822
C-57 License No
484288
☐ Check if address or phone number has changed

THIS SECTION TO BE COMPLETED FOR ALL MONITORING WELLS OR EXTRACTION/RECOVERY WELLS

Case Name/No Pacheco Creek Restoration Project
Oversight Agency Santa Clara Valley Habitat Agency
Caseworker Name N/A
Caseworker Telephone No 408-779-7261

Signature of Responsible Professional
Date
Jim P Walker
Print Name
(No substitution of signature will be accepted)

62160
Civil Engineer Registration No
OR
Geologist Registration No

Estimated Depth of Completed Well ☒ Less than 50 feet ☐ 50 to 300 feet ☐ Over 300 feet ☐ Other

Well is to be constructed ☐ In a public sidewalk ☐ In a public road ☐ On public property ☒ On private property ☐ On District property/easement*

*See General Condition F, page 2

WELL TYPE/USE

☐ WATER PRODUCTION	☒ MONITORING	☐ REMEDIATION	☐ DEWATERING	☐ HEAT EXCHANGE	☐ INJECTION	☐ CATHODIC PROTECTION	☐ OTHER
☐ Agricultural	☒ GW Level	☐ Air Sparge	☐ Permanent	☐ Closed Loop	☐ Groundwater Cleanup Reinjection		
☐ Domestic	☐ GW Quality	☐ GW Extraction	☐ Temporary	☐ Open Loop	☐ Stormwater		
☐ Industrial	☐ Inclinometer	☐ Material Emplacement			☐ Water Supply Recharge		
☐ Municipal	☐ Vapor	☐ Vapor Extraction			☐ Other		
	☐ Other	☐ Other					

Other wells exist on this property? ☒ Yes ☐ No If yes, status ☒ Active ☐ Inactive ☐ Abandoned

SIGNATURES

I understand and agree that all work associated with this permit is required to be done in accordance with Santa Clara Valley Water District (District) Well Ordinance 90-1, the District Well Standards, and the conditions of this permit (see page 2). I certify that the information given in this permit is correct to the best of my knowledge and that the signature below, whether original, electronic, or photocopied, is authorized and valid, and is affixed with the intent to be enforceable. I also certify that a right of entry/encroachment agreement has been formalized between the well owner and property owner, if parties differ. I also understand that it is my responsibility, as the well owner, to notify the District of any changes in the purpose of this well, from which, is indicated on this application.

Signature of Property Owner/Agent Date 05/01/19
Print Name of Property Owner/Agent
Peter Ciraulo - See Attachment

Signature of Well Owner/Agent Date 5/01/19
Print Name of Well Owner/Agent
Gerry Haas

Signature of Well Driller/Agent Date 5/1/2019
Print Name of Driller/Agent
John Collins

Signature of Consultant/Agent Date
Print Name of Consultant/Agent
Jim Walker

IMPORTANT: A minimum 24-hour notice must be given to Santa Clara Valley Water District Well Inspection Department prior to installing the annular seal. Call (408) 265-2607, ext. 2660. Please allow 10 working days to process permit application.

RECEIVED
MAY 09 2019
S.C.V.W.D.
WELLS

Santa Clara Valley Water District

5750 Almaden Expressway
San Jose, CA 95118-3686
(408) 265-2600

WELL CONSTRUCTION APPLICATION

FC 158 (03-26-15)
Page 2 of 2

DISTRICT WELL PERMIT NO.: C201905l3002

Based on information on this application and attachment(s) hereto (if any) and subject to approval noted below, permission is hereby granted to construct (drill) the described well. Permission to start work may be withheld until a field check verifies all statements made on application by permittee and is also subject to the "General" and "Special" Conditions stated below.

SANTA CLARA COUNTY DEPARTMENT OF ENVIRONMENTAL HEALTH APPROVAL (Water Supply Well Only)

NOTE: Department of Environmental Health approval must be granted before this application will be accepted by Santa Clara Valley Water District.

Approved by: , R.E.H.S

☐ Approved as submitted
☐ Approved as corrected

Date:

SITE PLAN

A 8½" x 11" paper site plan must be attached to this application, including:

1. Location of site features, including major buildings, landscaped areas, tank fields, existing wells, etc.
2. North arrow and scale
3. Location of proposed well with dimensions in feet from well to nearest cross streets

GENERAL CONDITIONS

A. **District (telephone 408-265-2607, ext. 2660) must be notified a minimum of one working day before construction of the annular seal.** An authorized District representative must be on site to witness the construction of the annular seal. This requirement may be waived by an authorized District representative. If the District waives the inspection requirement, the District may request the permittee(s) to furnish certification, under penalty of perjury, that the well was constructed in accordance with the District Well Standards and with the permit conditions.

B. Permittee agrees to construct, operate, and maintain the well according to provisions of the latest District Ordinance and the latest published revisions of District Well Standards to the end that this well will not cause pollution or contamination of groundwater or otherwise jeopardize the health, safety, or welfare of the people of the District.

C. This permit is valid only for the purpose specified herein. Well construction methods authorized under this permit may not be changed except by written approval of an authorized District representative, and only if the District believes that such a change will result in equal or superior compliance with the District and State Well Standards (e.g., if the District representative finds that site conditions warrant such a change).

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E. This permit may be voided if it contains incorrect information. If the permit is voided after work has begun, the well or boring that was constructed under this permit must be destroyed in accordance with District and State Well Standards.

F. If any work associated with this permit will take place on District property/easement, an encroachment or construction permit must be granted by the District's Community Projects Review Unit (telephone 408-265-2607, ext. 2589).

G. Before the well constructed under this permit can be used as a drinking water source, its use must be approved by the regulatory agency with authority over such use (typically the Santa Clara County Department of Environmental Health or the State of California Department of Public Health). A completed Well Inventory Form must also be approved.

H. If the well constructed under this permit cannot be or is not being used for its intended purpose, permittee is hereby required to destroy the well according to the District Well Standards and under permit from the District. Any test holes drilled under this permit must be destroyed within 24 hours of completion of testing activities. Destruction activities must be completed according to District standards. District must be notified a minimum of 24 hours prior to destruction.

I. Within 30 days of the completion of the well construction activities, the driller or consultant identified on this permit shall fully complete State of California DWR Form 188 and mail the original to the District's Wells and Water Production Unit.

J. The permittee(s) shall assume entire responsibility for all activities and uses under this permit and shall indemnify, defend, and hold the District, its officers, agents, and employees, free and harmless from any and all expense, cost, and liability in connection with or resulting from the granting or exercise of this permit including, but not limited to, property damage, personal injury, and wrongful death.

K. Permittees are required to be in full compliance with Cal/OSHA California Labor Code Section 6300.

L. A current C-57 Water Well Drilling Contractor's License is required for the construction of all wells.

M. Permittee, permittee's contractors, consultants, or agents shall be responsible to assure that all materials or waters generated during drilling, well construction, well development, pump testing, or other activities associated with this permit will be safely handled, properly managed, and disposed of according to all applicable federal, state, and local statutes regulating such. In no case shall these materials and/or waters be allowed to enter, or potentially enter, on- or off-site storm sewers, dry wells, or waterways. Such materials/waters must not be allowed to move off the property where the work is being completed.

N. The driller and consultants (if applicable) shall have an active copy of their Worker's Compensation Insurance on file with District.

O. This permit shall expire if not exercised within 180 calendar days of its approval, unless an extension of the permit expiration date is granted by an authorized District representative.

P. This permit must be kept on site during all activities associated with it and shall immediately be presented to an authorized District representative upon request.

Q. Permittee shall notify Underground Service Alert (USA) at 1-800-227-2600 or 811 prior to any digging.

SPECIAL CONDITIONS

Community Projects Review Unit Approval (if needed)

CPRU Permit No.

Approved by:

Date: 5/13/19

Please allow 10 working days to process this application.

SANTA CLARA VALLEY WATER DISTRICT

WELL CONSTRUCTION PERMIT ADDENDUM
FOR
GEOLOGIC ZONE 4
(Bedrock Areas of Santa Clara County)

The proposed well is located in Geologic Zone 4; the bedrock areas of Santa Clara County.

ANNULAR SEAL REQUIREMENTS

All wells constructed in Zone 4 must have an annular seal at least 50 feet deep with a radial thickness of at least 2 inches. Other seal requirements may be required by the District based on site specific or regional conditions.

If you have any questions about requirements in this permit addendum, please call the District's Well Ordinance Program at (408) 265-2607, extension 2660.

Attachment to Well Construction Application

Property Owner: Peter Ciraulo
Owner's/Consultant's Well No.: P-7
Assessor's Parcel No. of Well Site: Book 898 Page 53 Parcel 002

Pete Ciraulo, property owner, Agreement to this permit and right of entry/encroachment is with the understanding with Edmund Sullivan that the Santa Clara County Habitat Agency will be purchasing the property and with that understanding is signing the consent forms.

