NAPA RIVER OAKVILLE TO OAK KNOLL REACH RESTORATION PROJECT
ANNUAL MONITORING REPORT - 2018




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1. Introduction

The purpose of this document is to report on the results of surveys performed during calendar year 2018 related to the monitoring program for the Napa River Oakville to Oak Knoll Restoration Project (Project). Napa County, in partnership with the Napa County Resource Conservation District (RCD), conducts the monitoring in accordance with Project permits and as defined by the Monitoring Plan (Sarrow, J., Blank, P., Koehler, J., 2015) approved for the Project. The Monitoring Plan outlines the monitoring framework and defines survey protocols utilized for collecting data to measure the response and evaluate the effectiveness of restoration actions related to implementation of the Project.

This annual monitoring report and future reports, in addition to the Monitoring Plan, can be accessed online at the Napa County Watershed Information Center and Conservancy (WICC) document repository for the Oakville to Oak Knoll Restoration Project: https://www.napawatersheds.org/app_folders/view/10078.

1.1 Project Description

The Project includes 4.8 miles of active channel restoration activities along 9 miles of the mainstem Napa River between the Oakville Cross Road Bridge and the Oak Knoll Avenue Bridge. The Project consists of 23 individual sites (Restoration Sites) grouped together into four distinct areas (Construction Groups), based on funding, construction, and monitoring considerations. These areas are labeled Group A, Group B, Group C, and Group D (**Figure 1)**.

The Project encompasses 108 acres in total and includes approximately 83 acres of grading in order to create and restore floodplain and riparian areas, stabilize eroding streambanks, and install instream habitat features. The Project includes removal of approximately 36 acres of vineyards, and restoration of 84 acres of transitional riparian and riverine habitat.

The overarching goals of the Project are to restore and enhance long-term river and floodplain function, improve the quality and resilience of aquatic and terrestrial riparian habitat, and reduce property damage and sediment delivery associated with ongoing bank erosion processes. Restoration elements include bank stabilization, channel widening, instream habitat improvement, spawning gravel improvement, floodplain restoration, re-vegetation, and managed retreat.

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) in concert with landowners and their representatives.

The Project has strong landowner participation and includes landowner advisory committees (LAC) established to guide adaptive management needs within the respective Project areas. Additional

detailed descriptions for the Project can be found in the Initial Study/Mitigated Negative Declaration (IS/MND) that was prepared as a requirement for review under the California Environmental Quality Act (CEQA). The IS/MND for the Project is available for viewing and download on WICC: https://www.napawatersheds.org/app_folders/view/10078.

1.2 Project Status, Implementation, and Funding

As of December 2018, restoration construction and revegetation activities have been completed for Group A (Sites 21, 22, and 23) and Group C (Sites 12, 13 and 14). Full implementation and construction of the entire Project (all 23 Restoration Sites) is expected by fall 2021. **Table 1** provides a summary of funding sources and actual or estimated construction dates for each Construction Group.

Table 1: Funding source and construction year for each Construction Group

Fund Source	Amount Awarded	Measure A Match	Construction Group	Construction Year
EPA 2013-W9-99T07301	$1,271,350	$1,246,350	Group A-Construction	2015-2016
EPA 2012-W9-00T95301	$659,587	$659,587	Group C-Site 14 Construction	2017-2018
EPA 2014 W9-99T24201	$894,324	$894,324	Group C-Site 14 Construction	2017-2018
EPA 2018 W9-99T70901	$822,000		Group C-Revegetation, Group B Design, Group B Construction	2017-2019
Coastal Conservancy 2017-16-054	$850,000		Group C-Site 13 Construction	2017-2018
Coastal Conservancy 2018	$450,000		Group B Construction	2019
SWRCB 319-2017 NO-D1613202	$750,000	$250,000	Group C-Site 13 Construction	2017-2018
SWRCB 319-2018	$750,000		Group B-Construction	2019
CDFW-2017 P1696017	$1,000,000		Site 12 and 13 Construction and 12, 13, 14 revegetation	2017-2018
CDFW-2018 P1796036	$750,000		Group B & D-Design	2019-2020
WCB Prop 1-2018	$2,500,000		Group B & D-Construction and revegetation	2019-2021
Total	**$7,447,261**	**$3,050,261**		

