NAPA RIVER RUTHERFORD REACH RESTORATION PROJECT ANNUAL MONITORING REPORT- 2016

Napa County Flood Control and Water Conservation District
804 First Street
Napa, California, 94559
Contact: Jeremy Sarrow
(707) 259-8204

Napa County Resource Conservation District
1303 Jefferson Street, Suite 500 B
Napa, California, 94558
Contact: Paul Blank/Jonathan Koehler
(707) 252-4188

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APPENDICIES

1. Introduction

The purpose of this document is to report on the results of surveys performed during calendar year 2016 related to the monitoring program for the Napa River Rutherford Reach Restoration Project (Project). Napa County, in partnership with the Napa County Resource Conservation District (RCD), conducts the monitoring program in accordance with the various Project permits and as defined in the monitoring plan (Hayes 2012, Sarrow, Blank, Koehler 2015) approved for the Project. The monitoring was revised in April 2015 in order to better reflect the long-term schedule of various monitoring tasks over the life of the Project (20 years) and clearly define monitoring protocols based on Project construction being completed in the fall of 2014. The Plan outlines the monitoring framework and defines protocols that were utilized for collecting data and evaluating environmental parameters presented in this report.

The current revised monitoring plan and previous annual monitoring reports from calendar years 2009 through 2015 can be accessed online at the Napa County Watershed Information Center and Conservancy (WICC) document repository for the Rutherford Reach Restoration Project: http://www.napawatersheds.org/app_folders/view/5502.

1.1 Project Description

The Napa River Rutherford Reach Restoration Project is a landowner-initiated project being implemented along a 4.5-mile reach (comprised of approximately 41 parcels owned by 30 different entities) of the mainstem Napa River south of the City of St. Helena between Zinfandel Lane and the Oakville Cross Road. Changes in land use and management in the Napa River watershed have resulted in confinement of the river into a narrow channel, loss of riparian and wetland habitats, accelerated channel incision and bank erosion, and ongoing channel degradation and property loss. A suite of restoration approaches have been utilized to achieve the Project's goals and objectives, including: setting back earthen berms from the top of the river bank; creating vegetated buffers between the river and adjacent land uses; creating backwater habitat to provide high-flow refugia for native fish; installing instream structures to improve aquatic habitat; removing non-native invasive and Pierce's disease host plants; planting native understory species; and installing biotechnical bank stabilization to stabilize actively eroding banks.

The Project also includes an annual maintenance program funded by landowner assessments to proactively address debris, bank erosion, and inputs of fine sediments and to maintain the functions of the restoration features. Maintenance activities include debris removal; downed tree stabilization/relocation; in-channel vegetation management; planting native vegetation; invasive and Pierce's Disease host plant removal; and repairing (as needed) instream habitat structures and other constructed instream restoration features. This work is conducted under the supervision of the Napa County Flood Control and Water Conservation District (District) staff in coordination with landowners and their representatives. Maintenance reports from calendar year 2009 through 2016 can be accessed online at the WICC.

The Napa River is presently subject to a Clean Water Act Total Maximum Daily Load (TMDL) action due to excessive quantities of fine sediment degrading local water quality and beneficial uses. While sediment is a naturally-occurring input to the Napa River system, excessive amounts are considered a pollutant, and thus sediment load reductions mentioned in this report amount to 'pollutant reductions' in TMDL terms. The Rutherford Reach Restoration Project serves to support the TMDL objective of reducing fine sediment loads and as a result has been designated a regional priority by the San Francisco Bay Regional Water Quality Control Board responsible for TMDL development and implementation.

1.2 Project Status and Implementation

As of October 2014, restoration construction for the entire Project, Reaches 1-9, has been completed and the Project is now in the maintenance and monitoring phase. Implementation of the Project will be fully complete by the spring of 2018, following three years of vegetation establishment and maintenance in Reaches 5-9. Beginning in the spring of 2018, long-term monitoring and maintenance of the channel will be funded entirely by the Maintenance Assessment District (MAD) established for the Project comprised of landowners with riverfront property between Zinfandel Lane and the Oakville Cross Road.

For monitoring purposes, the 4.5 mile Project reach has been divided into reaches numbered from 1 to 9 starting from the Zinfandel Lane Bridge and ending at Oakville Cross Road and into construction contract phases numbering 1 through 5. Final design plans for all construction phases of the Project are available at the WICC website: http://www.napawatersheds.org/app_folders/view/3577. See **Table 1** below for a list of construction schedules, Project reaches, and river stationing and construction phases by year.

Table 1: Construction Phases, Reaches, River Stationing and Construction Year

Final Design & Construction Phase	River Reach	River Station	Construction Year
Zinfandel Lane Bridge	Upstream Project Limit	24,857	-
Phase 1-East Bank	Reach 1 and 2	24,857 – 21,875	2009
Phase 1-West Bank	Reach 1 and 2	24,857 – 21,875	2010
Phase 2	Reach 3	21,875 - 16,000	2010
Phase 3A-East Bank	Reach 4	16,000 - 12,000	2011
Phase 3B-West Bank	Reach 4	16,000 - 12,000	2012
Phase 4A	Reach 8 North	7,800 - 5,800	2012 - 2013
Phase 4BC	Reach 8 South	6,400 - 3,400	2013
Phase 5	Reach 6	11,000 – 9,200	2014
Phase 5	Reach 7	9,200 - 7,800	2014
Phase 5	Reach 9	3,400 - 0	2014
Oakville Cross Road Bridge	Downstream Project Limit	0	-

1.3 Restoration Site Descriptions and Elements by Construction Phase and Reach

The restoration elements built in each construction phase (1-5) are summarized in **Table 2** below and are illustrated in **Figures 1-5** below as well. For additional detailed descriptions of each restoration area please refer to previous monitoring reports available on the WICC website. **Table 2** lists restoration features by type, river station location, and year constructed by phase and **Figures 1-5** depict restoration elements, including graded structures, setback berms, and instream structures by construction phase.

As a result of construction and completion of the Project in 2014, 26 floodplain benches spanning a total of 8,580 linear feet with a surface area of 16.8 acres, were constructed in Reaches 1-9. A total of 6 side channel, wetland and alcove features were built totaling 3,054 linear feet, with a surface area of 4.6 acres including the secondary channels constructed at the Round Pond and Wilsey Properties and the backwater alcove features constructed at Rutherford Wine Studios and Cakebread properties. A total of 13 bank stabilization areas were constructed totaling 3,818 linear feet. Additionally, approximately 14,303 linear feet of setback berms were created in order to widen the distance between agricultural activities and the river channel.

Invasive species have been removed or managed, and riparian vegetation has been replanted on 30.5 acres including constructed benches, bank stabilization areas and widened riparian corridors where berms were setback. One hundred and forty nine (149) instream habitat structures, including 112 large woody debris structures and 37 boulder clusters, have been installed and assessed as a result of the Project; see **Table 2** below.

Table 2: Constructed Restoration Elements by Project Reach

River Reaches (9 Total)		Reach 1	Reach 2	Reach 3	Reach 4	Reach 8 North	Reach 8 South	Reach 5,6,7,9	Total
Floodplain Benches	Number	1	4	5	9	1	3	3	26
	Linear Feet	750	1,975	1,265	2,320	11	1450.0	809.0	8,580
	Acres	0.8	3.1	1.7	5.6	1.2	3.2	1.3	16.8
Tributary Alcoves, Created Linear Wetlands, Side Channels, Swales, Culvert outlet	Number	1	-	-	-	1	1	3	6
	Linear Feet	350	-	-	-	589	565.0	1550.0	3054
	Acres	0.7	-	-	-	0.1	2.1	1.7	4.6
Bank Stabilization Areas	Number	-	1	-	3	3	3	3	13
	Linear Feet	-	800	-	485	1,225	605.0	703.0	3,818
Setback Berms/Riparian Area	Linear Feet	-	3,565	1,205	8,665	-	615.0	253	14,303
	Acres	-	-	-	-	-	0.3	0.6	1
Instream Habitat Structures (Large Woody Debris & Boulder Clusters)	Number	15	18	7	26	21	44	18	149
Riparian Area Replanted (Riparian Areas + Bank Stabilization Areas + Instream Benches)	Acres	1.5	4.5	2.2	10.2	2.3	5.6	4.2	30.5

Figure 1: Constructed Restoration Elements Reaches 1 and 2

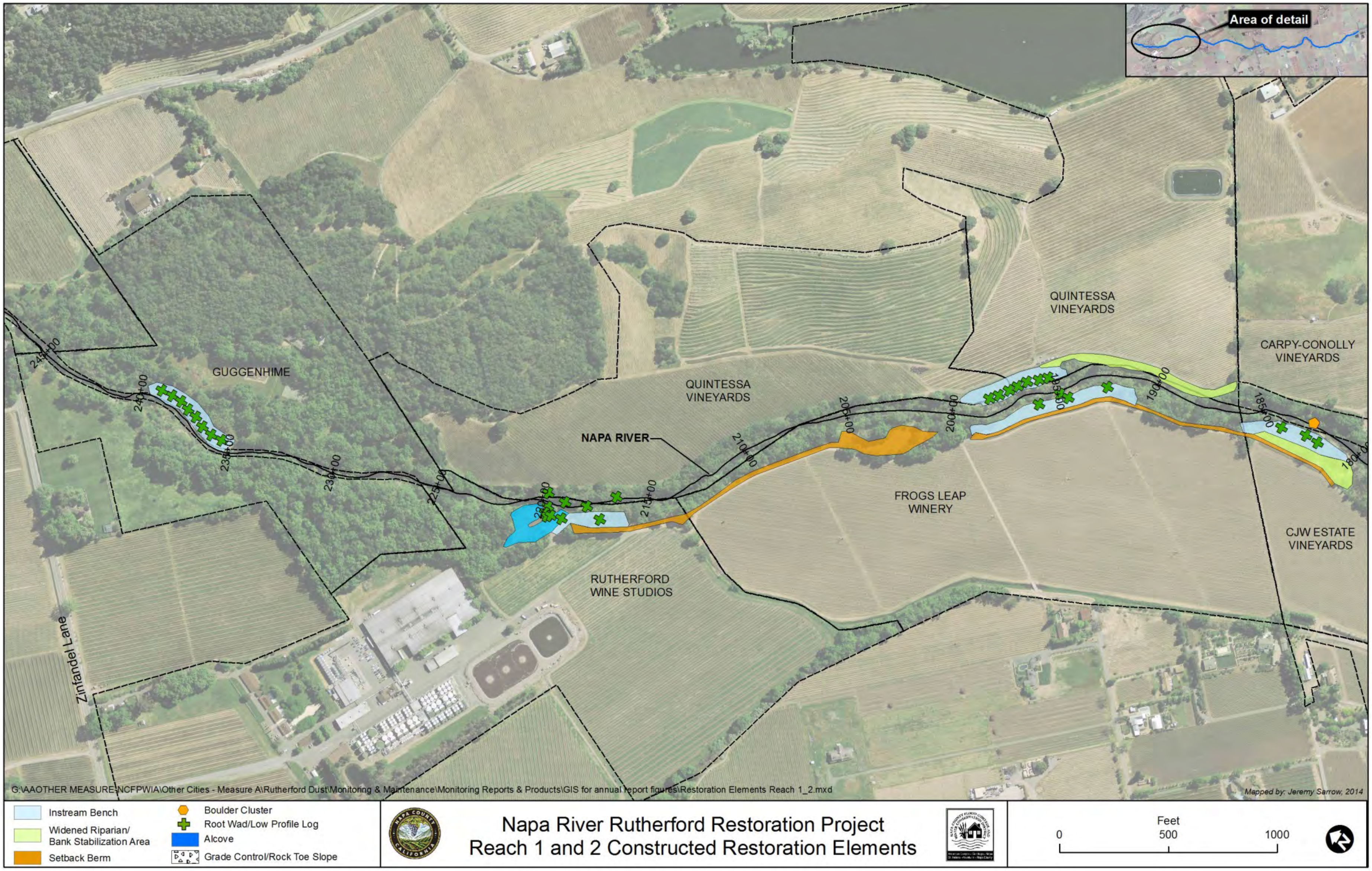


Figure 2: Constructed Restoration Elements Reaches 3 and 4

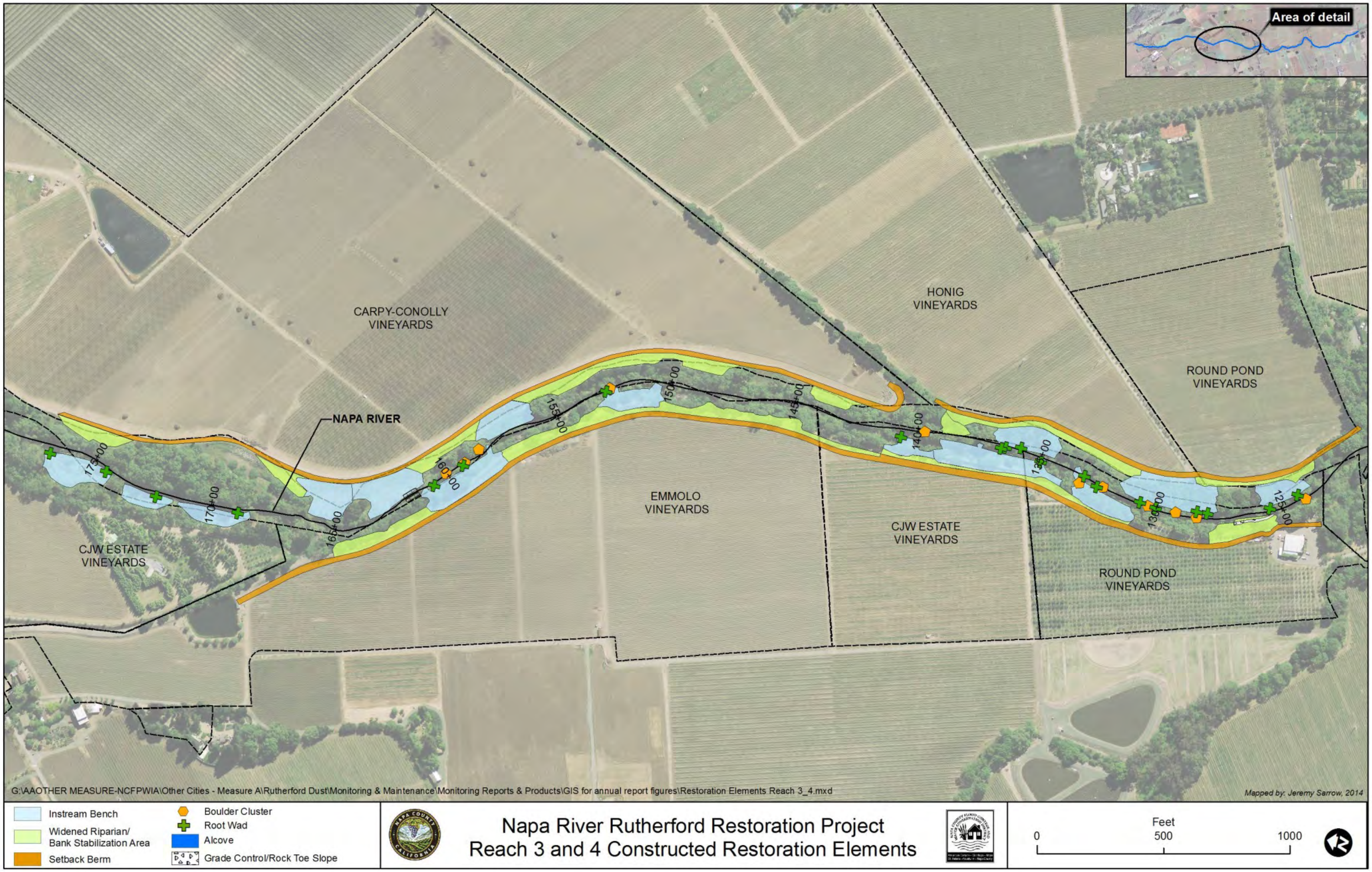


Figure 3: Constructed Restoration Elements Reaches 5, 6, and 7

Figure 4: Constructed Restoration Elements Reach 8

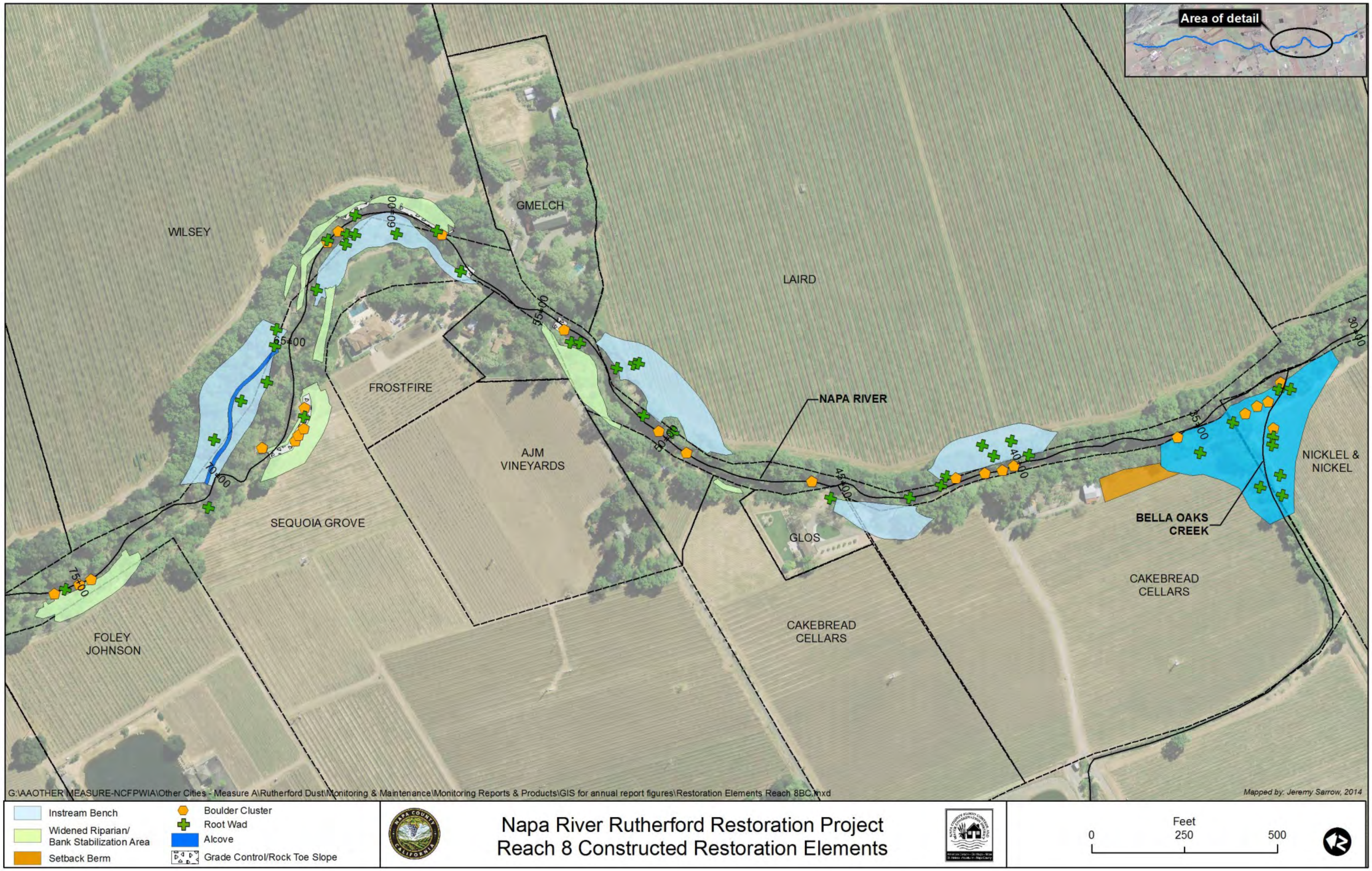
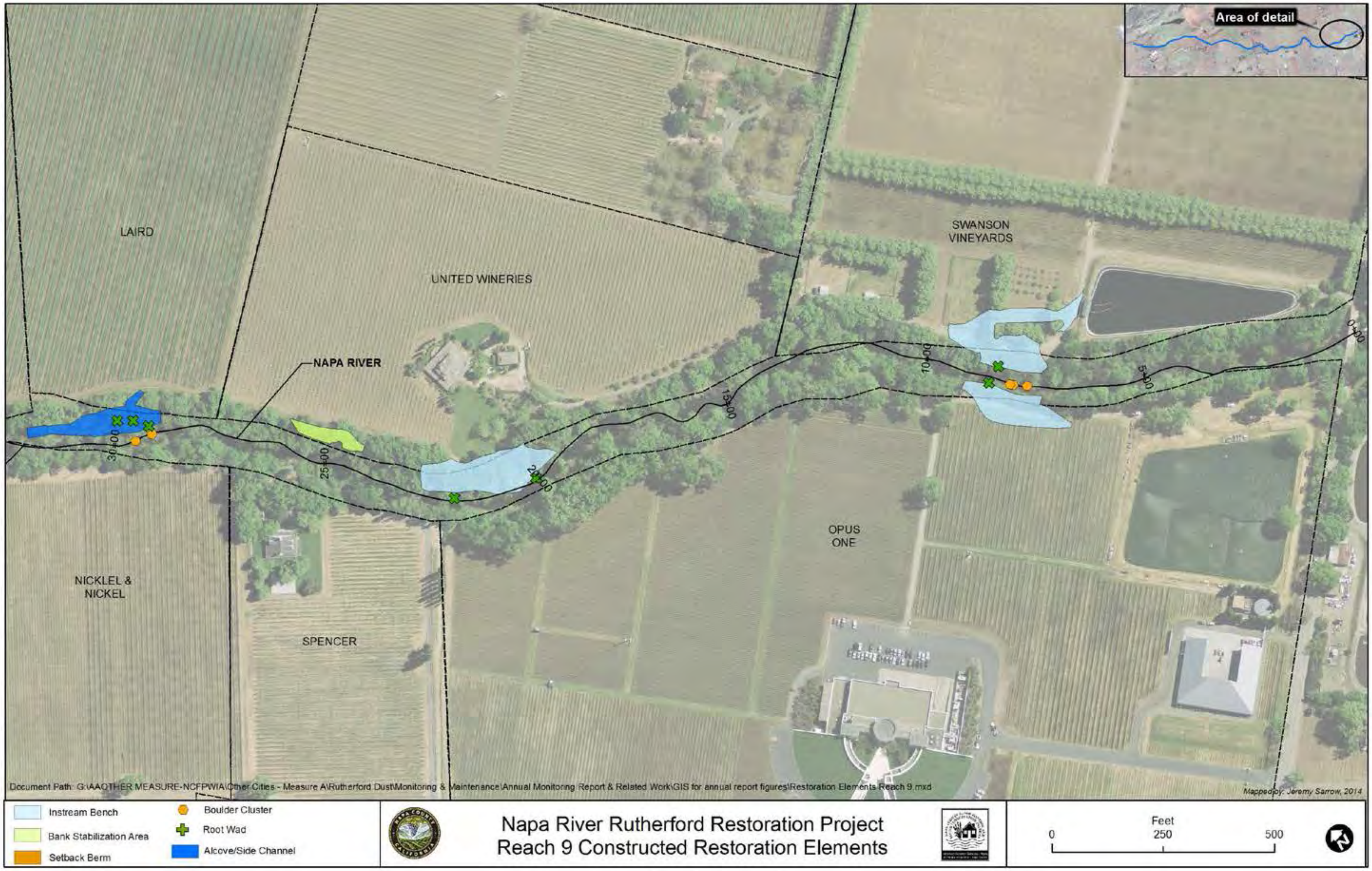