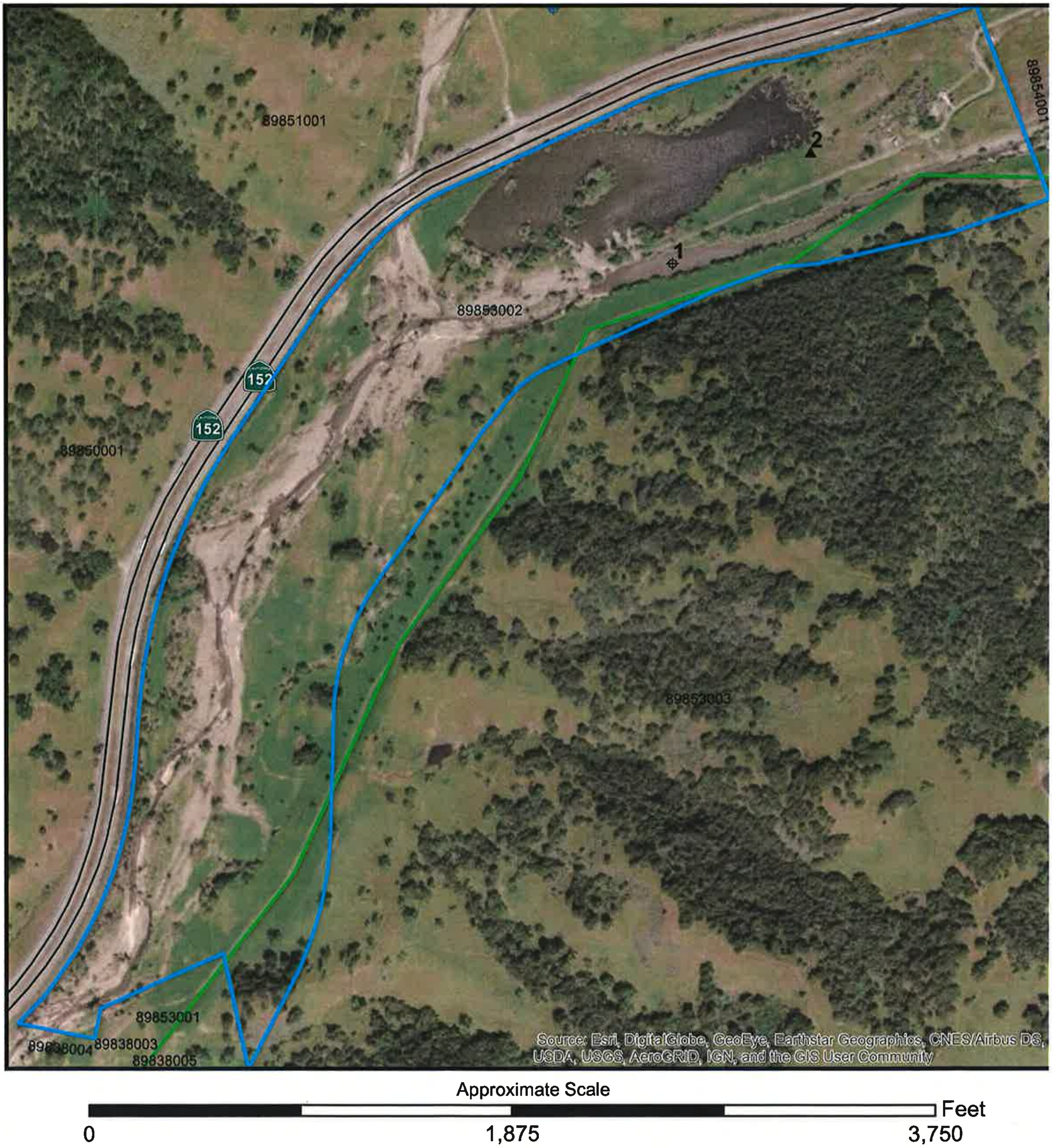
Given the fact that the Habitat Agency will be the sole owner of the property Pete Ciraulo is signing the consent form with no contingencies.

If the sale of the property does not take place per the agreement and in a reasonable amount of time, Peter Ciraulo and/or Karen Ciraulo has the right to terminate the permit and right of entry/encroachment.

Dated May 1, 2019

APN 898-53-002
14610 PACHECO PASS HIGHWAY
GILROY, CA 95020

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Wells

⊕ A01: Water Supply - Active

■ S: Water Supply - Standby

⊕ A02: Extraction (Env) - Active

■ I02: Extraction (Env) - Inactive

⊕ A: Other - Active

✱ B: Abandoned

⊕ D: Destroyed

▲ Undet: Status Undetermined

ID	CONSULTANT	PERMIT	WELLID	WELLSTATUS
1	VAULT #26	C20170726003-1	10S06E28P001	A
2		NO PERMIT111		Undet

State of California

Well Completion Report

Form DWR 188 Submitted 5/10/2019

WCR2019-006474

Owner's Well Number P-1
Date Work Began 04/10/2019
Date Work Ended 04/10/2019
Local Permit Agency Santa Clara Valley Water District
Secondary Permit Agency
Permit Number C20190326003
Permit Date 03/26/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,
Mailing Address 535 Alkire Avenue
City Morgan Hill
State CA
Zip 95037

Planned Use and Activity

Activity New Well
Planned Use Monitoring

Well Location

Address 12163 Pacheco Pass HWY
City Gilroy
Zip 95020
County Santa Clara

		Deg.	Min.	Sec.	
Latitude		37	0	56.1589	N
Longitude		-121	20	7.7177	W

Dec. Lat. 37.0155997
Dec. Long. -121.33547714
Vertical Datum
Horizontal Datum WGS84
Location Accuracy 2.5 Ft
Location Determination Method GPS
APN 89838006
Township 10 S
Range 06 E
Section 32
Baseline Meridian Mount Diablo
Ground Surface Elevation
Elevation Accuracy
Elevation Determination Method

Borehole Information

Orientation Vertical
Specify
Drilling Method Downhole Hammer
Drilling Fluid None
Total Depth of Boring 20 Feet
Total Depth of Completed Well 20 Feet

Water Level and Yield of Completed Well

Depth to first water 6.75 (Feet below surface)
Depth to Static Water Level (Feet)
Date Measured 04/10/2019
Estimated Yield* (GPM)
Test Type
Test Length (Hours)
Total Drawdown (feet)
*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	6	SAND WITH SILT (SP): Brown (7/5YR 4/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, poorly indurated, sub-angular to sub-rounded shaped gravels up to 1 inch in diameter, moist, medium dense.
6	13	SILTY GRAVEL WITH SAND: Yellowish brown (10YR 5/4), fine to very coarse grained, angular to rounded shaped quartz and sandstone sand, angular to well rounded shaped sandstone and quartz gravels up to 2 inches in diameter, wet, dense.
13	20	INTERBEDDED SILTY SAND WITH GRAVEL/SILTY GRAVEL WITH SAND (SM/GM): Yellowish brown (10YR 5/4), coarse to very coarse grained sand, angular to well rounded shaped sand and gravel, sandstone, quartz and chert rich, gravels up to 2 inches in diameter, fine to medium grained, CLAYEY SAND lens and 15 feet, CLAYEY SAND WITH GRAVEL lens from 19 1/2 to 20 feet, wet, very dense.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	20	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	4	Cement	Portland Cement/Neat Cement		
4	5	Bentonite	Other Bentonite		Hydrated 0.375 inch chips
5	20	Filter Pack	Other Gravel Pack	#3 Sand	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	20	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE — Address
SAN JOSE — City
CA — State
95112 — Zip

Signed *electronic signature received* — C-57 Licensed Water Well Contractor
05/10/2019 — Date Signed
484288 — C-57 License Number

Attachments

Fig. 2 - Well Construction Details P-1.pdf - Well Construction Diagram

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N

W

Latitude Deg/Min/Sec **Longitude Deg/Min/Sec**

TRS:

APN:

State of California

Well Completion Report

Form DWR 188 Submitted 5/10/2019

WCR2019-006476

Owner's Well Number P-2
Date Work Began 04/10/2019
Date Work Ended 04/10/2019
Local Permit Agency Santa Clara Valley Water District
Secondary Permit Agency
Permit Number C20190326004
Permit Date 03/26/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,
Mailing Address 535 Alkire Avenue
City Morgan Hill
State CA
Zip 95037

Planned Use and Activity

Activity New Well
Planned Use Monitoring

Well Location

Address 12163 Pacheco Pass HWY
City Gilroy
Zip 95020
County Santa Clara
Latitude 37 Deg. 0 Min. 53.8792 Sec. N
Longitude -121 Deg. 20 Min. 4.0472 Sec. W
Dec. Lat. 37.01496646
Dec. Long. -121.33445758
Vertical Datum
Horizontal Datum WGS84
Location Accuracy 2.5 Ft
Location Determination Method GPS
APN 89838006
Township 10 S
Range 06 E
Section 32
Baseline Meridian Mount Diablo
Ground Surface Elevation
Elevation Accuracy
Elevation Determination Method

Borehole Information

Orientation Vertical
Specify
Drilling Method Downhole Hammer
Drilling Fluid None
Total Depth of Boring 25 Feet
Total Depth of Completed Well 25 Feet

Water Level and Yield of Completed Well

Depth to first water 7.7 (Feet below surface)
Depth to Static Water Level (Feet)
Date Measured 04/10/2019
Estimated Yield* (GPM)
Test Type
Test Length (Hours)
Total Drawdown (feet)
*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	7	SILTY SAND (SM): Brown (10YR 4/3), very fine to fine grained, poorly graded, quartz rich, poorly indurated, trace sub-rounded shaped gravels up to 1/2 inch, slightly moist, loose.
7	19.5	SILTY GRAVEL WITH SAND/SILTY SAND WITH GRAVEL (GM/SM): Dark yellowish brown (10YR 4/4), angular to sub-rounded shaped, poorly graded, quartz and sandstone rich, coarse to very coarse grained sand, very fine to fine grained gravels, wet, medium dense.
19.5	23	SANDSTONE: Light olive brown (2.5Y 5/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, well cemented, moist to wet, very dense, (likely a boulder).
23	24.5	SAND (SP): Light olive brown (2.5Y 5/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, fine grained gravel lens at 24 feet, wet, very dense.
24.5	25	CLAYEY SAND (SC): Dark bluish gray (GLEY 2 4/5B), very fine to fine grained, poorly graded, quartz rich, poorly indurated, very moist, very dense.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	25	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	4	Cement	Portland Cement/Neat Cement		
4	5	Bentonite	Other Bentonite		0.375 inch Hydrated Chips
5	25	Filter Pack	Other Gravel Pack	#3 Sand	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	25	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE — Address
SAN JOSE — City
CA — State
95112 — Zip

Signed *electronic signature received* — C-57 Licensed Water Well Contractor
05/10/2019 — Date Signed
484288 — C-57 License Number

Attachments

Fig. 2 - Well Construction Details P-2.pdf - Well Construction Diagram

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

			N				W
Latitude Deg/Min/Sec				Longitude Deg/Min/Sec			

TRS:

APN:

State of California

Well Completion Report

Form DWR 188 Submitted 5/10/2019

WCR2019-006477

Owner's Well Number P-3 Date Work Began 04/10/2019 Date Work Ended 04/10/2019

Local Permit Agency Santa Clara Valley Water District

Secondary Permit Agency Permit Number C20190326001 Permit Date 03/26/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,

Mailing Address 535 Alkire Avenue

City Morgan Hill State CA Zip 95037

Planned Use and Activity

Activity New Well

Planned Use Monitoring

Well Location

Address 12163 Pacheco Pass HWY

City Gilroy Zip 95020 County Santa Clara

Latitude	37	1	13.3261	N	Longitude	-121	19	49.1409	W
	Deg.	Min.	Sec.			Deg.	Min.	Sec.	