1.3 Description of Restoration Activities Completed

A summary of specific restoration features constructed to date in Construction Groups A and C is provided in **Table 2**. This table will be expanded in subsequent monitoring reports as additional Restoration Groups and Sites are constructed. Brief summaries of completed Restoration Sites are presented below. For additional details and descriptions of all proposed and completed Construction Groups and Restoration Sites, please refer to the *Basis of Design Report* developed by Environmental Science Associates (ESA, 2014), and the *Napa River Restoration: Oakville to Oak Knoll Final Concept Plan* developed by the California Land Stewardship Institute (CLSI, 2011).

Table 2: Constructed restoration features in Groups A and C

Restoration Feature		Group A	Group C	Group B	Group D	Total
Floodplain Benches	Acres	1.48	6.89	N/A	N/A	8.37 Ac
Riparian Areas	Acres	2.68	10.24	N/A	N/A	12.92 Ac
Seasonal Wetlands	Acres	0	.68	N/A	N/A	0.68 Ac
Side Channels	Linear Feet	724	340	N/A	N/A	1,064 Lf
Instream Habitat Structures	Large Wood	24	21	N/A	N/A	45
	Boulder Clusters	17	37	N/A	N/A	54
Setback Berms	Linear Feet	0	2,872	N/A	N/A	2,872 Lf
Construction Year		**2015 -2016**	**2016 -2018**	**Pending**	**Pending**	

Summary of Restoration Sites 21, 22 and 23 (Group A)

Construction took place during the summers of 2015 and 2016. A total of 4.16 acres of riparian, upland, and vineyard areas were re-graded and enhanced to create and restore floodplain and upland riparian habitat through conversion of vineyard lands. Additionally, two side channel features were created totaling 724 linear feet at Sites 22 and 23.

Selective bench creation and bank stabilization was implemented over approximately 1,850 linear feet of over-steepened and actively eroding stream banks. In addition to channel widening and floodplain grading, a total of 41 in-channel habitat structures (17 boulder clusters and 24 large wood structures) were installed at Sites 21, 22, and 23. The Project also included approximately 6.5 acres of invasive vegetation management. All disturbed areas within the vegetation management zones were seeded with a native seed mix or covered with mulch. A total of 2 acres, within the 6.5 acres invasive management areas, were revegetated to support establishment of a more complex mix of appropriate native riparian plant species.

The Project reused as much material as possible on-site. Trees removed from the Project area were used to create the large wood structures. An estimated 29,522 cubic yards (cy) of earthen material and existing riprap debris (concrete and other anthropogenic materials) were excavated and disposed of off-site. All work was completed in accordance with permits and the construction plans and drawings prepared for the Project.

Summary of Restoration Sites 12, 13, and 14 (Group C)

Construction took place during the summer from 2016 - 2018. A total of 17.8 acres of riparian, upland, and vineyard areas were re-graded and enhanced to create and restore floodplain, seasonal wetland and upland riparian habitat through conversion of vineyard lands. Additionally, a 340 linear foot side channel feature was created at Site 12.

Selective floodplain bench creation and bank stabilization was implemented over approximately 4,550 linear feet of over-steepened and actively eroding stream banks. In addition to channel widening and floodplain grading, a total of 58 in-channel habitat structures (37 boulder clusters and 21 large wood structures) were installed at Sites 12, 13, and 14. A total of 42 bio-technical features including willow baffles, brush mattresses, etc. were installed. The Project also included approximately 3.3 acres of invasive vegetation management. All disturbed areas within the vegetation management zones were seeded with a native seed mix or covered with mulch and revegetated to support establishment of a more complex mix of appropriate native riparian plant species.