Figure 5: Constructed Restoration Elements Reach 9



2.0 Restoration Goals

Restoration goals defined for the Project in the monitoring Plan and in various regulatory permits include the following general categories:

- Sediment Load Reductions and Increased Channel Morphology Complexity
- Aquatic Habitat Enhancement
- Riparian Habitat Enhancement
- Ongoing Stakeholder Participation

2.1 Sediment Load Reduction and Increased Channel Morphology Complexity

Pre-Project Conditions

Changes in land use, construction of earthen berms, and filling of historic channels resulted in increased flow volumes and velocities within the Napa River leading to channel incision and streambank erosion and failure. In addition, inputs of fine sediments to the channel from eroding stream banks and other sources throughout the watershed led to a reduction in the quality and quantity of instream habitat for salmonids and other native fish in the Project reach.

Goals and Desired Outcomes

The goal for this category is to reduce fine sediment inputs to the Napa River by reducing rates of channel bank erosion and bed incision and creating a more stable long term channel configuration. Desired outcomes include:

- Decrease the total amount of eroding streambanks and stabilize severely eroding banks
- Reduce rates of channel incision
- Re-establish geomorphic and hydrologic processes to reconnect the river channel to floodplain areas
- Increase and enhance riverine, riparian, and floodplain habitat value and complexity, particularly to support increased quality and quantity of habitat for Chinook salmon and steelhead trout
- Create inset bankfull (1.5 year flood elevation) and mid-level terraces
- Minimize the need for ongoing channel stabilization and maintenance work

Restoration treatments to reduce sediment load and increase morphologic channel complexity include:

- Increased riparian buffer width
- Setback berms
- Channel reconfiguration, bank stabilization and creation of secondary channels
- Grade-control boulders and weirs

2.2 Aquatic Habitat Enhancement

Pre-Project Conditions

The pre-restoration condition for aquatic habitat within the Project reach generally consisted of long runs and glides, with fewer deep pools, and occasional riffles. Pool depths typically exceeded 3 feet and occasionally reached maximum depths of over 9 feet. When present, cover consisted of deep water, undercut banks, instream woody material, and overhead cover in the form of low growing riparian vegetation. In general, less cover and fewer cover types were present in runs and riffles compared to pools. The predominant substrate in the reach was gravel and sand-sized particles. Median particle size (D_{50}) on the bars and riffles sampled in 2005 varied from approximately 8mm to 50mm, with an average of 23mm. In comparison, preferred spawning habitat for Chinook salmon typically consists of bed material ranging from 25 to 102 mm in size. In summary, the diversity and abundance of native fish (including salmonids) in the Rutherford Reach was limited by a combination of factors including: the lack of winter and spring high flow refugia (low velocity flow areas); lack of suitable fall and winter spawning habitat (riffles and coarse gravel), lack of habitat complexity (pool, riffle, glide variability); a high percentage of predatory fish habitat (pools and glides); lack of instream and overhead cover; low summer base flows; and elevated summer water temperatures throughout the Project reach resulting in many areas being unsuitable for juvenile salmonid rearing.

Goals and Desired Outcomes

The goals/desired outcomes for aquatic habitat in the Project reach include:

- Re-establish geomorphic and hydrologic processes to support a continuous and diverse native riparian corridor
- Increase and enhance riverine, riparian, and floodplain habitat value and complexity, particularly to support increased quality and quantity of habitat for Chinook salmon and steelhead trout
- Increase habitat complexity by increasing variability in pool, riffle and glide habitats
- Decrease the percentage of deep pool and glide habitats that function as predatory fish habitat, and increase the percentage of shallow pool and riffle habitat

Steelhead and Chinook Rearing and Spawning Habitat

- Increase summer rearing and fall and winter spawning habitat and cover by inducing lateral pool scour associated with installed habitat structures (LWD)
- Increase and establish high flow (>500 cfs) and low velocity (<6 fps) bankfull refugia areas to increase fall and winter rearing habitat for 0-1+ steelhead and immigrating/emigrating salmonids
- Increase suitable fall and winter spawning habitat by increasing the frequency and length of riffle habitat; increase the recruitment of coarser spawning gravel by inducing sorting of bed and bar material resulting in increased deposition of spawning-sized sediments and decrease percentages of fines covering riffle crests / pool tail outs

Juvenile Steelhead and Chinook Rearing Habitat

- Increase and establish high flow (>500 cfs), low velocity (<6 fps) bankfull refugia areas to increase spring rearing habitat for 0+ steelhead, and immigrating/emigrating salmonids

- Increase quantity of high velocity feeding lanes by creating relatively high velocity riffle habitat and breaking up low velocity flat-water and pool habitat; induce local velocity accelerations and complexity and channel flow constrictions with installed habitat structures (LWD/Boulders)
- Enhance and encourage coarse sediment trapping for establishing riffle habitat and subsequent invertebrate production
- Increase and establish spring flow backwater pool habitat areas to increase spring rearing habitat for juvenile Chinook, and immigrating/emigrating salmonids
- Increase summer rearing habitat by enhancing pool habitat complexity, depth, and shelter/canopy cover

Restoration treatments installed in-channel to improve aquatic habitat include:

- Large woody debris structures
- Plant material: native willow cuttings, off-bench branch cover, branch bundles
- Constructed riffles
- Backwater alcoves on created instream benches and secondary channels
- Graded instream benches on alternating banks

2.3 Riparian Habitat Enhancement

Pre-Project Conditions

The pre-Project condition of riparian habitat varied considerably throughout the Project reach, depending on channel width, bank steepness, and adjacent land uses. In general, Reaches 1, 2, 3, and 5 supported the largest intact stands of mature riparian vegetation. Valley oak (*Quercus lobata*), coast live oak (*Quercus agrifolia*), and California walnut (*Juglans hindisi*) were the dominant species in these reaches. Reaches 3, 5, 6 and 7 supported stands of Fremont cottonwood (*Populus fremontii*), white alder (*Alnus rhombifolia*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*). In addition, California bay (*Umbellularia californica*), blue elderberry (*Sambucus mexicana*), and California buckeye (*Aesculus californica*) were also found throughout the Project area. The width of the riparian corridor (including vegetated areas along both banks) was greatest in Reach 1 (600 to 800 feet). The riparian corridor in Reaches 3, 5, 6, and 7 was also relatively wide, ranging from 250 to 400 feet in width. Reaches 2, 4, 8, and 9, which were confined by levees or adjacent land use, supported narrow bands of riparian vegetation (150 feet or less).

In many portions of the Rutherford Reach, the riparian understory was dominated by non-native species including Himalayan blackberry (*Rubus discolor*) and periwinkle (*Vinca major*). Other non-native invasive species such as giant reed (*Arundo donax*) were also pervasive throughout the Project area. However, other areas supported substantial patches of native understory species including snowberry (*Symphoricarpos albus*), Santa Barbara sedge (*Carex barbarae*) and California rose (*Rosa californica*).

In general, the extent and diversity of riparian habitat found within the Project area was limited by the morphology of the channel. In most reaches, the confined nature of the channel prevented the establishment of inset floodplain benches and bars that would enable recruitment and establishment of riparian species. Relevant design criteria included: establishing planting zones based on water surface elevations and distance from channel; establishing a minimum 50’ buffer to reduce disturbance to native wildlife and encourage migration; fill existing canopy, increase plant diversity and structure to improve quality for resident and migrant wildlife.

Absent significant change in land use practices and floodplain access, the riparian community will continue to decline as older trees die and recruitment is impaired due to numerous factors (lack of suitable surfaces for colonization, competition with invasive plant species, vineyard encroachment, etc.). Creation of inset flood terraces and bank setbacks increases the area suitable for riparian recruitment. In particular designing terraces for inundation at approximately the 1.5 to 2 year return interval flows creates new disturbance zones where future recruitment may be self-sustaining, assuming invasive species continue to be controlled as part of project maintenance.

Goals and Desired Outcomes
The goals/desired outcomes for enhancing riparian habitat include:

- Protect existing high value riparian habitat where possible
- Expand the native riparian buffer width and extent
- Remove invasive non-native vegetation and re-plant with native vegetation
- Re-establish geomorphic and hydrologic processes to support a continuous and diverse native riparian corridor

Restoration treatments to improve riparian habitat include:

- Revegetation and maintenance of restored areas with native under- and over-story species
- Vegetation of widened riparian corridor with native under-and over-story species
- Removal and management of invasive non-native plant species

2.4 Stakeholder Participation

Pre-Project Conditions
Landowners participated in the initial planning and design efforts for the project as well as in separate final design and construction phases.

Goals and Desired Outcomes
The goals/desired outcomes for stakeholder participation include:

- Maintaining ongoing access for team members, including Napa County Flood District, Napa County Resource Conservation District, and contractors
- Minimizing piecemeal efforts at channel stabilization and berm construction on the part of landowners
- Continued landowner leadership, as evidenced via the Landowner Advisory Committee

- Remove invasive non-native vegetation and replanting with native vegetation that will not promote Pierce’s Disease in vineyards
- Rehabilitate the river in a way that facilitates permitting agency approval

Elements to maintain stakeholder participation include:

- Conduct landowner advisory committee meetings
- Conduct informational outreach
- Manage channel maintenance and monitoring program

3.0 Monitoring Approach, Indicators and Performance Standards

Performance Standards have been developed for each of the Project goals; success of the Project will be evaluated by quantifying progress towards meeting these standards over the life of the Project.

Project monitoring has several components, including:

1. An annual survey of the entire Project reach to observe current conditions and identify if any immediate adaptive management actions are needed;
2. Detailed channel transect, longitudinal profile, and habitat typing surveys designed to characterize the long-term habitat response to changing channel conditions based on flow variation and vegetation establishment;
3. Phased vegetation establishment surveys to track plant establishment and guide adaptive management of re-vegetated areas;
4. Photo-monitoring at defined stations to capture changes over time;
5. One-time post-construction evaluation of instream habitat structures at representative seasonal flows;
6. Surveys of stakeholder participation.

Refer to the Monitoring Plan, revised in April 2015, prepared for the Project for a detailed description of the protocols, frequency of monitoring tasks and data management; see **Table 3** below for a summary of the Monitoring Indicators, Protocols and Performance Standards.

As mentioned previously, for monitoring purposes, the 4.5-mile Project has been divided into nine (9) reaches, with river stationing (RS) based on linear distance along the channel measured in feet. The Project extends from RS 0+00 at the Oakville Cross-road Bridge to RS 248+57 feet at the Zinfandel Lane Bridge.

A Before/After/Control/Impact (BACI) approach is being applied to document long-term changes in geomorphic and aquatic and riparian habitat parameters (Gerstein & Harris, 2005). Monitoring methods have also been chosen to balance the frequency and resolution of data collection in a meaningful and yet cost-effective manner, while ultimately evaluating the success of each restoration site within the Project reach.

Table 3. Monitoring Indicators, Protocol Summary and Performance Standards

Indicator	Monitoring Protocol	Performance Standard
Sediment Load Reduction and Increase in Channel Morphology Complexity		
Length of eroding banks (L x H or % L)	Eroding Streambank Survey	75% reduction in length of actively eroding banks
Changes in bed deposition and scour relative to cross sections	Cross Section and Thalweg Surveys	Reduction in bed and bank erosion rates
Channel width-to-depth ratio at surveyed cross-sections	Cross Section Surveys	Increase in channel width to depth ratios
Aquatic Habitat Enhancement		
Channel substrate size distribution (median size frequency distribution, % fine sediment)	Pebble Counts, Spawning Gravel	Statistically significant increase in riffle median grain size (D50 mm) and reduction in riffle substrate percentage of fines (<2mm)
Riffle length and frequency	Habitat Typing Survey: Riffle, Glide, Pool Distribution Mapping	30% increase in riffle length or riffle frequency
Residual pool depth	Residual Pool Depth Survey at Installed Instream Habitat Structures	25% increase in residual pool depth in treated locations
Large woody debris structure persistence (# years, % persisting)	Large Woody Debris Survey	Persistence (75%) of installed instream habitat enhancement structures
Flow velocities in constructed high-flow refugia areas (v)	Seasonal Salmonid Habitat Velocity Surveys	Creation of high flow refugia (velocities less than 6 fps) at flows of 500 cfs and above at constructed alcoves and instream bankfull benches

Indicator	Monitoring Protocol	Performance Standard
Riparian Habitat Enhancement		
Area successfully treated (acres)	Area Mapping Percent Cover and Composition Survey	A minimum of 20 acres over the life of the Project
Plant survival at revegetation sites (%)	Vegetation Establishment Surveys and Direct Count Plant Survival and Vigor Survey	80% survival of native plants at revegetation sites at years 3, 5 and 10 post-installation
Percent native vegetative cover: Absence/presence natural recruitment	Area Mapping Percent Cover and Line Intercept Surveys	Greater than 70% native cover and evidence of natural recruitment by year 5 at revegetation sites
Stakeholder Participation		
Landowner Participation in the Restoration Project	Records of Landowner Access Agreements and Maintenance Requests	Majority and owner participation in the Project.
Landowner Advisory Committee participation	Landowner Advisory Committee Meetings Attendance Records	Continued landowner attendance at Landowner Advisory Committee meetings

4.0 Results and Discussion

4.1 Instream Flow Measurements

Tracking and analyzing streamflow in the Napa River Rutherford Restoration Reach is key to identifying channel-forming flows and evaluating changes in stream geometry, bank condition, and sediment load, as well as guiding monitoring activities. Channel-forming flows are flow events that are sufficiently large to move all the mass and sizes of alluvial sediment supplied to the channel, and include a range of intermediate high flows. The most effective channel-forming flow is often associated with the bankfull discharge, which is in turn often associated with a 1.5-year recurrence interval. Although only a rule of thumb, the 1.5-year peak flow is used in this monitoring effort as a threshold to define a channel-forming flow.

Streamflow in the project reach is measured at USGS Station 11456000 NAPA R NR ST HELENA, located at Pope Street Bridge, approximately 2.1 miles upstream of the Project. Real-time and historical stage and flow data for the station are available at waterdata.usgs.gov. The difference in upstream watershed area between the station and the top of the project reach is approximately 5.5%, and similar increases in streamflow can be expected. No significant tributaries enter the river between the station and the top of the project reach. One named tributary, Bale Slough, enters the river along the project reach and by the downstream limit of the Project the watershed area has increased by approximately 25%, and similar increases in streamflow can be expected.

Station 11456000 has been in operation since 1929 and USGS provides peak flow statistics at streamstatsags.cr.usgs.gov. The calculated peak flows for the 1-, 2-, 5-, 10-, 25-, 50- and 100-year floods are summarized in **Table 4**. USGS does not provide a peak flow statistic for the 1.5-year flood, but it is estimated for the purposes of this monitoring effort at 4,800 cfs.

Table 4. Peak flow statistics for USGS Station 11456000.

Peak Flood	Discharge (cfs)
Mean Annual	3,160
2-Year	5,980
5-Year	10,300
10-Year	13,100
25-Year	16,400
50-Year	18,700
100-Year	20,700

The last rare flooding event occurred on December 31, 2005, prior to construction of the project, when a peak flow of 18,300 cfs was recorded at Station 11456000, making it an approximate 50-year flood. Since that time, all peak flow events have been below 10,000 cfs, or less than 5-year recurrence interval events. Flow events with peak discharges greater than the 1.5-year flood that have occurred since initiation of construction in 2009 are listed in **Table 5.** These events can be expected to have significantly altered the streambed, promoted further erosion of eroding streambank areas, and tested the stability of graded restoration areas.

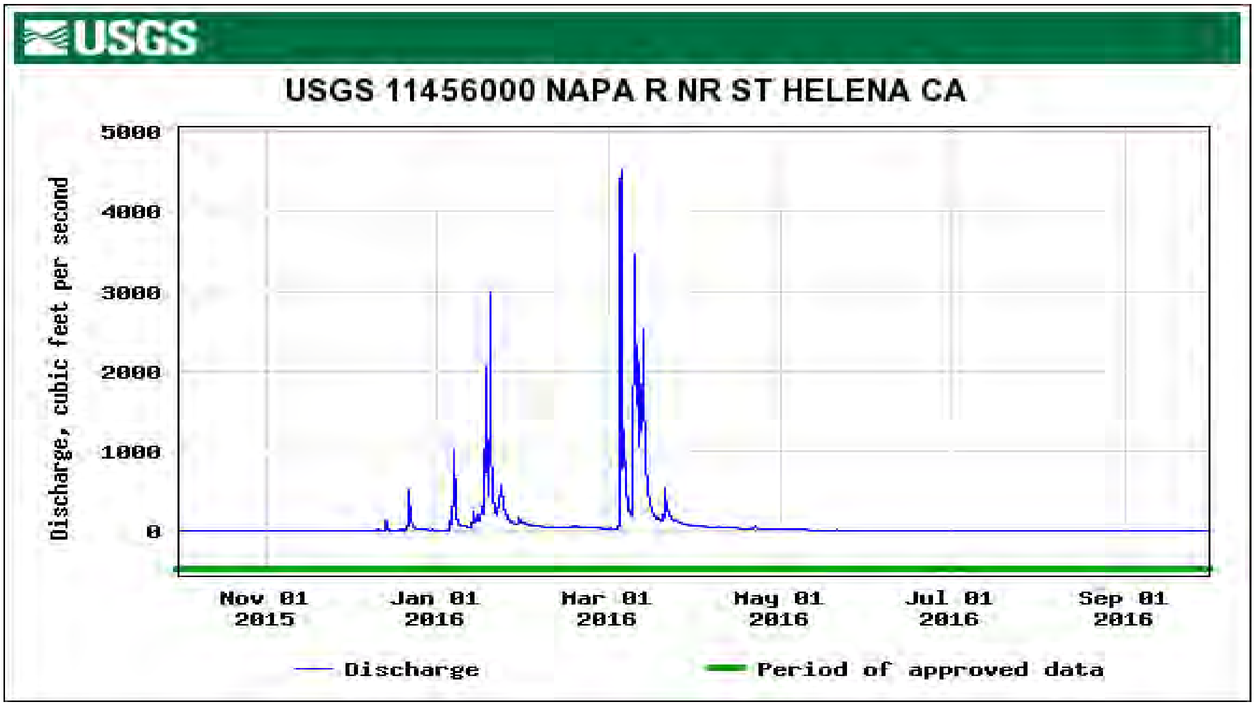
Table 5. High-flow events and peak discharges greater than 1.5-year flood since initiation of Project construction.