Dec. Lat. 37.02036837 Dec. Long. -121.33031693

Vertical Datum Horizontal Datum WGS84

Location Accuracy 2.5 Ft Location Determination Method GPS

APN 89838007

Township 10 S

Range 06 E

Section 32

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Downhole Hammer Drilling Fluid None

Total Depth of Boring 20 Feet

Total Depth of Completed Well 20 Feet

Water Level and Yield of Completed Well

Depth to first water 7.2 (Feet below surface)

Depth to Static Water Level (Feet) Date Measured 04/10/2019

Estimated Yield* (GPM) Test Type

Test Length (Hours) Total Drawdown (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	8	SILTY SAND WITH GRAVEL (SM): Brown (10YR 4/3), very fine to fine grained, quartz rich, poorly graded, poorly indurated, angular to rounded shaped quartz and sandstone gravels up to 1 inch in diameter, slightly moist, medium dense.
8	13	SILTY SAND WITH GRAVEL (SM): Dark brown (10YR 3/3), fine to very coarse grained, well graded, quartz, sandstone and chert rich, angular to well rounded shaped sand and gravel, wet, dense.
13	14.5	SILTY SAND (SM): Dark brown (10YR 3/3), fine to medium grained grading to coarse to very coarse grained with depth, poorly graded, quartz, sandstone and chert rich, angular to well rounded shaped, wet, very dense.
14.5	18	WEATHERED CONGLOMERATE: SILTY GRAVEL WITH SAND (GM): Olive brown (2.5Y 4/4), very fine to very coarse grained sand, sand and gravel are angular to well rounded shaped and sandstone, quartz and chert rich, very moist to wet, very dense.
18	19	SAND (SP): Dark brown (10YR 3/3), interbedded fine to medium grained and coarse to very coarse grained, gravel lens at 19 feet, wet, very dense.
19	20	CLAYEY SAND WITH GRAVEL (SC): Light olive brown (2.5Y 5/4), result of weathered conglomerate, very fine to fine grained with trace medium to coarse grains, sub-angular to sub-rounded shaped, poorly graded, sub-rounded shaped sandstone gravels up to 1 inch in diameter, very moist, very dense.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	20	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	4	Cement	Portland Cement/Neat Cement		
4	5	Bentonite	Other Bentonite		0.375 inch Hydrated Chips
5	20	Filter Pack	Other Gravel Pack	#3 Sand	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	20	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE — Address
SAN JOSE — City
CA — State
95112 — Zip

Signed *electronic signature received* — C-57 Licensed Water Well Contractor
05/10/2019 — Date Signed
484288 — C-57 License Number

Attachments

Fig. 2 - Well Construction Details P-3.pdf - Well Construction Diagram

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N
Latitude Deg/Min/Sec

W
Longitude Deg/Min/Sec

TRS:

APN:

State of California

Well Completion Report

Form DWR 188 Submitted 5/10/2019

WCR2019-006475

Owner's Well Number P-4
Date Work Began 04/10/2019
Date Work Ended 04/10/2019
Local Permit Agency Santa Clara Valley Water District
Secondary Permit Agency
Permit Number C20190326002
Permit Date 03/26/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,
Mailing Address 535 Alkire Avenue
City Morgan Hill
State CA
Zip 95037

Planned Use and Activity

Activity New Well
Planned Use Monitoring

Well Location

Address 12163 Pacheco Pass HWY
City Gilroy
Zip 95020
County Santa Clara
Latitude 37 Deg. 1 Min. 11.7176 Sec. N
Longitude -121 Deg. 19 Min. 46.3927 Sec. W
Dec. Lat. 37.01992158
Dec. Long. -121.32955354
Vertical Datum
Horizontal Datum WGS84
Location Accuracy 2.5 Ft
Location Determination Method GPS
APN 89838007
Township 10 S
Range 06 E
Section 32
Baseline Meridian Mount Diablo
Ground Surface Elevation
Elevation Accuracy
Elevation Determination Method

Borehole Information

Orientation Vertical
Specify
Drilling Method Downhole Hammer
Drilling Fluid None
Total Depth of Boring 25 Feet
Total Depth of Completed Well 25 Feet

Water Level and Yield of Completed Well

Depth to first water 7.2 (Feet below surface)
Depth to Static Water Level (Feet)
Date Measured 04/10/2019
Estimated Yield* (GPM)
Test Type
Test Length (Hours)
Total Drawdown (feet)
*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	8	SILTY SAND (SM): Dark brown (10YR 3/3), fine grained coarsening to fine to medium grained with depth, poorly graded, quartz rich, trace sub-angular shaped to well rounded chert and sandstone gravels up to 1 inch in diameter at 5 feet, slightly moist, medium dense.
8	14.5	SAND (SP): Dark brown (10YR 3/3), fine grained coarsening to coarse to very coarse grained with depth, sub-angular to well rounded shaped, quartz, chert and sandstone rich, poorly graded, very poorly indurated, trace rounded to well rounded sandstone gravels up to 1 inch in diameter, wet, medium dense to very dense.
14.5	18.5	SILTY SAND (SM): Olive brown (2.5Y 4/4), fine to coarse grained, angular to rounded shaped, poorly graded, quartz, sandstone and chert rich, trace rounded sandstone gravels up to 1 inch in diameter, wet, very dense.
18.5	19	SAND (SP): Dark brown (10YR 3/3), coarse to very coarse grained, wet, very dense.
19	23	WEATHERED CONGLOMERATE: SILTY GRAVEL (GM): Olive brown (2.5Y 4/4), sub-angular to well rounded shaped, sandstone gravels up to 1 inch in diameter, trace very fine to fine grained sand, moist, very dense.
23	25	CLAYEY SAND WITH GRAVEL (SC): Dark greenish gray (GLEY 2 4/10G), result of completely weathered conglomerate, very fine to fine grained with trace medium to coarse grains, sub-angular shaped, poorly graded, sub-rounded sandstone gravels up to 1 inch in diameter, moist to wet, dense.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	25	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	4	Cement	Portland Cement/Neat Cement		
4	5	Bentonite	Other Bentonite		0.375 inch Hydrated Chips
5	25	Filter Pack	Other Gravel Pack	#3	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	25	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE — Address
SAN JOSE — City
CA — State
95112 — Zip

Signed *electronic signature received* — C-57 Licensed Water Well Contractor
05/10/2019 — Date Signed
484288 — C-57 License Number

Attachments

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

Fig. 2 - Well Construction Details P-4.pdf - Well Construction Diagram

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N
Latitude Deg/Min/Sec

W
Longitude Deg/Min/Sec

TRS:

APN:

State of California

Well Completion Report

Form DWR 188 Submitted 6/6/2019

WCR2019-007857

Owner's Well Number P-5
Date Work Began 05/30/2019
Date Work Ended 05/30/2019
Local Permit Agency Santa Clara Valley Water District
Secondary Permit Agency
Permit Number C20190513004
Permit Date 05/13/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,
Mailing Address 535 Alkire Avenue
City Morgan Hill
State CA
Zip 95037

Planned Use and Activity

Activity New Well
Planned Use Monitoring

Well Location

Address 14610 Pacheco Pass HWY
City Gilroy
Zip 95020
County Santa Clara
Latitude 37 Deg. 1 Min. 25.9775 Sec. N
Longitude -121 Deg. 19 Min. 36.4991 Sec. W
Dec. Lat. 37.02388265
Dec. Long. -121.32680531
Vertical Datum
Horizontal Datum WGS84
Location Accuracy 2.5 Ft
Location Determination Method GPS
APN 89853002
Township 10 S
Range 06 E
Section 33
Baseline Meridian Mount Diablo
Ground Surface Elevation
Elevation Accuracy
Elevation Determination Method

Borehole Information

Orientation Vertical
Specify
Drilling Method Downhole Hammer
Drilling Fluid None
Total Depth of Boring 20 Feet
Total Depth of Completed Well 20 Feet

Water Level and Yield of Completed Well

Depth to first water 6 (Feet below surface)
Depth to Static Water Level (Feet)
Date Measured 05/30/2019
Estimated Yield* (GPM)
Test Type
Test Length (Hours)
Total Drawdown (feet)
*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	3	SILTY SAND (SM): Brown (10YR 4/3), fine to medium grained with trace coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, scattered rootlets, trace binder, slightly moist.
3	8	SILTY SAND WITH GRAVEL (SM): Brown (10YR 4/3), fine to medium grained with trace coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz, sandstone and chert rich, poorly indurated, sub-angular to well rounded shaped gravels up to 1 inch in diameter, slightly moist, medium dense.
8	13	SILTY GRAVEL WITH SAND (GM): Brown (10YR 4/3), sub-angular to well rounded shaped, predominately fine grained gravels ranging from 0.25 to 0.50 inches in diameter with a trace amount of gravels up to 2 inches in diameter, quartz, siltstone and sandstone rich, poorly graded, poorly indurated, fine to medium grained SILTY SAND lens near 9.5 feet, wet, very dense.
13	14	SILTY SAND (SM): Brown (10YR 4/3), fine to medium grained grading to coarse to very coarse grained near 14 feet, sub-angular to sub-rounded shaped, quartz, sandstone and chert rich, wet, very dense.
14	17.5	WEATHERED CONGLOMERATE; CLAYEY SAND WITH GRAVEL (SC): Light olive brown (2.5Y 5/3), very fine to medium grained with trace coarse to very coarse grains, sub-angular to well rounded shaped, quartz, sandstone and chert rich, poorly indurated, gravels up to 2 inches in diameter, wet, very dense.
17.5	19	SAND (SP): Brown (10YR 4/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, poorly indurated, wet, medium dense.
19	20	WEATHERED CONGLOMERATE; CLAYEY SAND WITH GRAVEL (SC): Bluish gray (GLEY2 5/5B), very fine to fine grained with trace medium to coarse grains, poorly graded, moderately indurated, sub-angular to well rounded shaped gravels up to 2 inches in diameter, very moist, very dense.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	20	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	3	Cement	Portland Cement/Neat Cement		
3	5	Bentonite	Other Bentonite		Hydrated 0.375 inch chips
5	20	Filter Pack	Other Gravel Pack	#3 Sand	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	20	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE (Address) SAN JOSE (City) CA (State) 95112 (Zip)

Signed *electronic signature received* (C-57 Licensed Water Well Contractor) 06/06/2019 (Date Signed) 484288 (C-57 License Number)

Attachments

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

Fig. 2 - Well Construction Details P-5.pdf - Well Construction Diagram

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N
Latitude Deg/Min/Sec

W
Longitude Deg/Min/Sec

TRS:

APN:

State of California

Well Completion Report

Form DWR 188 Submitted 6/6/2019

WCR2019-007861

Owner's Well Number P-6
Date Work Began 05/30/2019
Date Work Ended 05/30/2019
Local Permit Agency Santa Clara Valley Water District
Secondary Permit Agency
Permit Number C20190513003
Permit Date 05/13/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,
Mailing Address 535 Alkire Avenue
City Morgan Hill
State CA
Zip 95037

Planned Use and Activity

Activity New Well
Planned Use Monitoring

Well Location

Address 14610 Pacheco Pass HWY
City Gilroy
Zip 95020
County Santa Clara

Latitude	37	1	40.1455	N	Longitude	-121	19	31.1437	W
	Deg.	Min.	Sec.			Deg.	Min.	Sec.	

