H. T. HARVEY & ASSOCIATES
Ecological Consultants

Upper Penitencia Creek Improvement Project
Year 4 (2016) Monitoring Report

Project 3518-03

Prepared for:

Ann Calnan
Santa Clara Valley Transportation Authority
3331 N. First Street, Building B
San Jose, CA 95134

Prepared by:

H. T. Harvey & Associates
in collaboration with:
Balance Hydrologics

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983 University Avenue, Building D • Los Gatos, CA 95032 • Ph: 408.458.3200 • F: 408.458.3210

Executive Summary

Permit Numbers

- U.S. Army Corps of Engineers File No. 28924S
- Regional Water Quality Control Board Site No. 02-43-C0654 (bkw)
- California Department of Fish and Wildlife Notification No. 1600-2011-0303-R3

Background

The Upper Penitencia Creek Improvement Project (Project) was designed to mitigate construction-related impacts on riparian habitat and federal and state jurisdictional wetlands and waters arising from implementing the Santa Clara Valley Transportation Authority's Bay Area Rapid Transit Silicon Valley Berryessa Extension (SVBX) Project. The mitigation design consisted of the creation of 1.0 acre of riparian habitat, 1.06 acres of floodplain wetland habitat, and approximately 982 linear feet of stream channel. Mitigation site construction was completed in October 2012, and native riparian and wetland plants were installed in January 2013. The Project site is located at the downstream end of Upper Penitencia Creek, southwest of the intersection of Berryessa Road and North King Road, in San Jose, Santa Clara County, California (Figure 1).

The Project's mitigation and monitoring plan and fish monitoring plan require monitoring vegetation, stream geomorphology and hydrology, and fish ecology. The site failed to meet its Year 1 woody plant survival performance criterion because of the high mortality rate of Fremont cottonwood (*Populus fremontii*) and willow (*Salix* spp.) cuttings, which were installed at a very high density (1-foot on-center spacing). H. T. Harvey & Associates prepared a revised vegetation monitoring plan that shifted from a survival-based monitoring program to a habitat function–based monitoring program that assesses woody plant cover, tree height, invasive species cover, wetland habitat characteristics, woody plant health and vigor, natural recruitment, and woody plant species richness. The new monitoring methodology was developed in coordination with the California Department of Fish and Wildlife (CDFW) and approved by both the CDFW and the Regional Water Quality Control Board. It was based on an overall reassessment of the initial monitoring plan not only due to the die off of certain plants but also because CDFW felt the new methodology was a better approach to assess the development of the mitigation site over time. The Project's fish monitoring plan includes a quantitative assessment of the post-Project fish community, particularly site use by the Central California Coast steelhead (*Oncorhynchus mykiss*) distinct population segment, which is federally listed as endangered.

The Project's mitigation and monitoring plan identified the following mitigation goals:

- Restore hydrologic and geomorphic functions, including sediment transport and deposition.
- Restore floodplain connectivity and flood storage.

- Restore fish and wildlife habitats, including the provision of on-site habitat and passage for the federally listed Central California Coast steelhead distinct population segment.
- Improve water quality.

Vegetation monitoring is required in Years 2–4, 6, 8, and 10, in accordance with the revised vegetation monitoring plan. In accordance with the Project's mitigation and monitoring plan, hydrology and geomorphic monitoring will be conducted annually through Year 5, after which full monitoring will be implemented only in those years that experience a design bankfull flow (270 cubic feet per second) or greater. Fish monitoring will be conducted annually through Year 5, in accordance with the Project's fish monitoring plan. This report describes the overall conditions of the site in Year 4 and fulfills the requirement for Year 4 monitoring.

Results

Vegetation

Riparian woodland and wetland habitat is developing rapidly at the mitigation site. The Streamside, Bar, and Boulder Bank Planting Zones (Streamside Area) achieved 70.8% cover, which exceeds the 30% cover criterion required for Year 4 and also exceeds the final (Year 10) success criterion of 65% cover. The Floodplain and Upper Slope Planting Zones (Floodplain Area) achieved 32.1% cover, which exceeds the 10% cover criterion required for Year 4. The average percent cover of native woody species overhanging the bankfull channel increased from 24.7% in Year 3 to 53.2% in Year 4, and average tree height in the Streamside Area increased from 11.9 feet in Year 3 to 15.6 feet in Year 4, which meets the performance criteria of increasing percent cover of overhanging vegetation and increased tree height between monitoring years.

Invasive species were not observed along any of the vegetation monitoring transects. However, eight invasive species were identified elsewhere on the site. Two of the eight invasive species, giant reed (*Arundo donax*) and sweet fennel (*Foeniculum vulgare*), are rated "high" and one of the eight invasive species, stinkwort (*Dittrichia graveolens*), is rated "moderate–ALERT" by the California Invasive Plant Council. The percent cover of invasive species throughout the site as a whole was approximately 3%, meeting the Year 4 performance criterion of less than 5% cover by invasive species.

Dead and missing plants identified during the Year 3 monitoring were replaced in February 2016. Seventy-five willow cuttings were installed in vegetation gaps in the Streamside Area (red willow [*Salix laevigata*], arroyo willow [*Salix lasiolepis*], and sandbar willow [*Salix exigua*] cuttings), and 134 plantings (eight species) were installed in empty plant basins in the Floodplain Area.

Two floodplain wetlands, totaling approximately 0.23 acre, and two in-channel wetlands, totaling approximately 0.15 acre, have developed at the mitigation site. The wetlands are dominated by hydrophytes ("water-loving" vegetation) and have indicators of wetland hydrology, including surface water, saturation, surface soil cracks, and algal mats.

On average, the mitigation plantings were in good condition and exhibited high health and vigor. Approximately 92.4% of surviving woody plantings were in good condition, and 7.6% were in fair condition. Twenty-five stems of naturally recruiting native woody species were counted in seventeen 1,000-square-foot transect bands. The average number of recruiting individuals was 0.1 per 1,000 square feet in the Streamside Area and 0.2 per 1,000 square feet in the Floodplain Area. Coyote brush (*Baccharis pilularis*) had the highest stem densities of naturally recruited individuals. Twenty-one native woody species were observed on the Project site.

Stream Geomorphology and Hydrology

Total annual precipitation in water year 2016 was 14.91 inches, approximately 102% of average (14.7 inches); however, according to the National Drought Mitigation Center, the region continued to be in a state of moderate to severe drought. Most of the annual precipitation occurred during five storm events between November 2015 and April 2016. Streamflow was intermittent through much of the year and, because of low groundwater levels and high infiltration rates, went subsurface before entering the Project site during most rainfall and runoff events. Peak flows exceeded bankfull flow (270 cubic feet per second) three times. A peak streamflow of 650 cubic feet per second was recorded on January 18, 2016. The longest continuous streamflow event (18 days) was measured from March 6 to 24, 2016. Several streamflow events were large enough to mobilize bedload sediments. Sedimentation occurred throughout the channel and portions of the floodplain as a result of natural geomorphic processes, high peak flows, increased hydraulic roughness caused by young riparian vegetation, and backwatering caused by an instream logjam downstream of the Project site. Aggradation is expected to decrease over time as the riparian plantings mature and the logjam breaks apart. The creek channel cross-sections remained stable.

Fish

During Year 4, standard biannual (spring and fall) electrofishing surveys were not conducted. Because of the lack of persistent surface water during spring and fall monitoring periods for 2016, the habitat units on the Project site were dry or contained shallow, stagnant water not conducive to electrofishing. The Project site was hydrologically isolated from reaches downstream and upstream, and was not receiving surface flow at the time of our surveys. In habitat units containing standing water, there was no discernable flow, and the water quality in these units was determined to be too poor to allow safe electrofishing. Performing electrofishing surveys under these circumstances would cause additional, possibly lethal, stress to fish already subject to poor water quality conditions. Streamflow through the Project site, however, did occur on several occasions. The major streamflow events that were measured occurred during the typical (December through March) adult steelhead spawning migration period, and upstream passage through the Project site may have been possible for adult steelhead during the brief flow events.

Project goals for the provision of native fish habitat were not met in Year 4 because of 1) lack of flow likely due to drought conditions in previous years that reduced groundwater levels, 2) historically intermittent flow conditions in the Upper Penitencia Creek ecosystem, and 3) potentially because of upstream water diversions. Native and nonnative fishes are expected to redistribute into and through the restored channel when it becomes watered as the region emerges from drought.

Management Recommendations

The following management recommendations should be implemented to keep the site on a trajectory toward successful long-term establishment and attainment of the Project's final success criteria:

- Continue to monitor for invasive plant species to ensure that the invasive species percent cover criteria are met. The monitoring biologist should locate and map weeds once during late spring and once in mid-summer to inform invasive plant control needs. Invasive plants should be controlled within 1 month of the monitoring biologist's map results.
- Avoid removing invasive plants from the invasive plant maintenance test plots so that future monitoring may discern the likely long-term trajectory of plant community composition (i.e., the proportion of native versus invasive plant species) in the absence of invasive plant control.
- Maintain planting basins free of weeds by periodically hand-pulling all native and nonnative weeds growing in the planting basins.
- Maintain (through weed whacking) all herbaceous vegetation outside basins to a maximum height of 1 foot. Native woody species should be avoided during weed whacking.
- Formal irrigation should cease. However, the temporary irrigation system should be left in place in the event that significant drought stress is observed during the Year 5 growing season and it is determined that additional irrigation is required to avoid substantial plant mortality. Monitor the conditions of the mitigation plantings during summer 2017 to determine the condition of plants in response to weather conditions. If annual precipitation is below average and the plants show signs of drought stress (e.g., wilting leaves, chlorosis, thinning canopy), the biologist will determine whether the plants need to be irrigated.
- In accordance with input provided by NMFS during a field visit on November 8, 2016, large woody debris (e.g., fallen cottonwood in the upstream reach) should be left in the channel to provide instream habitat complexity for fish, provided that the Santa Clara Valley Water District approves of this approach from a flood control perspective.

Agency Actions

No agency action is requested at this time.

Table of Contents

Figures

Tables

Photographs

Appendices

Preparers

H. T. Harvey & Associates

Daniel Stephens, B.S., Principal Restoration Ecologist
Sharon Kramer, Ph.D., Principal Fish Ecologist
Max Busnardo, M.S., Senior Restoration Ecologist, Project Manager
Peter Nelson, Ph.D., Senior Fish Ecologist
Charles McClain, M.S., Restoration Ecologist
Matt Pollock, M.S., Restoration Ecologist
Neil Kalson, B.S., Fish Ecologist
Michele Childs, M.S., GIS Analyst
James Merk, M.A., Technical Editor

Balance Hydrologics

Shawn Chartrand, C.E.G, P.G., Principal Geomorphologist
Brian Hastings, M.S., P.G., Geomorphologist/Hydrologist

Section 1.0 Introduction

1.1 Permit Numbers

This report fulfills the requirement for annual mitigation monitoring reports in accordance with the following permits:

- U.S. Army Corps of Engineers File No. 28924S
- Regional Water Quality Control Board Site No. 02-43-C0654 (bkw)
- California Department of Fish and Wildlife Notification No. 1600-2011-0303-R3

1.2 Background

1.2.1 Jurisdictional Habitat Impacts and Mitigation Construction

The Upper Penitencia Creek Improvement Project (Project) was designed to mitigate construction-related impacts on riparian habitat and federal and state jurisdictional wetlands and waters arising from implementing the Santa Clara Valley Transportation Authority's (VTA's) Bay Area Rapid Transit (BART) Silicon Valley Berryessa Extension Project (SVBX Project). The mitigation design consisted of the creation of 1.0 acre of riparian habitat, 1.06 acres of floodplain wetland habitat, and approximately 982 linear feet of stream channel. The Project site is located at the downstream end of Upper Penitencia Creek, southwest of the intersection of Berryessa Road and North King Road, in San Jose, Santa Clara County, California (Figure 1). The 2.06-acre habitat mitigation site is situated approximately 1,400 feet upstream from the Coyote Creek confluence.

The SVBX Project site consists of the first approximately 10 miles of the larger 16-mile BART Silicon Valley Extension. Construction of the SVBX Project involved replacing a Union Pacific Railroad bridge with a BART aerial guideway and replacing an undersized roadway bridge over a double box culvert with a free-span bridge; both were constructed over Upper Penitencia Creek. The new crossings shaded 0.11 acre of the creek. Approximately 0.02 acre of the creek was daylighted by removing the double box culvert. Removal of this culvert and the undersized bridge increased flood conveyance capacity and reduced instream velocities of the creek, benefiting native fish populations. Throughout the rest of the SVBX Project alignment, construction included railroad realignment and regrading of 1,940 linear feet of earthen channels, which eliminated 0.5 acre of wetland habitat.

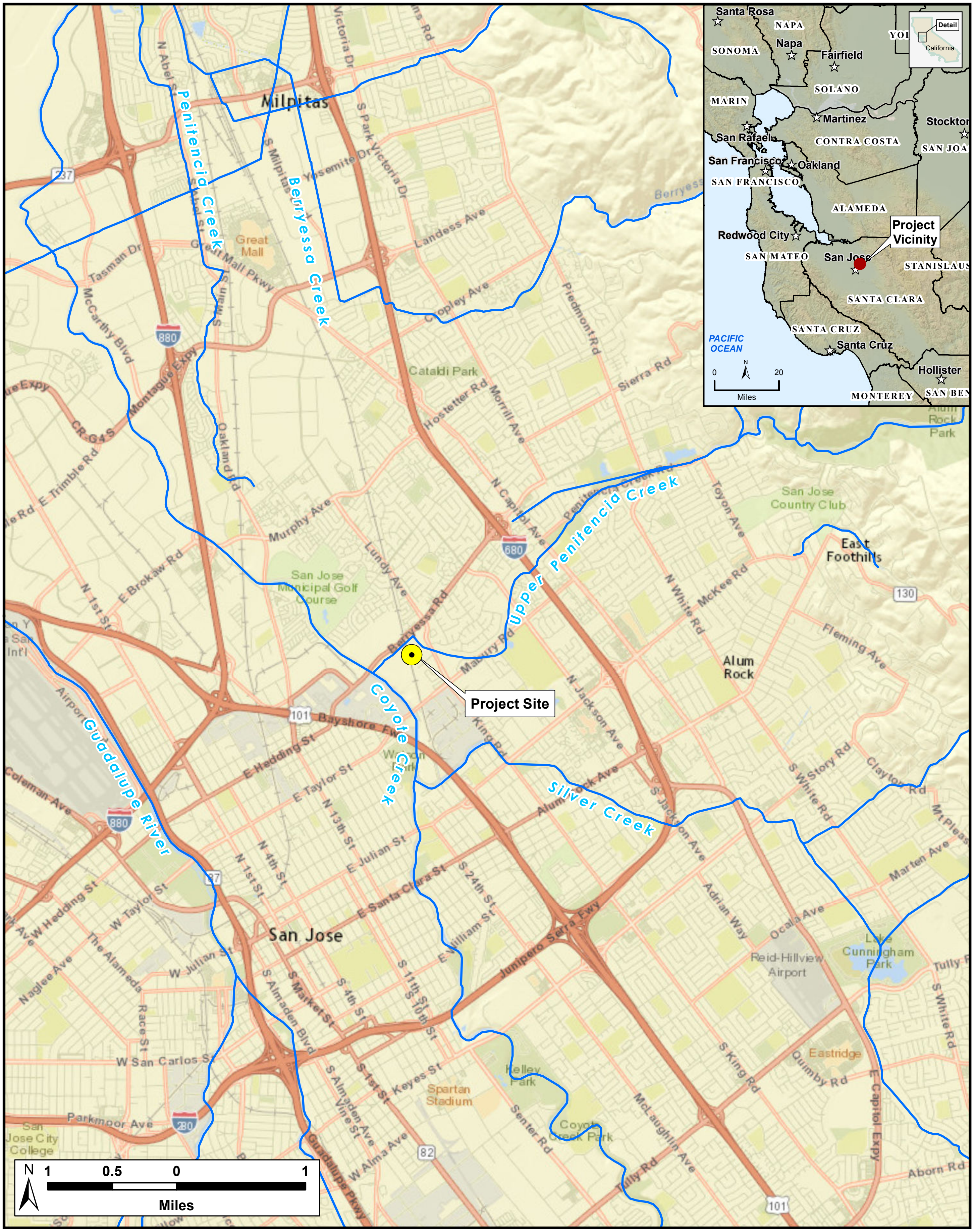

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Figure 1: Vicinity Map
Upper Penitencia Creek Improvement Project
Year 4 (2016) Monitoring Report (3518-03)
February 2017

To mitigate impacts on jurisdictional habitats, the Project's mitigation and monitoring plan (MMP) required creation of 1.06 acres of floodplain wetland habitat and restoration of 1.0 acre of riparian habitat on the Project site (ICF International 2012). The MMP identified the following mitigation goals for the Project:

- Restore hydrologic and geomorphic functions, including sediment transport and deposition.
- Restore floodplain connectivity and flood storage.
- Restore fish and wildlife habitats, including the provision of on-site habitat and passage for the federally listed Central California Coast steelhead (*Oncorhynchus mykiss*) distinct population segment.
- Improve water quality.

The Project involved realigning and regrading the creek channel to restore natural geomorphic and ecological functions, including constructing secondary channels and floodplain wetlands to accommodate high flows, as well as a widened floodplain with restored riparian habitat. Bioengineered bank treatment structures (root wads and boulders) were installed to protect the new creek configuration and improve aquatic habitat functions.

Mitigation site construction was completed in October 2012. Native riparian and wetland plants were installed in January 2013 by Marina/East Bay Construction. Plants were installed throughout six planting zones (Bar, Boulder Bank/Wrapped Soil Lift, Streamside, Floodplain, Wetland, and Upper Slope) and around bank treatment structures, including large woody debris root wads (Figure 2). The site was hydroseeded with native grasses and forbs. A total of 3,413 native woody trees and shrubs and 1,434 native herbaceous plantings were planted throughout the mitigation site (Anil Verma Associates 2013).

1.2.2 Revised Vegetation Monitoring Plan

H. T. Harvey & Associates restoration ecologists monitored the vegetation in 2013 (H. T. Harvey & Associates 2013a) in accordance with the MMP. Willow (*Salix* spp.) and Fremont cottonwood (*Populus fremontii*) cuttings were installed on 1-foot centers in the Boulder Bank Planting Zone (Figure 2)—a high planting density for these species—to rapidly stabilize the banks. The site failed to meet its Year 1 woody plant survival performance criterion of 90% in large part because of the high mortality rate of those cuttings. We speculate that the low cutting survival rate was attributable to the high planting density, which exacerbated the competition for water (H. T. Harvey & Associates 2013a). In response to the low survival rate and as prescribed by the MMP, VTA replanted 236 plants in February 2014 and 268 plants in March 2015 to bring the survival rate up to 90% (H. T. Harvey & Associates 2014a and 2016, Morley pers. comm. 2015).

In an interagency meeting held on April 29, 2014, with the California Department of Fish and Wildlife (CDFW), the Regional Water Quality Control Board (RWQCB), and VTA, H. T. Harvey & Associates expressed concern that the low survival rate of cuttings would continue in future years, that the final percent survival success criterion of 70% survival (ICF International 2012) may not be attainable, and that habitat-based metrics would better assess target vegetation establishment. CDFW, RWQCB, VTA, and H. T. Harvey & Associates agreed that VTA would propose a revised vegetation monitoring plan (VMP) (H. T. Harvey & Associates 2014b). The group also agreed that a habitat-based VMP would be more useful in assessing the trajectory of habitat

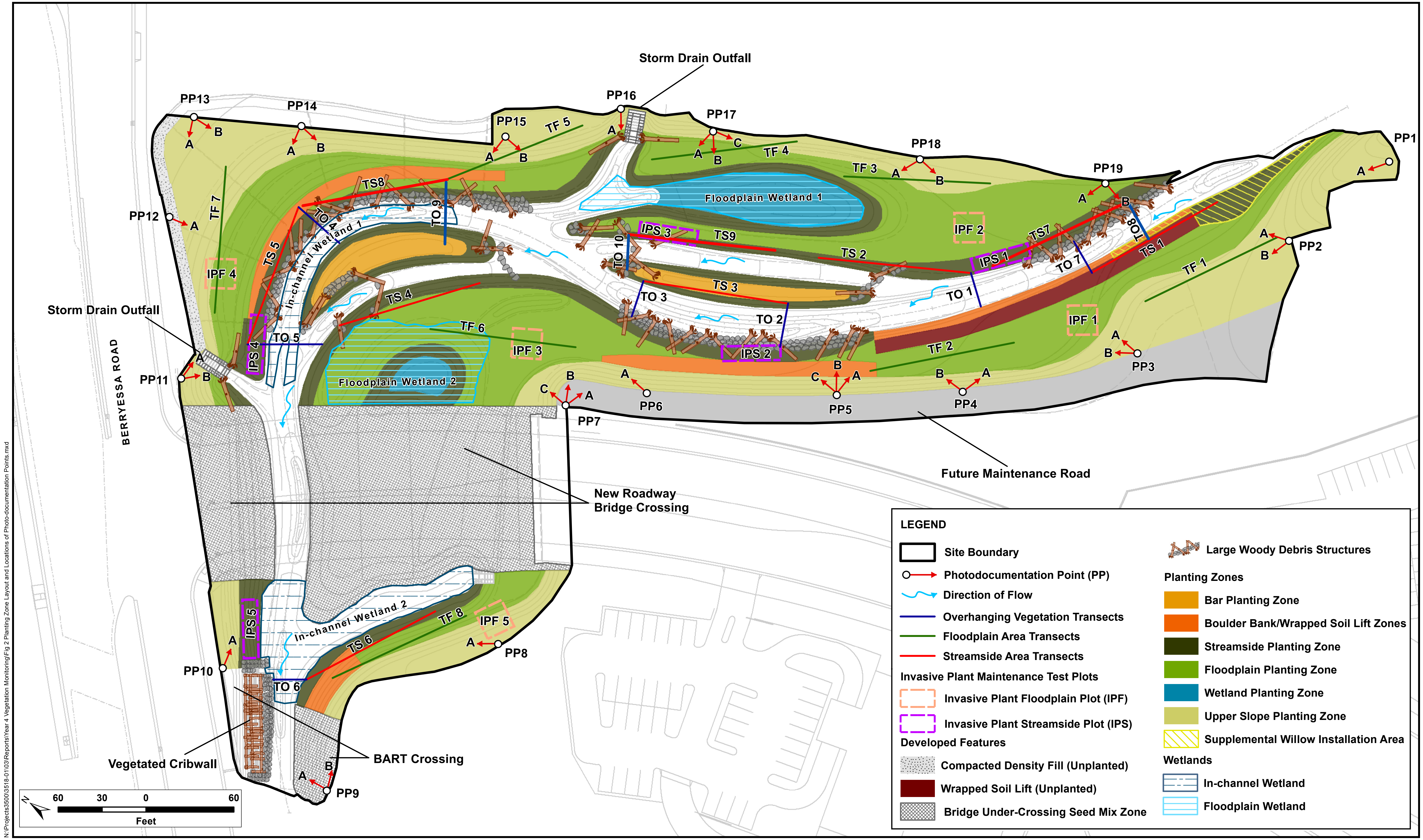


Figure 2: Planting Zone Layout and Locations of Vegetation Sampling Transect and Photodocumentation Points

Upper Penitencia Creek Improvement Project Year 4 (2016) Monitoring Report (3518-03)
February 2017

H. T. HARVEY & ASSOCIATES
Ecological Consultants

establishment and that the revised plan would shift from survival monitoring to a habitat function–based monitoring program (H. T. Harvey & Associates 2014b). Therefore, a revised VMP (H. T. Harvey & Associates 2014c) was submitted to the resource agencies on September 4, 2014.