Water Year	Date	Peak Discharge (cfs)
2010-11	Mar 20, 2011	7,330
2010-11	Mar 24, 2011	4,830
2012-13	Dec 2, 2012	9,260
2012-13	Dec 23, 2012	9,690
2014-15	Dec 11, 2014	5,540
2016-17	Dec 15, 2016	5,400*
2016-17	Jan 8, 2017	8,750*
2016-17	Jan 10, 2017	7,680*
2016-17	Feb 7, 2017	9,310*

** USGS data remained flagged as provisional at the time of preparation of this report.*

During the 2015-16 water year (October 1, 2015 through September 30, 2016), measureable streamflow began at Station 11456000 in early December and continued through mid-July. The peak flow of the season occurred on March 6, 2015, and was measured to be 4,520 cfs, slightly less than the 1.5-year peak flood. Following the last significant storm of the season in late March, flows in the river receded until the channel finally dried up in mid-July. A plot of streamflow measured at Station 11456000 during the 2015-16 water year is included as **Figure 6**.

Figure 6. 2015-2016 streamflow, Napa River Rutherford Restoration Reach, USGS Station 11456000.



The reporting period for this monitoring effort includes the start of the 2016-17 water year (October 1, 2016 through September 30, 2017), and measureable flows in the reach began on October 24, 2016. Provisional flow estimates indicate that, as of late January, 4 high-flow events exceeded the 1.5-year peak flow, with the largest estimated at 9,310 cfs, an approximate 4-year flood. This event and the streamflow data for the entire 2016-17 water year will be presented in the next annual monitoring report.

The Napa River tends to flow perennially through the project reach in wet years, and dry up completely for long subreaches during the summer months in dry years. Dry-season streamflow data for Station 11456000, including mean monthly discharge statistics, can be found at waterdata.usgs.gov.

4.2 Eroding Streambank Survey

An eroding stream bank survey is conducted along the entire length of the bankfull channel every year in order to evaluate the extent of stream bank erosion within the Project area and to assess effects on fine sediment loading. During the dry season, the team walks the entire project reach in the downstream direction and maps the start and end of erosion areas on each bank. For each erosion area, the length and average height of bank erosion is estimated and it is noted whether the erosion affects the whole bank, the top of bank, or the base of bank. In addition, it is noted whether the erosion is due to undercutting or a lack of vegetation. Project restoration efforts addressed stream bank erosion by grading over-steepened banks to a more stable profile and installing biotechnical bank stabilization features such as vegetated soil lifts (VSL's). Additional information regarding monitoring protocols and performance targets are in the *Monitoring Plan for the Rutherford Reach Restoration of the Napa River* which can be found at www.napawatersheds.org.

The performance standard for reducing stream bank erosion is to reduce actively eroding stream banks throughout the entire Project reach by 75%. During the baseline survey in 2009, 14,674 feet of channel banks were mapped as eroding, or 30% of the channel bank length in the Rutherford Reach. In 2016, 455 feet of channel banks were mapped as eroding or unstable throughout the Rutherford Reach, this is a reduction of 97% compared to the 2009 baseline. The results of the surveys from 2009-2016 are summarized in **Table 6** below. See **Appendix A** for figures depicting the location and extent of eroding stream banks mapped during the 2016 survey.

As expected, the total linear length of eroding stream banks has steadily decreased as construction of the Project has progressed. Based on the survey results from 2014 through 2016, the Project has realized and surpassed the goal of a 75% reduction in active stream bank erosion throughout the entire Project reach.

Table 6. Results of eroding stream bank surveys, 2009-2016.

Survey	Total Linear Length of Eroding Banks (ft.)	Reduction Relative to 2009 Baseline (%)
2009	14,674	-
2010	9,000	39%
2011	4,800	67%
2012	4,400	70%
2013	5,200	65%
2014	1,840	87%
2015	1,050	93%
2016	455	97%

4.3 Sediment Source Reduction Calculations

The sediment TMDL for the Napa River aims to reduce fine sediment delivery from all Napa River mainstem channel incision and bank erosion sources by 19,000 metric tons/year (Napolitano 2009). To measure the reduction in fine sediment sources as a result of the Project, the one-time removal of sediment available for delivery to the channel was measured and amortized over the life of the project (20 years). Added to this value was the estimated reduction in sediment delivery achieved through cessation of ongoing bank erosion, which was continuing to occur at an average rate of 750 metric tons/mile/year over the length of the unrestored channel (Napolitano 2009).

Following the completion of the Project in the fall of 2014, the cumulative amount of fine sediment removed as a result of Project construction grading activities was of 257,260 metric tons. Further, an estimated 16,394 metric tons/year of fine sediment will be prevented from entering the Napa River over the next 20 years. This represents 87% of the total TMDL target reduction for the Napa River watershed from mainstem channel incision and bank erosion sources. See previous years' monitoring reports for additional details regarding annual and cumulative sediment reduction related to the Project.

4.4 Longitudinal Profile Thalweg Surveys

Channel thalweg surveys reveal the lengths and frequencies of riffle and pool habitat, riffle heights, pool depths, streambed slope, and areas of bed scour and deposition in the reach. Channel thalweg surveys quantify the response of the streambed to changes in the channel and measure progress toward the following performance standards of the Project:

- A 30% increase in riffle length or riffle frequency in treated locations;
- A 25% increase in residual pool depth in treated locations;

During the reporting period (calendar year 2016), the monitoring team completed a survey of the channel thalweg along the entire project reach. It was the third such survey conducted since restoration monitoring began, and the first since construction of the project was completed. The next survey is scheduled to be conducted in the summer/fall 2021. The following subsections present the procedures and results of the 2016 channel thalweg survey, and analysis of the data including comparison to previous surveys.

Project Reach Overview

The 4.7-mile Project reach is located in the approximate center of the 31-mile freshwater portion of the mainstem channel of the Napa River, beginning just north of the City of Calistoga at the confluence of Kimball and Blossom Creeks extending southeast to the tidal boundary just north of the City of Napa. The general slope of the mainstem streambed is approximately 0.002 for the lower 28 miles, increasing slightly to 0.004 for the uppermost 3 miles. The Rutherford Reach is bounded by Zinfandel Lane Bridge at the upstream limit and Oakville Cross Road Bridge at the downstream limit, with Rutherford Road approximately bisecting the reach.

The stream channel through the Rutherford Restoration Reach is incised due to human activity and land uses in the watershed; however, channel incision throughout the Reach appears to have stabilized. No knickpoints are known to occur in the Reach. Major knickpoints in the mainstem are known to exist near Yountville Cross Road downstream of the Project and between Zinfandel Lane and Pope Street upstream of the Project. These two knickpoints are characterized by rip rap grade control and bedrock outcrops, respectively. The respective channel features appear to control upstream advancement of the knickpoints.

Previous Thalweg Surveys

The first channel thalweg survey of the entire Project reach was conducted in 2009 and 2010. The upper half of the reach, from Zinfandel Lane to Rutherford Cross Road was surveyed in the fall of 2009, at which time the first phase of project construction was recently completed on the east bank near the top of the reach between river station (RS) 18,600 and RS 24,000. The lower half of the project was surveyed in the fall of 2010. By that time, east bank construction was completed from the top of the reach down to RS 14,000, and west bank construction had begun and was completed down to RS 16,800.

The second channel thalweg survey was conducted in the fall of 2013. At the time of the survey, construction was completed in the upper half of the reach. The bulk of the Project in the lower half of the reach, between RS 2,800 and RS 8,000, was completed as well. The final phase of construction for the Project (RS 9,100 to RS 10,400 and RS 700 to RS 2,300) was completed during the summer/fall of 2014.

2016 Thalweg Survey

During October and November 2016, RCD staff surveyed the thalweg of the Napa River beginning just downstream of the Zinfandel Lane Bridge at the crest of the stone weir, and moved in the downstream direction to the Oakville Crossroad Bridge. Distance was measured with a 300-foot tape that was appropriately laid out to mimic the alignment of the thalweg. Elevation was measured with a theodolite and stadia rod relative to the 2015 channel cross section survey monuments, which were previously surveyed relative to NAVD88. Data points were collected at breaks-in-slope along the thalweg, with emphasis on riffle crests, end points of riffles, maximum depths of pools, locations of the 2015 cross sections, and locations of select installed habitat enhancement structures. Substrate class (bedrock, boulder, cobble, gravel, sand) was recorded at every data point. Survey segments began at a cross section monument and were closed to a monument at the next downstream cross section and ranged in length from 710 to 2,760 feet. Data were recorded in a spreadsheet with a tablet computer.

Data Processing

Ground surface elevations were calculated from raw survey data and vertical error was computed for each survey segment. Vertical error for the 17 segments ranged from -0.28 feet to 0.15 feet. Error for this type of thalweg survey is often greater than for other types of land surveys. Sources of error include starting and closing surveys to different monuments, setting up the instrument in suboptimal substrate or in pools, poor stadia rod footing at turning points, instrument calibration issues, misuse of the stadia rod, misreading of the stadia rod, and taking readings over extended distances, which is often necessary to move past un-wadeable pools or through poor visibility areas. Still, 15 of the 17 survey segments were well within, or extremely near, RCD error target ranges for the distance traversed (±0.13 foot per 1,000 feet). Vertical error is not expected to have significantly affected data quality.

Thalweg distances, collected in the downstream direction in 300-foot segments, were compiled into cumulative distance and the measured distance for each survey segment was compared to the standard river stationing stream layer using GIS software. Measured field distances were within 6% of mapped distances; field measurements tended to be slightly greater than those derived from the GIS layer. Measured distance was adjusted to match the standard GIS layer length and converted to river stationing by proportionally adjusting each value between the 16 channel cross sections with known river stations. This allows comparison to previous datasets which were similarly adjusted.

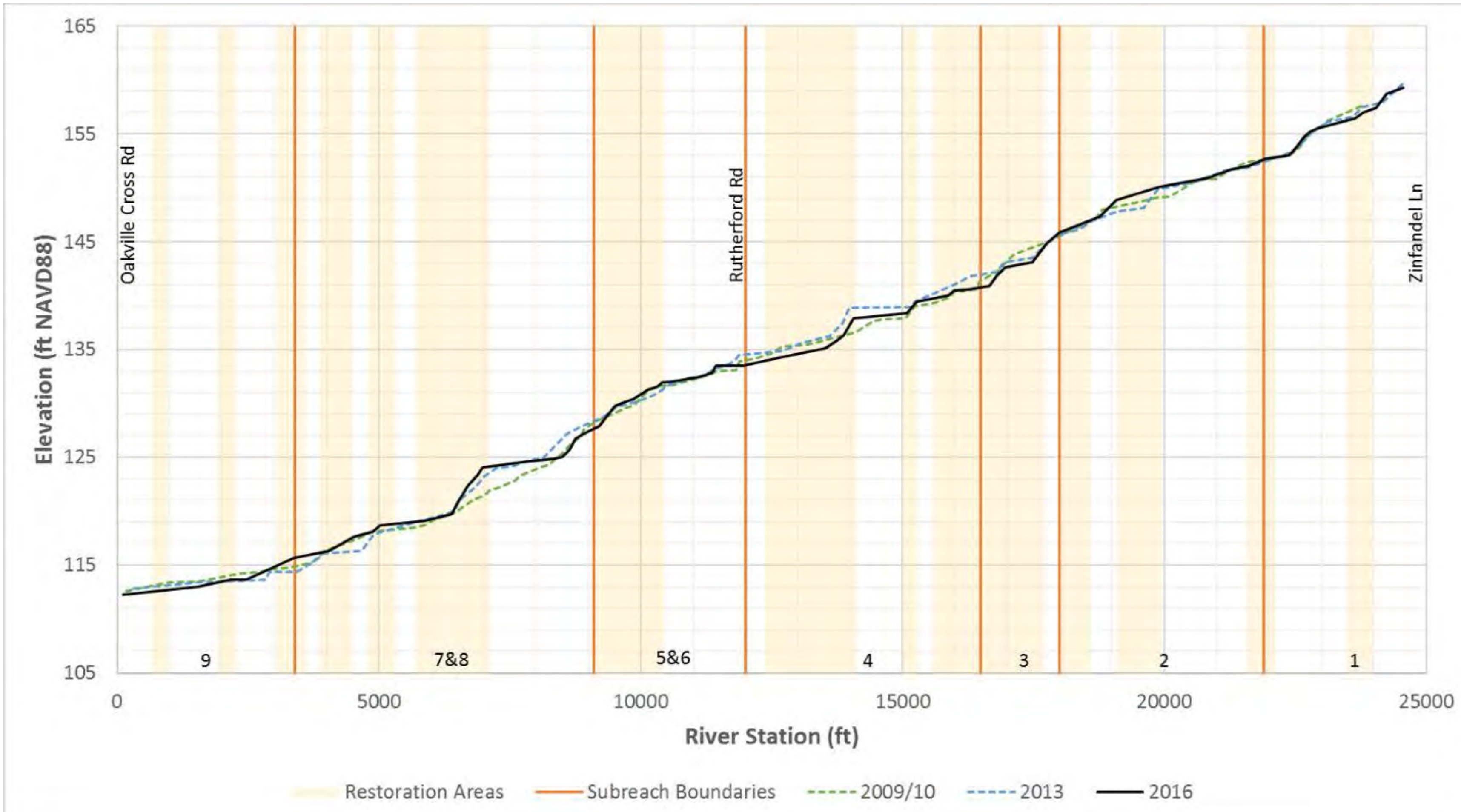
A plot of the survey was then examined, along with field notes, and each point in the dataset was labeled as being part of a riffle, a pool, a beaver dam, or a structure. Riffle crests and maximum pool depths were flagged, beaver dam elevation data were removed, and unit lengths, riffle heights, and residual pool depths were calculated.

Data Analysis

The 2016 thalweg survey data were analyzed and compared to the historical datasets collected in 2009/10 and 2013 to quantify streambed change since initiation of restoration activities. The reach was divided into 7 subreaches of similar channel form and slope. These subreaches correspond to the original 9 subreaches developed during restoration planning, except that Subreaches 5 and 6 are combined and Subreaches 7 and 8 are combined. A plot comparing riffle crest elevations from the three surveys gives an indication of overall streambed elevation change in the reach (**Figure 7**). While scour and deposition are evident in localized areas, the streambed has not systematically shifted upward or downward over this period, and the general bed slope of the reach has not changed.

The greatest change has taken place in Subreach 7&8 near river station (RS) 7000. This location coincides with 2012 restoration work on both banks including installation of bench cuts and a secondary channel. Other notable change has occurred in Subreach 4. Restoration in this subreach took place from 2010 through 2012. Typically, the streambed throughout the subreach aggraded prior to the 2013 survey. Under the 2016 survey, the streambed has scoured, partially below 2009/10 levels, in the lower section of the subreach.

Figure 7. Comparison of recent and historical thalweg survey riffle crests for entire Project reach.



The average gradient of each subreach, for each survey year, was determined by fitting linear regression lines to plots of the thalweg survey data. The slope of the regression line is considered to be the average gradient of the channel (Ramos 1996). **Table 7** below summarizes the channel subreach gradients. Decreasing trends are observed in Subreaches 1, 2, 3, and 5&6. Increasing trends are observed in Subreaches 4, 7&8 and 9.

Table 7. Summary of channel gradients by subreach.

Subreach	Average Channel Gradient 2009/10	2013	2016	Sparkline
1	0.0031	0.0027	0.0025	
2	0.0016	0.0016	0.0015	
3	0.0035	0.0027	0.0026	
4	0.0016	0.0018	0.0019	
5&6	0.0019	0.002	0.0016	
7&8	0.0022	0.0025	0.0024	
9	0.0007	0.0005	0.0011	

Channel thalweg surveying provides a means of measuring progress toward the goals of the Napa River Rutherford Restoration Project, specifically increasing streambed complexity. Indications of progress are increases in riffle frequency and corresponding decreases in mean riffle height, increases in riffle length and corresponding decreases in pool length, and increases in total and mean residual pool depth. Statistics from each of the three thalweg survey datasets were compiled and are presented in **Table 8** below.

Two key observations are apparent in the statistics: 1) an 11-riffle (14%) decrease in total riffle count most of which is due to changes in Subreaches 4 and 7&8, and 2) a 484-foot (11%) decrease in total riffle length most of which is due to changes in Subreaches 1 and 2. To evaluate these changes, RCD prepared plots comparing the channel thalweg surveys for each subreach (**Appendix C**). The plots show the length and frequency of riffle and pool habitats in relation to restoration areas, as well as locations of habitat enhancement structures. The downstream riffle crest elevation, or "point of zero flow," is shown over the pools.

Table 8. Habitat unit statistics for recent and historical channel thalweg surveys by subreach. Napa River Rutherford Reach Restoration Project.

Subreach	US RS	DS RS	Length	Survey Year	Riffle Count	Total Riffle Height (ft)	Riffle Length (ft)					Pool Length (ft)			Residual Pool Depth (ft)			
							Sum	%	Avg	Min	Max	Avg	Min	Max	Sum	Avg	Min	Max
1	23,900	21,900	2,000	2009/10	7	5.17	622	31.1%	89	40	162	172	61	495	18.28	2.61	1.33	4.56
				2013	9	5.57	569	28.5%	63	19	141	159	57	468	19.96	2.50	1.04	3.42
				2016	8.5	4.65	444	22.2%	52	8	113	183	49	432	24.12	3.02	1.14	4.36
2	21,900	18,000	3,900	2009/10	10	7.17	801	20.5%	80	24	244	305	44	735	35.17	3.52	0.83	7.70
				2013	8	6.38	517	13.3%	65	37	133	391	183	610	32.91	3.66	2.13	5.05
				2016	7.6	6.61	627	16.1%	84	31	158	409	153	767	33.38	4.17	1.34	6.82
3	18,000	16,500	1,500	2009/10	6	3.92	264	17.6%	44	15	81	206	84	508	19.19	3.20	1.45	5.57
				2013	5	3.73	210	14.0%	42	13	64	232	91	517	10.66	2.67	1.83	3.59
				2016	6.9	5.18	310	20.7%	44	9	137	172	104	355	10.47	1.75	0.77	3.03
4	16,500	12,000	4,500	2009/10	14	7.37	713	15.8%	51	7	131	277	47	839	45.57	3.26	1.13	5.75
				2013	10	7.34	656	14.6%	66	19	163	355	58	1155	58.06	5.28	1.01	9.43
				2016	10.1	7.02	645	14.3%	63	20	145	362	62	1002	49.53	4.50	1.23	7.20
5&6	12,000	9,100	2,900	2009/10	12	6.29	693	23.9%	58	11	195	187	40	420	27.18	2.47	1.18	4.11
				2013	14.9	6.45	764	26.3%	50	5	169	143	51	273	39.71	2.84	1.73	4.32
				2016	12.5	5.94	611	21.1%	47	10	129	191	54	445	33.73	2.81	0.95	4.74
7&8	9,100	3,400	5,700	2009/10	24	12.79	1026	18.0%	43	13	185	183	44	724	70.36	2.81	0.92	5.75
				2013	18.1	13.66	1082	19.0%	60	8	297	255	46	839	48.46	2.69	0.58	5.44
				2016	17.4	11.89	975	17.1%	54	9	119	245	38	823	53.27	2.96	0.89	7.09
9	3,400	0	3,400	2009/10	7	2.26	345	10.1%	49	9	91	427	136	731	22.12	3.69	2.65	5.20
				2013	4	1.55	113	3.3%	28	17	45	834	69	1247	16.45	4.11	2.50	5.20
				2016	6	3.43	368	10.8%	61	7	123	591	278	1384	21.01	4.20	3.74	4.90
Full Reach	23,900	0	23,900	2009/10	80	44.97	4464	18.7%	56	7	244	243	40	839	237.87	3.01	0.83	7.70
				2013	69	44.68	3911	16.4%	57	5	297	285	46	1247	226.21	3.34	0.58	9.43
				2016	69	44.72	3980	16.7%	58	7	161	291	38	1384	225.51	3.32	0.77	7.20

Assessment of the plotted data indicates that streambed aggradation areas are typically associated with restoration areas, and this is most evident in Subreaches 4 and 7&8. Riffle statistics were compiled for restored and non-restored areas of each subreach and are presented in **Table 9** below.

Table 9 indicates a modest increase in riffle counts in restored areas and that a reduction in the overall number of riffles has occurred disproportionately in un-restored reaches. In several instances, restoration-induced gravel deposition appears to have "drowned-out" upstream riffles accounting for perhaps two-thirds of the overall decrease. In some cases, backwater effects related to restoration areas appears to have increased this effect, drowning out more riffles outside of restoration areas. Several of the drowned-out riffles appear to be aggrading and may reemerge over time. Still other riffles appear to have been lost or gained due to non-restoration elements such as close proximity to beaver dams. Though submerged at the time of the 2016 survey, these drowned-out riffles are indicative of a more complex streambed since restoration. With time, improvements in riffle habitat are expected in most subreaches.

Assessing the decrease in riffle length is challenging. Overall, riffle length decreased in both restored and un-restored areas. Riffle crests are usually easily discernible, but downstream ends of riffles are often less obvious and subject to interpretation, especially in a dry streambed. As a result, riffle lengths can vary even when measured by the same crew using the same protocols.

The largest decreases in riffle length were observed in Subreaches 1 and 2. In Subreach 1, an especially long riffle at RS 23700 broke up into 2 smaller riffles resulting in a loss of 84 feet of riffle length. In this case, although riffle length was lost, streambed complexity in the form of a new riffle-pool unit was gained. With time, continued deposition may restore the lengths of these riffles. Other losses of riffle length in Subreaches 1 and 2 appear to have multiple causes, including the drowning out effect from aggradation in restored areas

Table 9. Riffle statistics for restored and un-restored areas by subreach for recent and historical channel thalweg surveys. Napa River Rutherford Reach Restoration Project.