Similar to Restoration Sites 21, 22, and 23, soil and woody material was reused on-site whenever possible. Trees removed during construction were repurposed to create the large wood structures. An estimated 65,410 cy of earthen material and existing riprap debris (concrete and other anthropogenic materials) were excavated and reused on site or disposed of off-site. All work was completed in accordance with permits and the construction plans and drawings prepared for the Project.

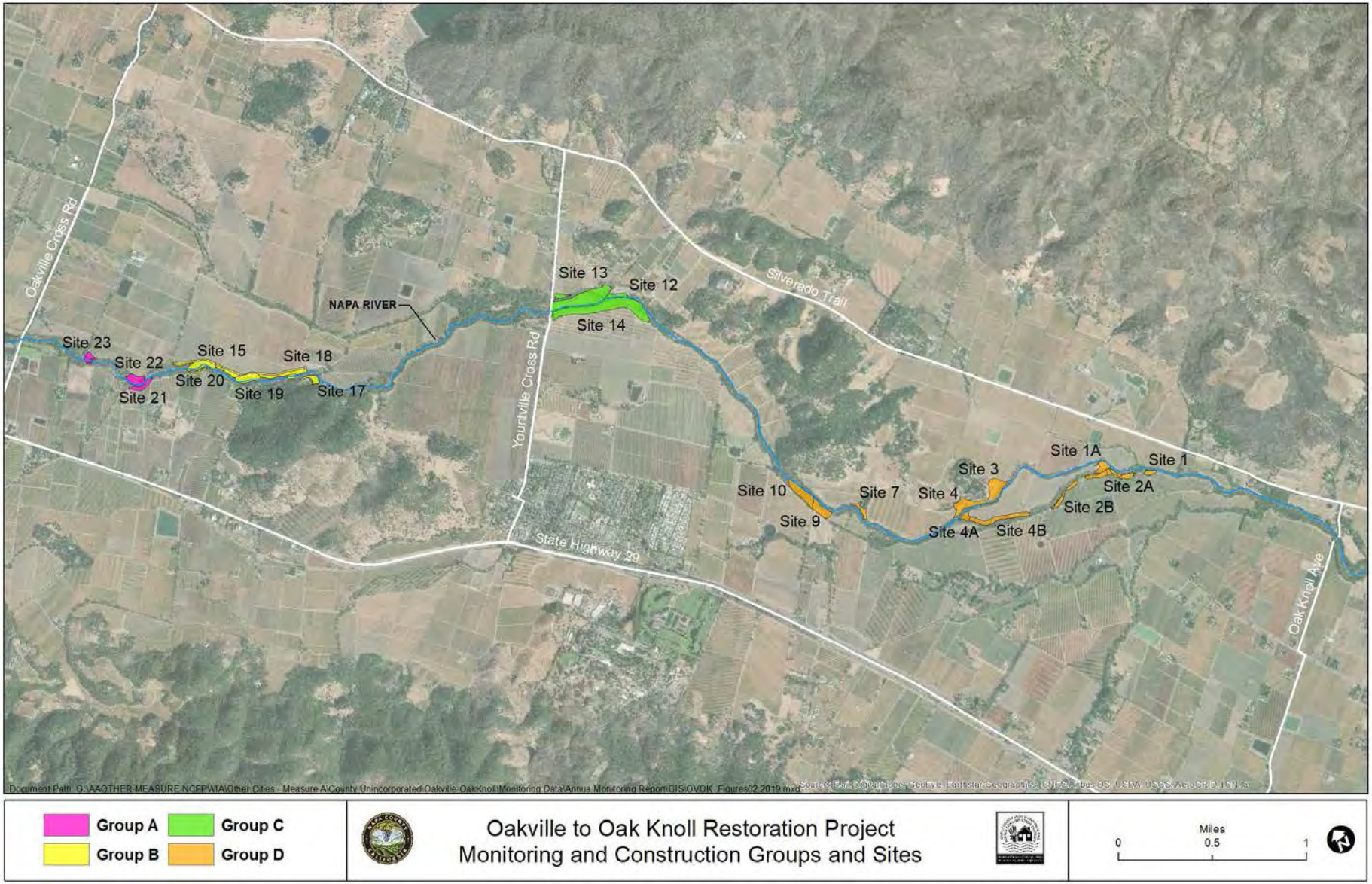


Figure 1: Construction Group and Restoration Site location map.