Dec. Lat. 37.0278182
Dec. Long. -121.32531771
Vertical Datum
Horizontal Datum WGS84
Location Accuracy 2.5 Ft
Location Determination Method GPS
APN 89853002
Township 10 S
Range 06 E
Section 33
Baseline Meridian Mount Diablo
Ground Surface Elevation
Elevation Accuracy
Elevation Determination Method

Borehole Information

Orientation Vertical
Specify
Drilling Method Downhole Hammer
Drilling Fluid None
Total Depth of Boring 20 Feet
Total Depth of Completed Well 20 Feet

Water Level and Yield of Completed Well

Depth to first water 6 (Feet below surface)
Depth to Static
Water Level (Feet)
Date Measured 05/30/2019
Estimated Yield* (GPM)
Test Type
Test Length (Hours)
Total Drawdown (feet)
*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	3	SILTY SAND (SM): Dark brown (10YR 3/3), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, scattered rootlets, slightly moist.
3	8	SILTY SAND WITH GRAVEL (SM): Brown (10YR 4/3), fine to coarse grained with trace very coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz, sandstone and chert rich, sub-angular to rounded shaped gravels up to 2 inches in diameter, poorly indurated, slightly moist, medium dense.
8	18	SILTY GRAVEL WITH SAND (GM): Brown (10YR 4/3), sub-angular to well rounded shaped, predominately fine grained gravels ranging from 0.25 to 0.50 inches in diameter with a trace amount of gravels up to 2 inches in diameter, quartz, siltstone, sandstone and chert rich, poorly graded, poorly indurated, fine to medium grained, quartz rich SILTY SAND lens near 8.5 feet, wet, very dense.
18	19.5	SILTY SAND (SM): Very dark (10YR 3/1), medium to coarse grained with trace fine grains, angular to rounded shaped, poorly graded, quartz, sandstone and chert rich, wet, very dense.
19.5	20	WEATHERED CONGLOMERATE; CLAYEY SAND WITH GRAVEL (SC): Bluish gray (GLEY2 5/5B), very fine to fine grained with trace medium to coarse grains, poorly graded, moderately indurated, sub-angular to well rounded shaped gravels up to 2 inches in diameter, very moist, very dense.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	20	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	3	Cement	Portland Cement/Neat Cement		
3	5	Bentonite	Other Bentonite		Hydrated 0.375 inch chips
5	20	Filter Pack	Other Gravel Pack	#3 Sand	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	20	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE SAN JOSE CA 95112
Address City State Zip

Signed *electronic signature received* 06/06/2019 484288
C-57 Licensed Water Well Contractor Date Signed C-57 License Number

Attachments

Fig. 2 - Well Construction Details P-6.pdf - Well Construction Diagram

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

			N

Latitude Deg/Min/Sec

			W

Longitude Deg/Min/Sec

TRS:

APN:

State of California

Well Completion Report

Form DWR 188 Submitted 6/6/2019

WCR2019-007863

Owner's Well Number P-7 Date Work Began 05/30/2019 Date Work Ended 05/30/2019

Local Permit Agency Santa Clara Valley Water District

Secondary Permit Agency Permit Number C20190513002 Permit Date 05/13/2019

Well Owner (must remain confidential pursuant to Water Code 13752)

Name SANTA CLARA VALLEY HABITAT AGENCY,

Mailing Address 535 Alkire Avenue

City Morgan Hill State CA Zip 95037

Planned Use and Activity

Activity New Well

Planned Use Monitoring

Well Location

Address 14610 Pacheco Pass HWY

City Gilroy Zip 95020 County Santa Clara

Latitude 37 Deg. 1 Min. 38.9135 Sec. N Longitude -121 Deg. 19 Min. 26.5883 Sec. W

Dec. Lat. 37.02747599 Dec. Long. -121.32405231

Vertical Datum Horizontal Datum WGS84

Location Accuracy 2.5 Ft Location Determination Method GPS

APN 89853002

Township 10 S

Range 06 E

Section 33

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Downhole Hammer Drilling Fluid None

Total Depth of Boring 25 Feet

Total Depth of Completed Well 25 Feet

Water Level and Yield of Completed Well

Depth to first water 6 (Feet below surface)

Depth to Static Water Level (Feet) Date Measured 05/30/2019

Estimated Yield* (GPM) Test Type

Test Length (Hours) Total Drawdown (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		**Description**
0	9	SILTY SAND WITH GRAVEL (SM): Dark brown (10YR 3/3), fine to medium grained with trace coarse grains, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, sub-angular to well rounded shaped gravels up to 3 inches in diameter, scattered rootlets, moist, loose to medium dense.
9	18	SILTY GRAVEL WITH SAND (GM): Brown (10YR 4/3), sub-angular to well rounded shaped, predominately fine grained gravels ranging from 0.25 to 0.50 inches in diameter with a trace amount of gravels up to 1 inch in diameter, fine to very coarse grained sand, sand and gravel are sub-angular to well rounded shaped, quartz, sandstone and chert rich, poorly graded, poorly indurated, wet, medium dense to very dense.
18	19.5	SILTY SAND (SM): Grayish brown (2.5Y 5/2), fine to medium grained, sub-angular to sub-rounded shaped, poorly graded, quartz rich, poorly indurated, wet, very dense.
19.5	23.5	WEATHERED CONGLOMERATE: SANDY LEAN CLAY/CLAYEY SAND (CL/SC): Bluish gray (GLEY2 5/5B) and light olive brown (2.5Y 5/6), fine to medium grained sand, sub-angular to sub-rounded shaped, poorly graded, angular to rounded shaped gravels up to 0.5 inches in diameter in a clay matrix, moist to very moist, very hard/very dense.
23.5	25	CLAY WITH GRAVEL (CI): Very dark gray (2.5Y 3/1), clay appears to exhibit intermediate plasticity, sub-rounded shaped gravels up to 1 inch in diameter in a clay matrix, moist, very hard.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description
1	0	5	Blank	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375			
1	5	25	Screen	PVC	OD: 2.375 in. | SDR: SCH 40 | Thickness: 0.154 in.	0.154	2.375	Milled Slots	0.01	

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	3	Cement	Portland Cement/Neat Cement		
3	5	Bentonite	Other Bentonite		Hydrated 0.375 inch chips
5	25	Filter Pack	Other Gravel Pack	#3 Sand	Lapis Lustre

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	25	8

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name EXPLORATION GEOSERVICES INC
Person, Firm or Corporation

1535 INDUSTRIAL AVENUE	SAN JOSE	CA	95112
Address	City	State	Zip

Signed	*electronic signature received*	06/06/2019	484288
	C-57 Licensed Water Well Contractor	Date Signed	C-57 License Number

Attachments

Fig. 2 - Well Construction Details P-7.pdf - Well Construction Diagram

Fig 1 - Site Map Showing Piezometer Locations.pdf - Location Map

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

						N							W

Latitude Deg/Min/Sec **Longitude Deg/Min/Sec**

TRS:

APN:

Appendix C. Cultural Resources Assessment

Memorandum

Prepared for: H.T. Harvey & Associates

Matt Quinn, Division Head, Restoration Ecologist

Prepared by: ICF

Lily Arias, M.A.

Date: June 10, 2019

Re: **Cultural Resources Assessment for the Pacheco Creek Restoration Project**

Introduction

The Santa Clara Valley Habitat Agency is proposing to restore habitat along a portion of Pacheco Creek in Santa Clara County, California (Figure 1 and Figure 2). H.T. Harvey & Associates (Harvey) is assisting the design and development of a habitat restoration plan; and is in the process of performing a series of environmental studies to help inform the design and to support anticipated future permitting needs. The project will likely require permits from the U.S. Army Corps of Engineers (USACE) and would therefore be considered a federal undertaking. As a result, it would need to comply with Section 106 of the National Historic Preservation Act (NHPA). Harvey retained ICF to perform cultural resources studies in support of the project's anticipated Section 106 of the NHPA obligations, and to help inform the project's restoration design. The purpose of this Memorandum is to identify and document cultural resources in the Study Area. It describes the methods and results of the cultural resources investigations and provides technical recommendations.

Records Search and Literature Review

ICF Archaeologist, Yuka Oiwa, completed a records search at the Northwest Information Center (NWIC) of the California Historical Resources Information System (CHRIS) for the Pacheco Creek Restoration Project (Project) on April 8, 2019. The Project is located in southeastern Santa Clara County, 12 miles east of the City of Gilroy. The Project Study Area consists of a 1.2-mile corridor along Pacheco Creek (Figure 1). The records search investigated the Study Area, as well as a 0.25-mile buffer around the Project Site, for previously recorded archaeological and built environment resources as well as previously conducted cultural resource studies.