Subreach	Condition	Riffle Count				Riffle Height (ft)				Riffle Length (ft)			
		2009/10	2013	2016	Change Since Restoration	2009/10	2013	2016	Change Since Restoration	2009/10	2013	2016	Change Since Restoration
1	Restored	1	3	2.5	1.5	1.31	2.11	1.57	0.26	162	200	107	-55
	Un-restored	6	6	6	0	3.86	3.46	3.08	-0.78	460	369	337	-123
2	Restored	3.6	3.8	2.7	-0.9	2.49	3.30	2.75	0.26	262	208	138	-124
	Un-restored	6.4	4.2	4.9	-1.5	4.68	3.08	3.86	-0.82	539	309	496	-43
3	Restored	4.8	3.1	5	0.2	3.36	1.82	2.53	-0.83	225	92	149	-76
	Un-restored	1.2	1.9	1.9	0.7	0.56	1.91	2.65	2.09	39	118	154	115
4	Restored	9.6	10	10	0.4	5.53	7.34	7.01	1.48	562	656	626	64
	Un-restored	4.4	0	0.1	-4.3	1.84	0.00	0.01	-1.83	151	0	15	-136
5&6	Restored	6	6.5	7.6	1.6	4.01	3.25	4.38	0.37	395	491	345	-50
	Un-restored	6	8.3	4.9	-1.1	2.28	3.20	1.56	-0.72	298	269	265	-33
7&8	Restored	9.7	8.7	10.9	1.2	5.23	6.92	8.26	3.03	433	519	599	166
	Un-restored	14.3	9.5	6.5	-7.8	7.56	6.74	3.63	-3.93	593	567	381	-212
9	Restored	2.5	0	2	-0.5	1.38	0.00	1.54	0.16	166	0	194	28
	Un-restored	4.5	4	4	-0.5	0.88	1.55	1.89	1.01	179	113	174	-5
Full Reach	Restored	37.2	35.1	40.7	3.5	23.31	24.74	28.04	4.73	2205	2166	2158	-47
	Un-restored	42.8	33.9	28.3	-14.5	21.66	19.94	16.68	-4.98	2259	1745	1822	-437
Total		80	69	69	-11	44.97	44.68	44.72	-0.25	4464	3911	3980	-484

In summary, decreases in riffle count and length observed in the Project reach since restoration are likely due in large part to gravel deposition in newly restored areas that have drowned out upstream riffles. Even with measured decreases in riffle habitat, there are signs of increasing streambed complexity. Several of the drowned-out riffles appear to be aggrading and may re-emerge with time as backwater effects trigger gravel deposition upstream of restored reaches.

4.5 Channel Cross Section Surveys and Pebble Counts

Pre-project cross sections were surveyed throughout the Project reach from 2004–2011. In October 2015, a complete set of 16 post-project cross sections were surveyed, 11 through treated areas and 5 through untreated areas; pebble counts were also conducted during this survey at each cross section. Results from the 2015 channel cross section surveys and corresponding pebble counts are presented in the 2015 annual monitoring report. The next Project wide channel cross section survey will be conducted in the fall of 2020. Please see the 2015 annual monitoring report and previous years' monitoring reports for results from previous surveys and additional details regarding the channel cross section surveys and pebble counts and achievement towards performance criteria for this metric.

4.6 Channel Morphology/Riffle Survey

The Project reach has experienced simplification in channel morphology due to channel incision. This has resulted in long sections of homogenous glides and a reduction in the frequency and spatial extent of riffle habitat. Restoration efforts aim to increase riffle length and frequency through a variety of treatments as outlined in the Monitoring Plan. The performance standard for the Project is a 30% increase in riffle length or riffle frequency in treated locations.

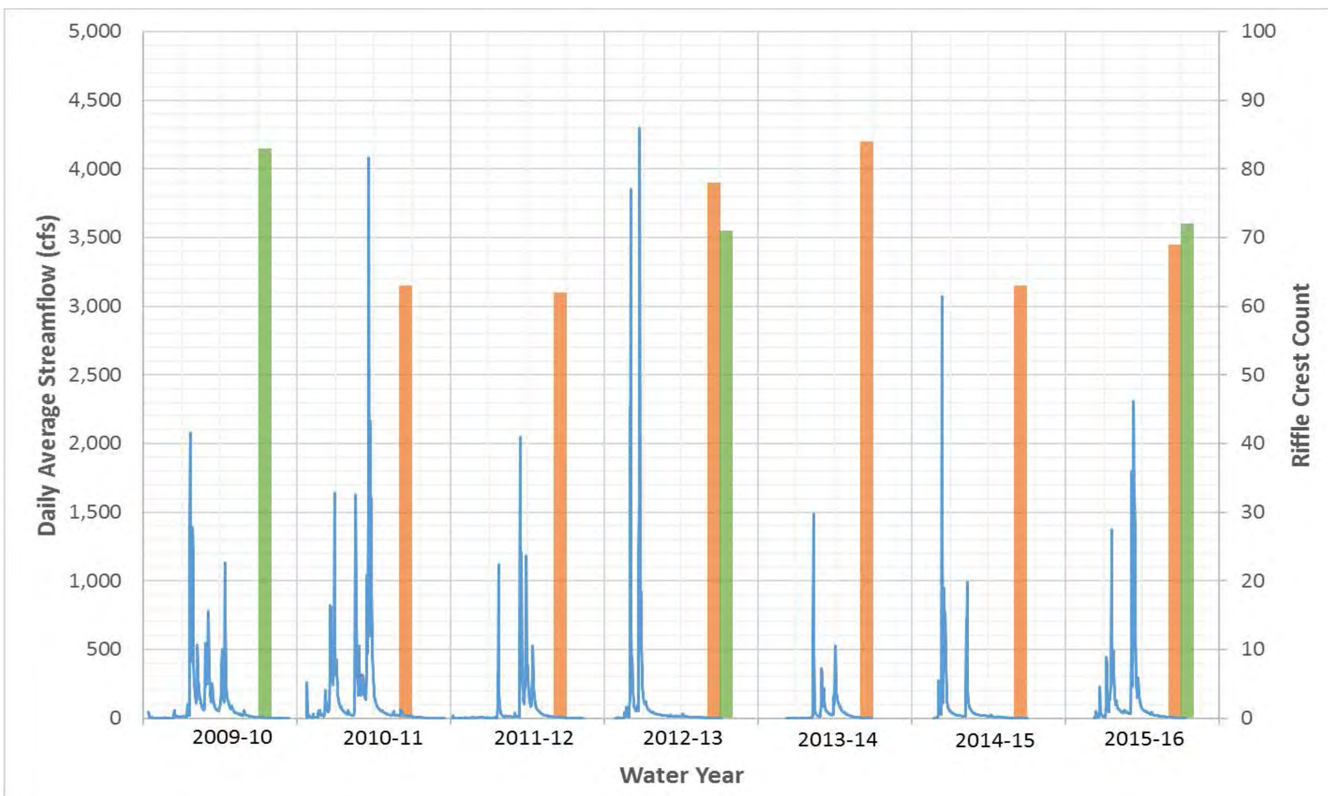
As part of the annual channel surveys, riffle crest mapping was performed from 2011 through 2016. The monitoring team identified each riffle crest visually in the field and recorded its location with a GPS device. The locations were then mapped, and riffle crest counts for the entire reach, or select areas, were compiled and compared.

Consistent identification of geomorphic and/or habitat units in streambeds can be difficult, and accurately counting riffle crests in the Napa River during these mapping efforts has proven to be a challenge. Riffle habitats can be lumped into a single riffle, split into multiple riffles, or drowned out by beaver ponds and missed by the survey crew. Some may fit the geomorphic definition of a riffle, but not the biological definition, or vice-versa; therefore, to a certain extent, riffles may be mapped or not mapped at the discretion of the survey crew.

In an attempt to gain insight into the accuracy of the riffle count data, RCD compared the results obtained during the annual channel survey to riffle counts derived from the 2013 and 2016 channel thalweg survey datasets. In 2013, 78 riffles were counted during the annual survey, compared to 71 derived from the thalweg survey data. Of the 78, 61 matched riffles from the thalweg survey, 12 were over-counted, meaning these riffle were counted as multiple features when topographically they were one, and 5 riffles were missing from the annual count data but apparent in the thalweg survey data. In 2016, 69 riffles were counted during the annual survey, compared to 72 derived from the thalweg survey data. Of the 69, 54 matched, 6 were over-counted, and 9 were missing. Based on this comparison, the results of the riffle mapping surveys may include significant error, perhaps enough error to obscure the target signal – change in riffle counts due to restoration efforts.

Assuming adequate data quality, a correlation is observed between large stormflows and riffle crest counts. The high count from the 2009-10 channel thalweg survey was followed by large storms in March 2011. Afterwards, the 2011 and 2012 riffle crest mapping totals are lower. Large stormflows in December 2012 are then followed by 2 years of higher riffle counts in 2013 and 2014. A large flow in December 2014 is then followed by lower riffle counts in 2015 and 2016. **Figure 8** depicts streamflow and riffle crest counts for the Project reach for all 7 years of data. It should be noted that the thalweg survey data indicate that there may not have been significant variation in riffle crest counts from 2013 to 2016. High stream flows from major winter storms may be a primary factor influencing the observed variation in riffle crest counts in the Project reach.

Figure 8. Daily average streamflow for USGS Station 11456000 Napa River near St Helena for Water Years 2009-10 through 2015-16, with riffle crest counts for the total Project reach. The green columns represent data derived from channel thalweg surveys. The orange columns represent data from visual riffle crest mapping surveys.



The performance standard states that riffle length or frequency increases should occur in treated areas. RCD identified six distinct treatment areas representing sections of the river where banks were re-contoured to promote hydraulic conditions favorable for riffle creation. Counts and trends from the riffle crest mapping surveys are summarized in **Table 10** below. Over the 6-year period, increasing trends were observed in 4 of 6 treatment areas.

Table 10. Restoration treatment areas and riffle crest counts, 2011-2016.

Treatment Area	Year Completed	River Station (ft)	Riffle Crest Count						Sparkline
			2011	2012	2013	2014	2015	2016	
1	2009	23,300 - 24,100	1	1	2	4	3	3	
2	2010	21,500 - 22,200	1	1	2	3	2	2	
3	2009-2012	12,300 - 20,000	18	15	18	20	19	19	
4	2012-2013	2,800 - 7,700	17	17	20	20	11	12	
5	2014	1,900 - 2,350	1	0	0	0	0	2	
6	2014	650 - 1,000	0	0	0	0	0	0	

Large stormflows and measurement variation appear to be the most significant factors influencing results of riffle crest mapping surveys. However, several other factors may be contributing to variation in surveyed riffle crests including, 1) prolonged drought conditions and low frequency of storm flows during the monitoring period, 2) backwatering effects of beaver dams, and/or 3) inconsistent identification and characterization of riffles (i.e. lumping vs. splitting units) from one year to the next by the field crew. Progress toward this performance standard is measured is also measured in Section 4.4, channel thalweg survey.

4.7 Large Woody Debris and Boulder Cluster Surveys

Beginning in 2009, naturally-recruited large wood debris (LWD), as well as installed structures (boulder clusters and log features); have been monitored during the annual channel survey. Naturally-occurring LWD is being monitored in an effort to track trends in location, quantity, size, and function over time. Installed structures are being monitored to verify their persistence, functionality (summer and winter refugia), and to assess potential damage or maintenance needs.

Persistence of Installed Structures

The stated performance standard for this project is a 75% persistence rate for all installed instream structures, including both wood and boulder features. To assess whether this performance standard was being achieved, the rate was calculated as follows:

$$\textit{Persistence (\%)} = \frac{\textit{Total number of structures installed - Number of structures not found}}{\textit{Total number of structures installed}} \textit{ X 100}$$

A total of 147 habitat structures (39 boulder features and 108 wood features) were installed over the course of this project between 2009 and 2014. Of that total, 132 structures were found during the 2016 field survey, including 37 of the boulder features and 95 of the wood features. Overall, this yields a persistence rate of 90%, which exceeds the performance standard of 75% (**Table 11**). It is worth noting that the actual persistence rate is likely higher than 90%, as field indicators (e.g. gravel deposition, channel morphology, etc.) observed around 6 of the “missing” structures suggested they were intact, but simply buried out of sight. The remaining 9 structures that were not found may have been buried or washed out, however there was no clear evidence of this during the field survey.

Table11. Installed habitat structure persistence rates.

Installed Habitat Structure Type	Total Installed Structures	Total Surveyed in 2016	Persistence Rate
Wood Features[1]	108	95	88%
Boulder Features[2]	39	37	95%
Combined Total	147	132	90%

[1]Includes root wads, snags, toe logs, bench logs, log weirs, spider-logs, low-profile logs, and terrace logs
[2]Includes boulder clusters, a boulder field, and a grade-control riffle

Instream Cover from Installed Structures

The performance standard for instream cover states that installed structures (both wood and boulder features) will increase the amount of refugia and cover by at least 40%. To assess whether this performance standard was being achieved, the amount of cover provided by naturally-occurring LWD (i.e. the natural background level) was compared to the amount provided by installed structures using the following simple calculation:

$$\textit{Change in Cover (\%)} = \frac{\textit{Number of installed structures providing cover}}{\textit{Number of pieces of naturally-occurring LWD providing cover}} \textit{ X 100}$$

For purposes of the survey, naturally-occurring LWD was defined as any piece of natural wood with a minimum length of 6 feet and diameter of at least 18 inches. The wood must be located in the channel below the top of bank. For each occurrence of LWD encountered, the field crew noted whether the feature was serving any of the following functions: spawning gravel recruitment, hydraulic constriction, pool scour, summer refugia, winter high-flow refugia, or bank stabilization.

During the 2016 survey, a total of 106 naturally-occurring LWD features were assessed, and 62 of those were found to be providing cover, **Table 12** below. A total of 87 of the installed structures were providing cover, yielding a 140% increase from the “natural” background levels within the project reach. This increase greatly exceeds the 40% target set by the performance standard for instream cover.

Table 12. Change in cover provided by installed structures compared to naturally-occurring LWD.

Habitat Function	Naturally-Occurring LWD Assessed 2016	Installed Structures Assessed 2016	Change in Cover
Summer Refugia	50	57	+ 114%
Winter Refugia	12	30	+ 250%
Combined Total	62	87	+ 140%

Naturally-occurring LWD Summary

The 2016 survey was the eighth and final year of monitoring naturally-occurring LWD within the project reach; summary statistics for all monitoring years are provided in **Table 13**. There are several long-term trends suggested by these data:

1. The number of single LWD pieces varied greatly from year to year and did not appear to correlate with large flow events.
2. The most common bedform associated with LWD was pools, followed by terraces.
3. Up to 25% of the LWD encountered in any given year was classified as "perched", meaning it was transient and not yet integrated into the channel bed or banks.
4. The average length of single LWD pieces was 26 feet and remained relatively consistent from year to year with a range of 23-30 feet.
5. An average of about 80% of the LWD encountered in any given year was in the 18- to 24-inch size class.
6. The most common functions provided by naturally-occurring LWD were summer refugia and pool scour.

Table 13. Summarized statistics on naturally-occurring LWD within the overall project reach.

Survey Year	2009	2010	2011	2012	2013	2014	2015	2016
Number of Occurrences								
Single	46	60	97	111	90	59	85	89
Accumulations (2-9)	23	19	19	24	20	27	21	17
Jams (>10)	3	3	3	1	3	1	2	0
Total	72	82	119	136	113	87	108	106
Bedform Association (%)								
Bank	---	9.8	9.2	3.7	16.8	10.3	18.5	10.3
Bar	---	15.9	12.6	13.2	9.7	12.6	---	---
Pool	---	36.6	37	41.9	36.3	35.6	37	45.3
Riffle	---	4.9	10.1	5.9	5.3	9.2	5.6	3.8
Terrace	---	24.4	29.4	19.1	16.8	12.6	15.7	14.2
Secondary Channel	---	1.2	1.7	0	1.8	1.1	1.9	0.9
Perched in Vegetation	---	7.3	---	16.2	13.3	18.4	21.3	25.5

Size								
Single Piece Length Range (ft.)	6-80	8-100	6-95	6-80	6-60	6-80	6-90	6-90
Single Piece Length Average (ft.)	30	25	25	23	23	29	28	25
Accumulation Length Range (ft.)	10-120	10-100	8-85	8-100	10-200	10-200	10-100	20-60
Diameter Class (%)								
18-in	25	63.4	69.7	68.4	68.1	60.9	67.6	67.9
24-in	38.9	19.5	16	17.6	15	26.4	20.4	18.9
30-in	22.2	3.7	6.7	2.2	5.3	8	4.6	3.8
36-in	6.9	7.3	4.2	5.9	8	1.1	7.4	7.6
42-in	2.8	6.1	2.5	3.7	2.7	2.3	0	0.9
≥ 48-in	4.2	0	0.8	2.2	0.9	1.1	0	0.9
***Function (%)** – note: some features provide more than one function, so totals add to over 100%*								
Hydraulic Constriction	---	---	28.6	26.5	18.6	29.9	13.9	16.5
Pool Scour	---	---	33.6	28.7	28.3	29.9	25	26.6
Gravel Recruitment	---	---	---	---	10.6	1.1	6.5	5.1
Summer Refugia	---	---	41.2	44.1	42.5	48.3	45.4	62.0
High-flow Refugia	---	---	6.7	17.6	30.1	27.6	27.8	13.9
Bank Stability	---	---	28.6	23.5	22.1	5.7	9.3	12.7
Other	---	---	21	17.6	---	---	---	---

4.8 Pool Scour/Residual Pool Depth Surveys

The performance standard for this project was a 25% increase in residual pool depth within the treated sections of the project reach. A total of 39 of the root-wad and toe-log structures installed throughout the project reach were specifically designed to induce pool scour and thus increase aquatic habitat complexity in the low-flow channel. Although none of the installed boulder structures were specifically designed to induce pool scour, many of these features did provide this function and are therefore included in the analysis and discussion below.

In order to assess whether the performance standard was being achieved, installed structures were visually assessed for function during the 2013, 2014, 2015, and 2016 annual surveys. If a pool was observed adjacent to an installed structure, the maximum water depth was measured as well as the water depth of the closest downstream riffle crest. The riffle crest depths were subtracted from the maximum pool depths to yield the residual pool depths, which are independent of flow conditions and therefore provide a comparable dataset from year to year.

In 2016, a total of 59 installed habitat structures were found to be providing pool scour, including 32 wood structures and 27 boulder structures. The average scour depth associated with installed wood structures in 2016 was the same as the 2013 baseline assessment, and the average scour depth around boulder structures remained unchanged from the previous year, **Table 14** below.

Table 14. Summarized residual pool depths for installed habitat structures. Note: 2013 was the first year of measuring residual pool depths, and was therefore used as the baseline for comparison.

Year	Installed Wood Structures			Installed Boulder Structures		
	Average Scour (ft.)	Change from 2013 Baseline	Average Scour (ft.)	Change from 2013 Baseline	Average Scour (ft.)	Change from 2013 Baseline
2013	13	2.5	-	10	1.9	-
2014	26	2.5	0	23	2.4	+ 26%
2015	36	2.1	- 16%	28	2.5	+ 32%
2016	32	2.5	0	27	2.5	+ 32%

Based on this relatively short-term dataset, the installed wood structures have not yet achieved the performance standard of increasing pool scour by 25%. However, boulder structures, which were not necessarily designed to provide pool scour, are exceeding the performance standard. Therefore, the overall benefit from both of these types of installed structures combined appears to be positive in terms of creating pool scour and topographic complexity.

4.9 High/Low Flow Instream Habitat Structure Surveys

LWD structures and boulder clusters have been installed throughout the project reach to create greater heterogeneity along the streambed and improve steelhead and salmon habitat quality and quantity under a broad range of flow conditions. The locations of instream habitat structures are depicted in the restoration monitoring maps, **Figures 1-5, Section 1.**

The RCD performed two assessments of installed structures, post construction, for each respective Reach: one during a winter high-flow event to evaluate graded habitat features and high-flow structures, and one during spring base flows in order to evaluate LWD and boulder structures in the low-flow channel. The RCD completed the final assessment of installed in-stream restoration features in Reaches 6, 7, and 9 of the Project during December 2014 and April 2015 respectively. Please see the 2015 annual monitoring report and previous years' monitoring reports, for results from prior surveys and additional details regarding high/low flow instream habitat structure.

4.10 Vegetation Establishment Surveys

Vegetation establishment surveys are conducted the first 3 years following plant installation and thereafter during years 5 and 10 post-installation. Non-native invasive vegetation is also managed and documented during routine maintenance activities and surveys. The target restoration goals and success criteria for vegetation establishment include:

- Establishment of a minimum of 20 acres of riparian habitat established over the life the Project (20 years)
- A minimum of 80% of native plants installed shall survive/establish at the re-vegetation sites within 3 years after being installed, and at years 5 and 10 will be in good health
- Greater than 70% vegetative cover will exist at any given planting site over the *life* of the

Project and evidence of natural recruitment will be documented after year 5 at any given re-vegetation site

As a result of completing construction for the Project in the fall of 2014, 30.5 acres of native riparian habitat has been restored and enhanced throughout the 9 Project reaches, exceeding the outlined restoration goal for establishing a minimum of 20 acres of riparian habitat over the life of the Project. A summary of the results from vegetation surveys through 2016, including direct count, percent vegetative cover, line intercept transect surveys and invasive plant management is presented herein and in **Appendix B**.