The revised VMP emphasized the use of metrics that assess habitat functionality. It also established vegetation performance and success criteria that, when compared to monitoring data, will indicate whether the mitigation site is developing toward the Project's long-term habitat goals. The VMP called for vegetation monitoring of both the Streamside Area (consisting of the Streamside, Bar, and Boulder Bank Planting Zones) and the Floodplain Area (consisting of the Floodplain and Upper Slope Planting Zones). The VMP established that all future vegetation monitoring will be conducted in accordance with the VMP and its performance and success criteria and that the VMP will supersede Sections 5.1, 5.3, and 5.4 of the MMP (ICF International 2012). Table 1 summarizes the VMP's vegetation performance and success criteria.

Table 1. Vegetation Performance and Final Success Criteria

Monitoring Task	Year 2 2014	Year 3 2015	Year 4 2016	Year 6 2018	Year 8 2020	Year 10[1] 2022
Woody Plant Percent Cover						
Streamside Area[2]	20%	25%	30%	40%	55%	65%
Floodplain Area[3]	5%	7%	10%	15%	20%	30%
Vegetation Overhanging Bank-full Channel[4]	Baseline (23.8%)	>Year 2	>Year 3	>Year 4	>Year 6	>Year 8
Invasive Species Percent Cover	<5%	<5%	<5%	<5%	<5%	<5%

[1] Final success criteria.

[2] Streamside, Bar, and Boulder Bank Planting Zones.

[3] Floodplain and Upper Slope Planting Zones.

[4] The average percent cover of vegetation overhanging the bankfull channel in Year 2 was 23.8%, which will serve as the baseline cover value for subsequent monitoring years.

The MMP's long-term monitoring requirements include fish monitoring, as well as vegetation and stream geomorphology/hydrology monitoring. Term and Condition 3b of the National Marine Fisheries Service (NMFS) Biological Opinion (NMFS 2012) for the Project required VTA to develop a post-construction fish monitoring plan (FMP) to evaluate post-Project use of the site by fish. The final FMP (H. T. Harvey & Associates 2013b) was approved by NMFS on June 13, 2013.

Vegetation monitoring is required in Years 2–4, 6, 8, and 10, in accordance with the VMP (H. T. Harvey & Associates 2014c). In accordance with the MMP, hydrology and geomorphic monitoring will be conducted annually through Year 5, after which full monitoring will be implemented only in those years that experience a design bankfull flow (270 cubic feet per second) or greater (ICF International 2012). Fish monitoring will be conducted annually through Year 5, in accordance with the FMP (H. T. Harvey & Associates 2013b). This report presents the Year 4 vegetation, stream geomorphology, and fish monitoring results; comparisons of current vegetation performance to VMP performance criteria; and management recommendations.

Section 2.0 Methods

2.1 Vegetation

The VMP's vegetation performance and final success criteria metrics include percent cover for native woody trees and shrubs, percent cover for invasive species, and tree height. Therefore, H. T. Harvey & Associates monitored these metrics in Year 4. In addition, per the VMP, we monitored wetland habitat characteristics, plant health and vigor, natural recruitment, and native tree and shrub species richness, and conducted photodocumentation.

H. T. Harvey & Associates' restoration ecologists Charles McClain, M.S., and Matt Pollock, M.S., collected the Year 4 vegetation monitoring data on August 31 and September 1, 2016. Plant nomenclature follows Baldwin et al. (2012). Vegetation monitoring was conducted in accordance with the VMP methods as summarized below.

2.1.1 Woody Plant Percent Cover

In Year 2, 14 permanent 100-foot vegetation monitoring transects were established (transect end points were marked with metal U-posts) in a stratified random design: six in the Streamside Area and eight in the Floodplain Area. In Year 4, three transects were added to the Streamside Area, to increase the accuracy of the percent cover estimate, for a total of nine transects in this area. The transect locations are shown in Figure 2. Percent cover of native woody species (trees and shrubs) was estimated along each transect using the line intercept method (Bonham 1989). Along each transect, data were collected by recording length of native woody vegetation transect intercept in inches. The Kershaw Method was used to verify that an adequate number of transects were sampled to estimate average percent cover (Kershaw 1973). Average percent cover was determined for native woody vegetation in each planting area to allow comparison with site performance criteria in Table 1. Percent cover was estimated for each species by averaging the total percent cover of woody plants (summed among species for each transect) across transects. This method allows the calculation of statistical variance.

2.1.2 Overhanging Vegetation Percent Cover

In accordance with the VMP, overhanging vegetation cover refers to the amount of vegetative canopy that hangs over the water surface of the bankfull channel. The bankfull channel is defined as the area between the field indicators of ordinary high water (e.g., shelving, wrack, upper extent of visible scour, lower extent of obligate riparian tree recruitment) on each bank slope.

In Year 2 (2014), seven vegetation monitoring transects were established in a stratified random design perpendicular to the streambank, extending the entire width of the bankfull channel. In Year 4, three additional transects were established to increase the accuracy of the percent cover estimate. The transect locations are shown in Figure 2. Percent cover of native woody species (trees and shrubs) overhanging the bankfull channel was estimated along each transect, using the line intercept method (Bonham 1989). The Kershaw Method was used to verify that an adequate number of transects were sampled to estimate average percent cover (Kershaw 1973). Average percent cover was determined for all native woody vegetation overhanging the bankfull channel to allow comparison with site performance criteria in Table 1. Percent cover was estimated for each species by averaging the total percent cover of woody plants (summed among species for each transect) across transects.

2.1.3 Tree Height

Tree height was measured in the Streamside Area on three or more randomly selected native trees along each transect that had at least three trees. A stadia rod was used to estimate the height of each tree to the nearest 0.1 foot. The Kershaw Method was used to verify that an adequate number of transects were sampled to estimate average tree height among species (Kershaw 1973). Average tree height of all trees and for each species was calculated for comparison between monitoring years. The VMP's final tree height success criterion requires an increasing temporal trend in average tree height among species, across monitoring years. Therefore, we calculated average tree height by averaging the total tree height across transects, then graphed the result as a function of monitoring year to assess the temporal trend to determine if the site is on a trajectory toward meeting the final success criterion.

2.1.4 Invasive Plant Species Percent Cover

Percent cover of invasive plant species was measured along all the monitoring transects and compared to the performance and success criteria presented in Table 1. Moreover, the entire site was visually assessed for invasive plants, and any substantial patches were mapped to inform control efforts. Invasive species were characterized as those species with moderate to high invasiveness as rated by California Invasive Plant Council (Cal-IPC) (2016). Cal-IPC ratings refer to the level of negative ecological impact presented by the species.

Per the VMP, we installed invasive plant maintenance test plots on September 1, 2016, to discern the likely long-term trajectory of plant community composition (i.e., the proportion of native versus invasive plant species) after the final criteria are met and invasive plant control ceases at the site. No invasive plant maintenance activities will be performed in the test plots. Five replicate test plots were established in each of the two primary habitat types at the site: Streamside Area and Floodplain Area. Each test plot is a 400-square-foot rectangle (thereby all test plots combined cover approximately 4–5% of the site) that is permanently marked with metal U-posts. The perimeter of each plot is delineated by yellow rope. Their locations are shown in Figure 2.

Each plot was visually surveyed for the presence of invasive and native species, and the dominant species were recorded by plot and by habitat type. The percent cover of invasive plant species (all species combined) and native plant species (all species combined) was recorded for each plot. The average percent cover of invasive species and native species was calculated among the plots by habitat type.

2.1.5 Dead Plant Assessment

Plant survival was monitored in Years 2 and 3 to guide dead plant replacement. Dead and missing plants identified during the Year 3 (2015) monitoring period were replaced in February 2016. Per the VMP, plant survival monitoring was not conducted in Year 4, and dead plant replacement is not required in future years unless the site is deemed to be falling so far short of performance criteria that it is clear that the final success criteria will not be met (H. T. Harvey & Associates 2014c).

2.1.6 Wetland Habitat Characterization

Floodplain wetlands that have developed throughout the mitigation site were qualitatively characterized through reconnaissance surveys. This assessment involved mapping the general locations of the wetlands, measuring the approximate surface area of each floodplain wetland feature, taking representative photographs, recording hydrological observations, and recording wetland plant community composition and structure.

2.1.7 Woody Plant Health and Vigor

Health and vigor were qualitatively assessed for all planted trees and shrub plantings that intercepted the Streamside Area and Floodplain Area vegetation monitoring transects, using the numerical scale shown in Table 2. Additional trees and shrubs within 5 feet of the monitoring transects were assessed to increase the sample size. Factors such as internode length, leaf color, leaf size, browse damage, disease symptoms, and insect infestation were considered. The percentage of individuals by species that fall into the three general health and vigor classes was calculated.

Table 2. Woody Plant Health and Vigor Scale

Health and Vigor Class	Numeric Rating	Observations
Good condition	3	Plant has relatively long internode lengths and most or all leaves show healthy color and size, and/or <25% of plant's aboveground growth is affected by browse damage, disease, or insect infestation.
Fair condition	2	Plant has medium to long internode lengths and most leaves show healthy color and size, and/or 25–75% of plant's aboveground growth is affected by browse damage, disease, or insect infestation.
Poor condition	1	Plant has relatively short internode lengths and few or some leaves show healthy color and size, and/or >75% of plant's aboveground growth is affected by browse damage, disease, or insect infestation.

Source: ICF International 2012

2.1.8 Woody Plant Natural Recruitment

Natural recruitment was measured by counting the number of stems of naturally recruiting native woody species encountered within 5 feet of the 17 permanent, 100-foot vegetation monitoring transects. Data were collected by species and transect, and the average number of recruiting individuals was calculated across transects by species.

2.1.9 Woody Plant Species Richness

Woody plant species richness was determined by compiling a list of all native tree and shrub species throughout the Project site by habitat type.

2.2 Stream Geomorphology and Hydrology

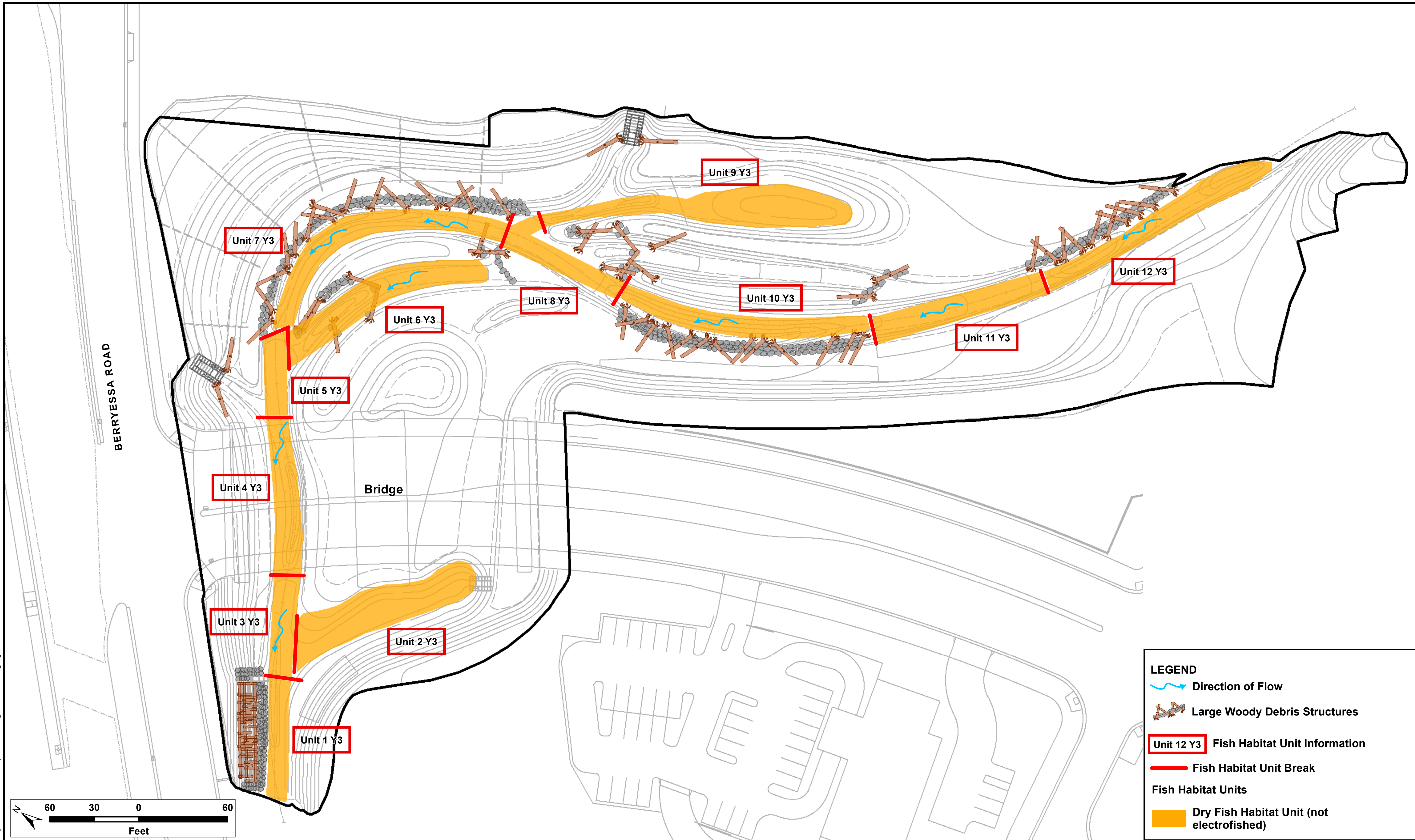
The Project's MMP requires geomorphic and hydrologic monitoring over two phases: 1–5 years after construction (Phase 1) and 6–10 years after construction (Phase 2). Phase 1 monitoring involves full physical monitoring in Years 1, 3, and 5 and scaled-back monitoring in Years 2 and 4; however, full physical monitoring was conducted this year (Year 4) instead of Year 3 because Year 4 included substantial flood events whereas Year 3 did not. During Phase 2, monitoring is required only in years that experience a design bankfull flow or greater (≥270 cubic feet per second).

In Year 4, the Project's geomorphologist (Balance Hydrologics) measured bedload sediment transport, completed four streamflow measurements and one indirect peak flow calculation, completed a habitat-velocity profile, repeated channel thalweg and cross-section surveys, reviewed groundwater levels and recent trends, collected sediment transport samples, and repeated photodocumentation. An instrument that records continuous water-level measurements was installed on the Project site in February 2016 near the downstream end of the Project reach. Details of the methods used for geomorphic and hydrologic monitoring are presented in Balance Hydrologics' Year 4 geomorphic and hydrologic monitoring report (Appendix A).

2.3 Fish

The purpose of fish monitoring at the Project site is, as stated in the FMP, "to identify the use of the restored site by fish, and to identify if the site is being used by steelhead, *Oncorhynchus mykiss*" (NMFS 2012). To this end, monitoring is focused on documenting the relative abundance of fish species and their habitat associations on the Project site. To meet that goal, the Project's FMP calls for fish monitoring, timed to coincide with the reported and observed outmigration of juvenile steelhead, by means of electrofishing. Electrofishing surveys were to be conducted two times per year—once in late spring/early summer and once in late summer/early fall—for 5 years. Drought conditions and the near absence of water from the Project site, however, has not allowed for electrofishing since Year 1.

H. T. Harvey & Associates fish ecologists conducted the initial Year 1 fish monitoring surveys in fall 2013 in accordance with the FMP. During the Year 1 surveys, H. T. Harvey & Associates fish ecologists identified and mapped 12 habitat units on the Project site (Figure 3). Each unit was defined by distinct features (e.g., depth, habitat structures) and described based on habitat types in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 2010). During Years 2–4, standard electrofishing surveys were not conducted because most



N:\Projects3500\3518-01\03\Reports\Year 4 Vegetation Monitoring\Fig 3 Distribution of Fisheries Habitat Units.mxd

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Figure 3: Distribution of Fish Habitat Units
Upper Penitencia Creek Improvement Project Year 4 (2016) Monitoring Report (3518-03)
February 2017

of the Project site was dry or contained standing water. Performing electrofishing surveys under these conditions would cause additional, possibly lethal, stress to fish already subject to poor water quality conditions. In spring 2016, H. T. Harvey & Associates fish ecologists Neil Kalson, B.S., and Peter Nelson, Ph.D., visited the Project site to confirm that habitat units were dry and that the Project site was disconnected from downstream and upstream reaches. In October 2016, Peter Nelson, while documenting changes to the streambed relevant to fish habitat and fish passage, confirmed that Project units were still dry and disconnected. Hence, Year 4 electrofishing surveys were not conducted during spring or fall.

2.4 Photodocumentation

Photographs to track habitat establishment were taken from 19 photodocumentation points on September 1, 2016, as shown in Figure 2. The Year 4 photographs were compared with photographs taken in Year 1 (2013). Twenty-seven additional photographs were taken during fish habitat and passage monitoring in fall 2016 to document changes to fish habitat units. Photographs taken during vegetation photodocumentation are presented in Appendix B, and photographs taken during fish habitat photodocumentation are presented in Appendix C.

Section 3.0 Results and Discussion

3.1 Vegetation

3.1.1 Woody Plant Percent Cover

Streamside Area. A relatively stable estimate of the average percent cover of woody plants in the Streamside Area was obtained after nine transects were surveyed (Figure 4). We concluded that nine transects composed an adequate sample size to accurately estimate average woody plant cover, and we calculated the margin of error using a 95% confidence interval, which allowed us to compare the average percent cover to the performance criterion and therefore represent the data more accurately.

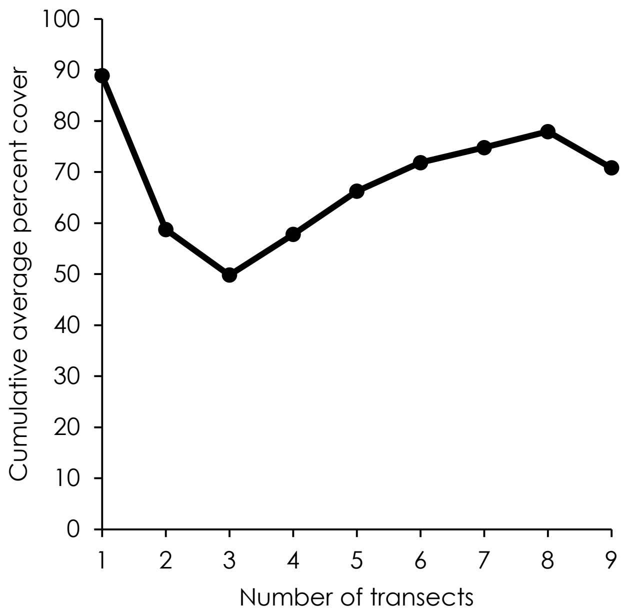

Figure 4. Cumulative Average Percent Cover of Woody Plants in the Streamside Area as a Function of the Number of Transects Sampled

The VMP performance criterion for native woody plant cover in the Streamside Area in Year 4 is 30% (H. T. Harvey & Associates 2014c). Average percent cover of woody plants in Year 4 was 70.8 ± 23.1%, exceeding the performance criterion and indicating that high-quality streamside riparian habitat is developing rapidly at the mitigation site (Figure 5). The average percent woody cover in Year 4 also exceeded the final (Year 10) success criterion of 65%.

A substantial increase in average woody plant cover was observed between Year 3 (51.9%) and Year 4 (70.8%), due to the rapid growth of native riparian plant species. Species with the greatest cover in the Streamside Area were sandbar willow (*Salix exigua*), arroyo willow (*Salix lasiolepis*), and white alder (*Alnus rhombifolia*) (Table 3).

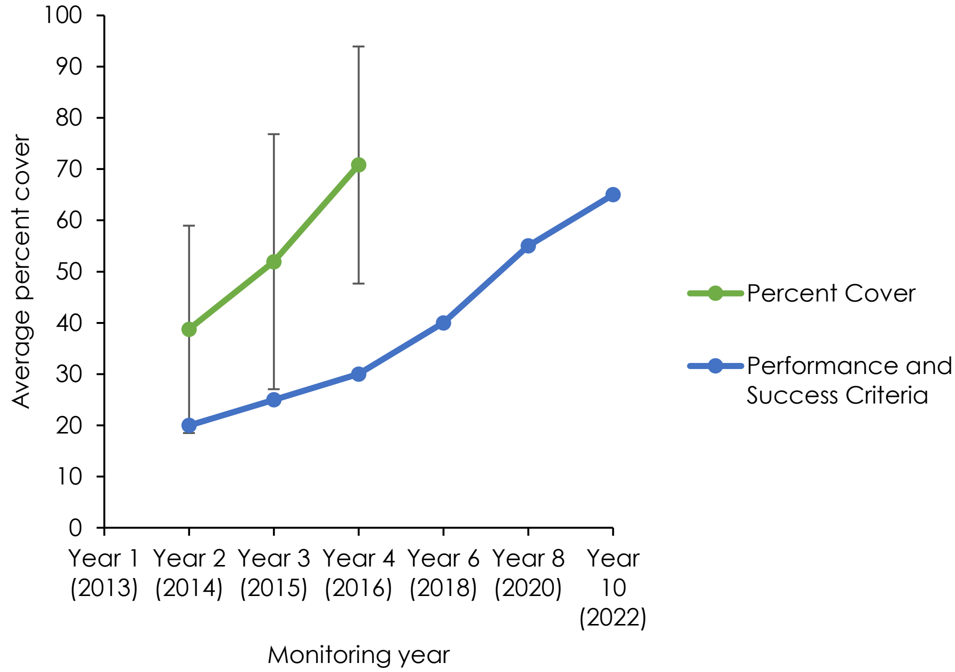

Figure 5. Streamside Area Woody Plant Cover Comparison to Performance Criteria

Table 3. Percent Cover of Planted Tree and Shrub Species in the Streamside Area

		Average Percent Cover by Monitoring Year[1]		
Scientific Name	**Common Name**	**Year 2**	**Year 3**	**Year 4**
Alnus rhombifolia	White alder	3.9	6.5	19.8
Artemisia californica	California sagebrush	0.1	0.0	0.0
Baccharis pilularis	Coyote brush	0.2	0.5	0.4
Baccharis salicifolia	Mulefat	5.8	7.7	6.7
Populus fremontii	Fremont cottonwood	2.1	6.5	5.7
Rosa californica	Rosa californica	1.1	0.5	1.7
Salix exigua	Sandbar willow	15.2	20.3	37.9
Salix laevigata	Red willow	6.0	4.7	4.6
Salix lasiolepis	Arroyo willow	12.9	16.6	30.0
Average Percent Cover of Woody Plants[2]		**38.8**	**51.9**	**70.8**

[1] Marsh baccharis (*Baccharis glutinosa*), which was included in the woody plant percent cover analysis in Year 2, was not included in the Year 3 or 4 analyses because marsh baccharis is a nonwoody perennial herb (Baldwin et al. 2012).

[2] The average percent cover of woody plants is less than the sum of the percent cover of woody plant species because of canopy overlap.

Floodplain Area. A relatively stable estimate of the average percent cover of woody plants in the Floodplain Area was obtained after eight transects were surveyed (Figure 6). Therefore, we concluded that eight transects composed an adequate sample size to accurately estimate average woody plant cover.