2.0 Restoration Goals and Desired Outcomes

Changes in land use, construction of earthen berms, and filling of historic channels has 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 has led to a reduction in the quality and quantity of instream habitat for salmonids and other native fishes within the Project reach.

The pre-restoration condition for aquatic habitat within the Project reach generally consisted of long homogenous glides and pools, with relatively few riffles and runs. In general, these pool/glide habitats offered less cover and feeding opportunities for salmonids. The predominant substrate in the reach was gravel and sand-sized particles. 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, 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.

In order to address these pre-project conditions and restore instream and riparian habitat, the following restoration goals and desired outcomes were developed in the Monitoring Plan as well as in the regulatory permits issued for the Project. These include generally:

- Minimizing the need for ongoing channel stabilization and repair work by establishing a more self-sustaining channel design which reduces maintenance needs;
- Enhancing geomorphic channel forms and processes to support a more diverse and complex instream condition;
- Increasing river and floodplain interactions where possible;
- Increasing and enhancing riverine, riparian, and floodplain habitat functions, with a focus to improve habitat for fish and wildlife;
- Removing and managing invasive nonnative vegetation and replanting native vegetation that will not promote Pierce's disease in vineyards while enhancing the complexity and width of the riparian corridor;
- Supporting the sediment reduction and habitat enhancement goals of the Napa River TMDL

3.0 Monitoring Protocols, Indicators and Performance Standards

Performance standards have been developed for the Project goals; success of the Project will be evaluated by quantifying progress towards meeting these standards over the life of the Project. The monitoring protocols, frequency of surveys and performance standards are summarized below and described in further detail in the Monitoring Plan.

Monitoring protocols and indicators developed for the Project include the following:

1. Annual reconnaissance of the entire Project reach to observe current Project conditions and identify if any immediate adaptive management (bank erosion, etc.) actions are needed;
2. Topographic cross sections survey of post construction cross sections to provide a basis to evaluate how instream habitat structures are performing at representative high- and low-flow events;
3. Detailed channel transect and longitudinal profile surveys designed to characterize the long term physical channel response to changing conditions based on flow variation and vegetation establishment;
4. Seasonal high-flow surveys and instream habitat assessment (snorkel surveys) at restoration sites designed to evaluate salmonid utilization of created habitat features and restoration area;
5. Phased vegetation establishment surveys to track plant establishment and guide adaptive management of re-vegetated areas; and
6. Photo-monitoring at defined stations to capture changes over time.

A Before/After approach is being applied to document long-term changes in geomorphic and aquatic and riparian habitat parameters (Gerstein & Harris, 2005). Monitoring indicators and protocols 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** provides a summary of the monitoring indicators, protocols and performance standards.

Table 3. Monitoring indicators, protocols, and performance standards for the Project

Monitoring Indicator	Monitoring Protocol	Performance Standard
Changes in bed deposition, scour and lateral migration	Cross section and thalweg surveys	Reduction in bed and bank erosion sites, vertical channel adjustment
Channel width-to-depth ratio at surveyed cross-sections	Cross section surveys	Increase in channel width to depth ratios
Channel substrate size distribution (median size frequency distribution, % fine sediment) and gravel recruitment	Pebble counts at cross sections	Statistically significant increase in riffle median grain size (D50 mm) and reduction in riffle substrate percentage of fines (<2mm)
Riffle length and frequency	Thalweg surveys	Increase in riffle length or riffle frequency, and increase in habitat type diversity