Based on the NWIC records search, seven cultural resources studies have been previously conducted within the Study Area and cover approximately 75% of the Study Area. These studies are detailed in Table 1 below.

Table 1. Previous Cultural Resource Study Adjacent to the Study Area

Study number	**Author**	**Date**	***Title***	**Findings**
S-011232	Kelly, M.	1989	*Negative Archaeological Survey Report for the Proposed Route 152 Property Exchange*	No resources identified within the Study Area.
S-004300	Carrell, T., J. Fritz, and J. Morris	1975	*Environmental Impact Statement, Archaeological Reconnaissance, Pacheco Tunnel Portal Construction*	No resources identified within the Study Area.
S-014767	Cartier, R.	1991	*Cultural Resource Evaluation of the Kalend Subdivision Project off Pacheco Highway in the County of Santa Clara*	No resources identified within the Study Area.
S-005222	King, T.F. and P.P. Hickman	1973	*Archaeological Impact Evaluation: San Felipe Division, Central Valley Project, Part I; The Southern Santa Clara Valley, California: A General Plan for Archaeology*	No resources identified within the Study Area.
S-005222a	King, T.F.	1973	*Archaeological Impact Evaluation: San Felipe Division, Central Valley Project, Part II: The Direct Impact of San Felipe Division Facilities on Archaeological Resources*	No resources identified within the Study Area.
S-005222b	Breschini, G. and T. Haversat	1978	*A Preliminary Archaeological Surface Reconnaissance of the San Felipe Division, Central Valley Project, Santa Clara and San Benito Counties, California*	No resources identified within the Study Area.
S-005222c	Van Horn, D.	1980	*Archaeological and Historical Investigations in Portions of the Central Valley Project, San Felipe Division*	No resources identified within the Study Area.
Source: Northwest Information Center (NWIC), April 8, 2019				

An additional 21 cultural resources studies have been conducted within 0.25-mile of the Study Area. These studies include 13 archaeological reconnaissance projects, four Environmental Impact Reports (EIR) and associated documentation, two management and monitoring plans, = two site specific evaluations, and three evaluation and/or testing projects focused on specific cultural resource sites. It is important to note that seven of these cultural resources studies identified archaeological resources within 0.25-mile of the Study Area.

Based on the NWIC records search, two previously recorded archaeological resources are described as being within the Study Area (Figure 2). These include one historic-era built resource and one precontact midden deposit and are detailed below:

P-43-000129 (CA-SCL-116) – This resource consists of a variable colored midden and flake scatter located within oak parkland on a large terrace. The terrace is situated on the northwest side of Harper Canyon Creek, at the mouth of the canyon. This resource has not been formally evaluated for inclusion to either the National Register of Historic Places (NRHP) or the California Register of Historic Resources (CRHR).

P-43-003576 - Roll On Inn Café, 1 story, built in 1970, gas pumps, driveway, and cabins nearby. This resource is no longer extant.

Based on the NWIC records search, five previously recorded cultural resources were identified within 0.25 mile of the Study Area. These resources include three precontact resources and two historic-era built resources and are detailed in Table 2 below.

Table 2. Previously Recorded Cultural Resources within 0.25 Mile of the Study Area

P-Number	Trinomial	Prehistoric/ Historic	Description
43-000052	CA-SC1-32	Prehistoric	Mortars and pestles recovered in gravel pit redeposited from unknown location.
43-000127	CA-SC1-114	Prehistoric	Isolated mortar fragment on north slope above ranger station.
43-000309	CA-SCL-301	Prehistoric	Isolated bedrock mortar located in intermittent streambed.
43-000680	04-SC1-152	Historic-Built	Pacheco Forest Fire Station--1 1/2 story fire engine house and office built in 1942.
43-003674	04-SC1-152	Historic-Built	Caltrans Maintenance Station, built in 1925.
Source: Northwest Information Center (NWIC), April 8, 2019			

Desktop Geoarchaeological Review

The Study Area is located within the southern portion of the Diablo Range in an east-west trending valley. Pacheco Creek runs through the west side of the project area. During review of historic maps, Pacheco Creeks channel migration zone ranges from 10 feet to over 200 feet, as the Creek has meandered through the valley over the years.

During the desktop geoarchaeological review, several distinct landforms were identified within the Study Area: flood plains, bedrock uplands, and the Pacheco Creek channel. The majority of the Study Area is located on flood plains, which consist of Holocene-aged alluvial sediment and are generally considered highly sensitive for buried archaeological deposits due their coincidence with precontact habitation. A smaller portion of the Study Area, located along the eastern boundary, is comprised of bedrock uplands. This landform is much older and generally considered to have limited sensitivity for buried archaeological deposits given its age. While the majority of the Study Area is considered highly sensitive for buried precontact archaeological deposits, the Pacheco Creek channel migration zone bisects the Study Area. Given its migration over time, has likely disturbed, and removed any intact archaeological deposits that may have existed within the channel migration zone (Figure 3) Elder et al. 2015).

Archaeological Site Reconnaissance

ICF Archaeologists, Lily Arias, M.A. and Yuka Oiwa, B.A., conducted a pedestrian survey of the Study Area on March 13, 2019. The purpose of the pedestrian survey was to identify any potential archaeological resources within the Study Area. The Study Area is bounded by Pacheco Pass Highway to the west and cattle grazing lands to the east. Pacheco Creek runs down the western portion of the Study Area. Seasonal Harper Canyon Creek joins Pacheco Creek at the southern end of the Study Area.

The entire Study Area was subject to the pedestrian survey. The survey consisted of walking across the Study Area in transects at 20-30 meter intervals and visually inspecting the ground surface for indicators of surface and subsurface archaeological deposits (e.g., dark, friable midden soil, flaked stone, fire affected rock). The pedestrian survey also involved inspecting the local topography to identify any areas that have been subject to modern anthropogenic landscape alteration (e.g., depressions or mounds).

During the pedestrian survey, visibility was low due to dense vegetation and disturbance caused by grazing activities. Where visible rodent burrows were inspected as a means to view potential subsurface sediment. Cut banks along Pacheco Creek were also inspected for stratigraphy. Several bedrock outcroppings are located throughout the Study Area. This outcropping were closely inspected for evidence of cultural modification. Dense brambles and poison oak sometimes inhibited access.

A portion of P-43-000129 (CA-SCL-116) was previously recorded in the southeastern portion of the Study Area (Figure 2). This area was closely examined for flaked stone and midden soils, as well as any other indicators of the previously recorded site. The area is densely vegetated and ground visibility was limited. However, rodent burrows did allow for some inspection of surface and partially subsurface sediments. No evidence of this resource was identified during the pedestrian survey.

P-43-003576, the Roll On Inn Café and associated structures, are longer present in this location.

Conclusions

Two previously recorded archaeological resources were identified during the records search at the NWIC. One (P-43-003675) is recorded as a historic-era built resource and is no longer present, and one (P-43-000129) is recorded as a precontact midden deposit with an associated surface lithics scatter. Pedestrian survey conducted of the Study Area could not relocate the deposit, however visibility was low due to dense vegetation and this area should be considered to have an elevated risk for containing archaeological deposits. Additionally, precontact isolated artifacts have been found within 0.5-mile of the Study Area.

Desktop geoarchaeological review revealed that the Study Area is located on Holocene-aged alluvial landforms, which generally have increased sensitivity for containing buried archaeological resources. While historic channel migration has caused erosion and reduced the potential for encountering archaeological resources across portions of the Study Area, archaeological sensitivity is considered to be high on the floodplains and alluvial terraces that border the historic channel migration zone.

The sensitivity of the Study Area can be broken down into several different sections. Both surface and subsurface work occurring within the Pacheco Creek channel migration zone has limited potential to contain as-yet undocumented archaeological resources, therefore no additional cultural resources considerations are needed. Surface work proposed across the Study Area, with the exception of the previous documented archaeological resources, also has limited archaeological sensitivity. However, subsurface work within the floodplains and alluvial terraces does have the potential to encounter as-yet undocumented archaeological deposits. It is recommended that all contractors conducting ground disturbance in these areas receive a cultural resources sensitivity training prior to commencing with construction activities. An unanticipated discovery protocol should also be developed to help facilitate the correct handling and recordation of archaeological resources in the event that they are inadvertently discovered. The area in the vicinity of the previously recorded precontact site (P-43-000129) has the highest potential to encounter archaeological deposits. While avoidance is preferred, if it is not possible archaeological testing is recommended prior to any ground disturbance to identifying and document the extent of the resource and to verify whether additional whether additional studies are needed.