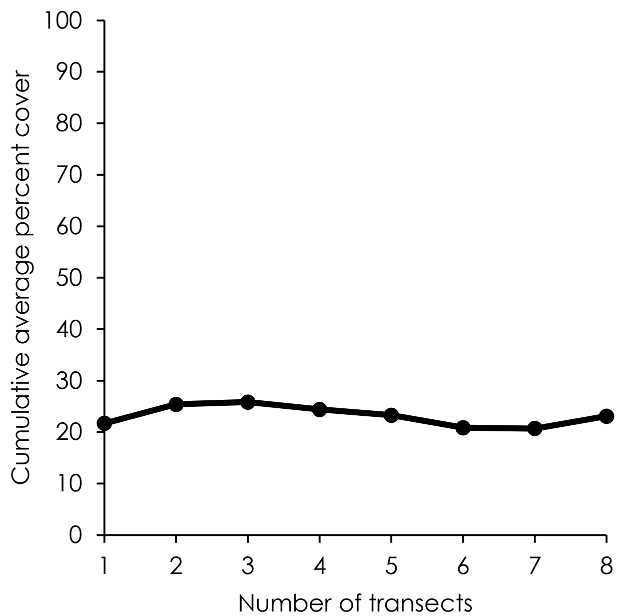

Figure 6. Cumulative Average Percent Cover of Woody Plants in the Floodplain Area as a Function of the Number of Transects Sampled

The VMP performance criterion for woody plant percent cover in the Floodplain Area in Year 4 is 10% (H. T. Harvey & Associates 2014c). Average percent cover of woody plants in Year 4 was 23.1 ± 6.3%, exceeding the performance criterion and indicating that the establishment rate of floodplain riparian habitat appears to be on a trajectory to meet the VMP's final (Year 10) criterion (30% cover) (Figure 7). Species with the greatest cover in the Floodplain Area were coyote brush (*Baccharis pilularis*) and California sagebrush (*Artemisia californica*) (Table 4).

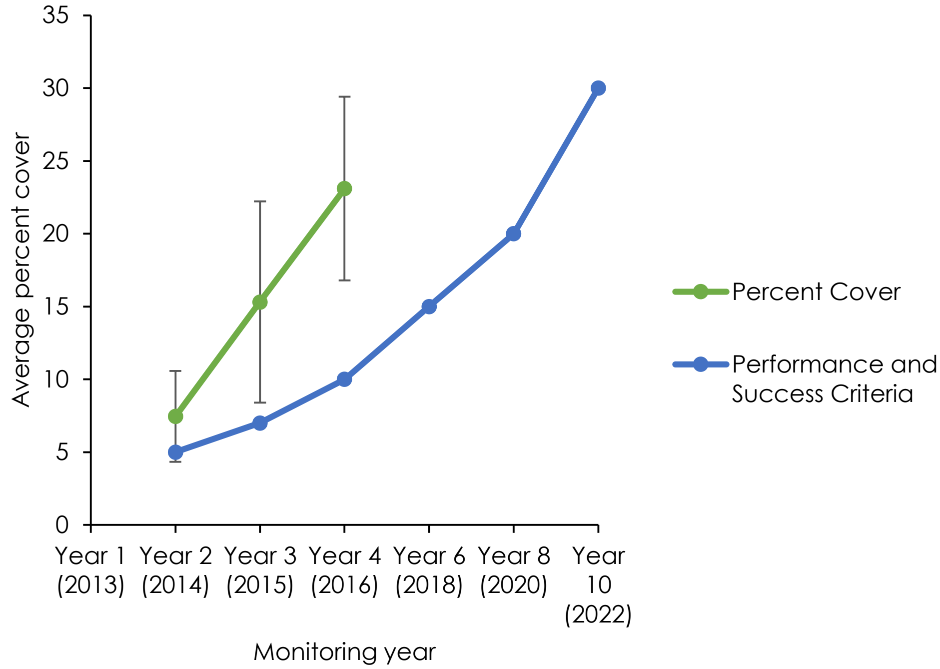

Figure 7. Comparison of Woody Plant Cover in Floodplain Area to Performance Criteria

Table 4. Percent Cover of Native Tree and Shrub Species in the Floodplain Area

		Average Percent Cover by Monitoring Year[1]		
Scientific Name	**Common Name**	**Year 2**	**Year 3**	**Year 4**
Acer negundo	Box elder	0.0	0.0	<0.1
Artemisia californica	California sagebrush	2.4	3.4	4.2
Baccharis pilularis	Coyote brush	3.2	6.2	14.0
Baccharis salicifolia	Mulefat	0.0	1.1	0.0
Heteromeles arbutifolia	Toyon	0.5	1.2	1.6
Populus fremontii	Fremont cottonwood	0.0	0.7	0.8
Rosa californica	Rosa californica	0.8	1.0	0.8
Rubus ursinus	California blackberry	0.1	0.1	0.0
Salix exigua	Sandbar willow	0.0	0.0	0.2
Salix lasiolepis	Arroyo willow	0.0	0.3	1.3
Sambucus nigra ssp. *caerulea*	Blue elderberry	0.6	1.3	0.4
	Average Percent Cover of Woody Plants[2]	**7.5**	**15.3**	**23.1**

[1] Marsh baccharis, which was included in the woody plant percent cover analysis in Year 2, was not included in the Year 3 and 4 analyses because marsh baccharis is a nonwoody perennial herb (Baldwin et al. 2012).

[2] The average percent cover of woody plants is less than the sum of the percent cover of woody plant species because of canopy overlap.

3.1.2 Overhanging Vegetation Percent Cover

A relatively stable estimate of the average percent cover of overhanging vegetation was obtained after ten transects were surveyed (Figure 8). Therefore, we concluded that ten transects constituted an adequate sample size, and we calculated the margin of error using a 95% confidence interval, which allowed us to represent the data more accurately.

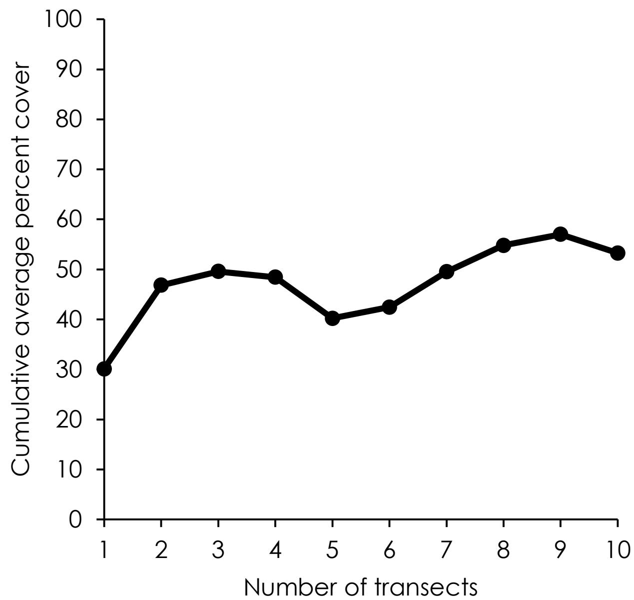

Figure 8. Cumulative Average Percent Cover of Overhanging Vegetation as a Function of the Number of Transects Sampled

No quantitative, annual performance criteria for overhanging vegetation percent cover are identified in the VMP. The final success criterion is an overall increasing trend in the average percent cover of overhanging vegetation among the monitoring years (H. T. Harvey & Associates 2014c). For this reason, the average percent cover of overhanging vegetation in Year 2 monitoring, 23.8%, serves as a baseline for the final success criterion of an overall increasing trend in overhanging vegetation percent cover across monitoring years. Average percent cover in Year 3 was 24.7%, and average percent cover in Year 4 was 53.2 ± 17.8% which indicates that the overhanging vegetation is on a trajectory toward achieving the final success criterion (Figure 9).

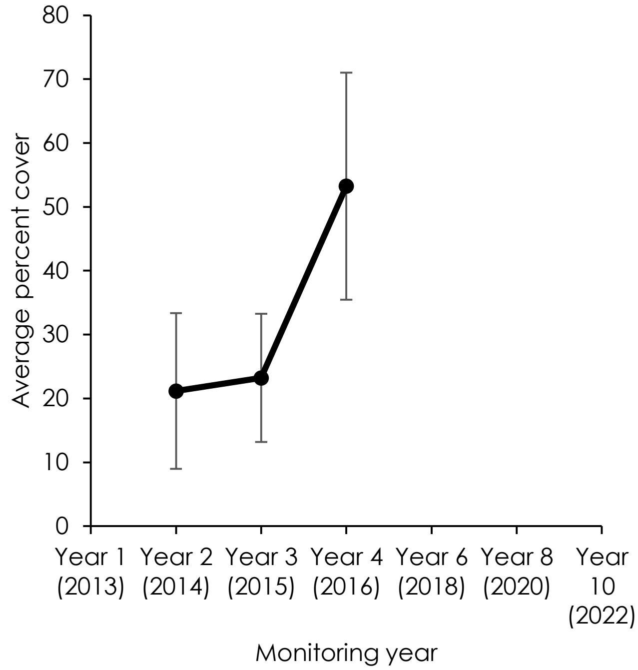

Figure 9. Percent Cover of Overhanging Woody Vegetation in Years 2–4.

The species with the greatest overhanging cover was sandbar willow (Table 5). The number of overhanging woody species increased from two in Year 3 to six in Year 4. White alder, which was recorded in Year 1 but not in Year 2, was recorded again in Year 3. This species may have been missed along transect TO4 in Year 3 because of slight differences in the position of the measuring tape between monitoring years.

Table 5. Percent Cover of Planted Tree and Shrubs Species Overhanging the Bankfull Channel

		Average Percent Cover by Monitoring Year		
Scientific Name	**Common Name**	**Year 2**	**Year 3**	**Year 4**
Alnus rhombifolia	White alder	4.8	0.0	5.6
Baccharis salicifolia	Mulefat	0.0	0.0	1.7
Populus fremontii	Fremont cottonwood	0.0	0.0	2.3
Salix exigua	Sandbar willow	13.7	16.8	31.2
Salix laevigata	Red willow	0.0	0.0	3.2
Salix lasiolepis	Arroyo willow	5.3	7.9	12.9
Average Percent Cover of Woody Plants[1]		**23.8**	**24.7**	**53.2**

[1] The average percent cover of woody plants is less than the sum of the percent cover of woody plant species because of canopy overlap.

3.1.3 Tree Height

The height of 72 trees was measured in the Streamside Area, exceeding the VMP's minimum requirement of 18 trees (three trees for each of the six combined Streamside Area transects). A relatively stable estimate of the average tree height was obtained after six transects were surveyed indicating that the sample size was adequate. (Figure 10).

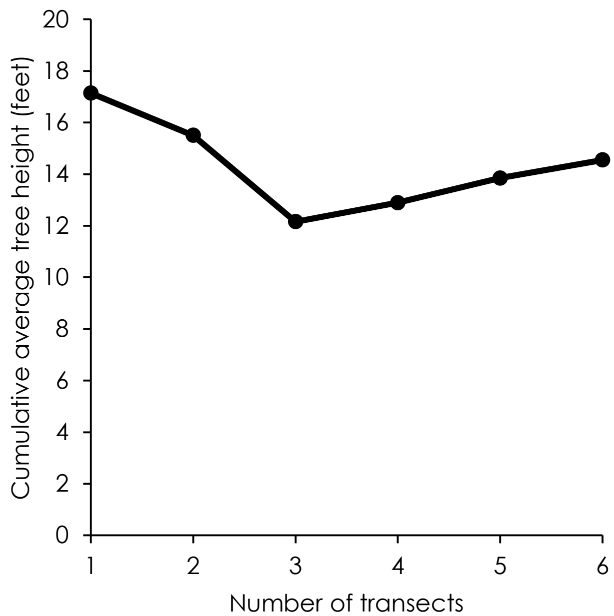

Figure 10. Cumulative Average Tree Height as a Function of the Number of Transects Sampled

No quantitative, annual performance criteria for tree heights are identified in the VMP. The final success criterion is an overall increasing trend in the average tree height among the monitoring years as a whole (H. T. Harvey & Associates 2014c). For this reason, the average tree height in Year 2 monitoring, 7.8 feet, serves as a baseline for the final success criterion of an overall increasing trend in average tree height across monitoring years. Average tree height was 11.8 feet in Year 3 and 15.6 feet in Year 4, which indicates that tree height is on a trajectory toward achieving the final success criterion (Table 6).

Average tree heights ranged from 10.5 feet for red willow (*Salix laevigata*) to 19.5 feet for white alder (Table 6). The average height of white alder, Fremont cottonwood, sandbar willow, and arroyo willow increased since Year 3. The average height of red willow decreased 3.3 feet. The apparent decrease in the average height of red willow is likely the result of sampling error associated with a small sample size of one in Year 3.

Table 6. Average Tree Height and Sample Size by Species

Scientific Name	Common Name	Year 2 Sample Size	Year 2 Average Height (feet)	Year 3 Sample Size	Year 3 Average Height (feet)	Year 4 Sample Size	Year 4 Average Height (feet)
Alnus rhombifolia	White alder	3	14.4	5	17.6	6	19.5
Populus fremontii	Fremont cottonwood	4	6.9	7	9.4	12	16.9
Salix exigua	Sandbar willow	8	7.0	7	12.7	23	18.3
Salix laevigata	Red willow	2	5.6	1	13.8	11	10.5
Salix lasiolepis	Arroyo willow	8	8.0	14	7.9	20	13.5
	Sum total	**25**	**—**	**34**	**—**	**72**	**—**
	Average total (all trees)	**—**	**7.8**	**—**	**11.8**	**—**	**15.6**

3.1.4 Invasive Plant Species Percent Cover

No invasive plant species were recorded along any percent cover monitoring transect. Therefore, the site has met the performance criterion of less than 5% invasive species cover. The lack of invasive species intercepting percent cover transects indicates that the current maintenance regime is successful in suppressing invasive species cover. However, eight invasive species were identified elsewhere on the site (Table 7). Two of the eight invasive species, giant reed (*Arundo donax*) and sweet fennel (*Foeniculum vulgare*), are rated "high" by Cal-IPC. One of the eight invasive species, stinkwort (*Dittrichia graveolens*), is rated "moderate–ALERT" by Cal-IPC. The Cal-IPC ratings refer to the level of native ecological impact presented by the species (Cal-IPC 2016).

The average percent cover of invasive species in the invasive plant maintenance test plots was less than 1% in the Streamside Area and 1% in the Floodplain Area (Table 8). Trace amounts (less than 1%) of black mustard (*Brassica nigra*) were observed in one of the Streamside Area test plots. Trace amounts of black mustard also were observed in two of the Floodplain Area test plots, and trace amounts of poison hemlock (*Conium maculatum*) and stinkwort were observed in one of the Floodplain Area test plots. Streamside Area test plots generally were dominated by willows (*Salix* spp.), and Floodplain Area test plots generally were dominated by nonnative annual grasses and forbs.

Table 7. Invasive Plant Species Present

Scientific Name	Common Name	Cal-IPC Rating[1]	Observations
Arundo donax	Giant reed	High	Two plants along the east fence behind the Casa De Los Amigos apartment building.
Brassica nigra	Black mustard	Moderate	Trace amounts in Streamside Area Invasive Plant Maintenance Test Plot 1 and Floodplain Area Invasive Plant Maintenance Test Plots 1 and 2; 100s throughout the site as a whole.

Scientific Name	Common Name	Cal-IPC Rating[1]	Observations
Cirsium vulgare	Bull thistle	Moderate	Tens of rosettes throughout the site.
Conium maculatum	Poison hemlock	Moderate	Trace amount in Floodplain Area Invasive Plant Maintenance Test Plot 3.
Dittrichia graveolens	Stinkwort	Moderate–ALERT	Trace amounts in Floodplain Area Invasive Plant Maintenance Test Plot 3 and 10s throughout the site as a whole.
Ficus carica	Common fig	Moderate	One plant just upstream of the roadway bridge crossing.
Foeniculum vulgare	Sweet fennel	High	Two plants on the west bank of the upstream portion of the site.
Nicotiana glauca	Tree tobacco	Moderate	Less than 10 plants throughout the site.

[1] Cal-IPC = California Invasive Plant Council. Cal-IPC ratings refer to the level of negative ecological impact presented by the species. See Cal-IPC (2016) for additional details on these ratings.

Table 8. Percent Cover of Invasive and Native Species in the Invasive Plant Maintenance Test Plots

Planting Zone / Invasive Plant Maintenance Test Plot	Percent Cover of Invasive Species	Percent Cover of Native Species
Streamside Area		
1	<1	75
2	0	100
3	0	12
4	0	95
5	0	85
Floodplain Area		
1	<1	1
2	<1	0
3	<1	2
4	0	7
5	0	3
Average percent cover in the Streamside Area	**<0.1**	**73.4**
Average percent cover in the Floodplain Area	**0.1**	**2.6**

3.1.5 Dead Plant Assessment

Dead and missing plants identified during the Year 3 (2015) monitoring were replaced in February 2016 in accordance with recommendations in the Year 3 Monitoring Report (H. T. Harvey & Associates 2016, Morley pers. comm. 2016). Seventy-five willow cuttings (a combination of red, arroyo, and sandbar willow) were installed in vegetation gaps in the Streamside Area. All cuttings were harvested from plants located on the Project site. A total of 134 plantings were installed in the Floodplain Area; the species and number of plantings installed are presented in Table 9. Plant survival monitoring is not required in Year 4 or in subsequent monitoring years unless the site is deemed to be falling so far short of meeting the performance criteria that it is clear that the final success criteria will not be met (H. T. Harvey & Associates 2014c).

Table 9. Number of Plantings Installed in the Floodplain Area

Scientific Name	Common Name	Number of Plantings Installed in February 2016 in Accordance with the Recommendations in the Year 3 Monitoring Report
Aesculus californica	California buckeye	7
Artemisia californica	California sagebrush	4
Baccharis salicifolia	Mulefat	18
Heteromeles arbutifolia	Toyon	42
Quercus agrifolia	Coast live oak	9
Rhamnus ilicifolia	Hollyleaf redberry	4
Rosa californica	California rose	35
Rubus ursinus	California blackberry	15
	Total	**134**

3.1.6 Wetland Habitat Characterization

Two wetlands totaling approximately 0.23 acre have developed on the restored floodplain, and two wetlands totaling approximately 0.15 acre have developed in the restored creek channel (Figure 2).

Photo 1. View of Floodplain Wetland 1, looking northwest from the south bank

Floodplain Wetland 1. Floodplain Wetland 1 is located east of the main stream channel (Figure 2). It is approximately 175 feet long and 25 feet wide with a surface area of approximately 4,400 square feet. The wetland has expanded northwest toward the storm drain outfall since Year 3, increasing the area of the wetland by approximately 1,340 square feet. Photo 1 shows a representative depiction of the state of the wetland in August 2016. Approximately 6 inches of standing water was present at the southern end. Hundreds of mosquito larvae were observed. The remainder of the wetland was dry but had small areas of saturated soil and dried algal mats. The plant community was stratified into distinct concentric rings of vegetation spanning a gradient from perennial, emergent wetlands at the lower elevations to seasonal wetland vegetation and riparian trees and shrubs along the upper slope. The lowest vegetation consisted of emergent cattails (*Typha* sp.) that are increasing in cover through lateral vegetative expansion. Wetland vegetation located upslope from the cattails included rabbitsfoot grass (*Polypogon monspeliensis*), tall flatsedge (*Cyperus eragrostis*), curly dock (*Rumex crispus*), knotweed (*Persicaria* sp.), planted irisleaf rush (*Juncus xiphioides*) and common bog rush (*Juncus effusus*), naturally recruited and planted marsh baccharis, and planted willow. The vigorous growth of willow and cottonwood indicated that they were likely rooted into groundwater. In the upper banks of the wetland, mulefat (*Baccharis salicifolia*) and Fremont cottonwood plantings showed new growth and good health.

Floodplain Wetland 2. Floodplain Wetland 2 is located east of the new roadway bridge crossing (Figure 2). It is approximately 100 feet long and 55 feet wide with a surface area of approximately 5,500 square feet. The wetland has expanded 4,870 square feet since Year 3. Photo 2 shows a representative depiction of the state of the wetland in August 2016. No standing water or saturated soil was present; however, soil cracks were observed in the deepest portion of the wetland. The plant community was composed of knotweed, curly dock, marsh baccharis, common plantain (*Plantago major*), bristly ox-tongue (*Helminthotheca echioides*), rabbitsfoot grass, rough cockleburr (*Xanthium strumarium*), and one cattail. Sandbar willow, arroyo willow, white alder, and Fremont cottonwood were growing along the wetland banks. The presence of emergent cattail indicates that the depth and duration of ponding at Wetland 2 has increased since Year 3. This area was submerged under water during winter storms because woody debris jams located downstream of the site cause water to back up into the mitigation site. Several sandbar willow recruits were observed in Wetland 2, indicating that high quality wetland habitat is developing on the floodplain.

Photo 2. View of Floodplain Wetland 2, looking northeast

In-Channel Wetland 1. In-Channel Wetland 1 is located upstream of the new roadway bridge crossing (Figure 2). It is approximately 215 feet long and 12 feet wide with a surface area of approximately 2,600 square feet. Photo 3 shows a representative depiction of the state of the wetland in August 2016. No standing water was present; however, soils in the low-flow channel were damp. The plant community was composed of knotweed along the channel bed and banks and willows along the top of the banks. This portion of the site was inundated during winter storms.

Photo 3. View of In-Channel Wetland 1, looking northeast from the New Roadway Bridge Crossing

In-Channel Wetland 2. In-Channel Wetland 2 is located downstream of the new roadway bridge crossing (Figure 2). It is approximately 160 feet long and 24 feet wide with a surface area of approximately 3,900 square feet. Photo 4 shows a representative depiction of the state of the wetland in August 2016. Standing water (approximately 3 inches in depth) was present at the downstream end of the wetland. Soils were dry at the upstream end of the wetland. The plant community was stratified into distinct concentric rings of vegetation spanning a moisture gradient from perennial, emergent wetlands at the lower elevations to seasonal wetland vegetation and riparian trees and shrubs along the upper slope. The lowest vegetation consisted of emergent cattails. Wetland vegetation upslope of the cattails included knotweed, alkali bulrush (*Bolboschoenus maritimus*), and tall flatsedge. Willows lined the tops of banks along the northwest and southwest sides of the channel. In-Channel Wetland 2 was submerged under water during winter storms because woody debris jams located downstream of the mitigation site caused water to back up into the wetland.

Photo 4. View of In-Channel Wetland 2, looking southwest from the New Roadway Bridge Crossing

3.1.7 Woody Plant Health and Vigor

Average woody plant health and vigor was high (average = 2.9), demonstrating that the planted trees and shrubs displayed healthy foliage and little physical damage or disease (Table 10). Of the 147 plantings characterized for health and vigor, 92.4% were in good condition and 7.6% were in fair condition (Table 10). No success criterion for this metric was established in the VMP; however, these results indicate that plantings are generally healthy and growing vigorously, despite the drought conditions over the past four growing seasons.

Table 10. Woody Plant Health and Vigor

				Year 4 Health Condition Percent of Individuals by Rating Category		
Scientific Name	**Common Name**	**Sample Size**	**Year 4 Average Health and Vigor Rating**	**Good**	**Fair**	**Poor**
Aesculus californica	California buckeye	2	2.0	0%	100%	0%
Alnus rhombifolia	White alder	7	3.0	100%	0%	0%
Artemisia californica	California sagebrush	7	3.0	100%	0%	0%
Baccharis pilularis	Coyote brush	25	3.0	100%	0%	0%
Baccharis salicifolia	Mulefat	12	2.4	42%	58%	0%
Heteromeles arbutifolia	Toyon	4	3.0	100%	0%	0%

Scientific Name	Common Name	Sample Size	Year 4 Average Health and Vigor Rating	Year 4 Health Condition Percent of Individuals by Rating Category		
				Good	Fair	Poor
Populus fremontii	Fremont cottonwood	17	3.0	100%	0%	0%
Rosa californica	California rose	8	2.9	88%	13%	0%
Rubus ursinus	California blackberry	1	3.0	100%	0%	0%
Salix exigua	Sandbar willow	24	3.0	100%	0%	0%
Salix laevigata	Red willow	11	3.0	100%	0%	0%
Salix lasiolepis	Arroyo willow	22	3.0	100%	0%	0%
Sambucus nigra ssp. *caerulea*	Blue elderberry	5	2.8	80%	20%	0%
	Sum total	**145**	**—**	**—**	**—**	**—**
	Average total (all woody plants)	**—**	**2.9**	**92.4%**	**7.6%**	**0.0%**

3.1.8 Woody Plant Natural Recruitment

Streamside Area. Five stems of naturally recruiting native species were counted in nine 1,000-square-foot transect bands in the Streamside Area. No nonnative plant species were observed. The average number of recruiting individuals was 0.1 per 1,000 square feet (Table 11). Coyote brush had the highest stem densities of naturally recruited individuals. Bay laurel (*Umbellularia californica*) was observed for the first time. The low numbers of naturally recruiting individuals in Year 4 are likely due to a lack of space for recruitment to occur because of the substantial increase in the average percent cover of the Streamside Area plantings in Years 2–4 (38.8–70.8%). Drought conditions may have also contributed to low recruitment.