Monitoring Indicator	Monitoring Protocol	Performance Standard
Water velocities in constructed high-flow refugia areas	Seasonal high-flow surveys	Creation of high-flow refugia (less than 6 fps) at flows of 500 cfs and greater at constructed features
Instream habitat utilization of installed structures under low-flow conditions	Seasonal low-flow and snorkel surveys	Presence of juvenile salmonids utilizing installed instream habitat structures
Vegetation communities and riparian buffer width	Cross section surveys	Positive trends in riparian vegetation buffer width
Plant survival at revegetation sites (%)	Vegetation establishment and annual maintenance surveys	70% survival of native plants at revegetation sites at years 3, 5 post-installation
Percent native vegetative cover: Absence/presence natural recruitment	Vegetation establishment and annual maintenance surveys	70% or greater native cover and evidence of natural recruitment by year 5 at revegetation sites
Documentation of change at restoration sites	Photo monitoring	Evidence of vegetation establishment, persistence of restoration features and increases in channel complexity

4.0 Results and Discussion

4.1 Hydrologic Conditions

Tracking and analyzing streamflow in the Napa River through the Project 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 (RI). 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 gaging Station 11458000 NAPA R NR NAPA, located at Oak Knoll Avenue Bridge, at the downstream extent of the Project reach. Real-time and historical stage and flow data for the station are available at waterdata.usgs.gov. Several tributary streams (Doak, Yount Mill, Conn, Chase, and Dry Creeks) join the Napa River within the Project reach, more than doubling the watershed area from approximately 99 square miles at the top of the reach to approximately 219 square miles at the bottom. A large portion of this increase is due to Conn Creek, which is regulated by Lake Hennessey and Rector Reservoir. Under any conditions, streamflow entering

the upstream extent of the OVOK reach will be significantly less than measured at Station 11458000 and can be estimated as approximately half when the reservoirs are spilling.

Station 11458000 has been in continuous operation since 1959 and USGS provides peak flow statistics at streamstats.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 6,500 cfs.

Table 4. Peak flow statistics for USGS Station 11458000.

Peak Flood	Discharge (cfs)
Mean Annual (1-Year)	4,520
2-Year	8,470
5-Year	15,300
10-Year	20,700
25-Year	28,100
50-Year	34,100
100-Year	40,400

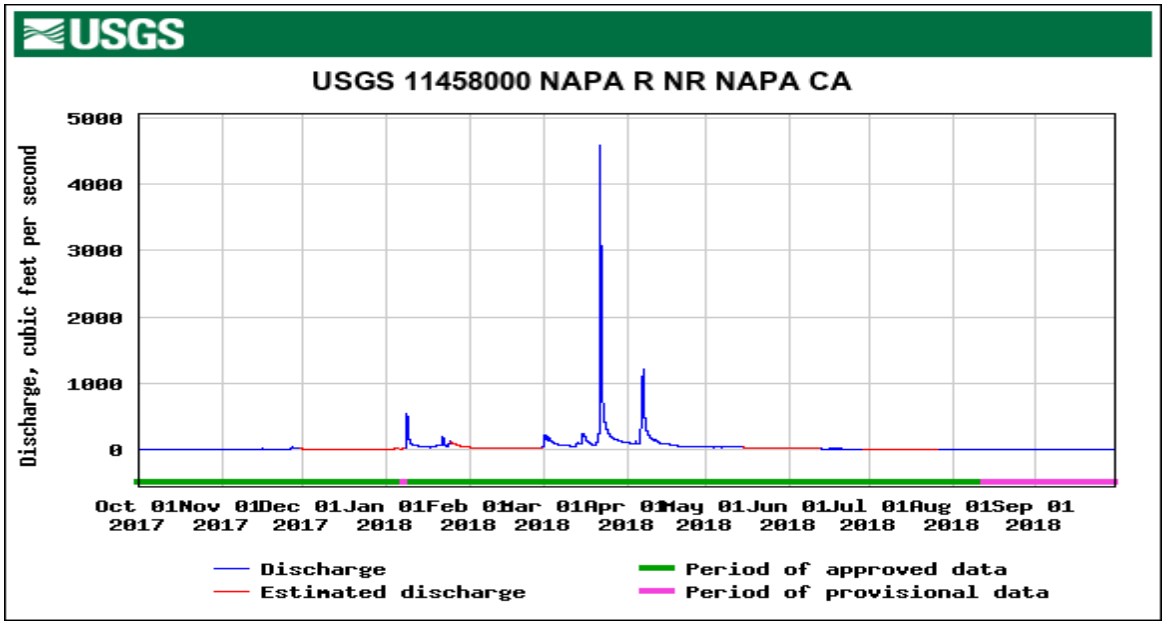
The last rare flooding event occurred on December 31, 2005, prior to construction of the Project, when a peak flow of 29,600 cfs was recorded at Station 11458000, making it an approximate 30-year flood. Since that time, only one peak flow event (15,900 cfs on January 8, 2017) has exceeded the 5-year peak flood. Flow events with peak discharges greater than the 1.5-year flood that have occurred since initiation of construction in 2015 are listed in **Table 5.** These events can be expected to have significantly altered the streambed, potentially triggering erosion of unstable 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)
2014-15	Dec 11, 2014	10,400
2015-16	Mar 6, 2016	7,380
2016-17	Dec 15, 2016	8,570
2016-17	Jan 8, 2017	15,900
2016-17	Jan 11, 2017	14,500
2016-17	Jan 22, 2017	7,160
2016-17	Feb 7, 2017	14,400
2016-17	Feb 9, 2017	9,580
2016-17	Feb 20, 2017	7,570