Direct count and photo documentation

During the fall of 2016, Flood District and contractor staff conducted annual direct count vegetation surveys of all restoration sites in Reaches 5, 6, 7, 8 and 9 shown in **Figure 9** below**.** As stated previously, vegetation establishment surveys are conducted the first three years following plant installation and thereafter during years 5 and 10 post installation, therefore Reaches 1-4 were not surveyed in 2016 but will be surveyed again in 2017. All planted restoration areas were surveyed to determine percent survivorship and qualitative health of installed and naturally recruited vegetation. **Table 15** and **16** below present the percent survivorship and health by a given species in reaches 5, 6, 7, 8 and 9 for monitoring year 2016; for representational photographs of each revegetation site surveyed see **Appendix B**. Napa County is responsible for plant establishment and monitoring in Reaches 1 - 4 while contractors were responsible for monitoring and maintenance in Reaches 5 - 9 in 2016.

Survey results in 2016 for reach 8 indicate overall survivorship for installed plants was 121%, well above plant establishment goals, in part due to a significant amount of natural recruitment of cottonwoods and various species of willows throughout the restoration sites. The 2016 survey for reaches 5, 6, 7 and 9 indicate overall survivorship for installed plants was 96% or greater, well above the 80% establishment goal. Vegetation in reaches 5, 6, 7 and 9 was installed in the fall of 2014 and spring of 2015. Representative photos of the survey sites are shown in **Appendix B.**

Table 15: Reach 8 (Includes Ritz-Carlton Mitigation Area) Woody Vegetation Direct Count/Survivorship Surveys 2016

Common Name	Total Installed Reach 8	Count 2014 Reach 8	% Survival	Count 2015 Reach 8	% Survival	Count 2016 Reach 8	% Survival	Health
Big leaf maple	59	63	107%	61	103%	59	100%	Good
Honeysuckle	26	18	69%	27	104%	18	69%	Fair
Snowberry	300	467	156%	512	171%	292	97%	Good
California Wild Rose	379	394	104%	531	140%	399	105%	Good
Spicebush	18	14	78%	16	89%	16	89%	Good
California Buckeye	98	159	162%	140	143%	121	123%	Good
White Alder	190	185	97%	275	145%	305	161%	Good
Oregon ash	189	157	83%	178	94%	174	92%	Good
Fremont's Cottonwood	116	238	205%	298	257%	282	243%**	Good
California Black Walnut	114	150	132%	163	143%	121	106%	Good
Coyote Bush	195	149	76%	245	126%	225	115%	Good
Valley Oak	225	254	113%	351	156%	309	137%**	Good
Bay Laurel	46	41	89%	41	89%	38	83%	Good
Toyon	52	79	152%	47	90%	46	88%	Good
Coast Live Oak	179	164	92%	264	147%	250	140%**	Good
Total	**2186**	**2532**	**116%**	**3149**	**144%**	**2655**	**121%**	

* Installed Spring 2013 and 2014, includes original planted stock and naturally recruited species.

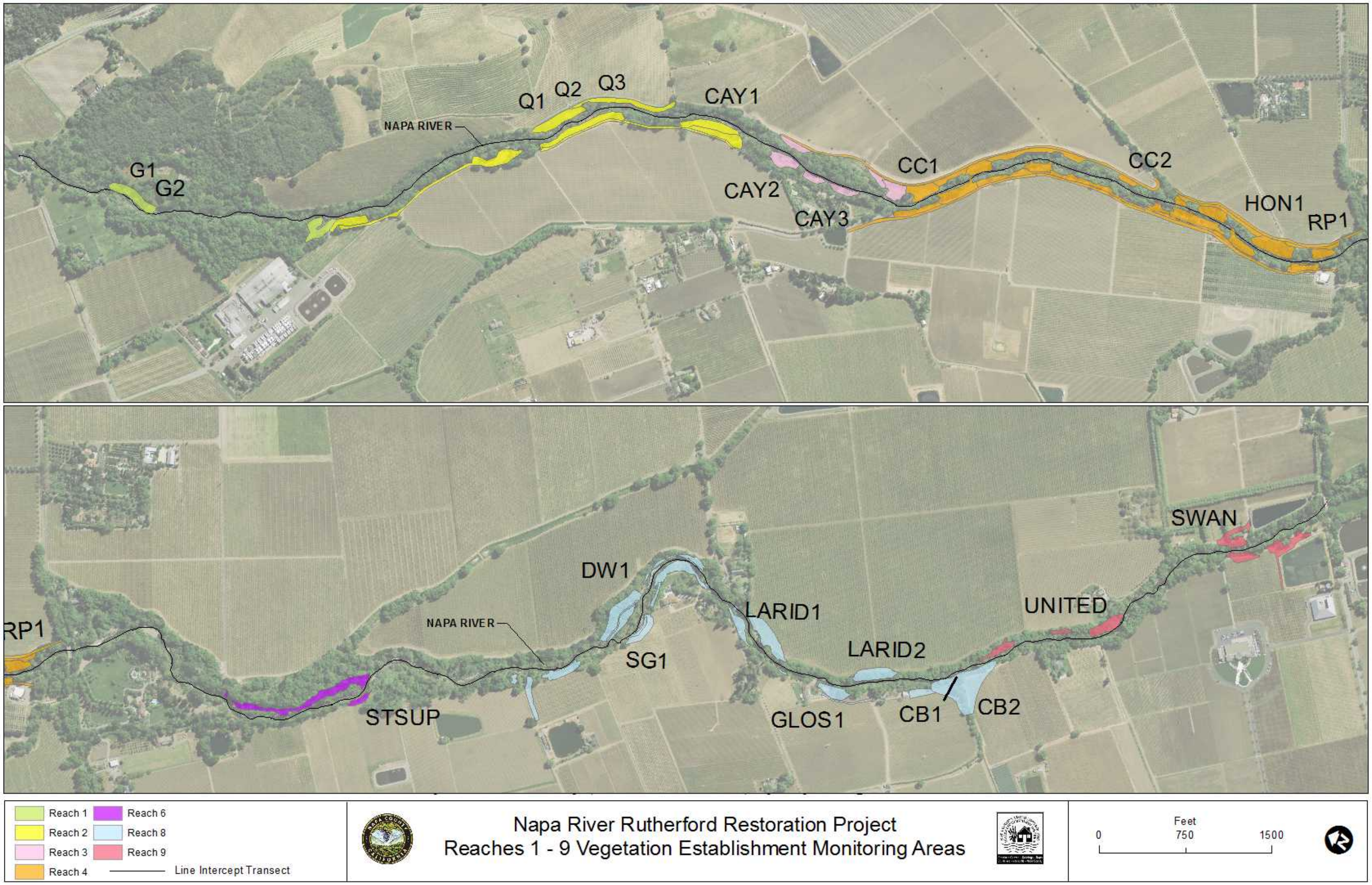
**A large number of cottonwoods and oaks are naturally recruiting within Reach 8.

Table 16: Reach 5, 6, 7 and 9 (Includes CalTrans Troutdale Creek Mitigation Area) Woody Vegetation Direct Count/Survivorship Surveys 2016

Common Name	**Total Installed 2015**	**Count 2015**	**% Survival**	**Count 2016**	**% Survival**	**Health**
Big Leaf Maple	29	29	100%	25	86%	Good
California Buckeye	54	36	67%	32	59%	Poor
White Alder	29	29	100%	36	124%	Good
Oregon Ash	45	45	100%	38	84%	Good
California Black Walnut	65	65	100%	60	92%	Good
Northern California Black Walnut *	60	60	100%	60	100%	Good
Fremont's Cottonwood	72	72	100%	98	136%	Good
Coast Live Oak	163	153	94%	149	91%	Good
Valley Oak	238	238	100%	197	83%	Good
Red Willow	106	106	100%	143	135%	Good
Arroyo Willow	48	48	100%	54	113%	Good
Bay Laurel	21	21	100%	18	86%	Good
Deergrass	343	318	93%	318	93%	Good
Coyote Bush	73	73	100%	78	107%	Good
Western Spice Bush	35	35	100%	25	71%	Good
Hairy Ceanothus	23	23	100%	18	78%	Good
Toyon	47	47	100%	45	96%	Good
Ninebark	34	34	100%	30	88%	Good
California gooseberry	52	52	100%	41	79%	Good
California Wild Rose	148	148	100%	144	97%	Good
Snowberry	91	91	100%	102	112%	Good
Total	**1776**	**1723**	**97%**	**1711**	**96%**	

*Installed Fall 2014 and spring 2015, includes original planted stock and naturally recruited species.

Figure 9: Location of direct count and line intercept vegetation surveys



Line intercept transect surveys

Line intercept transects have been established at 22 locations in all of the nine monitoring reaches in order to measure changes in vegetative cover and height class within restored areas (Harris 2005). Representative photos of the sites are shown in **Appendix B**. The transect lines range from 45 to 111 feet in length and typically span the entire width of a restoration area. **Figure 9** above shows the name and location of each transect line surveyed. **Chart 1** below presents the average relative percent native cover, by ground cover type, for all transect lines in Reaches 1- 9 for survey years 2012-2016. Results from the last five years of surveys indicate that the general trend in native ground cover has shifted from un-vegetated to herbaceous, with a *gradual* increase of native shrubs and tree cover types; this is to be expected as sites mature and shrubs and trees grow larger and provide more cover and structure at a given restoration area. The slight decrease in herbaceous cover in 2014 and slight decline in shrub cover type in 2015 is likely due to the addition of several new transect sites into the data set at locations that were planted and established for less than a year prior to the 2014 and 2015 surveys. Now that Project construction is complete, and all restoration sites have been planted, the vegetation establishment monitoring dataset should stabilize and continue to show long term trends.

Chart 1: Average percent cover by ground cover type for line transect surveys (2012-2016)

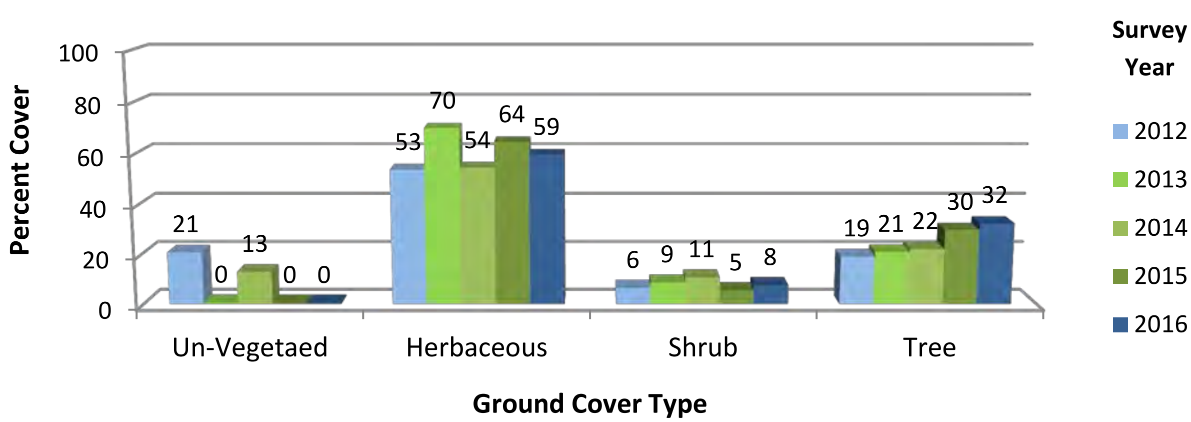
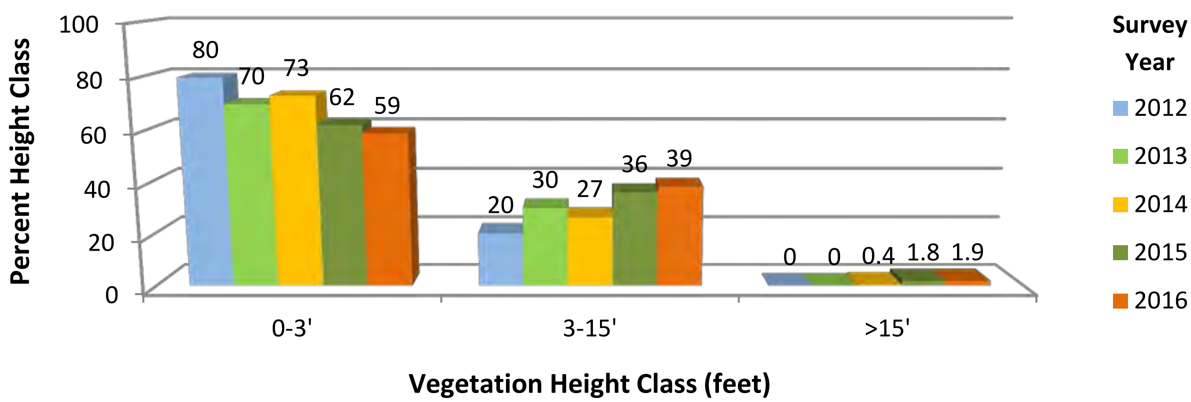


Chart 2 below represents the average height class of measured vegetation along all surveyed transects from 2012 through 2016. Approximately 59% of the vegetation measured in 2016 at a given transect ranged between 0 and 3 feet tall, while approximately 39% of the vegetation measured in 2016 ranged between 3 and 15 feet in height. As in 2015, in 2016 several trees (cottonwoods) measured along transects (CAY2 and DW1 in particular) in reach 3 and 8 were 15 feet in height or greater, providing data for the next height class and documenting maturation of the over story canopy within Project restoration areas. Representative photos of the monitoring sites are shown in **Appendix B.**

Chart 2: Average height class of herbaceous and woody vegetation for line transect surveys (2012-2016)



As in 2015, results from the 2016 surveys indicate a positive trend in vegetation establishment year over year in both relative native vegetative cover and average vegetation height measured at recently constructed restoration areas. Survivorship of installed native woody and herbaceous vegetation in all Reaches for a given species ranged 53% (California Buckeye in Reaches 5, 6, 7 and 9) to 243% (cottonwoods in Reach 8).

Results from the line intercept surveys also indicate that cover at restoration sites, on average, is approximately 59% herbaceous, 8% woody shrub and 32% tree native cover types, and 0% un-vegetated areas at any given transect. Further, in 2016 approximately 59% of installed native vegetation measured between 0 feet and 3 feet in height, 39% measured 3 feet to 15 feet high, and several trees now measure above 15 feet (primarily cottonwoods and willows) within the restoration areas. In general, these increases in relative cover and average vegetation height represent a positive trend in vegetation establishment at the restored sites, likely providing greater habitat value within the riparian corridor of the Napa River. The installed native vegetation is expected to increase at natural growth rates under typical, non-drought growing conditions.

Invasive plant management

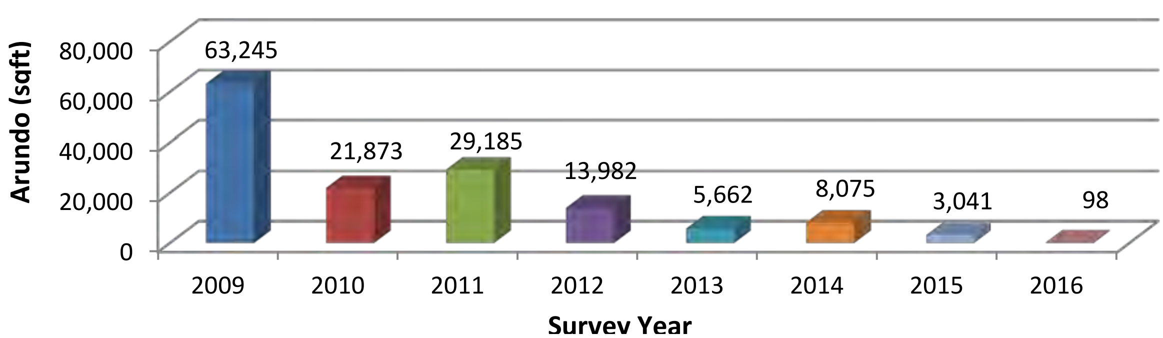
A total of 512,088 square feet (11.7 acres) of non-native invasive and Pierce host vegetation was documented and treated during the 2016 survey; for comparison, only 101,427 sqft were documented in 2015. Species documented in 2016 include 175,475 sqft of Himalayan blackberry, 329,915 sqft of native/hybrid CA grape, 3,625 of Vinca, 2,975 sqft of Mugwart and only 98 sqft of Arundo. **Table 17** below shows the total area of invasive and Pierce host plants treated by species since the inception of the Project in 2009 through 2016. As always, the District encourages landowners to contact the County maintenance lead with requests for management of invasive and/or Pierce host vegetation in the riparian zone, beyond the top of bank, that may have not been documented during the channel maintenance survey.

Previous and ongoing efforts related to the Project to manage and remove giant reed (*Arundo*) have been largely successful in reducing the total amount of giant reed within the Project area. **Chart 3** below depicts the general decline of *Arundo* throughout the Project area. The area of Arundo documented this year was the least ever documented, 98 sqft, and was comprised only of small re-sprouts from previously treated clumps which were re-treated in the fall of 2016. Areas of invasive plants that were treated in 2016 that had the potential to cause streambank erosion were replanted with willow stakes and broadcast seeded with native species during the winter and spring of 2016 and 2017.

Table 17: Invasive/Pierce host plant species mapped and treated, 2009-2016

Survey Year	Giant Reed	Himalayan Blackberry	Periwinkle (*Vinca sp.*)	Mugwart	CA Grape	Other Species (Sesbania, Tree of Heaven, etc.)	Total Area Treated
2009	73,180	-	-	-	-	-	73,180
2010	23,599	952	17,389	-	-	86	42,026
2011	30,749	35,809	9,163	-	7,447	49,138	132,306
2012	14,502	2,668	6,951	20,330	-	17,636	62,087
2013	5,662	42,688	1,901	143,959	5,070	17,903	217,183
2014	8,075	206,182	2,620	169,155	23,753	796	410,581
2015	8,562	33,272	8,588	23,252	27,752	-	101,427
2016	98	175,475	3,635	2,975	329,915	-	512,098
Total Treated to Date:							**1,550,888 (35.6 acres)**

Chart 3: Arundo mapped and treated (2009-2016)



4.11 Ritz-Carlton Hotel and Caltrans Troutdale Creek Mitigation Monitoring

Ritz-Carlton Mitigation Site

The linear wetland constructed in Phase 4A, Reach 8 North to satisfy the Ritz-Carlton Hotel mitigation requirements is continuing to function as designed. The linear wetland was built in 2012 and was incorporated into the Project as a 589-foot-long secondary channel constructed on Bench 1, of the east bank of the river between river stations 7,100-6,500 on the Wilsey property. The area functions as a wetland, secondary stream channel and backwater habitat. Cross section RS 6750 bisects this area; results of the cross section survey in 2015 indicated that the width to depth ratio in the area achieved "function width" which indicates the channel is less confined and therefore more likely to recruit new gravel bars and propagate riffle and pool formation which is one of the restoration goals for the Project. Vegetation direct count/survivorship Surveys for 2016 in this area ranged between 69% -243% (includes natural recruitment) with an average of 121% for the site, well above the 80% or greater vegetation survivorship monitoring requirements.

Caltrans Troutdale Creek Bridge Mitigation Site

In support of Caltans off-site mitigation requirements for the removal of approximately 251 trees as part of the Troutdale Creek Bridge Replacement Project (No. 21-0004) on State Route 29, 652 trees were planted at restoration sites in Reaches 6, 7 and 9 of the Project with the majority of the trees being installed in Reaches 6 and 9, covering an area of approximately 4.2 acres. Tree species planted included 238 coast live and 106 valley oaks, 54 California buckeyes, 29 big-leaf maples, 45 Oregon ashes, 72 Fremont cottonwoods, 65 California black walnuts, 29 white alders, and 14 red willows. Results of vegetation direct count/survivorship surveys for 2016 in this area ranged between 59% -136% (includes natural recruitment) with an average of 96% for all of the sites, well above the 80% or greater vegetation survivorship requirements.

Additional monitoring results for the Ritz Carlton and Caltrans mitigation sites, including summaries of the adaptive management measures taken to maintain these sites, are included throughout this report. See **Appendix B** and **D** for additional vegetation establishment data and photographs of the sites.

4.12 Stakeholder Participation Documentation

The Napa River Rutherford Restoration Project is a landowner-initiated project. The leadership of the Landowner Advisory Committee (LAC) and the active participation of landowners at these and other meetings have been central to the success of the Project. Maintaining active landowner participation remains a key element of Project viability; documentation of participation levels demonstrates the success of community engagement with the Project.

A group of 30 property owners own 41 parcels with riverfront property along the Rutherford Reach in Rutherford and Oakville. Temporary construction easements and maintenance access agreements were signed by 100 % of the landowners participating in the Project, and landowners continue to allow access for Project maintenance and monitoring activities.

All 30 landowners included in the Maintenance Assessment District (MAD) receive an annual report prepared by the Flood District documenting routine vegetation, debris and invasive/Pierce host plant management activities and a summary of work conducted pursuant to specific maintenance requests. Records of landowner maintenance requests are maintained by the Flood District. These reports can be accessed online at the Napa County Watershed Information Center and Conservancy (WICC) in the Rutherford Reach Restoration Project document repository (http://www.napawatersheds.org/app_folders/view/5501).