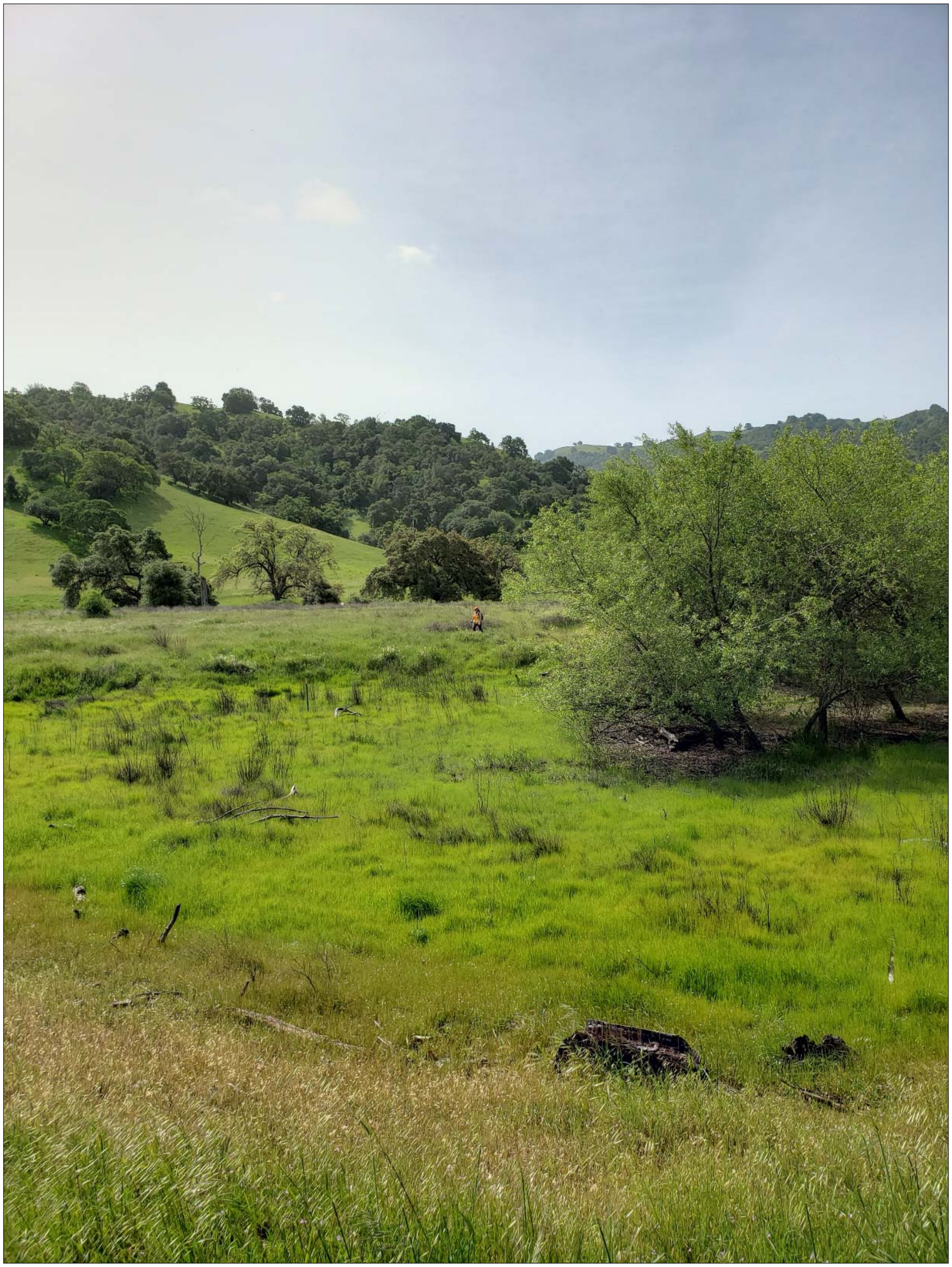
Works Cited

Elder, J.T. and P. Reed, A.E. Stevenson, and M.S. Sparks
2015 Archaeological Feature Preservation in Active Fluvial Environments: An Experimental Case Study from the Snoqualmie River, King County, Washington State. *The Journal of Northwest Anthropology*. 49(2):167-178.

Archaeological Site Reconnaissance Survey Photos

Overview of east side of project area, view north

Overview of project area, view southwest



Overview of depression/reservoir basin, view east

Overview of southwestern portion of the Project Site, view west

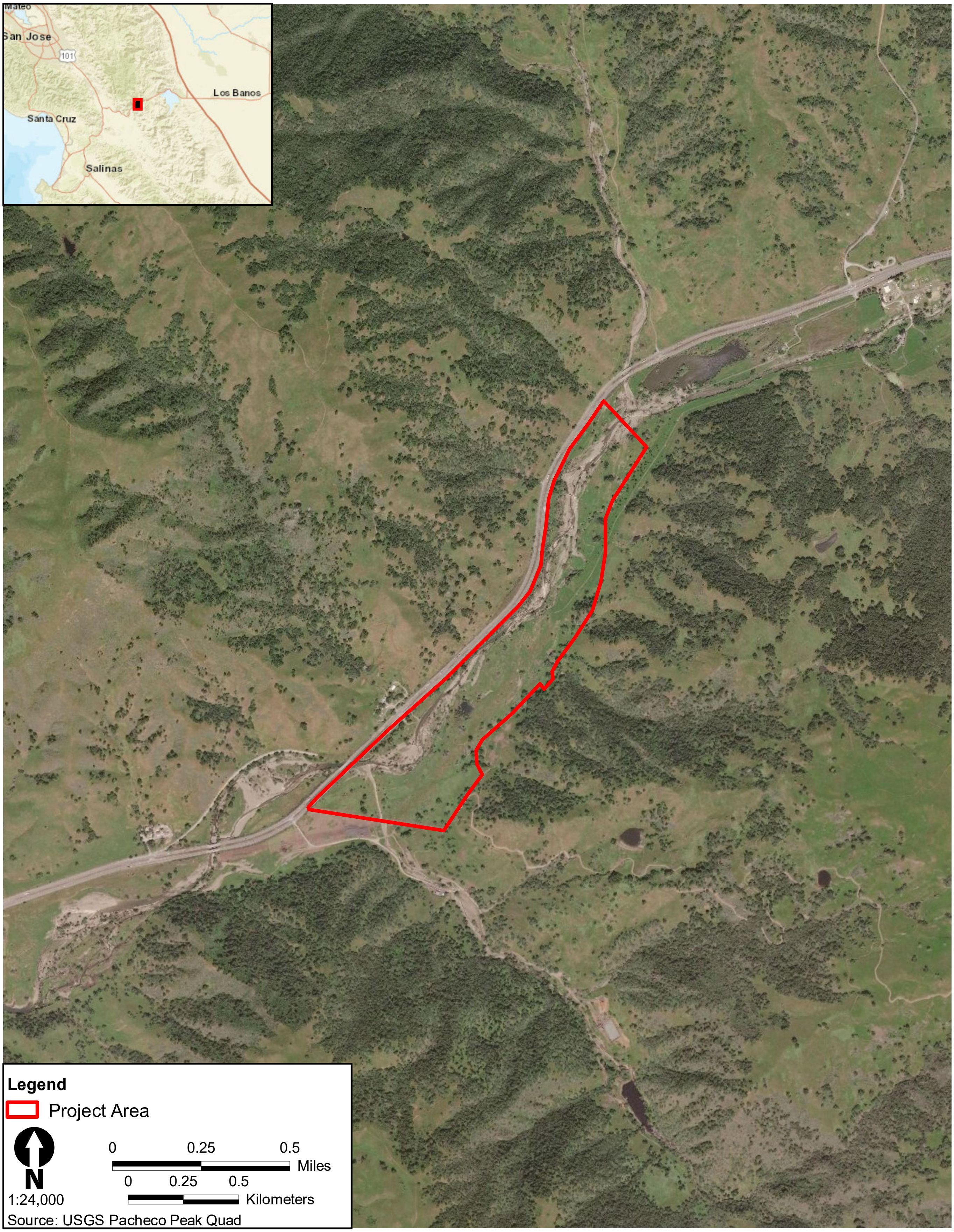


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Figure 1 - Project Area
Pacheco Creek Restoration Project

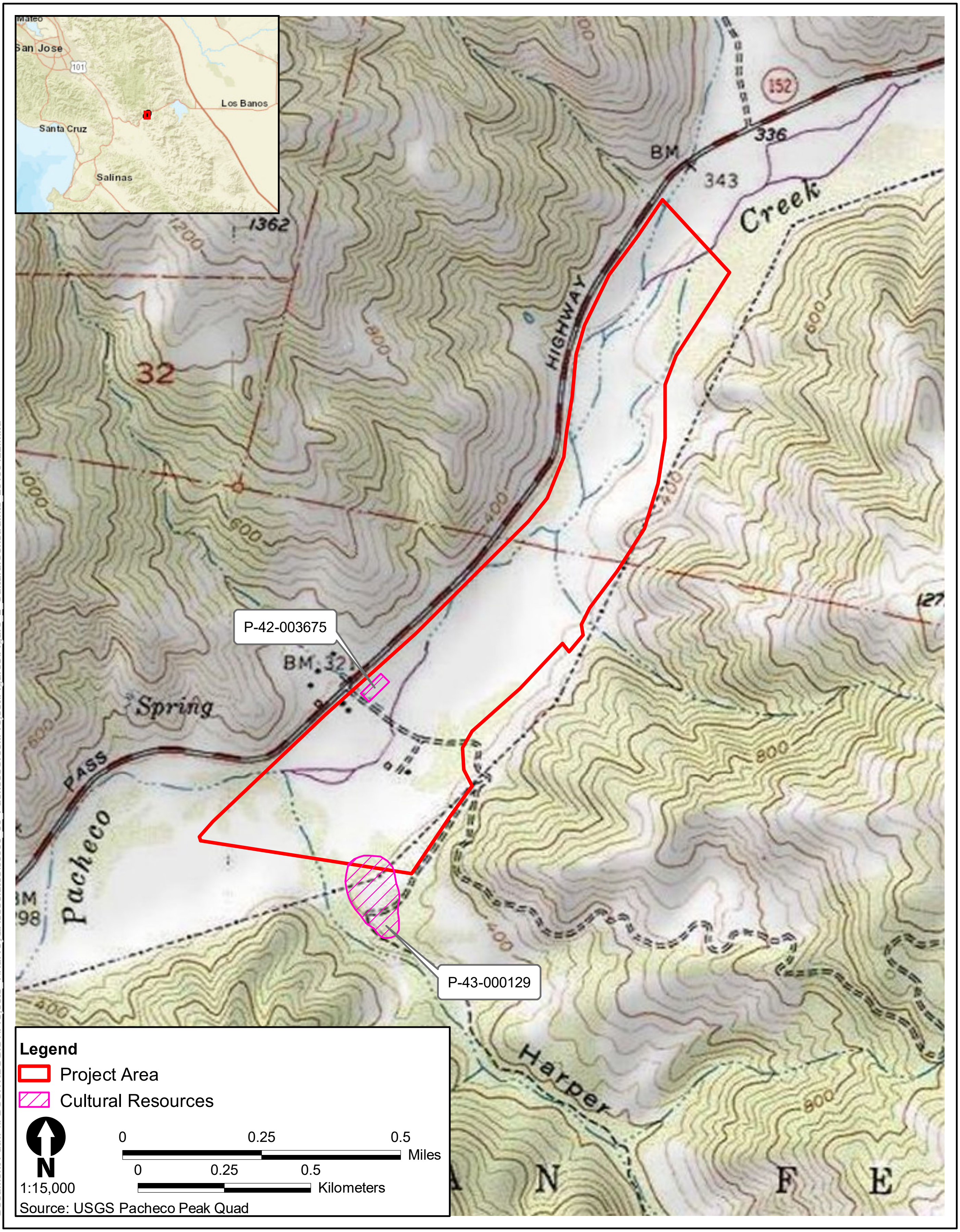

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Figure 2 - Previously Recorded Cultural Resources
Pacheco Creek Restoration Project