Table 11. Woody Plant Natural Recruitment in the Streamside Area

Scientific Name	Common Name	Average Number of Recruiting Individuals per 1,000 Square Feet by Monitoring Year		
		Year 2	Year 3	Year 4
Acer negundo	Boxelder	0.2	0.0	0.0
Alnus rhombifolia	White alder	0.0	0.0	0.0
Artemisia californica	California sagebrush	0.3	0.0	0.0
Baccharis pilularis	Coyote brush	1.5	0.5	0.3
Baccharis salicifolia	Mulefat	0.0	0.0	0.0
Populus fremontii	Fremont cottonwood	0.0	0.2	0.0
Rosa californica	California rose	1.7	1.0	0.0
Rubus ursinus	California blackberry	0.0	0.0	0.0

Scientific Name	Common Name	Average Number of Recruiting Individuals per 1,000 Square Feet by Monitoring Year		
		Year 2	Year 3	Year 4
Salix exigua	Sandbar willow	1.5	0.3	0.1
Salix lasiolepis	Arroyo willow	0.3	0.0	0.0
Umbellularia californica	Bay laurel	0.0	0.0	0.1
	Average (all woody plants)	**0.6**	**0.2**	**0.1**

Floodplain Area. Twenty stems of naturally recruiting native species were counted in the eight 1,000-square-foot transect bands in the Floodplain Area. No nonnative plant species were observed. The average number of recruiting individuals was 0.2 per 1,000 square feet (Table 12). Coyote brush had the highest stem densities of naturally recruited individuals. Sandbar willow natural recruits were observed in the floodplain area for the first time. The low numbers of naturally recruiting individuals in Year 4 are likely due to drought conditions and low water availability during the summer months.

Table 12. Woody Plant Natural Recruitment in the Floodplain Area

Scientific Name	Common Name	Average Number of Recruiting Individuals per 1,000 Square Feet by Monitoring Year		
		Year 2	Year 3	Year 4
Acer negundo	Boxelder	0.0	0.1	0.1
Aesculus californica	California buckeye	0.0	0.0	0.0
Artemisia californica	California sagebrush	0.0	0.0	0.0
Baccharis pilularis	Coyote brush	5.5	5.8	1.6
Heteromeles arbutifolia	Toyon	0.0	0.0	0.0
Populus fremontii	Fremont cottonwood	0.1	0.0	0.0
Quercus agrifolia	Coast live oak	0.0	0.0	0.0
Rhamnus ilicifolia	Hollyleaf redberry	0.0	0.0	0.0
Rosa californica	California rose	2.6	1.5	0.3
Rubus ursinus	California blackberry	0.2	0.0	0.0
Salix exigua	Sandbar willow	0.0	0.0	0.5
Salix laevigata	Red willow	0.0	0.1	0.0
Sambucus nigra ssp. *caerulea*	Blue elderberry	0.0	0.0	0.0
	Average (all woody plants)	**0.7**	**0.6**	**0.2**

3.1.9 Native Woody Plant Species Richness

Native woody plant species richness (i.e., number of species) was relatively high on the Project site. A total of 21 native woody plant species were observed on the site: 11 in the Streamside Area, 17 in the Floodplain Area, and seven in the floodplain wetlands (Table 13). Three species were observed in Year 4 that had not been observed in the past: common snowberry (*Symphoricarpos albus*), poison oak (*Toxicodendron diversilobum*), and bay laurel (*Umbellularia californica*).

Table 13. Native Woody Species Richness by Habitat Type

Scientific Name	Common Name	Habitat Type		
		Streamside Area	Floodplain Area	Floodplain Wetlands
Acer negundo	Boxelder	X	X	
Aesculus californica	California buckeye		X	
Alnus rhombifolia	White alder	X		X
Artemisia californica	California sagebrush		X	
Baccharis pilularis	Coyote brush	X	X	
Baccharis salicifolia	Mulefat	X	X	X
Heteromeles arbutifolia	Toyon		X	
Mimulus aurantiacus	Sticky monkeyflower		X	
Platanus racemosa	California sycamore	X		
Populus fremontii	Fremont cottonwood	X	X	X
Quercus agrifolia	Coast live oak		X	
Rhamnus ilicifolia	Hollyleaf redberry		X	
Rosa californica	California rose	X	X	X
Rubus ursinus	California blackberry		X	
Salix exigua	Sandbar willow	X	X	X
Salix laevigata	Red willow	X		X
Salix lasiolepis	Arroyo willow	X	X	X
Sambucus nigra ssp. *caerulea*	Blue elderberry		X	
Symphoricarpos albus	Common snowberry		X	
Toxicodendron diversilobum	Poison oak		X	
Umbellularia californica	Bay laurel	X		
	Number of Species	**11**	**17**	**7**

Note: Marsh baccharis, which was included in the native woody species richness analysis in Year 2, was not included in the Year 3 or Year 4 analyses because marsh baccharis is a nonwoody perennial herb (Baldwin et al. 2012).

3.2 Stream Geomorphology and Hydrology

Detailed stream geomorphology and hydrology monitoring results are presented in Balance Hydrologics' Year 4 monitoring report (Appendix A). This section presents a summary of that discussion.

Precipitation totaled 14.91 inches during the 2016 water year (October 1, 2015, through September 30, 2016); approximately 102% of the average yearly precipitation (14.7 inches) for the area. The largest daily rainfall or largest rainfall over consecutive days occurred during five events between November 2015 and April 2016. Precipitation was below average during each of the four previous years.

Streamflow through the Project site was intermittent. Streamflows were recorded on approximately 40 days across four storm events in December through March. Peak flows exceeded bankfull flow (270 cubic feet per second) three times. The annual peak streamflow occurred on January 18, 2016, and was estimated to be 650 cubic feet per second. Streamflow levels rose and fell rapidly during rain events because groundwater levels were low and infiltration generally exceeded overland flow. Streamflow went subsurface before entering the Project site during most rainfall and runoff events. Intermittent streamflows and declines in groundwater levels are driven in part by the current regional drought conditions.

Several streamflow events were large enough to carry bedload sediments onto the Project site. Instream logjams and low-lying vegetation caused backwatering of the lower reach, which resulted in the deposition of fine sediment throughout the low-flow channel. The observed deposition of sediment and woody debris is a natural fluvial geomorphic process that was anticipated during the site design because the project reach is a natural depositional zone in Upper Penitencia Creek. Aggradation is expected to decrease as floodplain and streamside riparian plantings mature, allowing floods to transport excessive sediment out of the Project reach. The creek channel cross-sections remained stable, showing minimal horizontal shifts. No adaptive management is deemed necessary at this time.

3.3 Fish

All habitat units on the Project site were dry or contained water that was too poor in quality (i.e., stagnant) to allow safe electrofishing. The upper reaches of the main channel (Units 8–12) had damp substrate or were completely dry with the exception of Unit 9, which included a small, heavily vegetated pond (Table 14). The lower reaches of the main channel and the remaining units (Units 1–7) contained wet substrate and there was standing water in two units (Table 14). In all habitat units, there was not enough water, or the water quality was too poor, to support fish. Representative photographs taken during the fall fish habitat surveys are presented in Appendix B.

Table 14. Habitat Unit Type/Condition Observed during Fish Surveys

Habitat Unit Name	Habitat Unit Type/Condition		
	Year 1 Fall	Year 4 Spring	Year 4 Fall
Unit 1	Glide	Stagnant pool	Stagnant pool and dry
Unit 2	Backwater	Damp	Damp
Unit 3	Glide	Damp	Damp
Unit 4	Midchannel pool	Damp	Damp
Unit 5	Low-gradient riffle	Damp	Damp
Unit 6	Backwater	Damp	Damp

Habitat Unit Name	Habitat Unit Type/Condition		
	Year 1 Fall	**Year 4 Spring**	**Year 4 Fall**
Unit 7	Lateral scour pool, rootwad formed	Stagnant pool	Damp
Unit 8	Dry	Dry	Dry
Unit 9	Dry	Stagnant pool	Stagnant pool
Unit 10	Lateral scour pool, rootwad formed	Dry	Dry
Unit 11	Dry	Dry	Dry
Unit 12	Low-gradient riffle	Dry	Dry

Intermittent streamflows made steelhead transit possible through the Project site and provided access to upstream spawning (adults) and rearing (juveniles) habitat. Steelhead kelts and outmigrating juvenile steelhead also had opportunities for passing through the Project site. The lack of persistent surface water precluded any extended use of instream habitat for spawning or rearing this year, but Balance Hydrologics measured multiple short-term events with continuous flow at the site (see Section 3.2, "Stream Geomorphology and Hydrology," and Appendix A). These conditions were not unique to the Project site; dry reaches were observed upstream near the entrance to Alum Rock Park and probably occurred at other locations between the park and the Project site.

An extensive accumulation of large woody debris off-site, below Unit 1 near the downstream end of the Project site appears to have been a substantial barrier to fish movement under most flow conditions throughout Year 4. Nonetheless, the major streamflow events that were measured occurred during the typical adult steelhead spawning migration period (December through March), and upstream and downstream passage through the Project site may have been possible for adult steelhead during these flow events.

The presence of persistent pools charged by subsurface flow can provide critical over-summering habitat for juvenile steelhead on the Project site if pools were accessible and water quality was suitable. During H. T. Harvey & Associates' Year 1 surveys, it was apparent that steelhead were using restoration features (i.e., root wad scour pools) as habitat during low summer flows. However, during Years 2, 3, and 4, the water quality in persistent pools was poor; pools were absent or were stagnant and choked with algae and emergent vegetation.

Steelhead are known to use intermittent streams (NMFS 2015), but adult steelhead need continuous flow for a period sufficient to allow them to migrate upstream to spawning habitat, spawn, and potentially return to the bay as kelts. Continuous flow also would be necessary for (1) spawning success to support egg and embryo development and (2) juvenile rearing. However, juvenile rearing habitat does not need to be located in the same part of the watershed as spawning habitat, because juveniles can move downstream or upstream into reaches that have continuous flow to rear. As long as continuous flow occurs during these critical periods of the steelhead's life cycle in a portion of the watershed, intermittent flow in other reaches does not prohibit use of a watershed.

Intermittent, non-continuous flow is a condition of the Upper Penitencia Creek ecosystem and existed before construction of the Project (Beller et. al. 2012). Leicester and Smith (2012) reported that in all but the wettest years, Upper Penitencia Creek is subject to subsurface flow at some point between Dorel Drive and the percolation ponds located between Noble Avenue and Piedmont Road—an approximately 2,200-foot-long reach located approximately 3 miles upstream of the Project site. Although intermittent flow is probably a historical condition that occurs regularly during drought conditions and seasonally dry periods (Stillwater Sciences 2006), contributing factors also may include water impoundment (Cherry Lake Reservoir); diversion to percolation ponds; and the presence of porous, unconsolidated sediment on the Project site after construction.

Continuous flow (>1.0 cubic feet per second) was measured within the Project site on four occasions (Appendix A). Reduced area and volume of habitat units attributable to low-flow conditions may result in changes to water quality (e.g., dissolved oxygen, temperature), increased predation, and reduced foraging opportunities (Heggenes and Borgstrom 1988, Hakala and Hartman 2004, May and Lee 2004) that may influence the growth and survival rates of fish and, in some cases, may result in mortality. During most of the year, dry reaches (such as those present both downstream and upstream of the Project site and on the site) block access by adult steelhead to upstream spawning habitat and access to the San Francisco Bay by steelhead kelts and outmigrating juveniles. As a result, adult steelhead spawning success and juvenile growth, fitness, and survival may be limited in part by insufficient flows in the Upper Penitencia Creek system. Although the Project site is located low in the watershed, steelhead redds have previously been observed near the confluence with Coyote Creek, and the potential exists for spawning to occur on the Project site as long as connectivity exists up to and through the Project site (Habitat Restoration Group 1992, as cited in Leidy et al. 2005).

Project goals for the provision of native fish habitat were not met in Year 4 because of lack of flow most likely associated with persistent regional drought conditions (the water year's rainfall, notwithstanding), and also potentially because of upstream water diversions and historically intermittent flow conditions in the Upper Penitencia Creek ecosystem. Native and nonnative fishes are expected to redistribute into and through the restored channel when it becomes watered as the region emerges from drought.

3.4 Photodocumentation

Photographs taken from 19 permanent photodocumentation points during Year 1 and 4 vegetation monitoring are presented in Appendix C to allow comparison of vegetation growth on the site between the two years. No event was recorded that may significantly affect the success of the mitigation. Representative photographs of fish unit conditions are presented in Appendix B.

3.5 Management Recommendations

3.5.1 Management Recommendations

The following management recommendations should be implemented to keep the site on a trajectory toward successful long-term establishment and attainment of the Project's final success criteria:

- Continue to monitor for invasive plant species to ensure that the invasive species percent cover criteria are met. The monitoring biologist should locate and map weeds once during late spring and once in mid-summer to inform invasive plant control needs. Invasive plants should be controlled within 1 month of the monitoring biologist's map results.
- Avoid removing invasive plants from the invasive plant maintenance test plots so that future monitoring may discern the likely long-term trajectory of plant community composition (i.e., the proportion of native versus invasive plant species) in the absence of invasive plant control.
- Maintain planting basins free of weeds by periodically hand-pulling all native and nonnative weeds growing in the planting basins.
- Maintain (through weed whacking) all herbaceous vegetation outside basins to a maximum height of 1 foot. Native woody species should be avoided during weed whacking.
- Formal irrigation should cease. However, the temporary irrigation system should be left in place in the event that significant drought stress is observed during the Year 5 growing season and it is determined that additional irrigation is required to avoid substantial plant mortality. Monitor the conditions of the mitigation plantings once during summer to determine the condition of plants in response to weather conditions. If annual precipitation is below average and the plants show signs of drought stress (e.g., wilting leaves, chlorosis, thinning canopy), the biologist will determine whether the plants need to be irrigated.
- In accordance with input provided by NMFS during a field visit on November 8, 2016, large woody debris (e.g., fallen cottonwood in the upstream reach) should be left in the channel to provide instream habitat complexity for fish, provided that the Santa Clara Valley Water District approves of this approach from a flood control perspective.

3.5.2 Agency Actions

No agency actions are requested at this time.

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Appendix A. Stream Geomorphology and Hydrology Monitoring Memorandum Prepared by Balance Hydrologics

800 Bancroft Way • Suite 101 • Berkeley, CA 94710 • (510) 704-1000
224 Walnut Avenue • Suite E • Santa Cruz, CA 95060 • (831) 457-9900
PO Box 1077 • Truckee, CA 96160 • (530) 550-9776
www.balancehydro.com • email: office@balancehydro.com

November 28, 2016
Revised January 31, 2017

Mr. Max Busnardo
Senior Associate Restoration Ecologist
H. T. Harvey and Associates
983 University Avenue, Building D
Los Gatos, California 95032

Submitted Via Email

Dear Mr. Busnardo:

Balance Hydrologics Inc. (Balance) is pleased to provide you with the Year 4 annual report for water year[1] 2016 (WY2016) geomorphic and hydrologic monitoring of the Upper Penitencia Creek Improvement Project (project), mitigation for the BART Silicon Valley Berryessa Extension Project. As stated in the Mitigation and Monitoring Plan (MMP, Jones, 2012), the frequency of monitoring elements depends on the monitoring phase (Phase 1: years 1-5 or Phase 2: years 6-10), post-construction year, and conditions observed during the monitoring year. In Year 4, physical monitoring elements required by the MMP included: 1) streamflow and bedload transport measurements, 2) habitat velocity measurements, 3) channel dynamics observations, 4) channel bed samples, and 5) repeat photo point documentation. In the absence of channel changing flows in Year 3, repeat longitudinal profile and cross-section surveys were postponed and completed in Year 4.

Executive Summary

Balance completed the fourth year of a 10-year geomorphic and hydrologic monitoring plan in accordance with the project's MMP (Jones, 2012). In Year 4, we recorded a normal rainfall year and multiple peak flows with flood recurrence intervals between 2 and 5 years. While we documented continuous streamflow through the project reach on multiple occasions, streamflow continues to exhibit intermittent conditions through salmonid migration season and throughout the year. While intermittent streamflow may be a natural occurrence in Upper Penitencia Creek at this location in its watershed, the current moderate to severe drought may be increasing its occurrence, duration and/or frequency. Notably, groundwater levels in the region showed declines over the last 3 to 4 years in the absence of normal rainfall and runoff, and presently range from 20 to 50 feet or more below the ground surface. As a result, and given the alluvial fan setting of the project site, streamflow is discontinuous for flows less than

[1] A "water year" (WY) is defined as that period from October 1st of a preceding year through September 30th of the following year, and is named according to the following year. For example, water year 2016 started October 1, 2015 and ended September 30, 2016.

approximately 0.5 cubic feet per second (cfs) because the vertical rate of water loss exceeds the upstream supply. Whereas streamflow continues to be monitored, we do not anticipate substantial changes or improvement in streamflow continuity through the project reach until the local aquifer is filled (i.e. water table intersects the ground surface).

In Year 4, peak flows did generate measurable changes within the project reach including sedimentation of the bed and an increase in fine sediment within the channel. These changes were anticipated and likely temporary until planted vegetation matures and instream logjams are removed by subsequent floods.

Introduction and Background

The geomorphic and hydrologic monitoring program has been developed to facilitate evaluation of geomorphic processes and general aquatic habitat conditions as the channel evolves from initial constructed conditions, to a corridor with geomorphic and ecological character and function. The project MMP (Jones, 2012) provides the framework to evaluate project performance or success relative to design goals based on both quantitative and qualitative characterization and professional judgments. As such, we find it useful to revisit questions outlined in the MMP for monitoring components. These questions include:

- Will the sizes and shapes of the pools, riffles, and floodplain benches evolve as sediment-transporting flows occur?
- Will the connections of the main channel to the high-flow secondary channels and the backwater wetlands change significantly over the short term?
- Will the backwater wetlands develop as intended and increase the complexity of the stream corridor habitat?
- Will general channel bed composition change?
- Will downstream riffles keep upstream pools sufficiently backwatered to maximize usable pool habitat and cover area?
- Will the floodplain flood every 1 to 2 years? Will the primary and secondary channels convey the estimated bankfull flow?
- Will the creek corridor thalweg, pools and riffles, floodplain benches, banks, secondary channels, and backwater wetlands be stable?
- Will the stream corridor increase in habitat complexity and provide conditions for salmonid passage?

Figure 1 illustrates the general design features of the site and the location of monitoring elements that serve as the basis for our monitoring work. **Figure 2** shows a sequence of historical aerial photographs of the project site before, during, and 4 years after construction.

Year 4 Hydrologic and Geomorphic Monitoring: Work Completed

Balance conducted multiple project-site visits during both dry and wet periods to assess conditions. A summary of elements monitored in Year 4, including dates and responsible parties, is presented in **Table 1** and described in more detail below:

- Reviewed local rainfall conditions for San Jose International Airport located approximately 3.0 miles west of the project site;
- Measured bedload sediment transport through the constructed reach to assess the fundamental assumptions of the channel design and sediment model, and evaluated rate of sediment transport relative to pre-project rates;
- Completed four streamflow measurements during short-duration runoff events and completed one indirect peak flow calculation using high-water mark survey and improved our preliminary record of streamflow at a station;
- Installed and monitored water levels in the lower section of the project reach to facilitate evaluation of flow continuity;
- Completed a habitat-velocity profile at an elevated streamflow;
- Repeated channel thalweg and cross-section surveys of the project reach to evaluate changes relative to post-construction conditions;
- Reviewed groundwater levels and recent trends from several California Department of Water Resources (DWR) monitoring wells within the vicinity of the project site for context of the drought;
- Collected sediment transport samples and, bedcores, performed a sediment size class analysis and compared the results with constructed bed fill material; and
- Repeated photo point documentation along the project reach.

Year 4 Hydrologic and Geomorphic Monitoring: Results and Discussion, WY2016

WY2016 Rainfall Summary

Cumulative daily rainfall for Years 1 through 4 is illustrated in **Figure 3.** Annual total precipitation of 14.91 inches was recorded at the San Jose International Airport in Year 4, slightly above the long-term average (14.66 inches) for the same station (National Weather Service, 2016). Most of the annual precipitation in Year 4 fell between November and April. The largest daily or consecutive days with rainfall were recorded on November 2, 2015 (1.13 inches), December 21-24, 2016 (1.06 inches), January 5-6, 2016 (1.59 inches), January 15-19, 2016 (1.69 inches), March 4-7, 2016 (2.82 inches), and April 8-10 (0.98 inches). The largest daily rainfall was recorded on March 5, 2016 (1.20 inches). The last day of rainfall in Year 4, as recorded at the San Jose International Airport, was on May 21, 2016 (0.14 inches).

Although Year 4 was an average precipitation year, the National Drought Mitigation Center (NDMC, 2016) continues to identify the San Jose Area in a state of moderate to severe drought.

Hydrology

An observer log describing our observations and data collected in Year 4 is shown in **Table 2**. In Year 4, we continued to operate a streamflow gaging station immediately upstream of the project site below North King Road, (upstream station, see Figure 1) and manually measured streamflow over a range of stream depths. A preliminary record of daily streamflow in Year 4 is presented in **Figure 4**.

In Year 4, the gage recorded stages significantly higher than those observed in previous years. In an effort to verify peak flow magnitudes, Balance completed a high-water mark survey after the December 22, 2015 high-flow event. Additional indirect methods were used to estimate the magnitude of the January 18, 2016 high flow. These efforts improved our stage-to-discharge rating curve and our ability to provide an accurate and continuous record of streamflow.

The complete streamflow record from the project gaging station suggests the following:

1. Streamflow in Upper Penitencia Creek below North King Road continued to exhibit intermittent conditions in Year 4—streamflow is present at times and absent during other times.
2. Continuous streamflow (above about 1.0 cfs) was recorded for 4 distinct periods, each lasting between roughly 4 and 18 days: December 22-26, 2015, January 5-10, 2016, January 20-30, 2016, and March 6-24, 2016; and
3. Peak flows in Year 4 exceeded estimated bankfull flow (270 cfs) on four different occasions: December 22, 2015, 400 cfs; January 19, 2016, 625 cfs; March 7, 2016, 280 cfs and; March 12, 2016, 370 cfs. Based on previous hydrologic analyses (Chartrand, 2011, Jordan and others, 2009) we estimate that the annual peak flow (625 cfs) was between a 2 and 5 year recurrence flood. The other peak flows were less than a 2-year recurrence flood, but under these conditions, secondary high-flow channels and floodplains were flowing or inundated, as evidenced by high-water marks and large wood deposition.