The LAC meets twice per year: once in July to review and comment on the results of the maintenance survey and work plan, and a second time in March to review and comment on work completed the budget, and the prioritization of channel maintenance activities. Attendance at each LAC meeting has ranged between 6-15 people, representing approximately20-50% of the properties in the MAD **Table 18** below. The Napa County MAD representative is available via email and phone throughout the year and is in communication with all of the landowners in the MAD on a regular basis.

Table 18: Landowner Advisory Committee (LAC) meeting attendance

Meeting Date	Landowner Attendees	Properties Represented (of 30)	Percent of Properties Represented
6/18/2009	No Record	No Record	No Record
11/13/2009	No Record	No Record	No Record
4/10/2010	No Record	No Record	No Record
12/7/2010	No Record	No Record	No Record
4/22/2011	6	9	30%
8/2/2011	10	9	30%
12/6/2011	7	10	33%
4/12/2012	9	10	33%
7/24/2012	11	8	27%
4/9/2013	8	7	23%
7/25/2013	6	8	27%
4/10/2014	11	15	50%
7/17/2014	6	8	27%
3/24/2015	11	9	30%
7/30/2015	7	7	23%
3/31/2016	12	10	33%
7/28/2016	6	9	30%
3/30/17	8	11	36%

4.13 Photo Monitoring

Photo monitoring is conducted concurrently with the annual stream survey and was also conducted immediately at restoration sites construction activities. Site-specific monitoring of restoration sites creates a visual record of vegetation survival rates, establishment, and seasonal change year over year. As aerial photography becomes available, and as the Project budget allows, the riparian buffer width and stream network are also assessed and incorporated into a spatial database (GIS). Results of annual photo monitoring for the entire Project area (Reaches 1 through 9) conducted in 2016 (and in the winter of 2017 in some instances) are shown in **Appendix D.**

4.14 Complementary Monitoring

The Project team coordinates with partner agencies responsible for complementary fish, and wildlife monitoring including the RCD and others and will encourage an active exchange of data and findings.

Salmonid Monitoring

The Napa RCD conducts annual spawner surveys to document salmonid spawning activity in the mainstem Napa River. Spawner surveys are typically conducted from November through January for Chinook salmon, and from January through April for steelhead. In addition, the RCD operates a salmonid smolt trap in the lowest non-tidal reach of the Napa River each spring from March through June. The results of these two monitoring efforts are used to generate abundance estimates, describe details of adult and juvenile migration timing, estimate average smolt sizes, and estimate freshwater and ocean survival rates. Over the long-term, these data can be used to gauge ecological responses to ongoing habitat restoration throughout the watershed.

2016/17 Spawner Survey Results

The Napa RCD completed three Chinook salmon spawner surveys within the project reach during the 2016/17 spawning year (**Table 19**). Additional details and results from this watershed-wide monitoring effort will be provided in the RCD's annual report for their Napa River Steelhead and Salmon Monitoring Program, which will be available in late 2017. Previous reports are available on the RCD and WICC websites.

Table 19. Survey details and summarized results of spawner surveys conducted within the project reach during the 2016/17 monitoring season.

Date	November 4, 2016	December 5, 2016	December 6, 2016
Target Species	Chinook salmon	Chinook salmon	Chinook salmon
Survey Method	Kayak	Kayak	Kayak
Starting Location	Sutter Home Alcove	Pope Street Bridge	Rutherford Road Bridge
Ending Location	Oakville Road Bridge	Rutherford Road Bridge	Yountville Crossroad Bridge
Distance Surveyed (mi)	4.13	4.57	5.54
Results			
# Live Fish Observed	1	4	1
# Spawning Redds Counted	0	30	9
# Carcasses Recovered	0	2	0

5.0 Summary and Conclusions

To date, monitoring results indicate that the restoration is meeting, or is on target to meet, the Project goals and performance standards. The cumulative amount of fine sediment reduced as a result of Project completion is 257,260 metric tons with an estimated 16,394 metric tons/year reduced each year from the Napa River watershed over the next 20 years. This represents 87% of the total TMDL sediment reduction for the Napa River watershed. In 2016, 455 feet of channel banks were mapped as eroding or unstable throughout the Rutherford Reach, this is a reduction of 97% compared to the 2009 baseline.

Based these results, the Project has greatly exceeded the performance standard of a 75% reduction in active stream bank erosion throughout the entire Project reach.

Results of the channel bed (thalweg) survey indicate there has been a slight reduction in the overall number of riffles in non-restored reaches and a slight increase in the number of riffles in restored reaches. The channel bed appears to be aggrading (rising) with incision through the Project reach possibly reversing.

39 spawning redd (nests) and 6 adults spawning pairs of Chinook salmon were detected in the Project reach during late November/early December spawners surveys. 132 of the 147 habitat structures (boulder clusters and large wood features) were found during the 2016 field survey, 87 of the installed structures were providing cover, yielding a 140% increase from the "natural" background levels within the project. This increase greatly exceeds the 40% target set by the performance standard for instream cover.

A total of 11.7 acres of non-native invasive and Pierce host vegetation was documented and treated in 2016. Species treated included Himalayan blackberry (4 acres), native/hybrid CA grape (7.5 acres), Vinca (.1 acres), Mugwart (.06 acres) and 98 sqft of Arundo. Survival of installed native woody and herbaceous vegetation in all Reaches except for Reach 3, ranged between 96% -144% which exceeds the performance standard of 80% for vegetation survivorship (the 144% includes natural recruitment of native plants). Results from line intercept surveys indicate that native cover, on average, is approximately 59% herbaceous, 8% woody shrub and 32% tree cover type. In general, the increase in relative native cover represents a positive trend in vegetation establishment at the restored sites, likely providing greater habitat value within the riparian corridor of the Napa River.

Overall, the created aquatic and terrestrial habitats are providing important foraging and rearing areas for native wildlife. The channel bed appears to be aggrading (rising) and incision has slowed and possibly begun to reverse throughout the Project reach (a positive trend). Within the Project reach fine sediment sources have been reduced and are expected to be reduced year to year over the life of the Project as a result of related bank stabilization and other channel enhancement activities.

6.0 References

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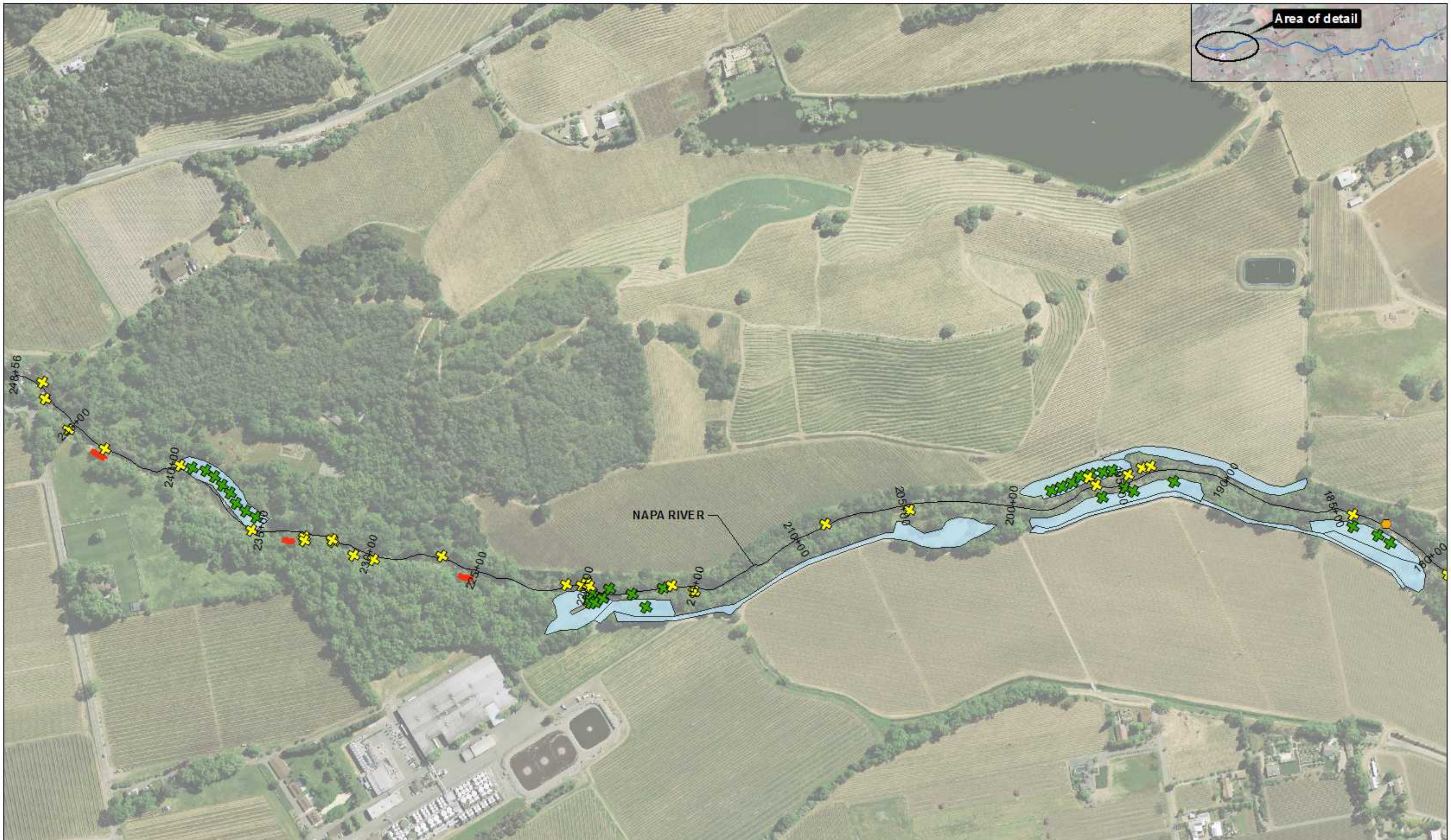
Appendix A
Eroding Stream Bank and Large Woody Debris (LWD) Survey Figures and Tables
2016



Stream Bank Erosion
Constructed Features
Boulder Cluster
Naturally Recruited LWD
Installed LWD

Napa River Rutherford Restoration Project Reach 1-2
Eroding Stream Bank and Large Woody Debris Survey

Feet
0 250 500

Stream Bank Erosion
Constructed Features
Boulder Cluster
Naturally Recruited LWD
Installed LWD

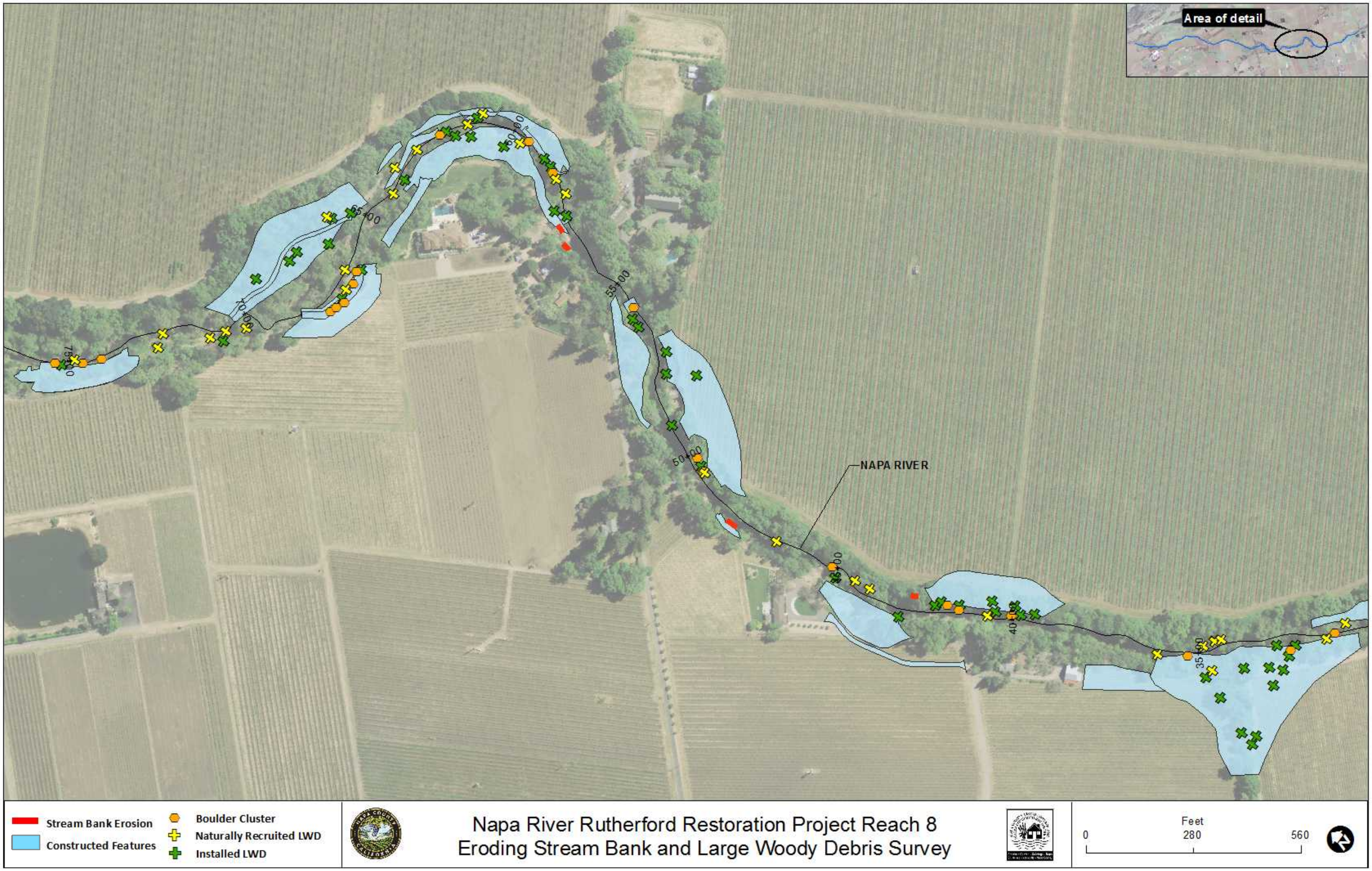
Napa River Rutherford Restoration Project Reach 3-4
Eroding Stream Bank and Large Woody Debris Survey

Feet
0 250 500

Stream Bank Erosion
Constructed Features
Boulder Cluster
Naturally Recruited LWD
Installed LWD

Napa River Rutherford Restoration Project Reach 5-7
Eroding Stream Bank and Large Woody Debris Survey

Feet
0 250 500



Napa River Rutherford Restoration Project Reach 8
Eroding Stream Bank and Large Woody Debris Survey

Stream Bank Erosion
Constructed Features
Boulder Cluster
Naturally Recruited LWD
Installed LWD

Napa River Rutherford Restoration Project Reach 9
Eroding Stream Bank and Large Woody Debris Survey

Feet
0 250 500

Table A1: Summarized statistics on naturally-occurring LWD within the entire Project reach, 2016.

Survey Year	2009	2010	2011	2012	2013	2014	2015	2016
Number of Occurrences								
Single	46	60	97	111	90	59	85	89
Accumulations (2-9)	23	19	19	24	20	27	21	17
Jams (>10)	3	3	3	1	3	1	2	0
Total	72	82	119	136	113	87	108	106
Bedform Association (%)								
Bank	---	9.8	9.2	3.7	16.8	10.3	18.5	10.3
Bar	---	15.9	12.6	13.2	9.7	12.6	---	---
Pool	---	36.6	37	41.9	36.3	35.6	37	45.3
Riffle	---	4.9	10.1	5.9	5.3	9.2	5.6	3.8
Terrace	---	24.4	29.4	19.1	16.8	12.6	15.7	14.2
Secondary Channel	---	1.2	1.7	0	1.8	1.1	1.9	0.9
Perched in Vegetation	---	7.3	---	16.2	13.3	18.4	21.3	25.5
Size								
Single Piece Length Range (ft)	6-80	8-100	6-95	6-80	6-60	6-80	6-90	6-90
Single Piece Length Average (ft)	30	25	25	23	23	29	28	25
Accumulation Length Range (ft)	10-120	10-100	8-85	8-100	10-200	10-200	10-100	20-60
Diameter Class (%)								
18-in	25	63.4	69.7	68.4	68.1	60.9	67.6	67.9
24-in	38.9	19.5	16	17.6	15	26.4	20.4	18.9
30-in	22.2	3.7	6.7	2.2	5.3	8	4.6	3.8
36-in	6.9	7.3	4.2	5.9	8	1.1	7.4	7.6
42-in	2.8	6.1	2.5	3.7	2.7	2.3	0	0.9
≥ 48-in	4.2	0	0.8	2.2	0.9	1.1	0	0.9
***Function (%)** – note: some features provide more than one function, so totals add to over 100%*								
Hydraulic Constriction	---	---	28.6	26.5	18.6	29.9	13.9	16.5
Pool Scour	---	---	33.6	28.7	28.3	29.9	25	26.6
Gravel Recruitment	---	---	---	---	10.6	1.1	6.5	5.1
Summer Refugia	---	---	41.2	44.1	42.5	48.3	45.4	62.0
High-flow Refugia	---	---	6.7	17.6	30.1	27.6	27.8	13.9
Bank Stability	---	---	28.6	23.5	22.1	5.7	9.3	12.7
Other	---	---	21	17.6	---	---	---	---

Appendix B

Vegetation Establishment Survey Figures and Tables

Figure B1: Vegetation establishment direct count, transect survey and photo monitoring locations

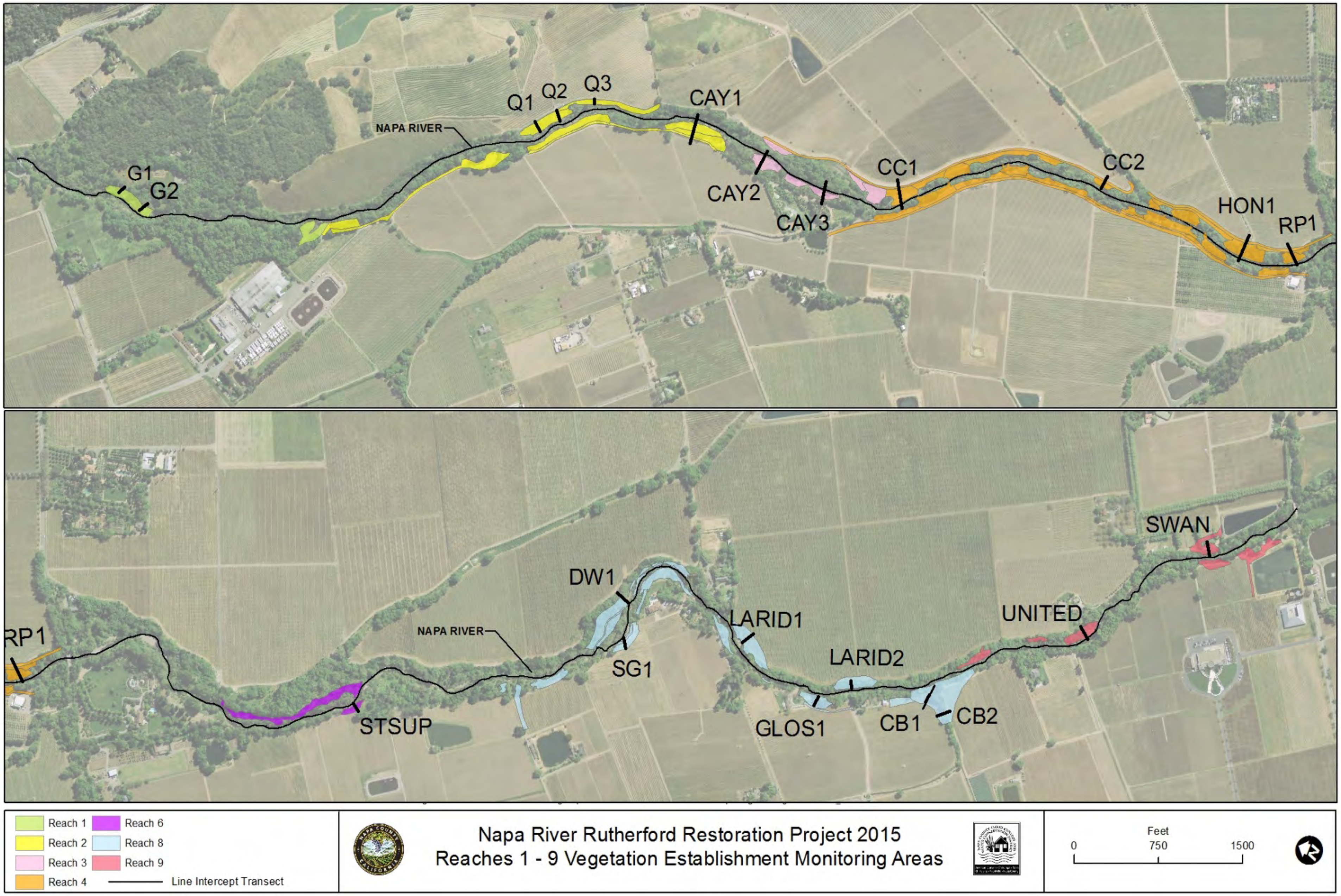


Table B1: Reach 8 (Includes Ritz-Carlton Mitigation Area) Woody Vegetation Direct Count/Survivorship Surveys 2016

Common Name	Total Installed Reach 8	Count 2014 Reach 8	% Survival	Count 2015 Reach 8	% Survival	Count 2016 Reach 8	% Survival	Health
Big leaf maple	59	63	107%	61	103%	59	100%	Good
Honeysuckle	26	18	69%	27	104%	18	69%	Fair
Snowberry	300	467	156%	512	171%	292	97%	Good
California Wild Rose	379	394	104%	531	140%	399	105%	Good
Spicebush	18	14	78%	16	89%	16	89%	Good
California Buckeye	98	159	162%	140	143%	121	123%	Good
White Alder	190	185	97%	275	145%	305	161%	Good
Oregon ash	189	157	83%	178	94%	174	92%	Good
Fremont's Cottonwood	116	238	205%	298	257%	282	243%	Good
California Black Walnut	114	150	132%	163	143%	121	106%	Good
Coyote Bush	195	149	76%	245	126%	225	115%	Good
Valley Oak	225	254	113%	351	156%	309	137%	Good
Bay Laurel	46	41	89%	41	89%	38	83%	Good
Toyon	52	79	152%	47	90%	46	88%	Good
Coast Live Oak	179	164	92%	264	147%	250	140%	Good
Total	**2186**	**2532**	**116%**	**3149**	**144%**	**2655**	**121%**	

* Installed Spring 2013 and 2014, includes original planted stock and naturally recruited species.