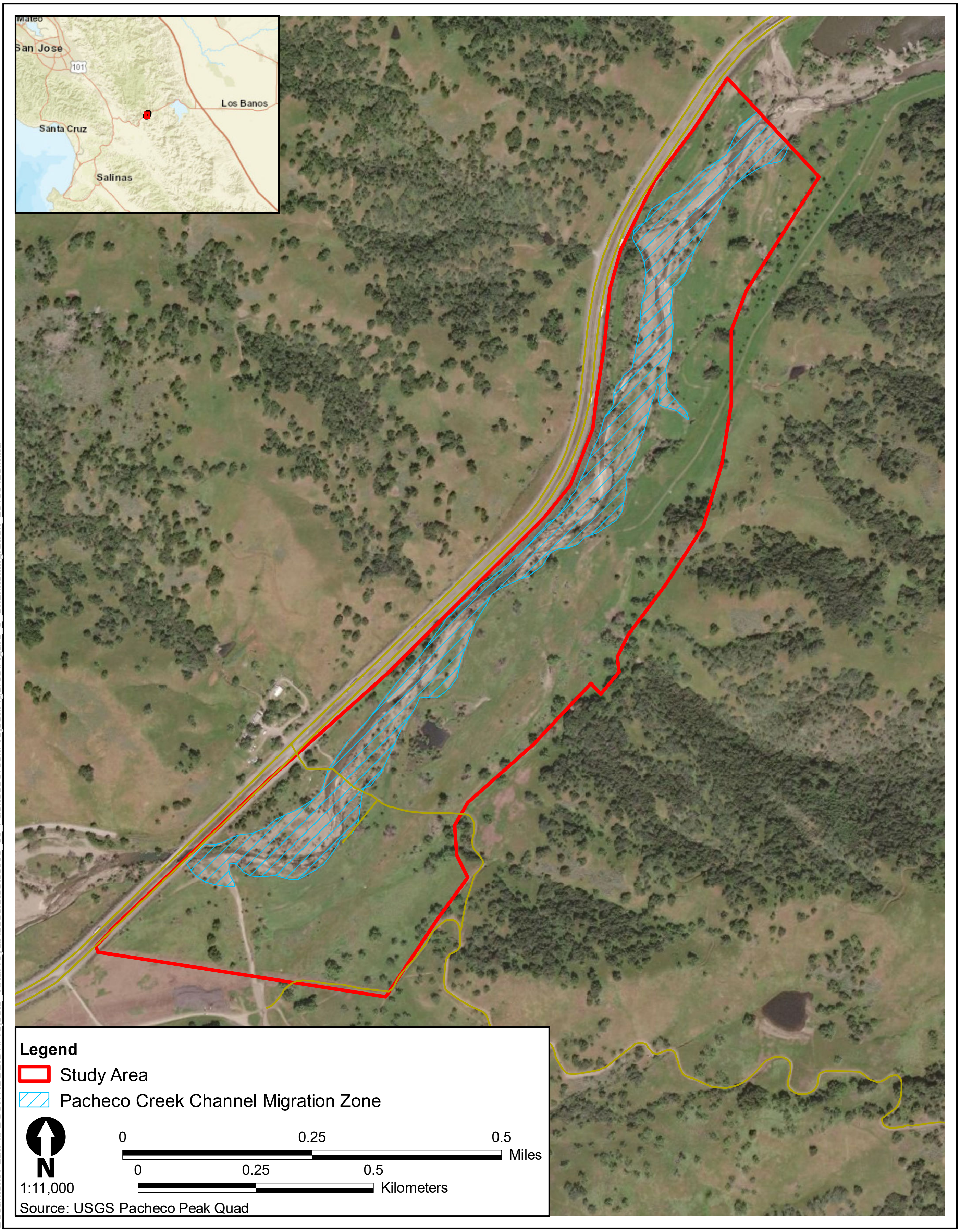

Figure 3
Pacheco Creek Channel Migration Zone
Pacheco Creek Restoration Project

Appendix D. Physical Process Restoration Element Definitions

Earthwork Measures

Floodplain Lowering

Elevated floodplain surfaces along Pacheco Creek can be lowered through grading to increase floodplain connectivity both with surface water during high flows and with the shallow groundwater table. Elevated surfaces within the active channel corridor as well as the less frequently activated channel corridor can be lowered to promote greater frequency, duration and depth of inundation. Terrace lowering can promote physical processes and dynamic channel behavior as well as improve habitat for riparian vegetation (including sycamores) and aquatic species. Excavated material can be utilized for other on-site enhancement measures.

Channel Bed Aggradation

Since the construction of Pacheco Reservoir in 1939, Pacheco Creek has been disconnected from a significant portion of its contributing watershed's sediment supply and is adjusting to the reduced sediment load, primarily through channel incision. In areas where Pacheco Creek has experienced significant incision and is particularly disconnected from its floodplain, the channel bed could be aggraded through the strategic placement of sediment. Bed aggradation can rely on reuse of material from other grading measures (e.g., terrace lowering, secondary channel inlet lowering, bank laybacks, etc.) to aggrade the full width of the stream channel. Bed aggradation activities can be located to promote connectivity (by raising the WSE) of secondary channels or relatively well-connected floodplain surfaces. Bed aggradation can also be implemented in conjunction with other measures such as installation of large wood or rock to promote additional bed aggradation and/or floodplain connectivity.

Point Bar/Lateral Bar Placement

Particularly along homogeneous and incised reaches of Pacheco Creek, sediment can be placed in point bar or lateral bar configurations to enhance complexity of channel form and to encourage dynamic channel behavior. Point bars are depositional sedimentary features that establish on the interior of a meander bend and are generally composed of sediment grain sizes ranging from sand to cobble. Lateral bars are similar accumulations of sediment that occur along the margins of a stream channel (namely the toe of the stream bank). As a channel migrates laterally (and away from its current alignment), depositional bar features can also provide suitable habitat (freshly deposited non-vegetated areas in close proximity to the water table) for successional riparian vegetation communities and other valuable habitat features within the inner floodplain.

Transverse Gravel/Cobble Bar Placement

Transverse bars are accumulations of sediment that occur diagonally along the stream bed or perpendicular to flow, reaching from the toe of one bank to the toe of the other. These bar features are generally the site of riffles. The top of transverse bars are typically local high points along the stream bed's longitudinal profile and serve as a local hydraulic control. At suitable locations, gravels or cobbles can be placed along the Pacheco Creek stream bed in a transverse bar formation to enhance channel complexity along otherwise homogeneous or degraded stream reaches and to promote hydrologic connectivity of secondary channels.

Armored Bank Heterogeneity Enhancement

Dense stands of riparian vegetation growing along the margins of the Pacheco Creek low-flow channel can effectively armor and anchor the stream bank and inhibit dynamic channel behavior and physical processes. Establishment of this dense riparian vegetation at the channel margins, particularly willows, may be driven in part by the enhanced summer base flows resulting from Pacheco Reservoir releases. Along otherwise homogenous stream reaches, selective removal of vegetation and grading of the stream bank can be used to enhance connectivity of inner floodplain and secondary channel features as well as encourage dynamic channel behavior and diverse flow paths. In turn, the more heterogeneous stream channel can enhance riparian and inner floodplain habitat and may also benefit sycamore establishment (by providing open areas at the correct elevation relative to the water table) and steelhead rearing and holding habitat (by providing low velocity areas with instream structure or overhanging vegetation).

Secondary Channel Enhancement

Numerous secondary channels are present along Pacheco Creek's floodplain with varying levels of connectivity to the primary main channel. While a number of these secondary channels activate fairly frequently, as observed in photos provided by the Habitat Agency from a February 2019 high flow event, an opportunity exists to lower these channels through grading and thereby increasing the frequency, duration and depth of their activation. Potential benefits derived from secondary channel lowering include increased lateral connectivity and groundwater recharge and enhancement of riparian, steelhead and amphibian habitat. Depending on the location and the objectives of the effort, secondary channel lowering can also be used to increase dynamism of channel behavior and increase the possibility of channel migration and/or avulsion.

Seasonal Wetland Enhancement

Existing seasonal wetland features located along the Pacheco Creek valley floor can be enhanced through grading measures that expand and/or deepen their footprint. Similarly, new seasonal wetlands can be created through grading. Design considerations should include existing and desired habitat, soils, contributing surface flow paths, groundwater levels and other factors.

Bank Layback

Bank erosion along a vertical (or near-vertical) bank can be addressed in part through grading that lays back the bank to a more stable slope (i.e., 2:1 slope or less) and associated stabilization measures (e.g., biotechnical methods). Bank laybacks can be applied in appropriate locations where Pacheco Creek is laterally migrating and driving bank retreat. Laying back a bank typically involves moving the top of the bank back from the channel while maintaining the position of the bank's toe, which requires removal of the wedge of bank material between the existing and new bank alignment and placement of that material elsewhere. Alternative options can include extending the bank toe into the channel while simultaneous pulling the top of bank away from the channel and achieving cut/fill balance on site. Bank laybacks can be accompanied by biotechnical bank stabilization measures including root wads driven into the bank or rock placed to armor the toe, revegetation, biodegradable erosion control fabric and other strategies.

Large Wood Placement

Bar Apex Jam

Naturally occurring bar apex jams in their most basic form are typically defined by a key large wood member that is oriented parallel to flow and that generally possesses a large, intact root wad at its upstream end. Smaller logs and woody material may accumulate immediately upstream of the root wad and be racked against it during high flows in an alignment perpendicular to the general flow direction. Additional members may also accumulate alongside the key member, generally with an oblique orientation (i.e., at an angle slightly offset from the key member's orientation parallel to flow). The jam's influence on local hydraulics generally results in the formation of an arcuate bar a small distance upstream of the jam, a crescent pool immediately upstream and along the margins of the head of the jam and a central bar alongside and downstream of the key member (i.e., in the lee of the head of the jam). This central bar that forms alongside and downstream of the key member often provides suitable substrate and protection from scour that supports natural recruitment and persistence of riparian vegetation. As riparian vegetation establishes on the central bar, it further enhances local sediment deposition and growth of the bar surface, which in turn enables additional vegetation colonization and enlargement of the bar (Abbe and Montgomery 2003). In the absence of a single large tree that serves as a catalyst for jam development, these jams can be constructed with smaller woody material supported by vertically oriented posts driven into the stream bed. Bar apex jams can be installed in strategic locations along Pacheco Creek to achieve several objectives:

- Enhance natural processes and channel complexity.
- Protect existing juvenile sycamores and other riparian vegetation that are positioned downstream of the jam.
- Drive additional recruitment of sycamores and other riparian vegetation along the bar surface.
- Improve in-channel habitat and cover for steelhead.