In February 2016, at the request of VTA, Balance installed a continuous water-level monitoring station near the downstream end of the project reach (downstream station) (see Figure 1) to verify that flows through the project reach were continuous. Data from this station is limited to relative stream depth and is compared to stream depths measured at the upstream station as a general tool to evaluate continuity of flow through the project reach (**Figure 5)**. Because instruments were installed at the deepest pool location, active streamflow does not occur at the downstream station until recorded pool depths exceed roughly 0.5 feet.

Streamflow levels compared between the upstream and downstream stations (since February 2016) suggest the following:

1. In Year 4, the project reach continues to exhibit intermittent streamflow conditions;
2. Continuous streamflow through the project reach was recorded for a continuous 18-day period in March (March 6-24, 2016) and likely occurred for a shorter period during the January event (prior to installation of the downstream water-level station); and

3. Rapid rising and falling streamflow levels at the downstream station were recorded on several instances in the absence of streamflow at the upstream station. These events likely occurred as the result of localized rain events that generated stormwater runoff directly to the project reach. At least one major urban outfall discharges to the project reach upstream of the downstream station.

In a fourth consecutive year, Upper Penitencia Creek continues to be an intermittent stream—a stream that does not flow continuously throughout the year, as when water losses from infiltration/seepage or groundwater recharge exceed the available streamflow. Intermittent streamflow is believed to be a natural occurrence downstream of Alum Rock Park especially during dry years or periods of drought (Stillwater Sciences, 2006). Because we have also observed intermittent streamflow conditions in adjacent watersheds, we evaluated factors that were potentially affecting streamflow conditions regionally, including groundwater.

Local and Regional Groundwater Conditions

Groundwater provides a hydraulic floor that sustains perennial flow in most alluvial channels. Changes in depth to groundwater can have measurable effects on streamflow magnitude, duration, and continuity. The California Department of Water Resources (2016) monitors groundwater levels for at least 2 wells within 1.5 miles of the project reach (Well #373938N1218748W001 and Well #373772N1218499W001). These data indicate that while groundwater levels did increase in WY2016 in response to an average rainfall year, groundwater levels continue to be below those measured in 2011 and 2012 by as much as 3.6 to 7.6 feet (**Figure 6**). A falling groundwater table can be the result of drought (absence of groundwater recharge), groundwater pumping or both. The Santa Clara Valley Water District operates several groundwater recharge ponds around the San Jose area to minimize rapid declines in groundwater and associated subsidence. Two such recharge ponds (Bob Gross Recharge Ponds) are located adjacent to Upper Penitencia Creek and upstream of the project reach. These ponds were off-line in WY2014, WY2015 (Sparkman, J., pers. comm., 2015), and presumably in WY2016, due to the absence of adequate streamflow for diversion to the ponds. In the absence of groundwater recharge and with the continued pumping of groundwater, the rate of groundwater decline is likely exacerbated.

These data further suggest that streams in the Santa Clara Valley, including Upper Penitencia Creek, may continue to exhibit intermittent conditions as surface flows function to recharge local groundwater.

Salmonid Winter-Refuge Habitat and Passage to Upstream Habitat

In spite of intermittent streamflow conditions, we measured periods when streamflow was continuous through the project reach and likely passable by salmonids. In Year 4, one habitat velocity compound-transect was recorded at the established cross-section (station 4+00) using an Acoustic Doppler Current Profiler (ADCP). Habitat depth and streamflow velocities were measured continuously across the section when streamflow was approximately 143 cfs and on the falling limb of the January 18, 2016 peak flow event (**Figure 7**). The active channel conveyed most of the flow while the secondary high-flow channel and floodplain were observed to be ponded or slightly backwatered. At a streamflow that was less than the designed bankfull discharge, 143 cfs still generated stream depths between 1.0 ft and 5.0 ft at station 4+00, with streamflow velocities between zero and 4.0 feet per second (ft/s). At this cross-section, flow conditions provided both deep pool as well as low-velocity habitat, and suitably passable flow conditions for salmonids moving to upstream habitat. Bank vegetation and instream wood elements also affected flow patterns and provided additional high-flow refuge or low-velocity habitat.

Bedload Sediment Transport Survey

Bedload sediment transport was measured on several occasions in Year 4 and across a range of streamflows. Last year's measurements along with the historical bedload transport observations (WY2005-WY2007, Baggett and others, 2009) suggest that transport behavior through the project reach is similar to pre-project conditions (**Figure 8)**. This is encouraging and implies that the design process was adequate from a transport perspective.

Increased sedimentation throughout the project reach was measured in Year 4; however, the increased sedimentation may be temporary and the result of the young age and roughness of the floodplain and bankside vegetation as well as backwatering effects of a downstream log-jam (discussed in subsequent sections).

Channel Bank and Bed Stability and General Geomorphic Observations

In the absence of measureable peak flow events in Year 3, channel thalweg and cross-section surveys were delayed and repeated in Year 4. Results are compared with Year 1 and post-construction as-builts (**Appendix A**). Overall, in Year 4, the project reach maintained its planform but exhibited measurable changes in elevation in both profile and cross-section. For example, the long-profile of the low-flow channel aggraded between 1 and 6 feet when elevations were compared between Year 4 and as-built elevations. Cross-sections also illustrate this aggradation, but show minimal horizontal channel-shifts. Based on observations, we believe most of this change occurred in Year 4 with the occurrence of multiple peak flow events.

Below, we describe several reasons for channel aggradation:

1) In the Feasibility Study and Design Basis Report (Chartrand, 2011), the historical geomorphic and geologic setting identified that the project reach is located at the terminus of an alluvial fan, where deposition is the primary geomorphic process. This process is still dominant today.

2) In Year 4, we recorded the highest peak flows to date, post-construction. In fact, as mentioned earlier, several peak flows exceeded the estimated bankfull flow (270 cfs) as computed by Jordan and others (2009). Based on current estimates of instantaneous, bedload sediment-transport rates, peak flows in Year 4 transported between 200 tons/day and 1,670 tons/day.

3) Stream restoration required total revegetation and a period of uniform vegetation growth. In the first 3 to 7 years after restoration, young vegetation occupies most low-lying areas and imposes increased hydraulic roughness on the channel. Increased roughness, in turn, reduces streamflow velocities and reduces the capacity of floods to transport sediment through the restored reach. As a result, the bed and floodplain exhibit temporary aggradation or sedimentation. It is anticipated that hydraulic roughness will decrease over time as vegetation matures and shades out low-lying,

understory vegetation. In the absence of abundant low-lying vegetation, subsequent floods will likely scour and transport excessive sediment from the project reach.

4) The on-going drought in California has resulted in mortality of some mature riparian trees. Several of these trees have fallen into Upper Penitencia Creek upstream and within the project reach. As a result, an in-stream log-jam, downstream of the project reach, formed and caused measurable backwatering of the lower project reach. Backwatering caused fine sediment deposition within the constructed channel, on the floodplain, and within the vicinity of at least one stormwater outfall. At the time of this report, spring flows have partially dismantled sections of the log-jam. Continued backwatering and sedimentation during higher flows is anticipated until the log-jam is removed naturally by subsequent floods.

In Year 4, Balance collected bed-core sediment samples (surface to 6 inches below surface) from the channel bed in three different locations and sieved each sample for sediment-size class analysis. Results were compared with sediment-size class analysis for materials (i.e., channel bed fill, ASTM D422) used for construction (**Figure 9a**). Sediment used for the construction of the channel bed fill included a D_{50} (median diameter size by weight) measured to be 76 millimeters (mm) or cobble size; whereas, sediment collected from the bed in Year 4 exhibited a D_{50} measured to be between 1.5 mm and 18 mm or sand to gravel size material. These results indicate a fining of the channel bed. The finer material originated from upstream sources and was transported into the reach as illustrated from a size class analysis from samples collected from active bedload sediment-transport during floods (**Figure 9b**).

Photographic Documentation Points

Repeat photographs are documented annually for qualitative evaluation of channel changes and post-construction conditions (**Appendix B**). Based on repeat photographs, we documented an evolving channel in Year 4 in the absence of continuous flow. Photos show abundant floodplain and bank vegetation, channel aggradation, an increase in fine sediment of the channel bed, and active instream wood loading and deposition.

Conclusions

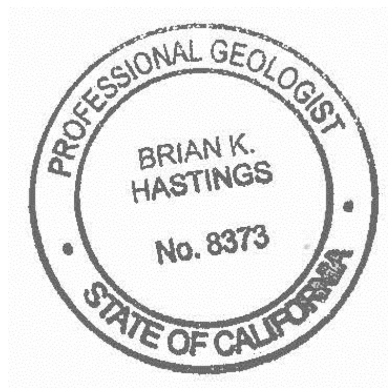
Year 4 is reflective of a normal rainfall year, following several below-average rainfall years. For the first time during this monitoring program, we recorded multiple peak flows and active sediment transport into and through the project reach. Both bedload sediment-transport measurements and samples of the channel bed indicated an introduction of fine sediment from upstream. Channel thalweg and cross-section surveys indicated active sediment deposition and changes in channel elevations. The wide, constructed channel-corridor was intended to accommodate these changes. In subsequent years, we may observe or measure active sediment scouring and different channel dynamics. In addition, we observed abundant wood transported through the reach and wood deposition on the floodplain. All of these observations and measurements suggest a functioning channel with physical habitat complexity.

The project reach is primarily a fish passage reach. In past years, Upper Penitencia Creek and other Coyote Creek tributaries, have been observed dry for extended periods as the result of a severe, multi-year drought. This year, under near average precipitation, we measured periods of continuous streamflow through the project reach, some periods lasting many days. While streamflow was more frequent this year, groundwater surface levels continue to be below historical averages. Shallow groundwater supports surface flow and can improve flow duration and continuity in a channel. It may take several years of average to above average precipitation and runoff to recharge local groundwater and support surface flow in Upper Penitencia Creek. As part of this monitoring program, Balance will continue to monitor streamflow and groundwater levels from nearby wells.

Closing

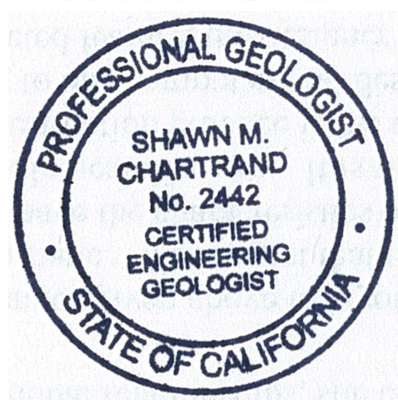
We greatly appreciate the opportunity to assist you with this monitoring effort and look forward to reporting on the Year-5 geomorphic and hydrologic monitoring efforts.

Respectfully Submitted,



Brian Hastings, PG
Geomorphologist

Reviewed by:



Shawn Chartrand, CEG, PG
Principal Geomorphologist

Encl. Tables 1-2
Figures 1-9
Appendices A and B

References Cited:

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TABLES

Table 1. Stream geomorphology, monitoring summary, Baseline + Years 1, 2, 3, and 4 (Water Years 2013-2016)
Upper Penitencia Creek at Berryessa Road, San Jose, California

Monitoring Components	Baseline (Post-Construction)	Baseline (Post-Construction)	Years After Construction: Year 1 (WY2013)	Year 2 (WY2014)*	Year 3 (WY2015)*	Year 4 (WY2016)	Monitoring
	Date	*Responsible Party*	*Date*	*Date*	*Date*	*Date*	*Responsible Party*
Longitudinal profile	1-Dec-2012	Allied Engineering	4-Jun-2013	not applicable	post-poned	29-Mar-2016	Balance Hydrologics
Cross-sections	1-Dec-2012	Allied Engineering	4-Jun-2013	not applicable	post-poned	29-Mar-2016	Balance Hydrologics
Flow and bedload transport	--	--	Nov 2012 thru March 2013	Nov 2013 thru March 2014	Nov 2014 thru March 2015	Dec 2015 thru Feb 2016	Balance Hydrologics
Habitat velocity profile	--	--	Nov 2012 thru March 2013	Nov 2013 thru March 2014	n/a	Dec 2015 thru Feb 2016	Balance Hydrologics
Channel dynamics observations	--	--	4-Jun-2013	15-Jun-2014	post-poned	29-Mar-2016	Balance Hydrologics
Channel bed samples	--	--	4-Jun-2013	post-poned	post-poned	29-Mar-2016	Balance Hydrologics
Photopoints	10-Dec-2012	Balance Hydrologics	4-Jun-2013	15-Jun-2014	post-poned	29-Mar-2016	Balance Hydrologics

Notes
Channel construction and rewatering was completed in November 2012
Baseline surveys completed by Allied Engineering were provided to Balance Hydrologics in March 2013
* In the absence of bedload transport sampling opportunities in WY2014 and WY2015, channel bed samples were not collected and surveys were post-poned.

Table 2. Station observer log:
Upper Penitencia Creek below North King Road, water year 2016

Site Conditions						*Streamflow*			*Water Quality Observations*				*Remarks*
Date/Time (observer time)	Observer	Stage	High water marks	HWM Date:Time	Hydrograph	Measured Streamflow	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Additional sampling?	
		(feet)	(feet)		(R/F/S/B)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(Qss, Qbed)	
10/19/2015 13:15	ks, gp	--	--	--	dry	--	--	--					Download gage; abundant trash and debris in channel; mobile bed at gage
12/13/2015 11:15	gp, cs	--	--	--	dry	--	--	--	10.40	74	103	--	Steady rain; runoff entering channel from stormdrains, flow through lower half of project reach; no flow at gage or from upstream; ponded water in pool sections between gage and first outfall
12/22/2015 12:00	gp, dj	1.75	3.75	12/22/2015	F	120	AA	f	--	--	--	--	
12/31/2015 12:00	dj, cn		3.75	12/22/2015	Peak	*400*	survey	f-p	--	--	--	--	Estimated peak flow from indirect survey of HWMs and from 3 cross-sections; Manning's roughness estimated 0.037
1/5/2016 7:45	ed, cs	0.45	0.6-0.7	1/5/16 AM	f	6.26	AA	p	10.90	159	217	--	Bedload test, no load, rapidly falling hydrograph, entire site had continuous surface flows. Water levels at DS end of site much higher than previous visits likely due to backwatering from log-jam
1/5/2016 7:55	ed, cs	0.36	0.6-0.7	1/5/16 AM	f	4.42	AA	p	10.90	159	217	--	see above. ADCP velocity profiles taken, 6 measurements. Q totals unreliable.
1/11/2016 13:30	ed	--			dry	--	--	--	--	--	--	--	No flow through upper portion of site. No apparent through-flow in pools at downstream end of the site. Installed second pressure transducer and third staff plate on site. Left the site upstream. No surface flows downstream of Capitol Blvd.
1/18/2016 6:30	jo, dj	4.60			peak	*650*	est.	p	--	--	--	--	Used data collected in 12/31/15 survey and difference in HWMs to estimate peak flow for this event.
1/18/2016 10:45	jo, dj	see notes	4.60	this AM	F	161	ADCP	f	--	--	--	Qss, 3 Qbed	On site for several hours, flow was falling, measured flow and bedload upstream of King Road; also measured flow and habitat-velocity profile; Qss was dip sample about 1.5 feet deep. Best ADCP measurement appears to by 12:10 pm 143 cfs
1/18/2016 13:08	jo, dj	2.60	--	--	--	--	--	--	--	--	--	--	Debris on staff plate; removed debris after reading stage (stage shift)
1/18/2016 13:15	jo, dj	2.05	--	--	--	--	--	--	--	--	--	--	Stage after debris removed
2/17/2016 9:00	bkh	dry	4.60	1/18/2016	dry	dry	--	--	--	--	--	--	Site visit to evaluate channel conditions after two moderate flood events; relocated water-level logger further downstream to big bend; downloaded both instruments; observed large wood jam downstream--caused backwatering to soffet of bridge. Significant sedimentation with some local scour at pools; urban outfalls are in good shape. No flow entering project reach or observed upstream of N. King Road
2/17/2016 10:30	bkh	dry	--	--	dry	dry	--	--	--	--	--	--	Continuous stage gage installed in January was damaged in storm; gage removed and relocated downstream to station 4+00; staff plate installed such that sediment or bed of channel is measured at 0.90 ft on staff plate; levelogger will be engaged at stage of 1.2-1.3
3/29/2016 9:30	bkh, ed	dry	--	--	dry	dry	--	--	--	--	--	--	Continuous stage gage: channel is wet at gage and some ponding behind rootwad. Recent rains likely generated several days of flow in channel. Wood racked up on staff plate, but secure. Sediment at 1.85 ft (filled)
3/29/2016 9:40	bkh, ed	dry	--	--	dry	dry	--	--	--	--	--	--	Sunny, cool, channel is dry at gage, but wet at end of project reach with some minor flow from culvert at bridge. Recent rains likely generated several days of flow in channel. Scour at gage is apparent with stilling well and staff plate rouhgly 0.3 ft above bed; however, downstream cobble likely controls a pool to this depth. On-site to conduct stream survey
7/28/2016 11:30	ks, gp	dry	--	--	dry	dry	--	--	--	--	--	--	Dry with significant growth in vegetation along channel; HWM at d/s gage 4.60'; downloaded both gages
9/15/2016 11:45	ed	dry	--	--	dry	dry	--	--	--	--	--	--	Site visit, final download. Conditions are dry. Collected 3 bedcore samples to characterize bed conditions at end of WY2016; water ponded at downstream gage

Observer Key: (bkh) Brian Hastings, (jo) Jonathan Owens, (ed) Eric Donaldson, cn (Chelsea Neill), aes (Anne Senter), dj (Dana Jepsen), ks (Krysia Skorko), gp (Gustavo Por
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (E
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductar
Additional Sampling: Qss = Suspended Sediment, Qbed = Bedload Sedimer

FIGURES

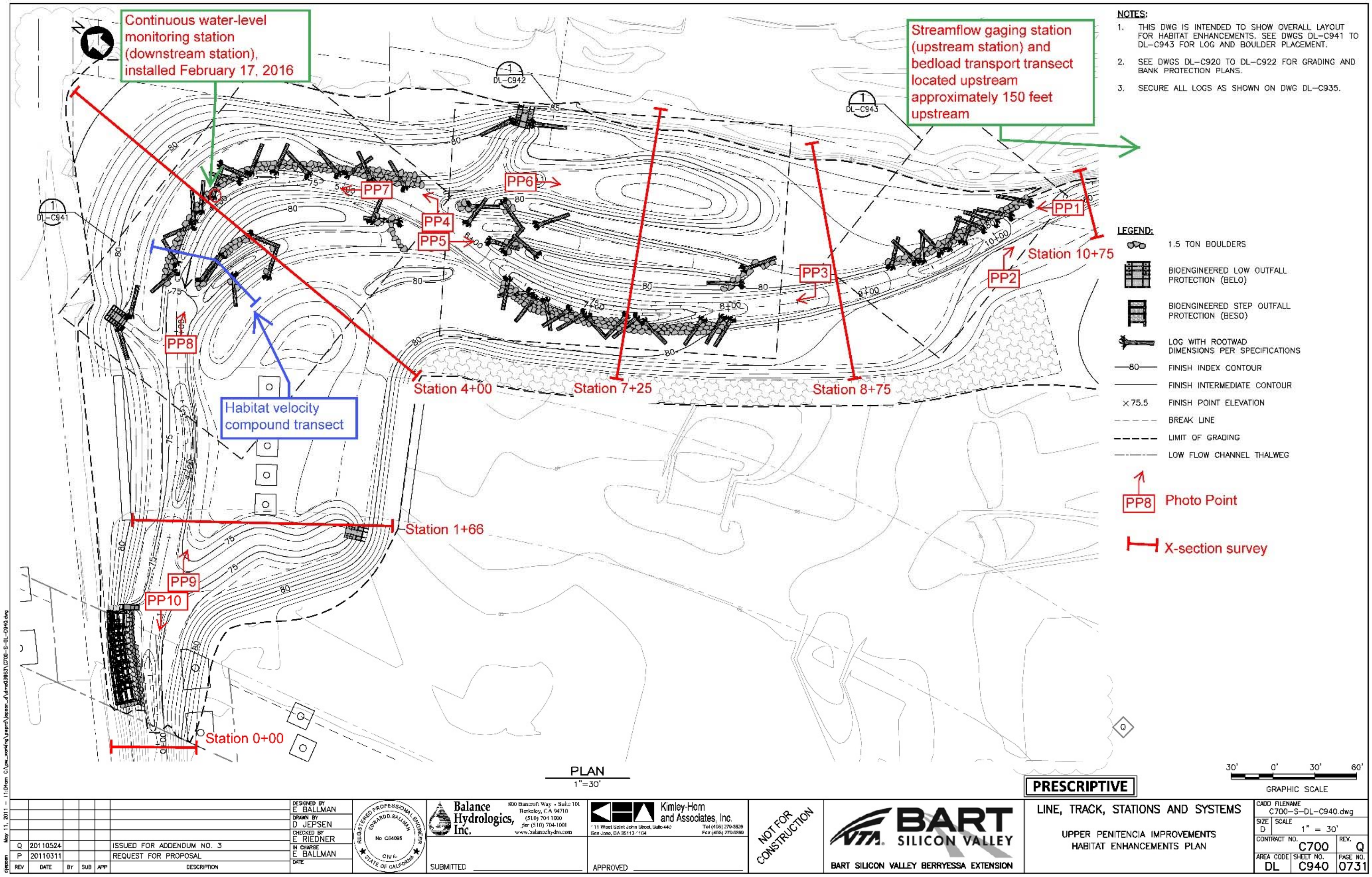
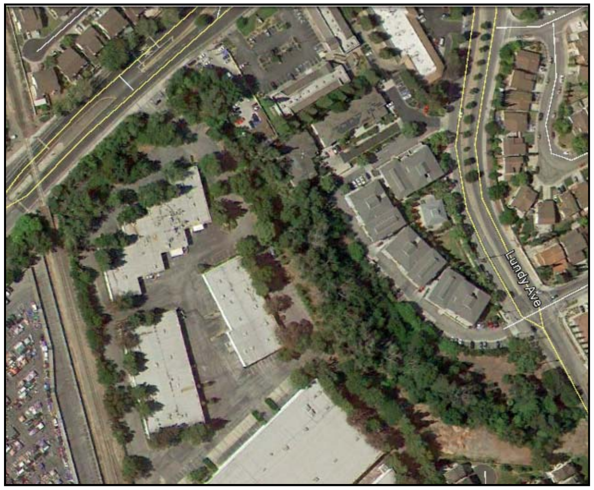


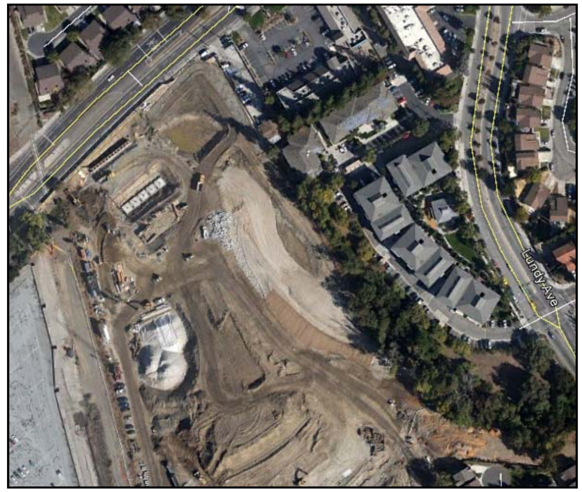
Figure 1. Project reach and monitoring elements, Upper Penitencia Creek, San Jose, California.

Balance Hydrologics, Inc.