**A large number of cottonwoods and oaks are naturally recruiting within Reach 8.

Table B2: Reach 5, 6, 7 and 9 (Includes CalTrans Troutdale Creek Mitigation Area) Woody Vegetation Direct Count/Survivorship Surveys 2016

Common Name	Total Installed 2015	Count 2015	% Survival	Count 2016	% Survival	Health
Big Leaf Maple	29	29	100%	25	86%	Good
California Buckeye	54	36	67%	32	59%	Poor
White Alder	29	29	100%	36	124%	Good
Oregon Ash	45	45	100%	38	84%	Good
California Black Walnut	65	65	100%	60	92%	Good
Northern California Black Walnut *	60	60	100%	60	100%	Good
Fremont's Cottonwood	72	72	100%	98	136%	Good
Coast Live Oak	163	153	94%	149	91%	Good
Valley Oak	238	238	100%	197	83%	Good
Red Willow	106	106	100%	143	135%	Good
Arroyo Willow	48	48	100%	54	113%	Good
Bay Laurel	21	21	100%	18	86%	Good
Deergrass	343	318	93%	318	93%	Good
Coyote Bush	73	73	100%	78	107%	Good
Western Spice Bush	35	35	100%	25	71%	Good
Hairy Ceanothus	23	23	100%	18	78%	Good
Toyon	47	47	100%	45	96%	Good
Ninebark	34	34	100%	30	88%	Good
California gooseberry	52	52	100%	41	79%	Good
California Wild Rose	148	148	100%	144	97%	Good
Snowberry	91	91	100%	102	112%	Good
Total	**1776**	**1723**	**97%**	**1711**	**96%**	

*Installed Fall 2014 and spring 2015, includes original planted stock and naturally recruited species.

Figure B2: Representative photos of direct count and transect monitoring sites Reach 8

Transect GLOS1 (July 2015)

Transect GLOS1 (May 2016)

Transect DW1- Ritz Carlton Mitigation Site (September 2012)

Transect DW1- Ritz Carlton Mitigation Site (May 2016)

Figure B2: Representative photos of direct count and transect monitoring sites Reaches 5, 6, 7, 9

Transect UNITED- Caltrans Mitigation Site (July 2015)

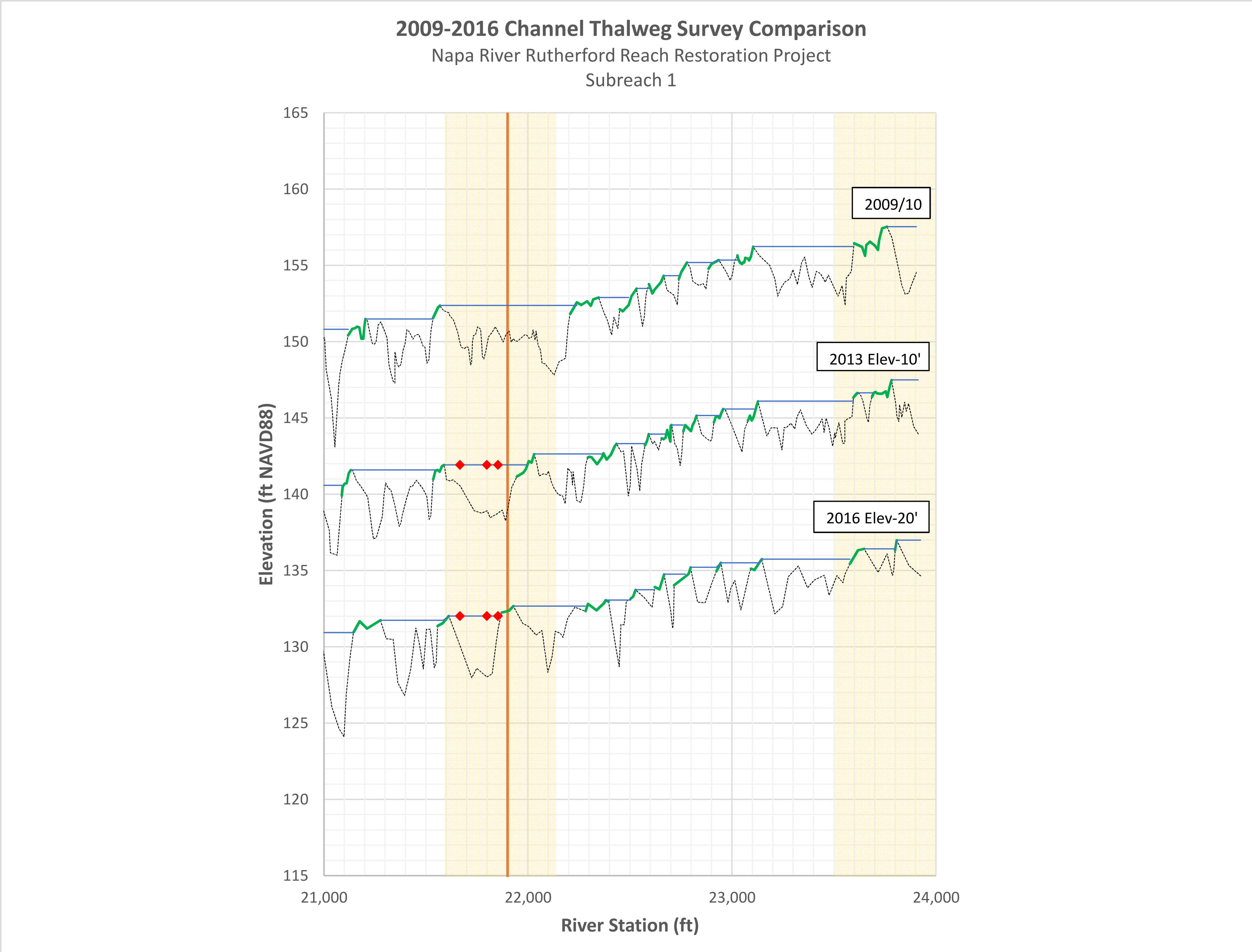
Transect UNITED- Caltrans Mitigation Site (July 2016)

Transect SWAN- Caltrans Mitigation Site (*July 2015*)

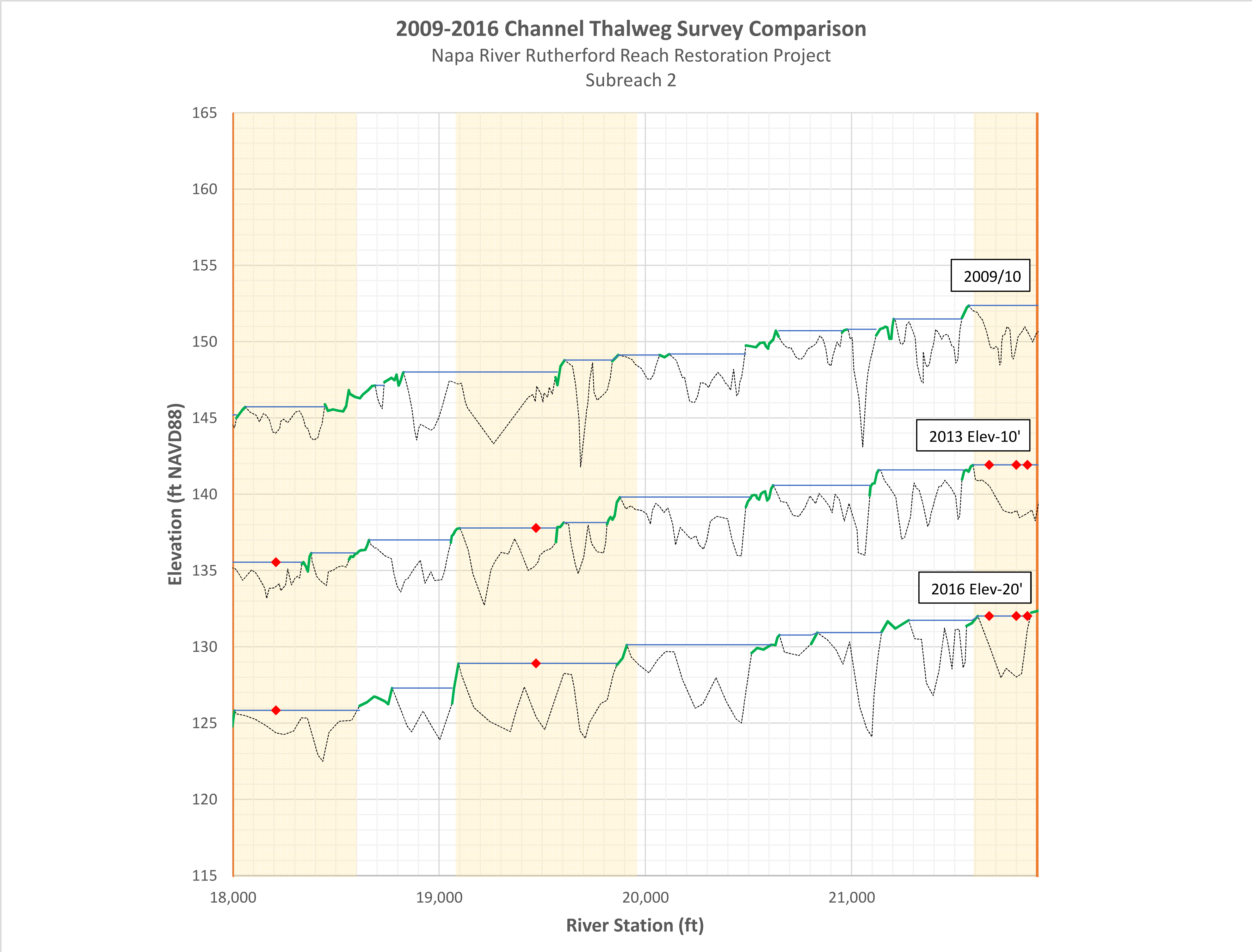
Transect SWAN- Caltrans Mitigation Site (*July 2016*)