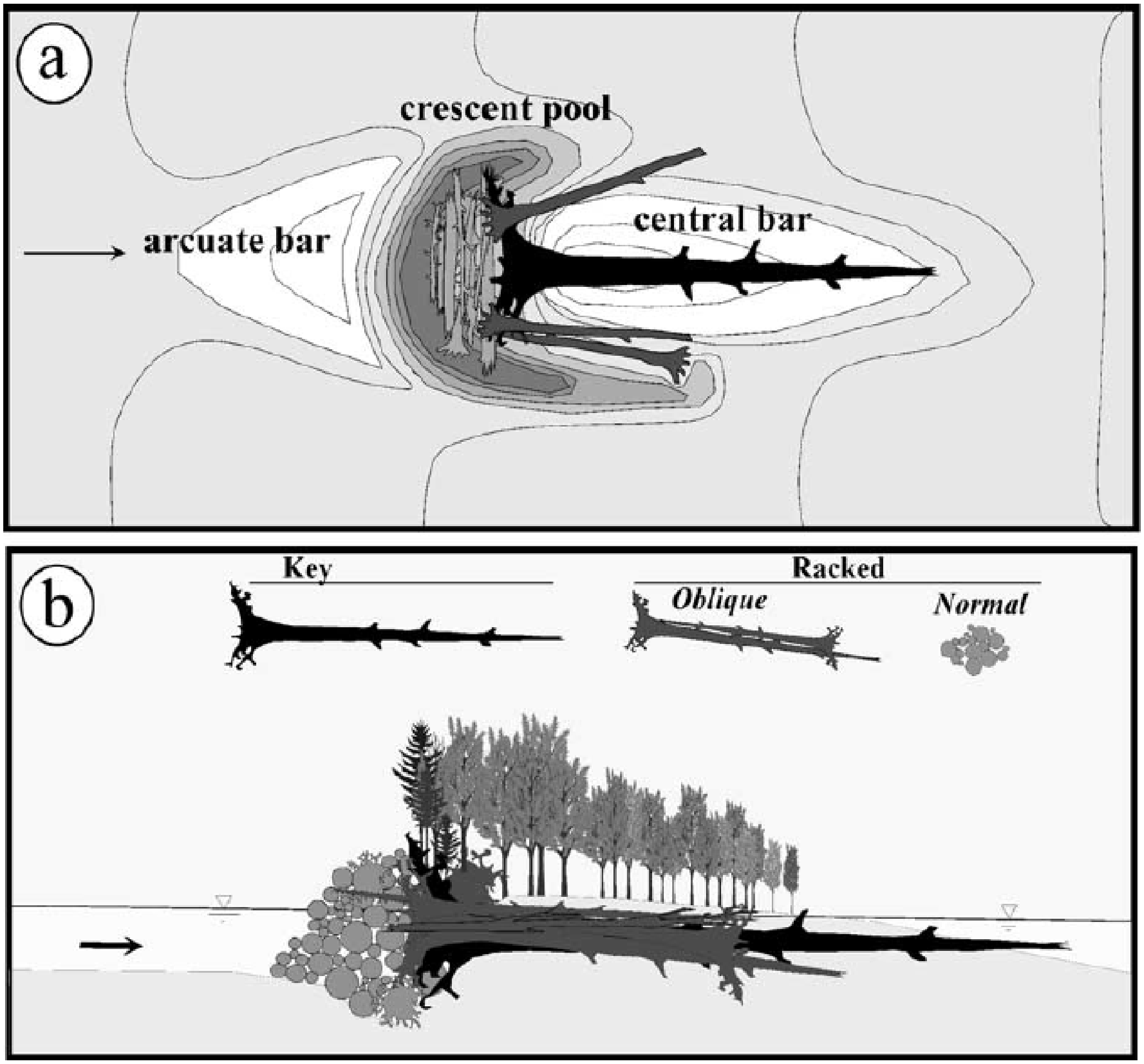

Fig. 6. (a) Planview illustration of basic structure of bar apex jams. Alluvial morphology associated with bar apex jams includes an upstream arcuate bar, a crescent pool adjacent to the jam, and a central bar downstream (Abbe and Montgomery, 1996). (b) Profile illustrating tree colonization along the axis of a bar apex jam commonly exhibiting a distinctive age sequence decreasing downstream from the key-member rootwad.

Bar apex jam from Abbe and Montgomery 2003

Flow Deflection Jam

Flow deflection jams typically consist of several key members and additional smaller woody material that together redirect in-stream flows across the channel toward the opposite bank, driving channel widening. A flow deflection jam typically occupies a portion of the bankfull channel width but is not a channel spanning jam. The local hydraulics introduced by the jam usually drive bed scour and pool formation immediately upstream and alongside the jam as well as sediment bar formation downstream of the jam (Abbe and Montgomery 2003). Flow deflection jams are capable of driving significant adjustments to channel morphology and can be used in Pacheco Creek to enhance channel dynamism, physical processes and channel complexity.

These jams can be specifically used to encourage lateral migration of the channel into the eroding bank of an elevated floodplain surface or terrace. This material will be incorporated into the channel and the channel migration will ultimately increase the width of the active channel corridor and the potential for establishment of new riparian vegetation, including sycamores.

Channel Spanning Jam

A channel spanning jam typically consists of multiple key log members as well as accumulated woody material that effectively fill and block much or all of the channel's bankfull cross section. Depending on the density of the jam, it may substantially deflect flows or impound the channel altogether. Channel spanning jams can have significant effects on reach-scale hydraulics and WSEs, particularly during high flow events. Often the jam raises WSEs upstream and can encourage floodplain and secondary channel activation. Channel spanning jams can also drive channel widening, avulsion and other forms of channel dynamism. These jams can also encourage bed aggradation in the reach upstream of the jam where increased WSEs occur and decreased in-channel velocities during high flow events promote sediment deposition. Installation of a channel spanning jam can be considered at Pacheco Creek to promote bed aggradation and secondary channel and floodplain activation, particularly along the more incised reach at the upstream extent of the Pacheco Creek Reserve property.

Floodplain Large Wood Complex

Large wood can naturally accumulate on a floodplain, often beginning with one or more larger members being snagged by or racked on a standing tree or other stationary object (e.g., boulder or rock outcrop, infrastructure, etc.) on the floodplain. Additional woody material can accumulate, forming a large wood complex on the floodplain. This material can influence local hydraulics during high flows and drive localized areas of scour, deposition and topographic complexity on the floodplain. At Pacheco Creek, several examples of small complexes of large wood on the floodplain are visible, typically anchored by a mature, living tree. Additional floodplain large wood complexes could be installed to drive localized topographic complexity, protect existing or planted juvenile sycamores, and drive formation of habitat conditions (e.g., local scour pockets) that may increase likelihood of natural recruitment of riparian vegetation, including sycamores. These complexes may be particularly fruitful along otherwise topographically homogenous depositional bars near the main channel.

Log Step

A log step typically consists of a single, channel-spanning log situated on the stream bed. The log is usually oriented perpendicular to flow and completely or partially blocks flow, such that water flows over the top of the log. Log steps often serve as low-flow hydraulic controls. Scour pools typically form downstream of the log and may ultimately undermine the log step and its control on low-flow hydraulics (Abbe and Montgomery 2003; BOR and U.S. Army Engineer Research and Development Center 2016). Log steps can be installed along Pacheco Creek's less frequently activated secondary channels and flows paths across the floodplain (floodplain runners) to drive formation of scour pools or scour features that can serve as natural recruitment or planting locations for sycamores. Within the study area, riparian vegetation, including sycamores have naturally recruited along similar floodplain runners and infrequently activated secondary channels where buried/at-grade riprap grade controls have generated downstream scour features that have likely provided suitable proximity to shallow groundwater facilitating riparian vegetation establishment. Log step site selection and orientation can be modeled on this successful example of unintentional riparian vegetation recruitment behind grade control features.

Wood Augmentation (locally sourced, not stabilized)

Locally sourced large wood that is currently present on the outer floodplain (e.g., fallen dead sycamores) or further upland can be strategically relocated in the main channel or inner floodplain. This material can be placed in the main channel to enhance physical processes (e.g., localized bed scour), channel complexity and habitat quality, particularly along more homogeneous reaches. These benefits will support steelhead, as will the presence of additional cover provided by the large wood. Locally sourced large wood can also be placed on the inner floodplain to drive greater topographic complexity and to potentially support recruitment of riparian vegetation, including sycamores. Large wood can be either partially secured by situating it against and/or between trunks of standing trees or it can be left in positions where it can be transported during higher flows. Before utilizing existing on-site large wood for this purpose, however, the ecological value of the wood in its present location (likely far from the channel) must also be considered unless it's at significant risk for off-site transport (e.g., illegally collected for firewood by trespassers).

Biotechnical Bank Stabilization

Biotechnical bank stabilization measures refer to environmentally sensitive approaches to stabilizing a stream bank using a combination of plant material and structural elements. Compared with traditional engineering approaches to bank stabilization, biotechnical approaches can improve habitat for aquatic and terrestrial species and enhance and ecological health while achieving bank stability goals. Specific biotechnical solutions include but are not limited to large woody structures (e.g., root wads), live brushlayering, live staking, vegetated mechanically stabilized earth and coir netting. At Pacheco Creek, these measures can also be combined with a bank layback to provide shallower more stable bank slopes. In addition to providing greater habitat value that traditional bank stabilization approaches, biotechnical solutions are typically more amenable to wildlife agencies when they are reviewed for permits.