Monitoring map



A. May 2012 , Before construction



B. September 2012, channel construction

C. April 2013, 6 months after channel construction.

D. June 2015, 3 years after construction

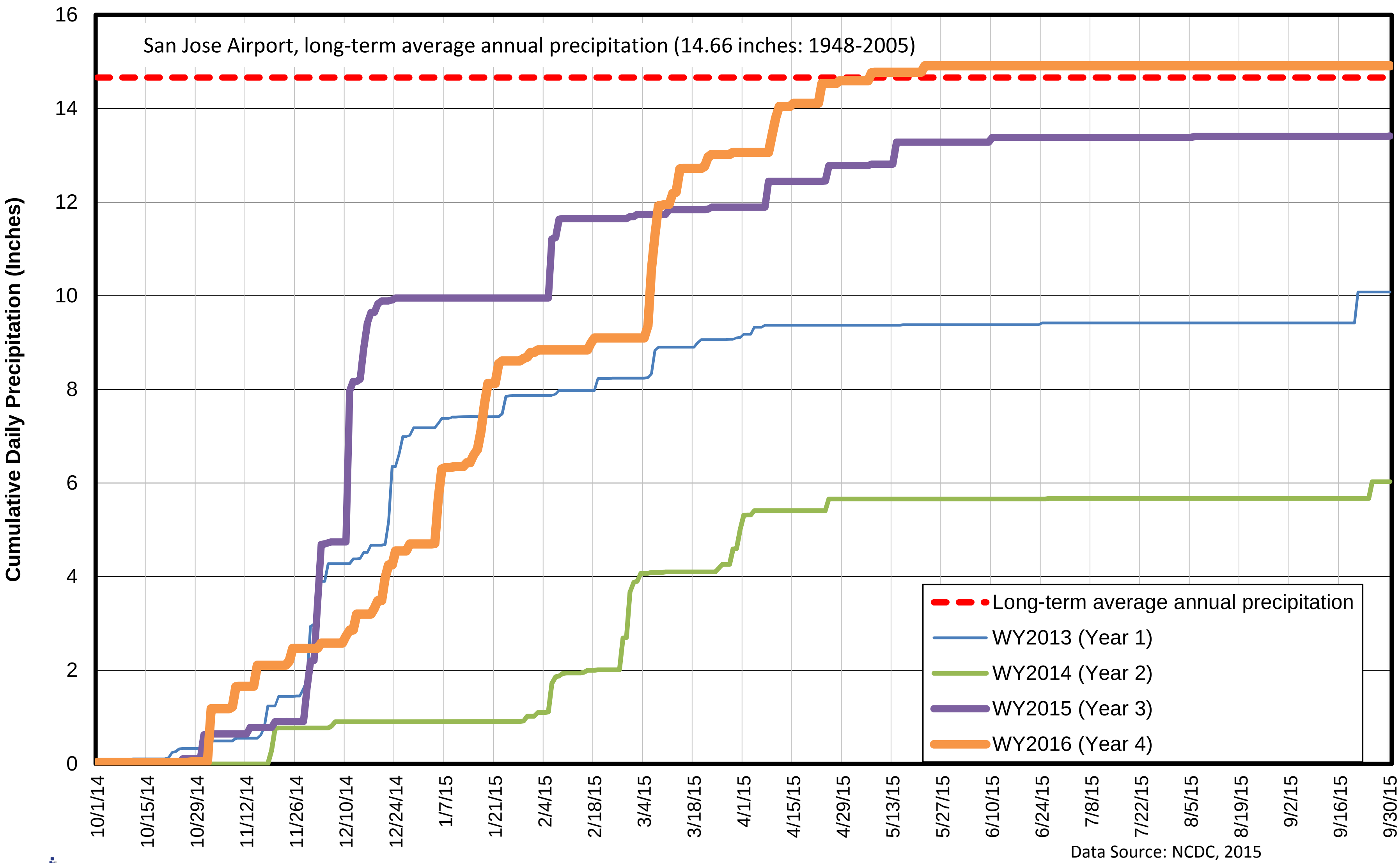
E. January 2016, after Jan 18, 2016 flood

F. April 2016, 4 years after construction

Balance Hydrologics, Inc.

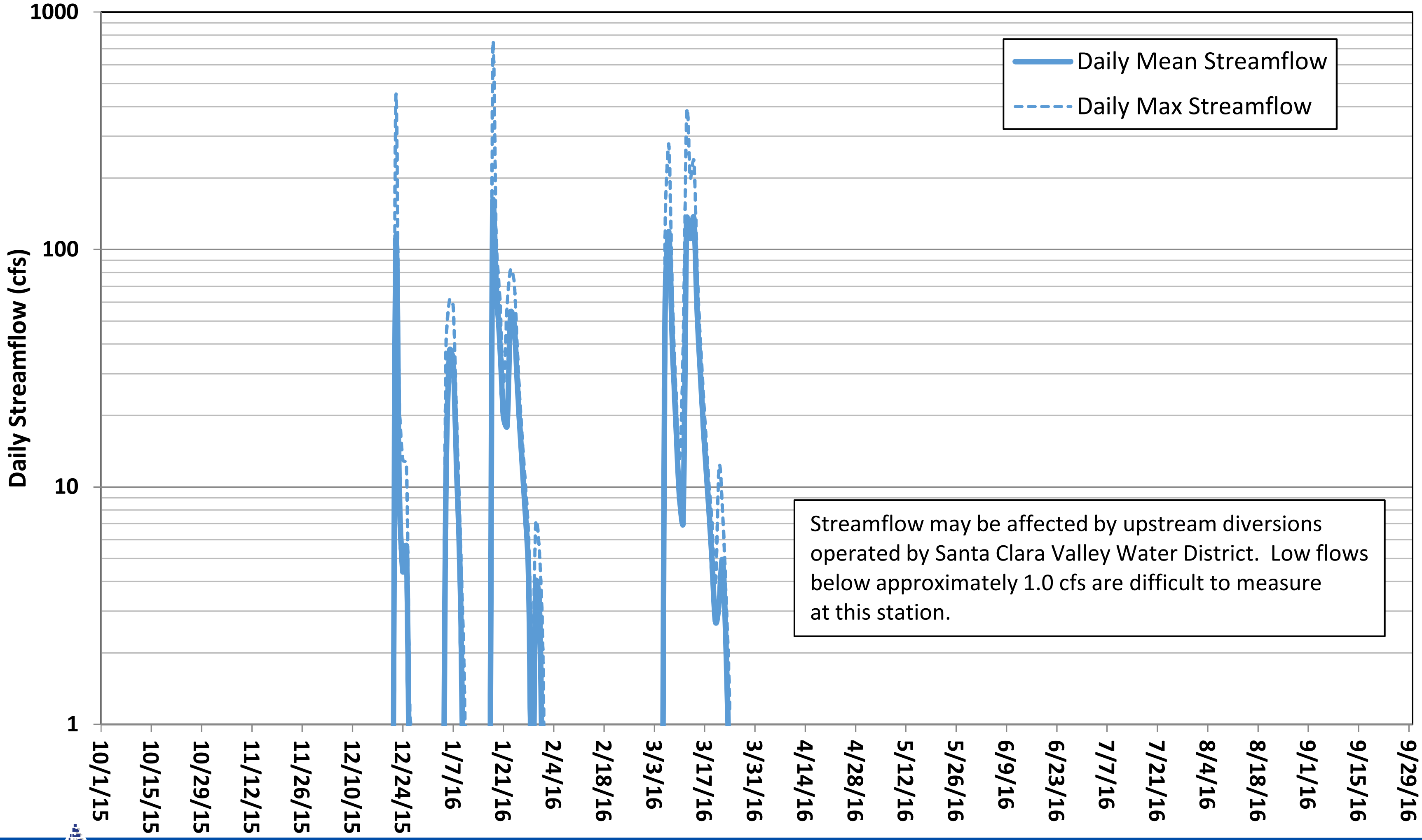
Imagery: Google Earth

Figure 2. **Sequence of project completion and channel evolution, Upper Penitencia Creek, San Jose, California**
Aerial photographs taken between May 2012 and April 2016 show the project before, during and after construction.



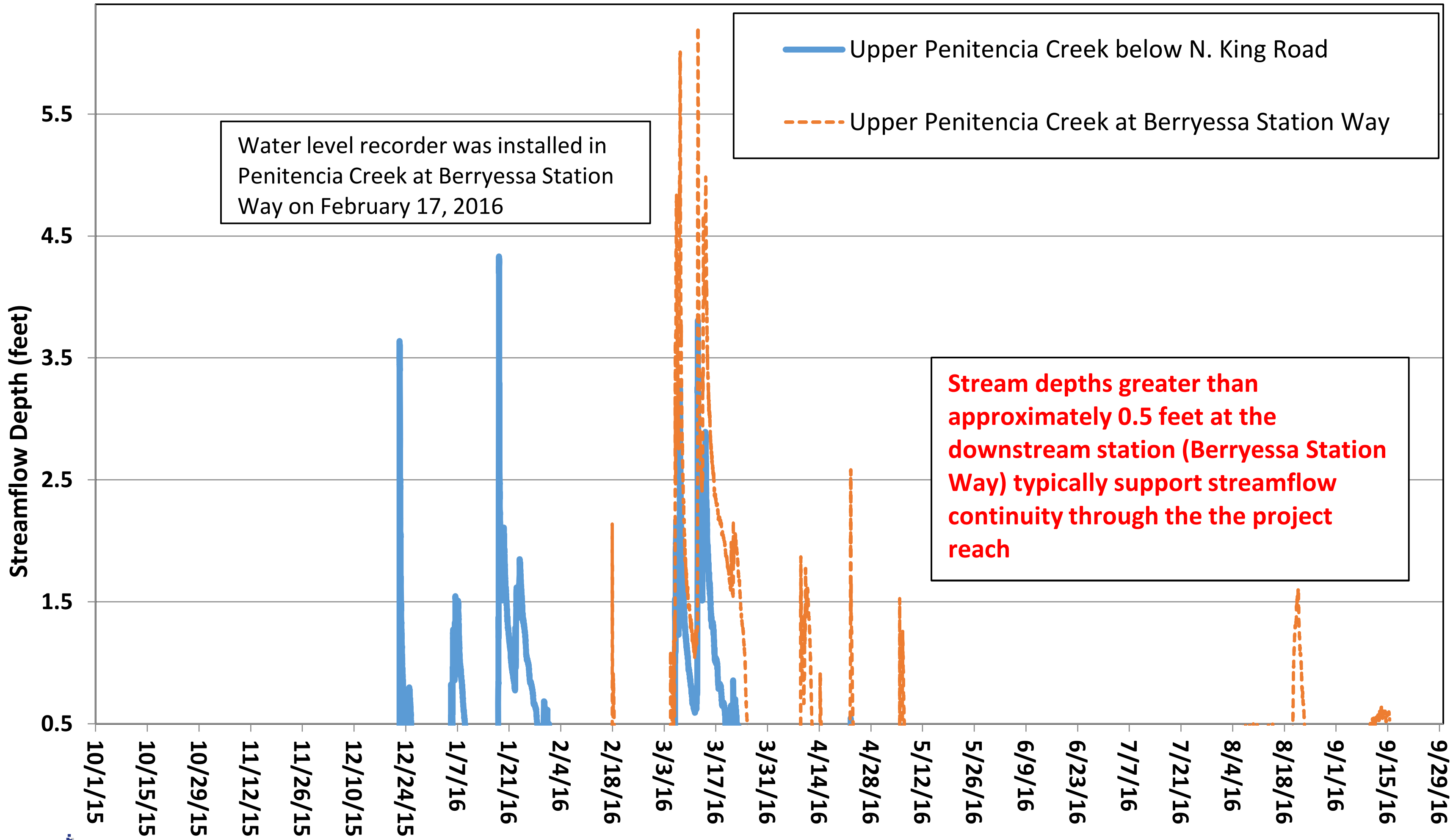
Balance Hydrologics, Inc.

Figure 3. **Cumulative daily precipitation, San Jose Airport, San Jose, California, water years 2013, 2014, 2015 and 2016.** Total annual rainfall in WY2016 was near normal after three consecutive below average rainfall years.



Balance Hydrologics, Inc.

Figure 4. Daily mean streamflow, Upper Penitencia Creek, below North King Road, San Jose, California, Water Year 2016.



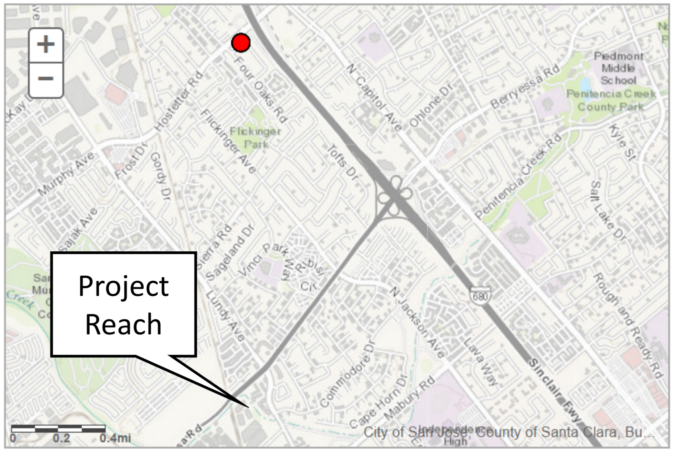
Balance Hydrologics, Inc.

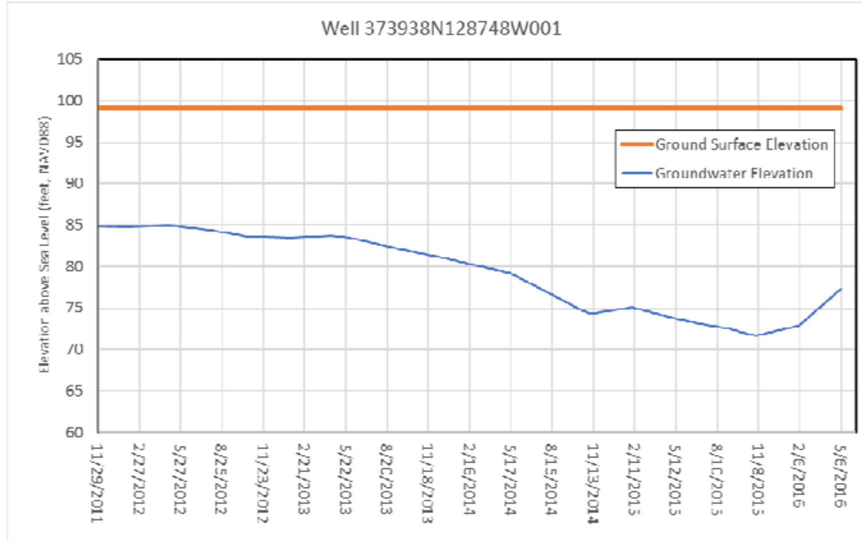
Figure 5. Estimation of streamflow continuity through project reach using continuously measured stream depths at two stations, Penitencia Creek, San Jose, California, water year 2016.

216135 Upper Pen WY16, 15-min data

State Well Number: 06S01E21M011M
Local Well ID: 06S01E21M011
Site Code: 373938N1218748W001
Latitude (NAD83): 37.393830
Longitude (NAD83): -121.87482
Groundwater Basin (code): Santa Clara (2-9.02)

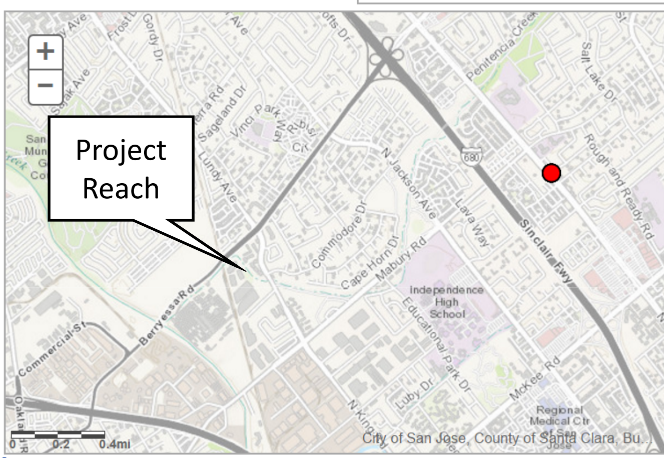
Well Use: Observation
Well Status: Active
Well Completion Report Number:
Reference Point Elevation (NAVD88 ft): 98.90
Ground Surface Elevation (NAVD88 ft): 99.10
Total Depth (ft): 325
Perforated Interval Depths (ft):





State Well Number: 06S01E27P002M
Local Well ID: 06S01E27P002
Site Code: 373772N1218499W001
Latitude (NAD83): 37.377210
Longitude (NAD83): -121.84994
Groundwater Basin (code): Santa Clara (2-9.02)

Well Use: Observation
Well Status: Active
Well Completion Report Number:
Reference Point Elevation (NAVD88 ft): 149.70
Ground Surface Elevation (NAVD88 ft): 149.90
Total Depth (ft): 389
Perforated Interval Depths (ft):



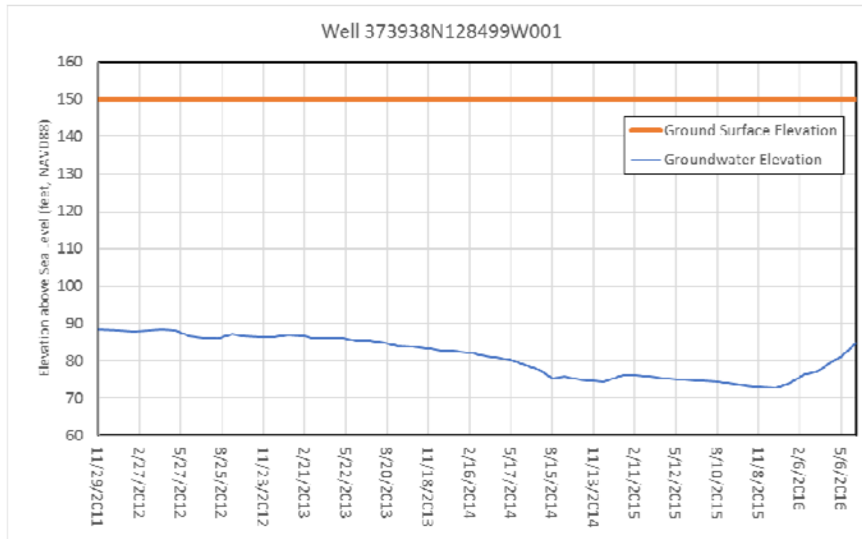


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Figure 6. **Groundwater conditions near Upper Penitencia Creek, San Jose, California**
After consecutive years of a falling groundwater table, normal precipitation has increased the groundwater table slightly; however groundwater elevations remain below 2011-2012 levels.

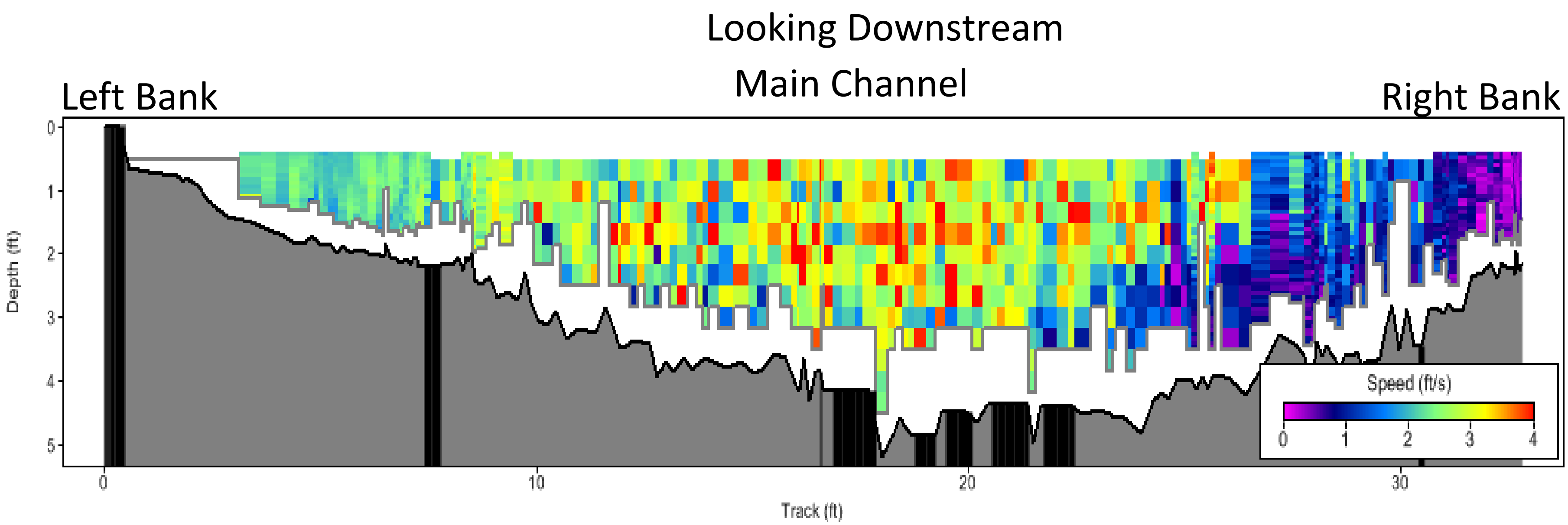

Figure 7. Habitat depth and velocity cross-section for 143 cfs, Upper Penitencia Creek, San Jose, California. Data were recorded with a Acoustic Doppler Current Profiler (ADCP). Depths between less than 1.0 ft and 5.0 ft were measured across the channel with a range of velocities between near zero feet per second (ft/s) and 4.0 ft/s. Under this streamflow, only the main channel was active (shown), while the secondary, high-flow channel and floodplain were ponded.