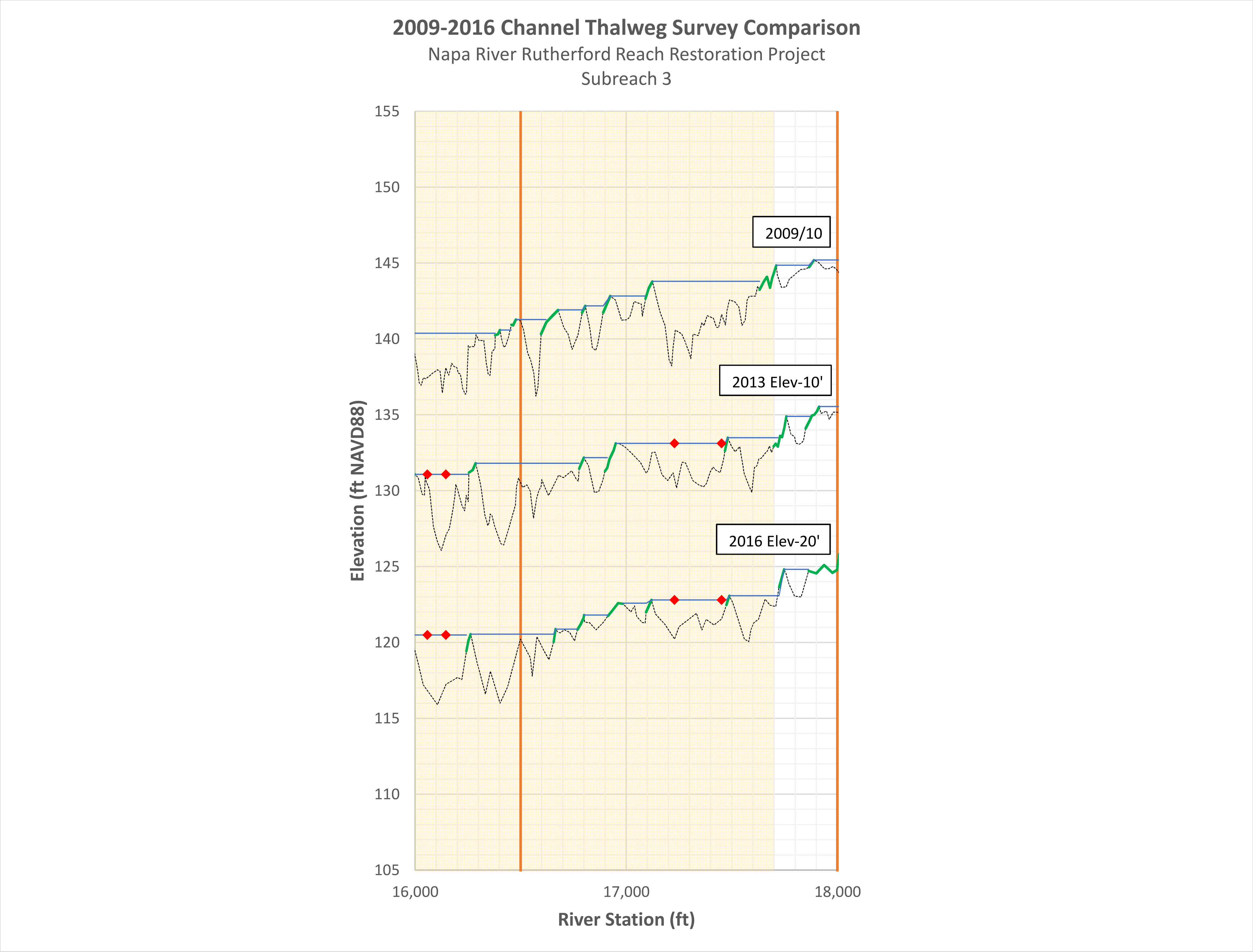
Appendix C

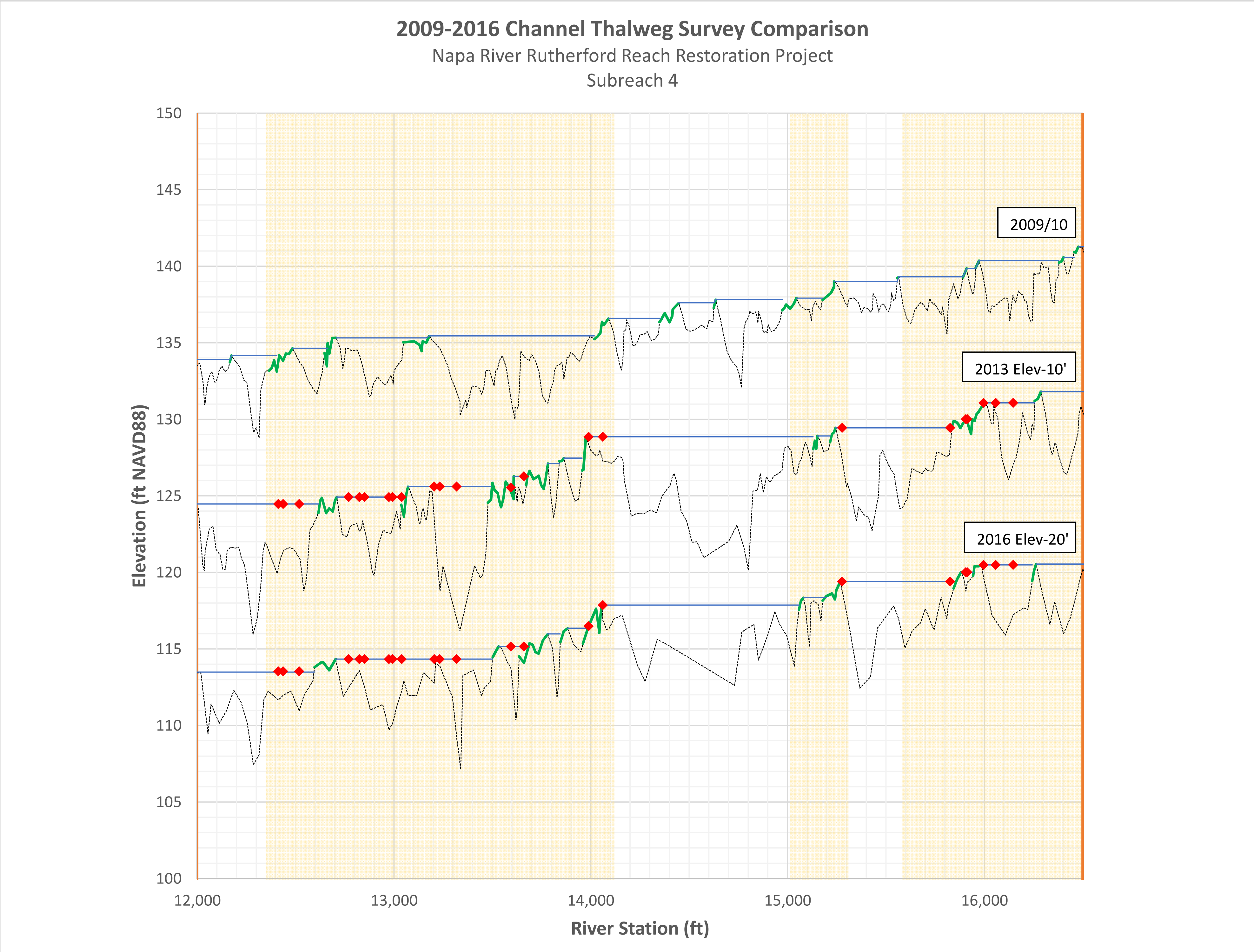
Longitudinal Profile Thalweg Surveys

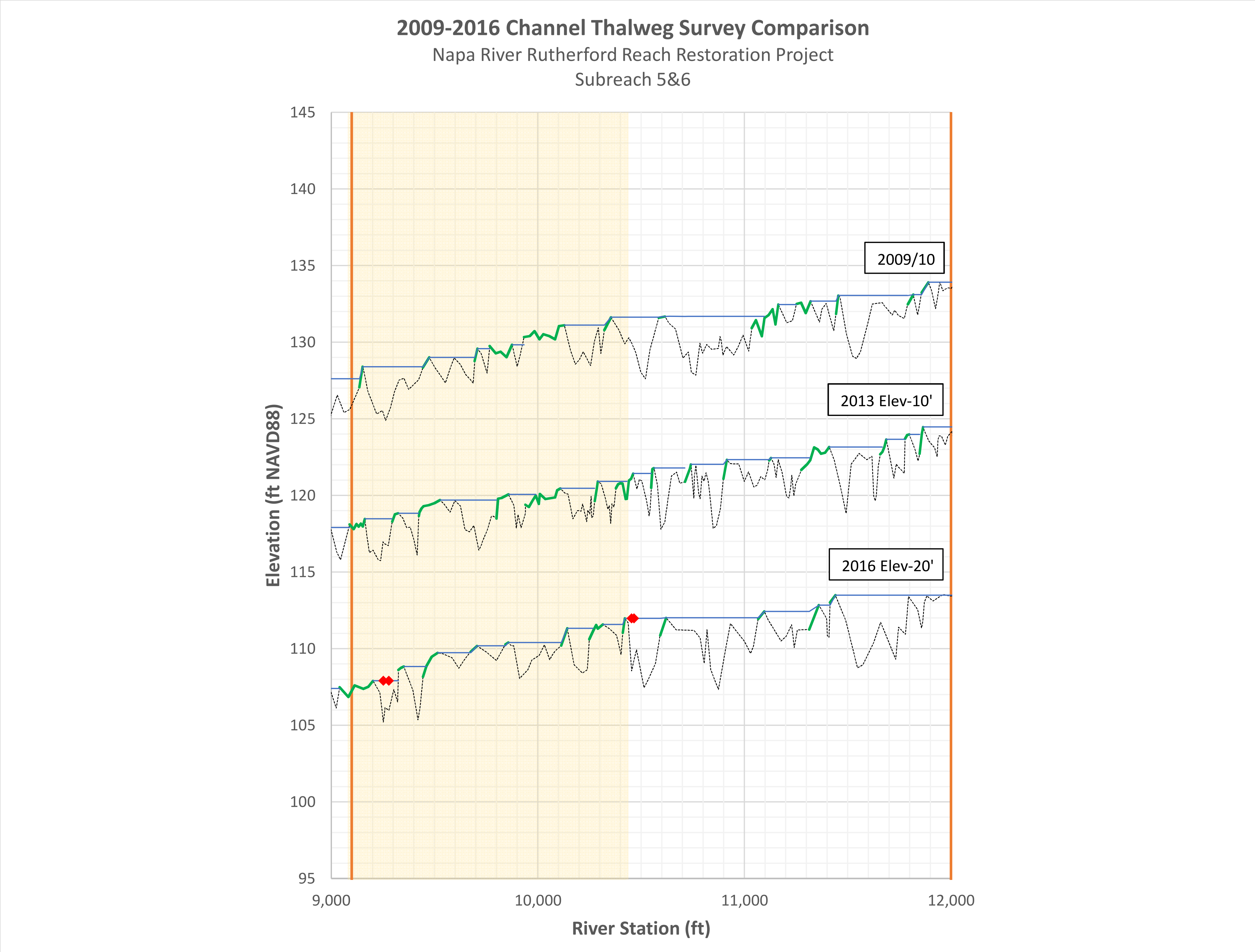


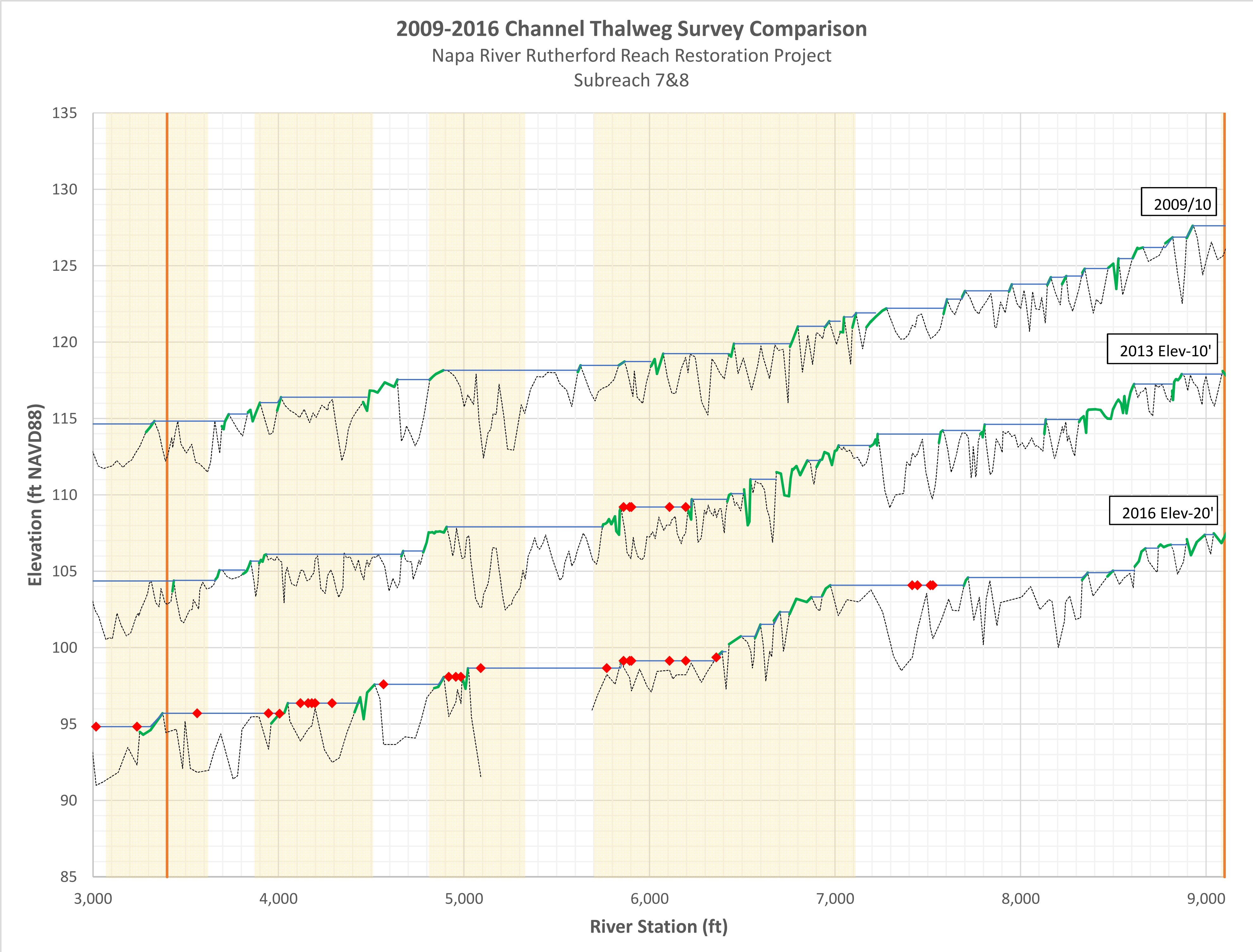
2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 1
Elevation (ft NAVD88)
River Station (ft)
2009/10
2013 Elev-10'
2016 Elev-20'
165
160
155
150
145
140
135
130
125
120
115
21,000
22,000
23,000
24,000


2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 2
2009/10
2013 Elev-10'
2016 Elev-20'
Elevation (ft NAVD88)
River Station (ft)
165
160
155
150
145
140
135
130
125
120
115
18,000
19,000
20,000
21,000

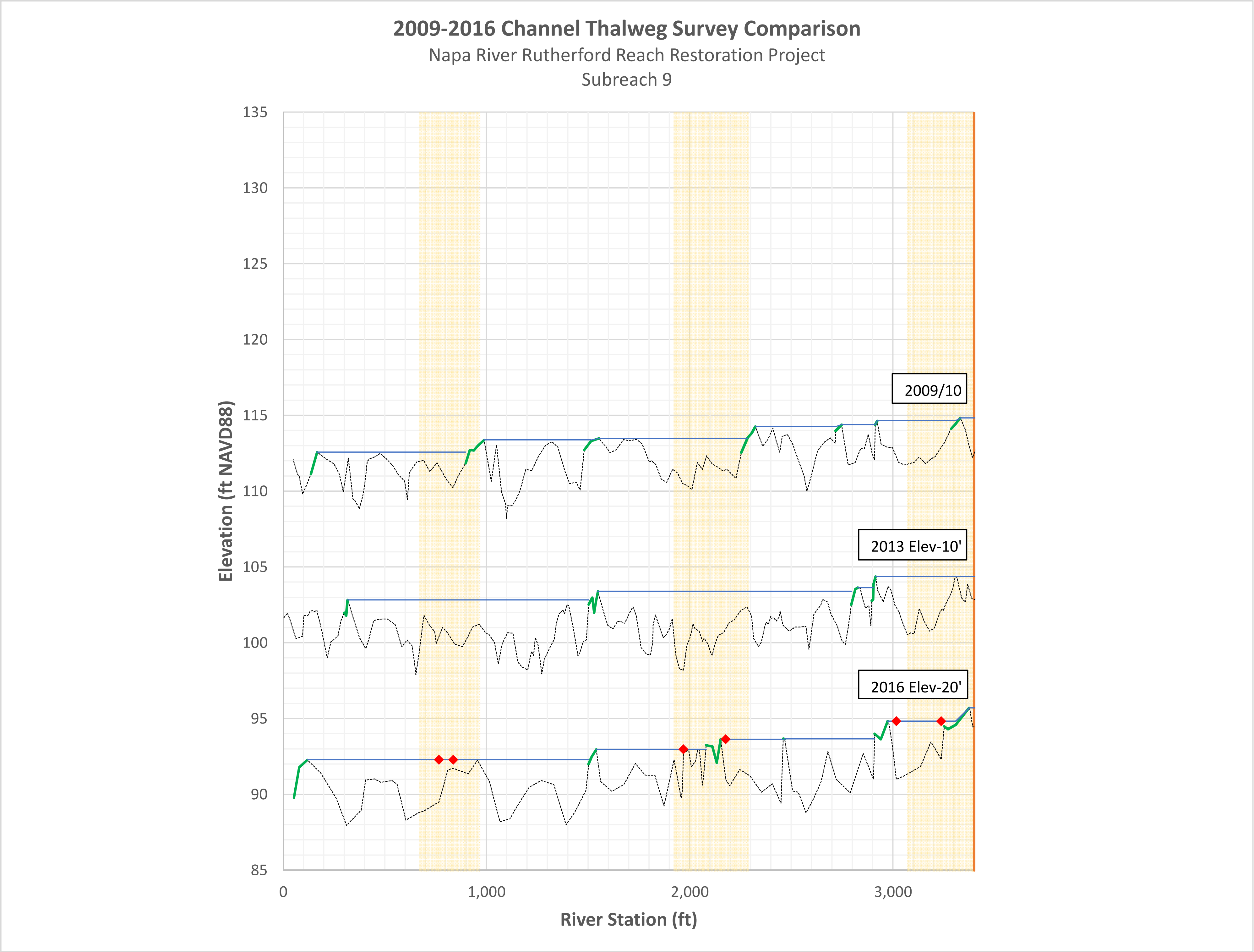

2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 3
2009/10
2013 Elev-10'
2016 Elev-20'
Elevation (ft NAVD88)
155
150
145
140
135
130
125
120
115
110
105
16,000
17,000
18,000
River Station (ft)


2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 4
2009/10
2013 Elev-10'
2016 Elev-20'
Elevation (ft NAVD88)
150
145
140
135
130
125
120
115
110
105
100
River Station (ft)
12,000
13,000
14,000
15,000
16,000


2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 5&6
2009/10
2013 Elev-10'
2016 Elev-20'
Elevation (ft NAVD88)
145
140
135
130
125
120
115
110
105
100
95
9,000
10,000
11,000
12,000
River Station (ft)



2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 7&8
2009/10
2013 Elev-10'
2016 Elev-20'
Elevation (ft NAVD88)
River Station (ft)
135
130
125
120
115
110
105
100
95
90
85
3,000
4,000
5,000
6,000
7,000
8,000
9,000


2009-2016 Channel Thalweg Survey Comparison
Napa River Rutherford Reach Restoration Project
Subreach 9
Elevation (ft NAVD88)
135
130
125
120
115
110
105
100
95
90
85
0
1,000
2,000
3,000
River Station (ft)
2009/10
2013 Elev-10'
2016 Elev-20'

Appendix D

Photographic Monitoring

Reaches 1 and 2 East Bank
(Phase 1)

Constructed 2009

Guggenhime
Quintessa

River Station 235+00

Bench: Guggenhime, East Bank

October 2009

June 2011

March 2015

December 2016

River Station 195+50

Benches: Quintessa, East Bank

June 2009

March 2011

June 2015

December 2016

River Station 19,550

Benches: Quintessa, East Bank to West Bank

September 2009

June 2015

December 2016

Reaches 1 and 2 West Bank
(Phase 1)

Constructed 2010

The Ranch Winery & Trinchero Family Estates
Frog’s Leap
Caymus

River Station 219+50
Alcove: The Ranch Winery / Sutter Home, West Bank

September 2009


June 2015


December 2016

River Station 198+50
Bench: Frog's Leap, West Bank


August 2010


June 2015


December 2016

River Station 191+00

Frog's Leap Bench from Quintessa Road, East Bank

September 2010

December 2016

River Station 181+00

Setback Berm: Caymus Bench, West Bank

October 2010

June 2015

December 2016

Reach 3
(Phase 2)

Constructed 2010

Carpy Conolly and Caymus

River Station 176+50

Bench 1: Caymus, West Bank

September 2010


June 2015

December 2010


December 2016

River Station 172+00
Bench 2: Caymus, West Bank

October 2010

June 2015

December 2016

River Station 168+50

Bench 3: Caymus, Downstream to Upstream

October 2010

June 2015

December 2016

River Station 164+20

Bench 4: Carpy Conolly, East Bank

September 2010

November 2011

June 2015

December 2016

River Station 162+00

Carpy Conolly Bench 5, East Bank

September 2010

June 2015

December 2016

River Station 144+00 Carpy Conolly Bench 6, East Bank

August 2011

June 2015

December 2016

Reach 4 East Bank
(Phase 3)

2011

Honig
Round Pond East Bank

River Station 135+40

Bench 11: Honig, East Bank

October 2011


March 2012


June 2015


December 2016

River Station 130+50

Bench 13: Honig, East Bank

August 2011

March 2012

June 2015

December 2016

River Station 127+50
Bench 13: Honig, East Bank to Upstream


May 2011


October 2011


June 2015


December 2016

River Station 124+25

Bench 14: Round Pond, East Bank

October 2011

June 2015

December 2016

Reach 4 West Bank
(Phase 3)

Constructed 2012

Emmolo, Caymus and Round Pond

River Station 161+10

Bench 6: Emmolo, West Bank

May 2012

June 2015

November 2012

December 2016

River Station 157+60
Bench 6: Emmolo, West Bank to Upstream


May 2012


June 2015


August 2012


December 2016

River Station 152+90
Bench 8: Emmolo, West Bank to Downstream


May 2012


June 2015


November 2012


March 2016

River Station 15,000

Bench 8: Emmolo, West Bank Looking Upstream


May 2012


June 2015


November 2012


March 2016

River Station 139+20

Bench 10: Caymus, West Bank to Downstream


August 2012


March 2016


June 2015


December 2016

River Station 135+60

Bench 10: Caymus, West Bank to Upstream

November 2012

March 2016

June 2015

December 2016

River Station 133+30
Bench 12: Round Pond West, West Bank to Downstream

August 2012

March 2016

June 2015

December 2016

River Station 130+80

Bench 12: Round Pond West, West Bank to Upstream

November 2012

Boulder Cluster, Reach 4, March 2015

March 2016

December 2016

River Station 127+80

Bank Stabilization 3: Round Pond West Bank Looking Downstream

November 2012

March 2016

June 2015

December 2016

River Station 126+00

Bank Stabilization 3: Round Pond West, West Bank to Upstream

May 2012

June 2015

December 2012

March 2016

Reach 8 North
(Phase 4A)

Constructed 2012

Foley Johnson (Sawyer), Sequoia Grove, Wilsey

Ritz Carlton Hotel Linear Wetland Mitigation
(Part of Secondary Channel on Bench 1 on Wilsey)

Station 73+30

Reach 8 North, West Bank, Foley Johnson (Sawyer) West Bank

May 2012

October 2012

June 2015

March 2016

Ritz Carlton Hotel Linear Wetland Mitigation
(Phase 4A)

Constructed 2012

Part of Phase 4a: Reach 8 North
Secondary Channel on Bench 1 on Wilsey

River Station 65+50

Bench 1: Wilsey, Secondary Channel Looking Upstream

September 2012

December 2012

June 2015

December 2016

River Station 66+30
Bank Stabilization 2: Sequoia Grove, West Bank

2011

October 2012

March 2015

December 2016

River Station 66+30

Bank Stabilization 2: Sequoia Grove, West Bank to Upstream

May 2012

March 2015

December 2012

December 2016

Reach 8 South
(Phase 4BC)

Constructed 2013

El Encino (Gmelch), Laird, Frostfire (Davis)
AJM Vineyards (McDowell), Glos
Cakebread, Nickel & Nickel

River Station 61 +00

Reach 8 South, Bench 1: Upstream to Downstream

October 2012

March 2016

October 2016

December 2016

River Station 53+00

Reach 8 South, Bank Stabilization 1: Downstream to Upstream


August 2012


March 2016


November 2012


March 2016

River Station 53+00
Reach 8 South, Bench 2: Upstream to Downstream


August 2012


June 2015


November 2012

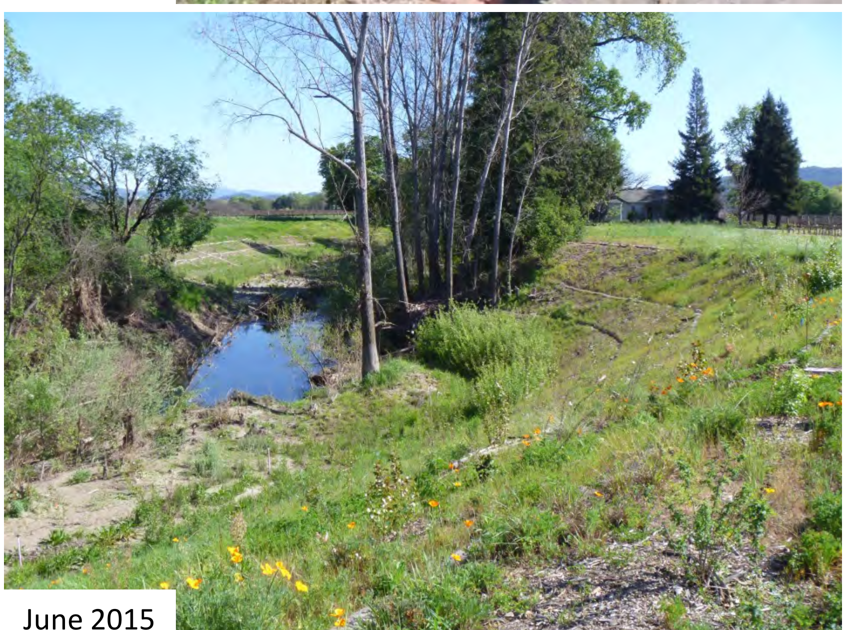

March 2016

River Station 44+00

Reach 8 South, Bank Stabilization 3 to Bench 3: Upstream to Downstream

July 2010

March 2016



June 2015

December 2016

River Station 43+00

Reach 8 South, Bank Stabilization 3: Downstream to Upstream


February 2013


June 2015


December 2014


December 2016

River Station 42+00

Reach 8 South, Bench 3: Upstream to Downstream


August 2013


March 2016


June 2015


December 2016

River Station 40+00

Reach 8 South, Bench 3: Downstream to Upstream

August 2013

June 2015

December 2016

River Station 36+00, Reach 8 South, Bella Oaks Tributary Alcove: Upstream to Downstream

August 2013

March 2016

June 2015

December 2016

River Station 31+00, Reach 8 South, Cakebread Alcove: Downstream to Upstream


August 2013


June 2015


December 2014


March 2016

Reach 5, 6 and 7
(Phase 5)
Constructed 2014

Round Pond, Peju,
St. Supery, Foley Johnston

River Station 93+50, Reach 6, Peju-St. Supery Bank Stabilization Area 1, West Bank

July 2014

March 2016

June 2015

December 2016

River Station 92+00, Reach 6, Peju-St. Supery Bank Stabilization Area 1, West Bank

December 2014

March 2016

Boulder Cluster, BSSR 1, March 2015

December 2016

River Station 103+00, Reach 6, Round Pond Secondary Channel Inlet


July 2014


March 2015


December 2014


December 2016

River Station 104+50, Reach 6, Round Pond Secondary Channel Inlet LWD Structure

December 2014

March 2015

March 2016

River Station 97+00, Reach 6, Round Pond Secondary Channel, Mid-reach


July 2014


June 2015


December 2014


December 2016

River Station 95+00, Reach 6, Round Pond Secondary Channel, Mid-reach


July 2014


June 2015


December 2014


March 2016

River Station 91+00, Reach 6, Round Pond Secondary Channel, Outlet

July 2014

June 2015

December 2014

December 2016

Reach 9
(Phase 5)

Constructed 2014

Laird, United
Swanson and Opus One

River Station 29+25, Reach 9, Laird Bank Stabilization Area 2, East Bank


July 2014


March 2016


June 2015


December 2016

River Station 25+25, Reach 9, United Bank Stabilization Area 3, East Bank


July 2014


June 2015


December 2014


December 2016

River Station 22+50, Reach 9, United Bench 1, Upstream to Downstream, East Bank

July 2014

March 2016

June 2015

December 2016

River Station 20+00, Reach 9, United Bench 1, Downstream to Upstream, East Bank


July 2014


December 2016


June 2015


LWD Structure December 2016

River Station 9+00, Reach 9, Swanson Bench 2, Upstream to Downstream, East Bank

July 2014

March 2016

June 2015

December 2016

River Station 7+50, Reach 9, Swanson Bench 2, Downstream to Upstream, East Bank


July 2014


March 2016


June 2015


December 2016

River Station 7+50, Reach 9, Opus One Bench 3, Downstream to Upstream, West Bank


July 2014


March 2016


June 2015


December 2016

River Station 9+00, Reach 9, Opus One Bench 3, Upstream to Downstream, West Bank

July 2014

March 2016

June 2015

December 2016

Beaver Dams

Beaver Dam, Reach 3, July 2016

Beaver Dam, Reach 4, July 2016

Beaver Dam, Reach 8, July 2016

Beaver Dam, Reach 4, July 2016

Beaver Dams and Instream Habitat Structures

Beaver Dam, Reach 8, July 2016

Same Beaver Dam, Reach 8, December 2016

LWD Structure, Reach 2, July 2016

LWD Structure, Reach 3, July 2016

Instream Habitat/LWD Structures

Reach 4, July 2016

Reach 4, July 2016

Reach 8, July 2016

Reach 7, July 2016