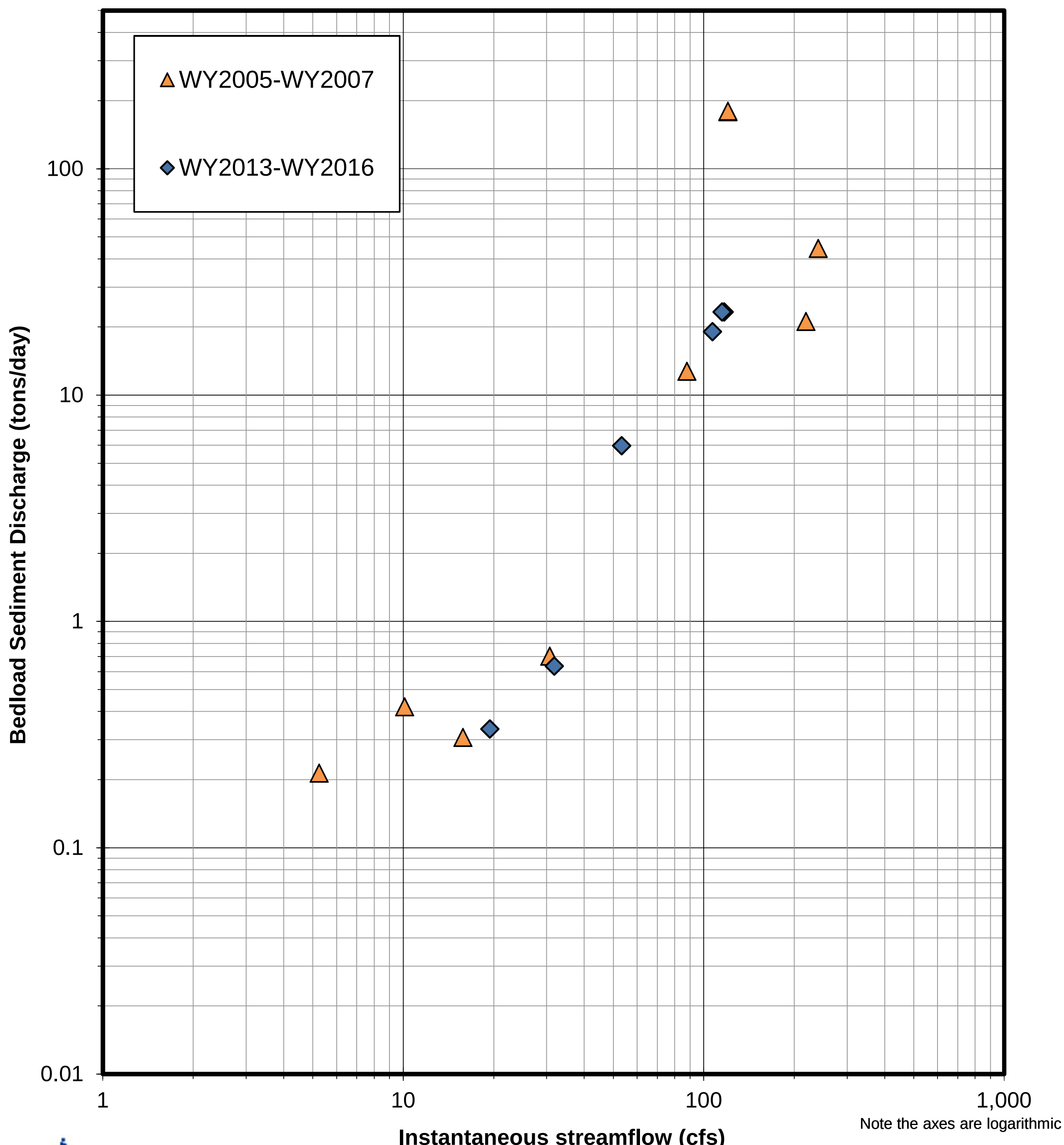

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Figure 8. **Relationship between streamflow and bedload sediment discharge, Penitencia Creek near North King Road, San Jose, California, pre-project (WY2005-WY2007) and post-project (WY2013-WY2016)**

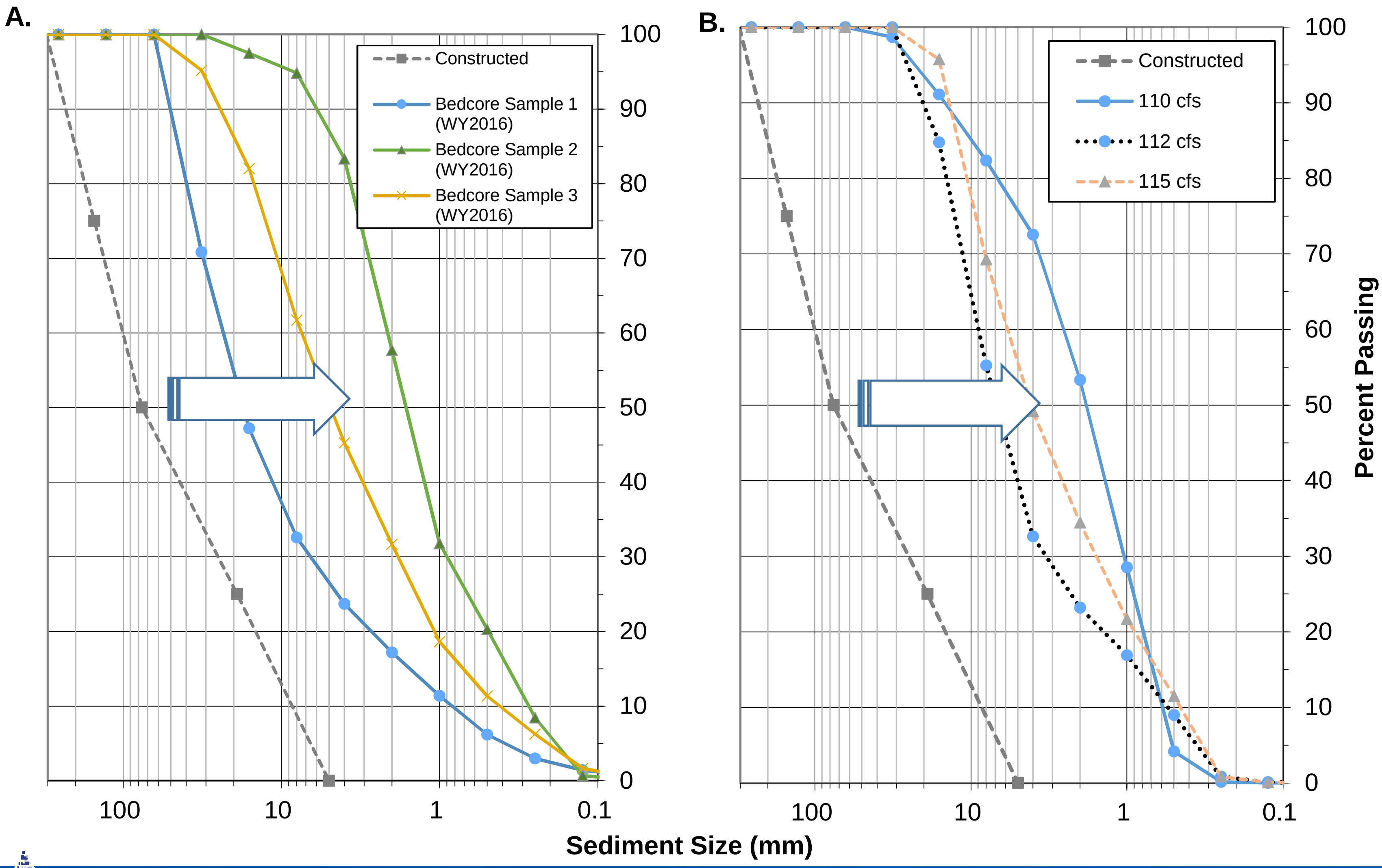

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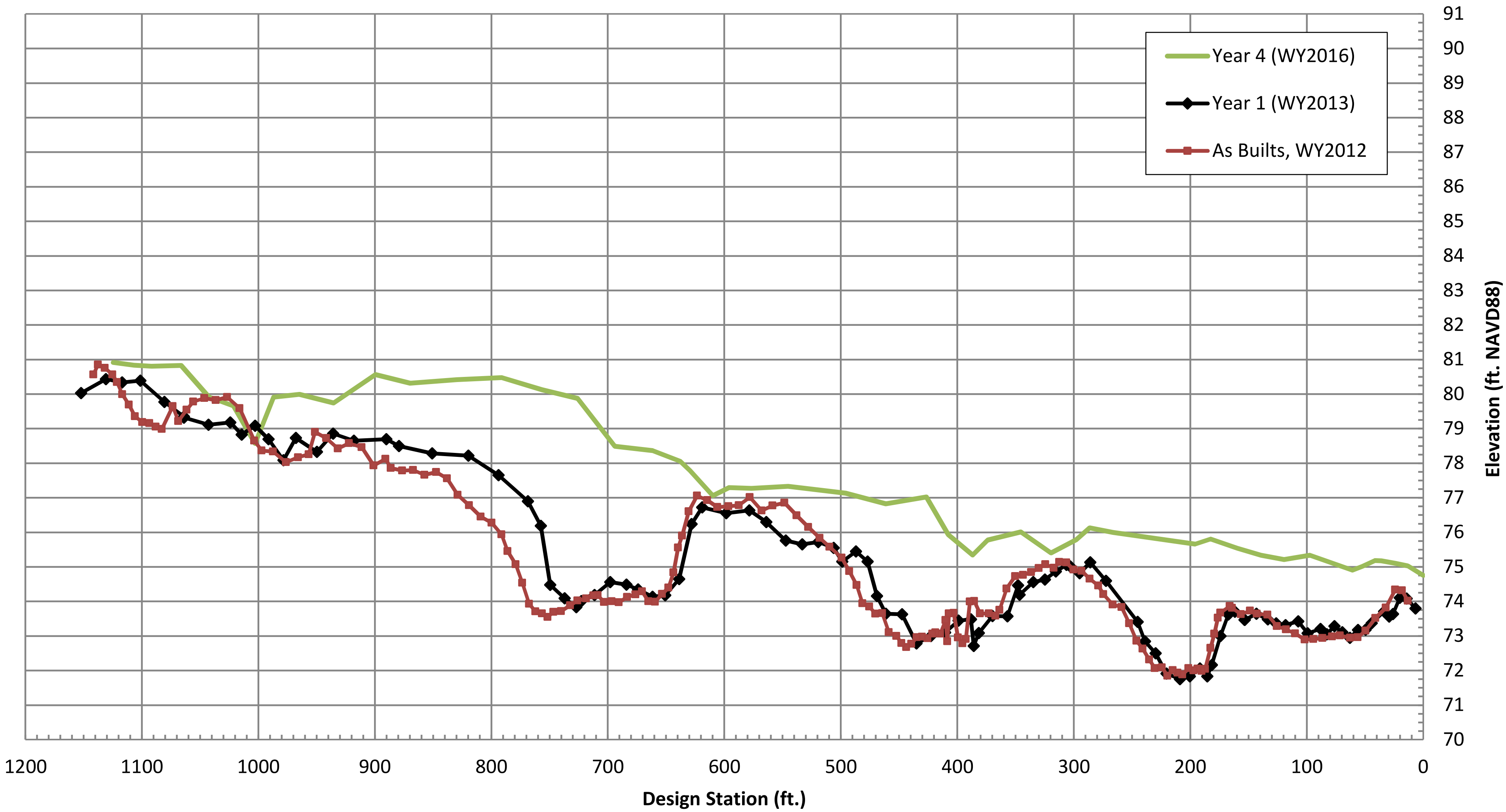
Figure 9. Sediment size class analysis of bedcores and bedload sediment transported as compared to constructed materials, Upper Penitencia Creek at Berryessa Campus, San Jose, CA

A. Constructed bed fill material as compared to bedcores in WY2016

B. Constructed bed fill material as compared to bedload transported

APPENDIX A



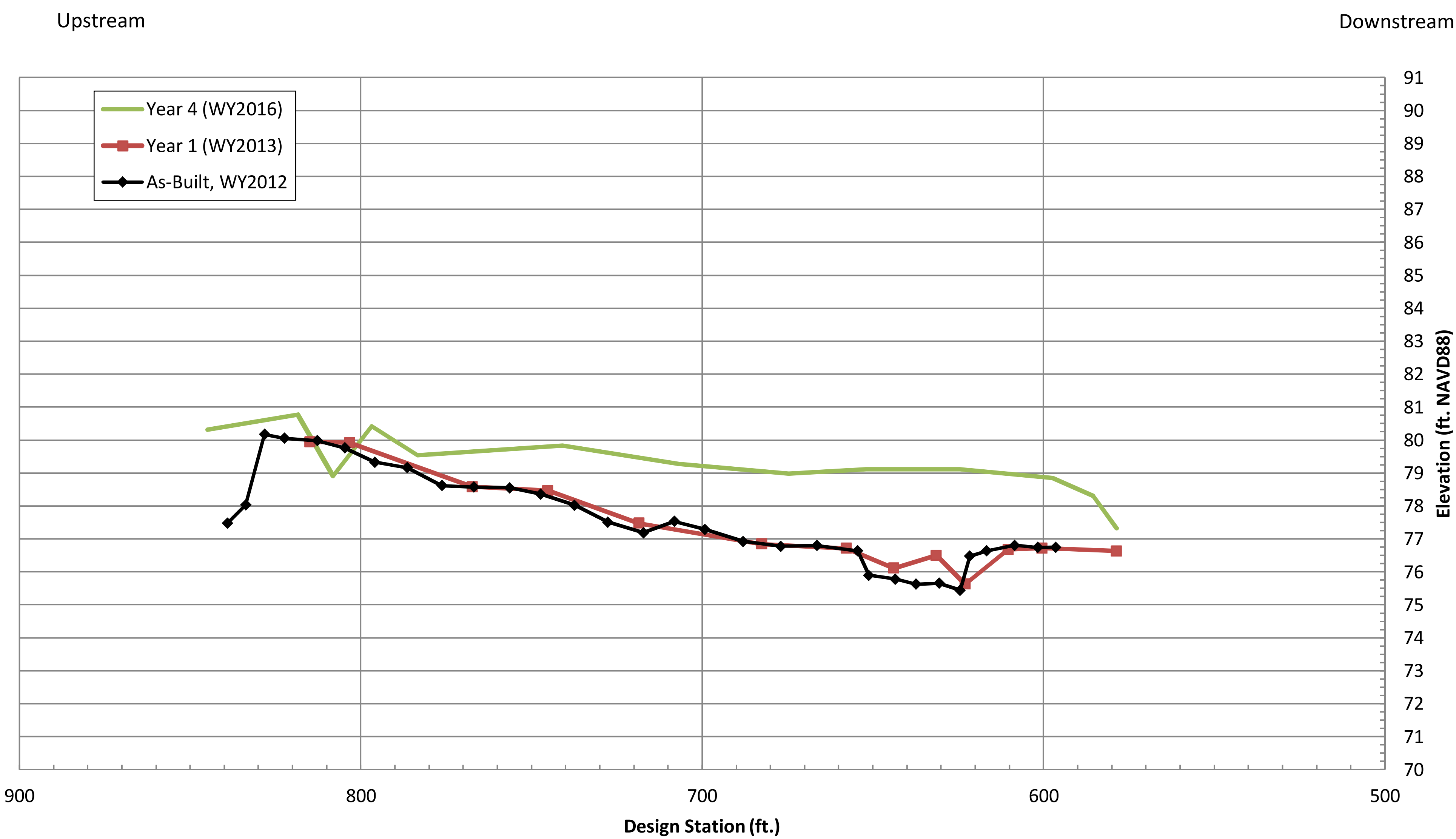
Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A1. **Long Profile, Upper Penetencia Creek Restoration, Santa Clara County, California.**

Horizontal and vertical scales do not match.

212135 Survey Master WY2013

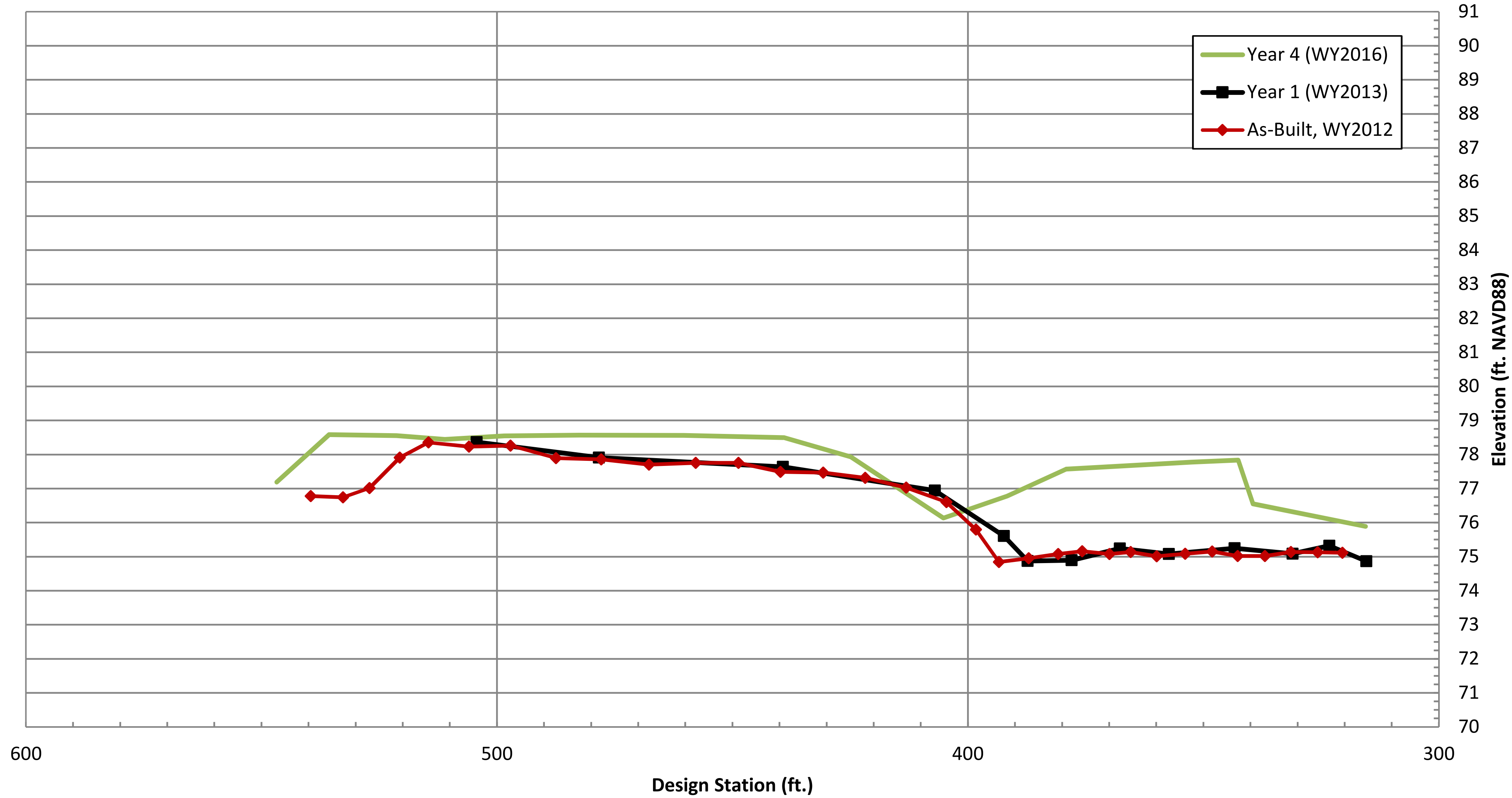


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A2. **Long profile, high-flow channel, right bank, Upper Penetencia Creek Restoration, Santa Clara County, California.**
Horizontal and vertical scales do not match.

212135 Survey Master WY2013

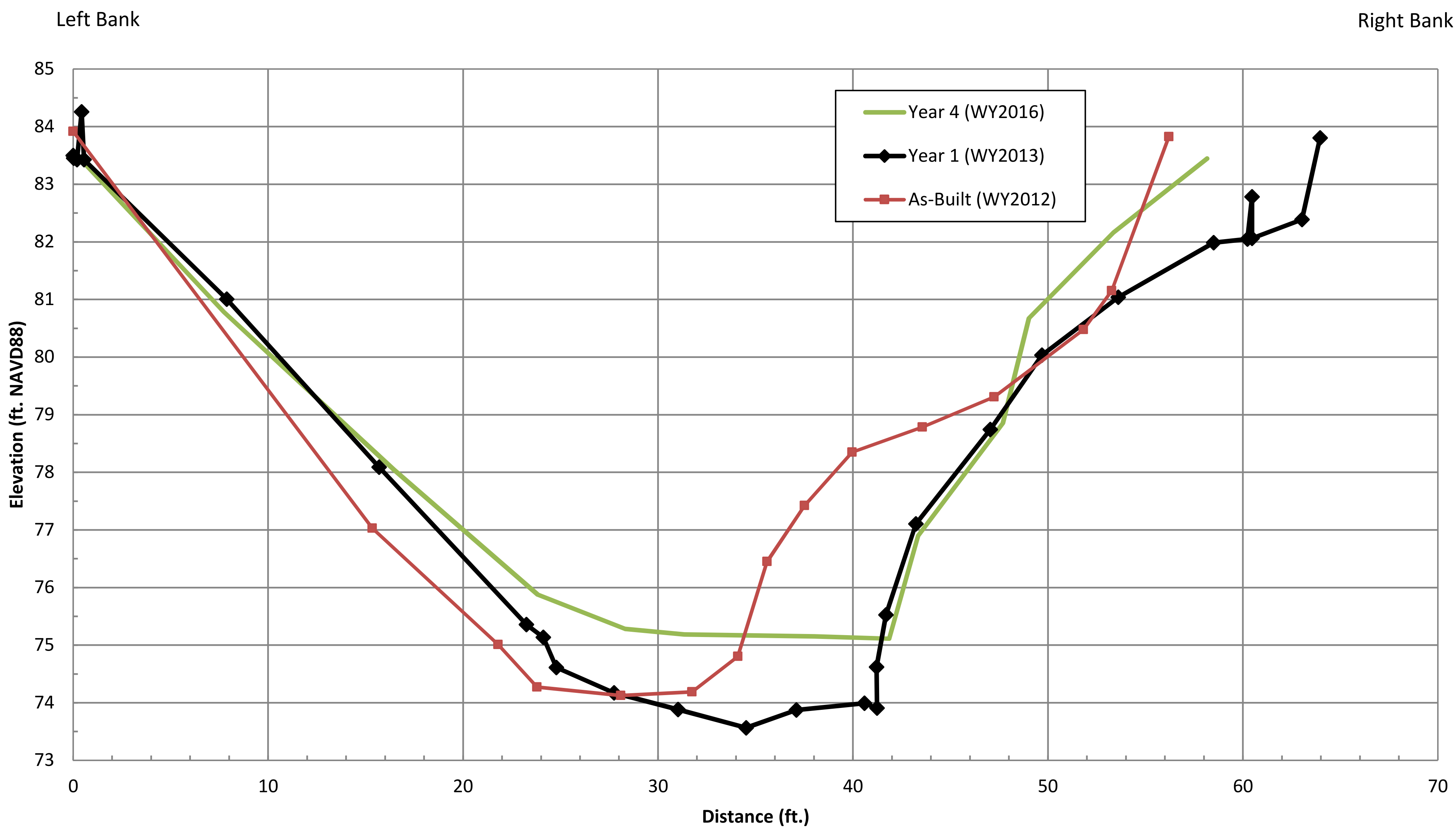


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A3. **Long profile, high-flow channel, left bank, Upper Penetencia Creek Restoration, Santa Clara County, California.**
Horizontal and vertical scales do not match.

212135 Survey Master WY2013

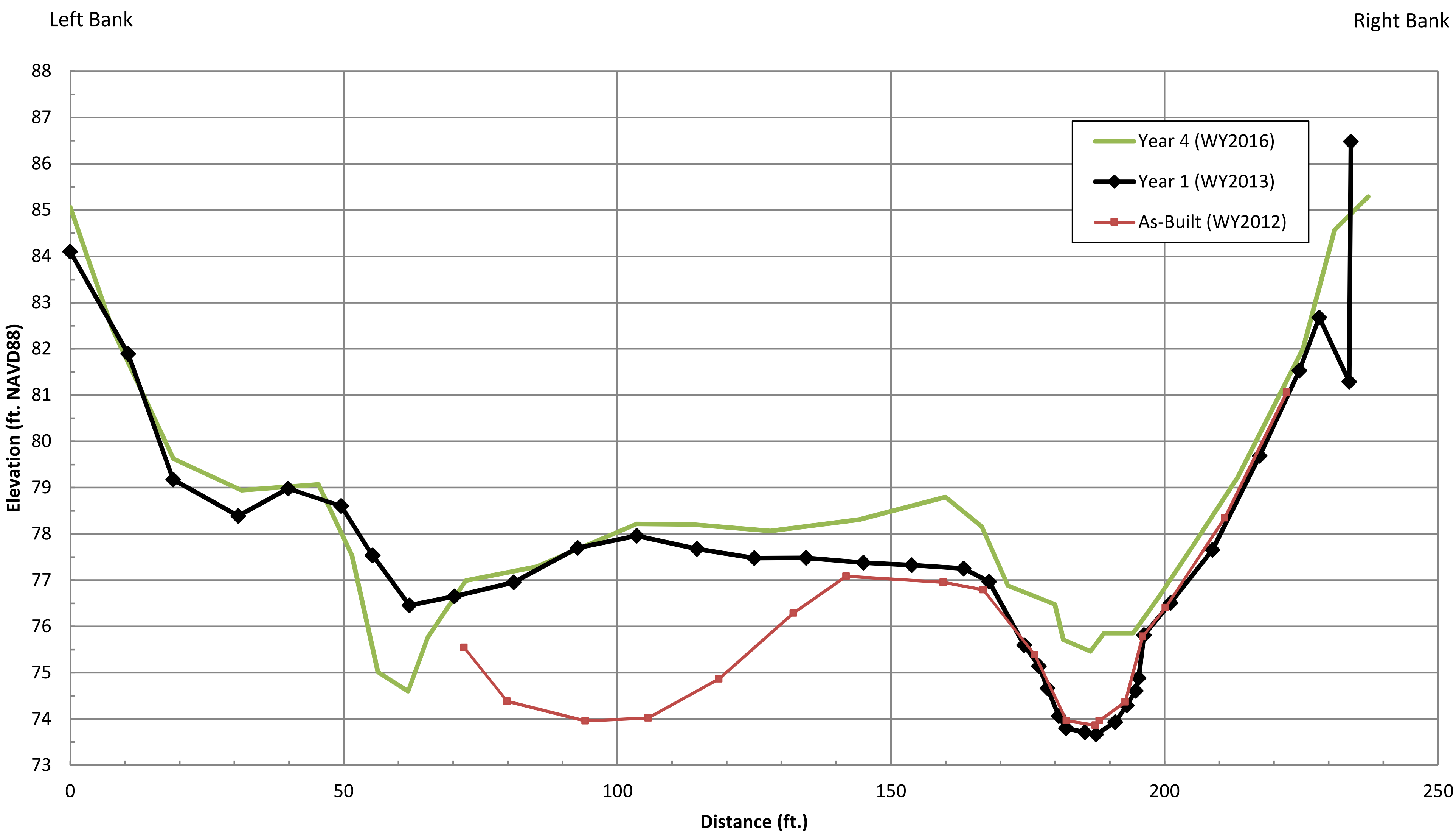


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A4. **Cross-section 0+00, Upper Penetencia Creek Restoration, Santa Clara County, California.**
Horizontal and vertical scales do not match.

212135 Survey Master WY2013

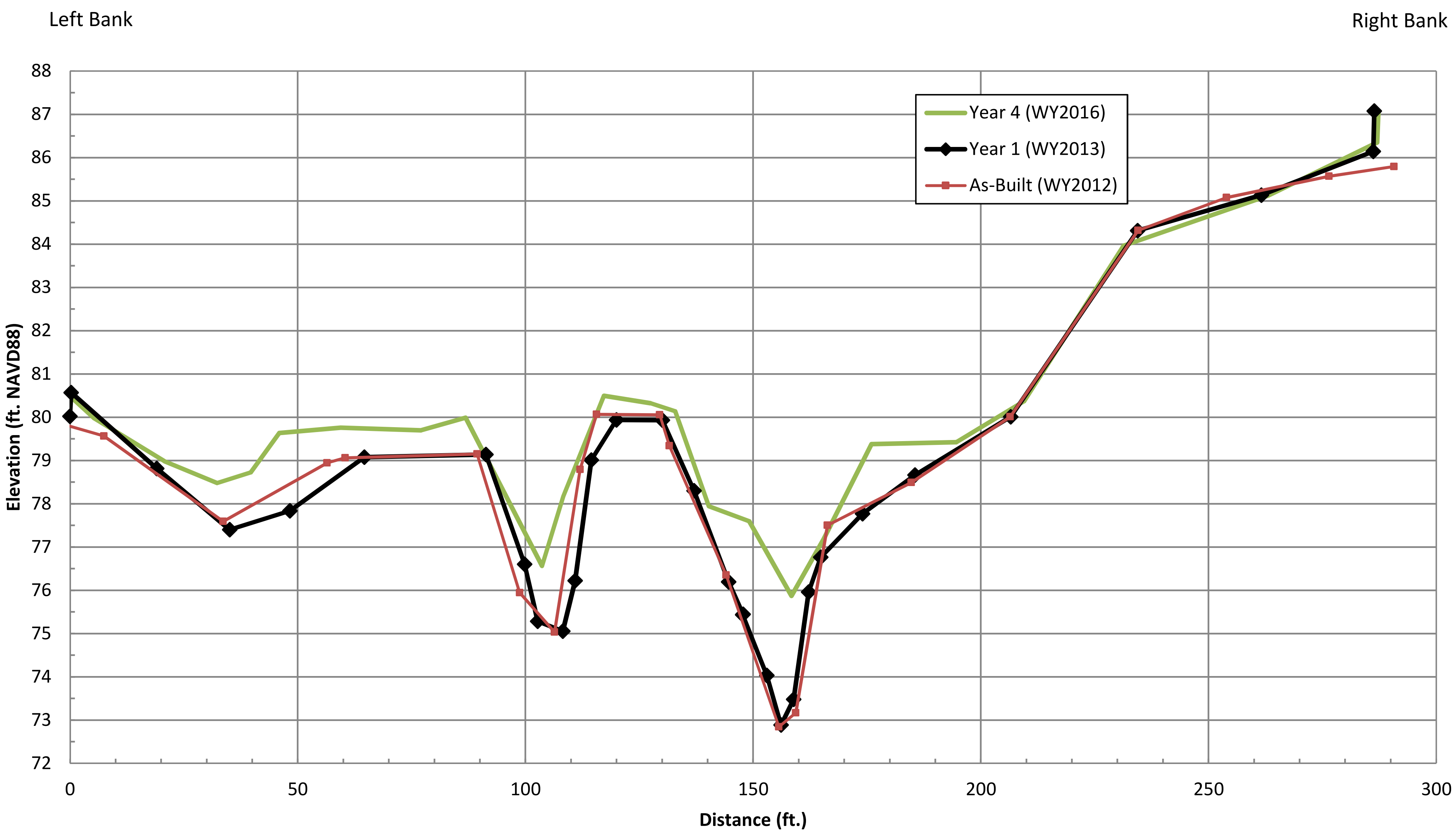


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A5. **Cross-section 1+66, Upper Penetencia Creek Restoration, Santa Clara County, California.**
Horizontal and vertical scales do not match.

212135 Survey Master WY2013

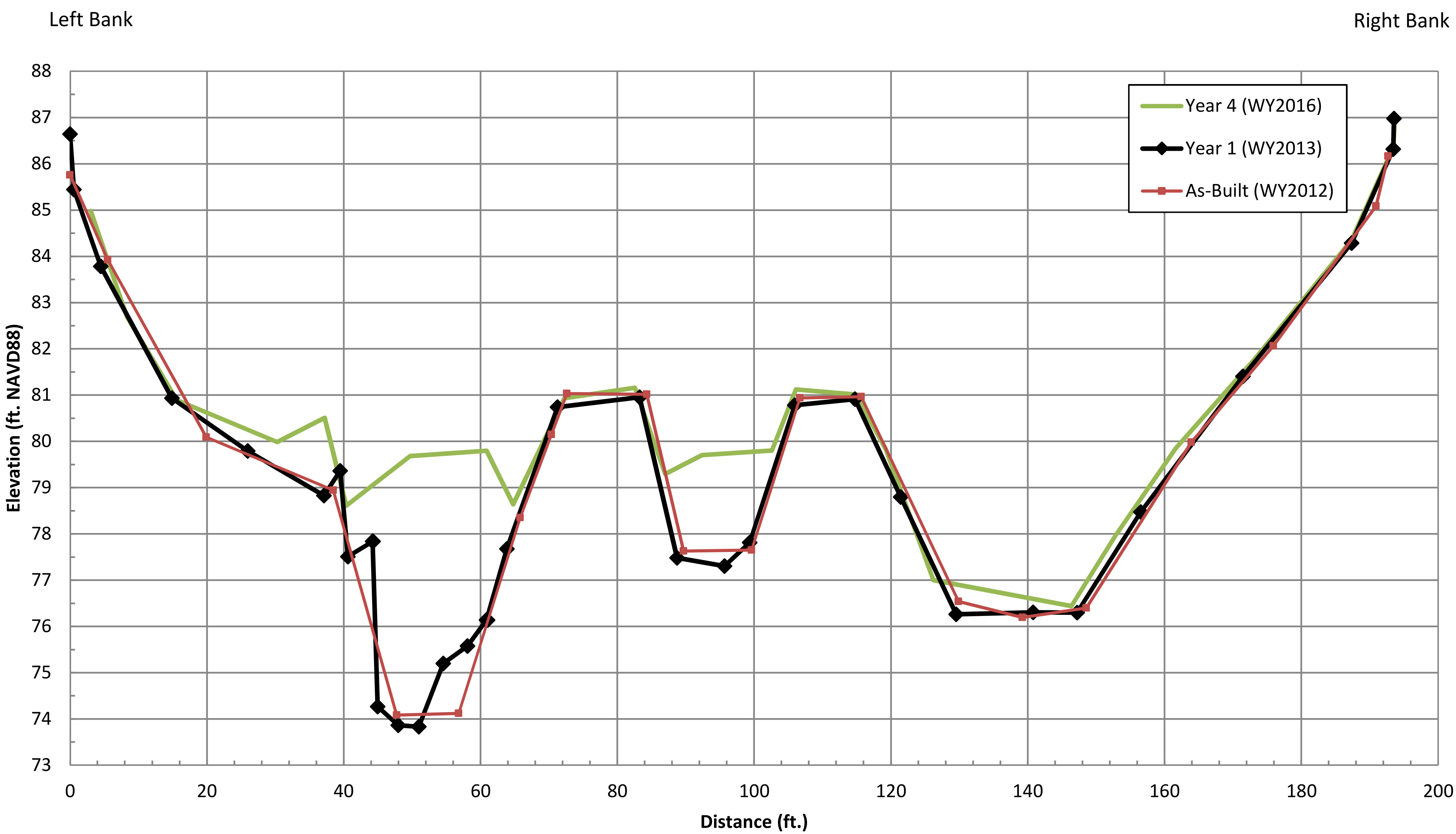


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A6. **Cross-section 4+00, Upper Penetencia Creek Restoration, Santa Clara County, California.**
Horizontal and vertical scales do not match.

212135 Survey Master WY2013

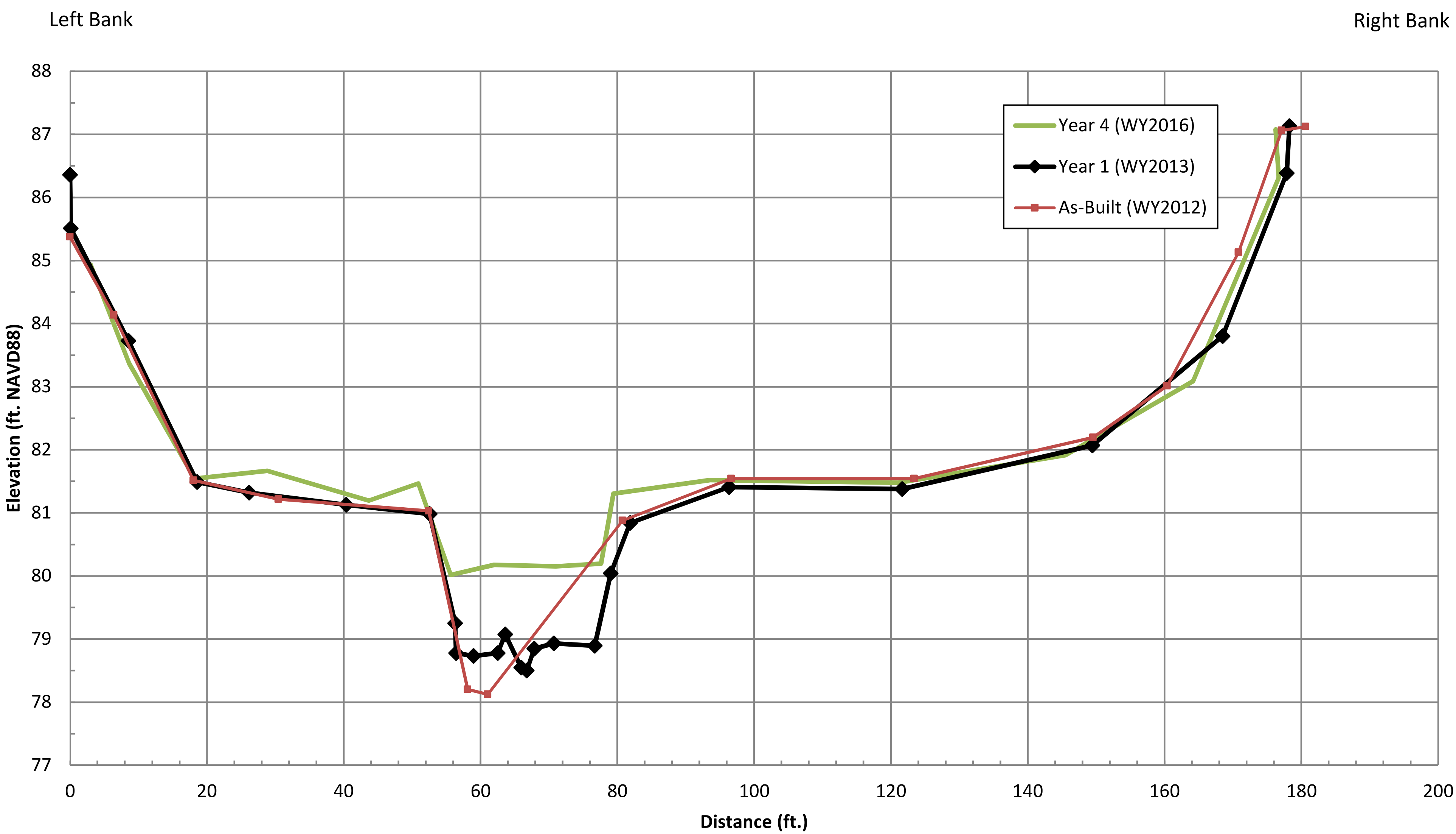


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A7. **Cross-section 7+25, Upper Penetencia Creek Restoration, Santa Clara County, California.**
Horizontal and vertical scales do not match.

212135 Survey Master WY2013

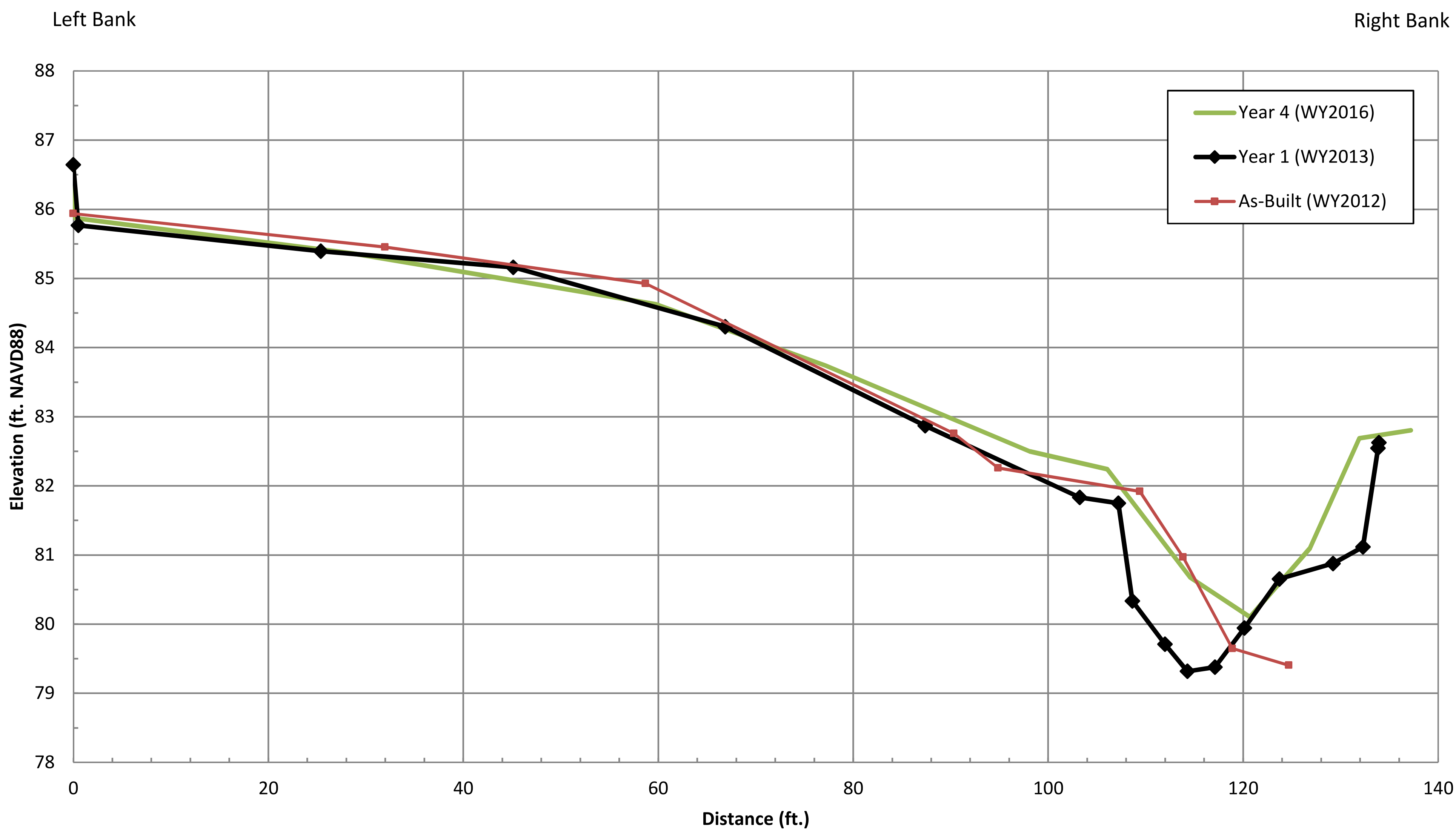


Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A8. Cross-section 8+75, Upper Penetencia Creek Restoration, Santa Clara County, California.
Horizontal and vertical scales do not match.

212135 Survey Master WY2013



Source: Balance Survey Control Provided by SCVWD

Balance Hydrologics, Inc.

Appendix A9. Cross-section 10+75, Upper Penetencia Creek Restoration, Santa Clara County, California.

Horizontal and vertical scales do not match.

212135 Survey Master WY2013

APPENDIX B

Photo Point #1: Station 10+75, December 2012 Year 1.

Photo Point #1: Station 10+75, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B1. **View downstream, entrance to project reach, Station 10+75, Upper Penitencia Creek, San Jose, California.** Riparian vegetation continues to mature and establish the banks. Two large cottonwood trees fell into the channel in Year 4, constricting the channel slightly at this station.

Photo Point #2: Station 10+00, December 2012 Year 1.

Photo Point #2: Station 10+00, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B2. View upstream, entrance to project reach, Station 10+00, Upper Penitencia Creek, San Jose, California. Riparian vegetation continues to mature and establish the banks. A large cottonwood tree fell into the channel in Year 4, creating the potential for an instream wood jam to occur in the future.

Photo Point #3: Station 8+75, December 2012 Year 1.

Photo Point #3: Station 8+75, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B3. **View downstream, entrance to upper high-flow channel, Station 8+75, Upper Penitencia Creek, San Jose, California.** After measurable precipitation and runoff in WY2016, the channel has exhibited a flux of sediment movement and aggradation typical of channels on alluvial fans.

Photo Point #4: Station 5+75, December 2012 Year 1.

Photo Point #4: Station 5+75, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B4. **View downstream, entrance to lower high-flow channel, Station 5+75, Upper Penitencia Creek, San Jose, California.** Recent runoff events have supplied instream wood to the high flow channels and floodplain

Photo Point #5: Station 5+75, December 2012 Year 1.

Photo Point #5: Station 5+75, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B5. **View upstream, entrance to lower high-flow channel, Station 5+75, Upper Penitencia Creek, San Jose, California.**

Photo Point #6: Station 6+00, December 2012 Year 1.

Photo Point #6: Station 6+00, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B6. View upstream, backwater depression, Station 6+00 (of channel), Upper Penitencia Creek, San Jose, California.

Photo Point #7: Station 5+00, December 2012 Year 1.

Photo Point #7: Station 5+00, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B7. View downstream, 90-degree bend, Station 5+00, Upper Penitencia Creek, San Jose, California. Riparian continues to mature and shade pool habitat at rootwads; bar development continues to evolve.

Photo Point #8: Station 3+00, December 2012 Year 1.

Photo Point #8: Station 3+00, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B8. View upstream, 90-degree bend and confluence of high-flow channel, Station 5+00, Upper Penitencia Creek, San Jose, California.

Photo Point #9: Station 1+25, December 2012 Year 1.

Photo Point #9: Station 1+25, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B9. View upstream, Berryessa Station Way Bridge, Station 1+25, Upper Penitencia Creek, San Jose, California.

Photo Point #10: Station 1+25, December 2012 Year 1.

Photo Point #10: Station 1+25, March 2016, Year 4.

Balance Hydrologics, Inc.

Appendix B10. View downstream, BART bridge, Station 1+25, Upper Penitencia Creek, San Jose, California.

Appendix B. Vegetation Photodocumentation

Photo 1. Photodocumentation Point 1A looking northwest at the Upper Slope Planting Zone at the eastern end of the mitigation site (August 28, 2013)

Photo 2. Photodocumentation Point 1A looking northwest at the Upper Slope Planting Zone at the eastern end of the mitigation site (September 1, 2016)

Photo 3. **Photodocumentation Point 5A, looking east at the Upper Floodplain Planting Zone along the western boundary of the mitigation site (August 28, 2013)**

Photo 4. **Photodocumentation Point 5A, looking east at the Upper Floodplain Planting Zone along the western boundary of the mitigation site (September 1, 2016)**

Photo 5. Photodocumentation Point 6A looking north at the Upper Streamside Planting Zone along the western boundary of the mitigation site (August 28, 2013)

Photo 6. Photodocumentation Point 6A looking north at the Upper Streamside Planting Zone along the western boundary of the mitigation site (September 1, 2016)

Photo 7. Photodocumentation Point 7C, looking north at the Floodplain Planting Zone in the northwestern portion of the mitigation site (August 28, 2013)

Photo 8. Photodocumentation Point 7C, looking north at the Floodplain Planting Zone in the northwestern portion of the mitigation site (September 1, 2016)

Photo 9. Photodocumentation Point 13B looking south across the Upper Slope Planting Zone to the Floodplain Planting Zone (August 28, 2013)

Photo 10. Photodocumentation Point 13B looking south across the Upper Slope Planting Zone to the Floodplain Planting Zone (September 1, 2016)

Photo 11. Photodocumentation Point 18B, looking south at the Floodplain Planting Zone (August 28, 2013)

Photo 12. Photodocumentation Point 18B, looking south at the Floodplain Planting Zone (September 1, 2016)

Appendix C. Fish Habitat Photodocumentation

Photo 1. Habitat unit 3, no water (damp) and heavily vegetated, looking downstream (October 2016)

Photo 2. Habitat unit 4, coarse gravel bars and scour channels, heavily over-grown, standing water at the lowest elevation, looking upstream (October 2016)

Photo 3. Habitat unit 6, dry with woody debris (October 2016)

Photo 4. Near junction of Habitat units 7 and 8, dry and heavily vegetated (October 2016)

Photo 5. Habitat unit 8, main channel of fines and large pebbles, large woody debris deposition, dry, looking downstream (October 2016)

Photo 6. Habitat unit 9, off-channel depression, damp (October 2016)

Photo 7. Habitat unit 11, off-channel pond (October 2016)

Photo 8. Habitat unit 9, secondary and main channels, dry, coarse gravel and sand, cobble (October 2016)

Photo 9. **Habitat unit 11, main and secondary channels, rootwad and boulders, dry, cobble and coarse sand (October 2016)**

Photo 10. **Habitat unit 12, single channel narrows, lined with downed tree, small pebbles to large cobble, dry (October 2016)**