During the 2017-18 water year (October 1, 2017 through September 30, 2018), measurable streamflow began at Station 11458000 on October 16, 2017 and continued through early August. The peak flow of the season occurred on March 22, 2018, and was measured to be 4,580 cfs, an approximate mean annual flood. Following the last significant storm of the season on April 7, 2018, flows in the river receded until change in measureable streamflow subsided on August 2, 2018. A plot of streamflow measured at Station 11458000 during the 2017-18 water year is included as **Figure 2**.

Figure 2. 2017-18 streamflow, Napa River Oakville-to-Oak Knoll Restoration Reach, USGS Station 11458000.



The reporting period for this monitoring effort includes the start of the 2018-19 water year (October 1, 2018 through September 30, 2019), and measurable flows in the reach began on November 29, 2018. As of early-February, one high-flow event has exceeded the 1.5-year peak flow. The peak occurred on January 17, 2019 and reached an estimated flow of 9,500 cfs. The streamflow data for the entire 2018-19 water year will be presented in the next annual monitoring report.

According to historical streamflow data from Station 11458000, Napa River flow at the gage site typically subsides by July or August and begins again in October or November. Rarely, the river will flow perennially or remain dry well into winter, depending on rainfall timing and magnitude. During this dry period, conditions in the Project reach vary, with subreach conditions ranging from completely dry, to isolated pools, to trickling. Dry-season streamflow data for Station 11458000, including mean monthly discharge statistics, can be found at waterdata.usgs.gov.

4.2 Longitudinal Profile Thalweg Surveys

Channel thalweg surveying provides a means of measuring changes in streambed complexity. Indications of progress include 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.

Three distinct subreaches with a combined length of approximately 4.5 miles of the 8.4-mile OVOK restoration reach have been selected for post-project channel longitudinal profile surveys as shown on **Figure 3**. The subreaches encompass all completed and planned restoration sites and groups. The first post-construction survey is currently expected to be completed in 2021.

Pre-project (baseline) channel thalweg surveys were completed for 2 of the 3 subreaches covering Groups A through C. The surveys were conducted by the California Land Stewardship Institute (CLSI) in partnership with RCD in 2012 as part of the design phase of the Project. The pre-construction baseline surveys were analyzed to compile several monitoring metrics including riffle count, riffle length, pool length, and residual pool depth. Comparison of these metrics to the results of future surveys will allow assessment of streambed change and evaluation of the effects of restoration activities. Pre-project thalweg survey metrics are presented in **Table 6**.

Table 6. Streambed unit statistics for pre-project channel thalweg surveys by subreach. Napa River OVOK Reach Restoration Project.

Subreach	Construction Group	US RS	DS RS	Length (ft)	Survey Year	Riffle Count	Riffle Height (ft)		Riffle Length (ft)					Pool Length (ft)			Residual Pool Depth (ft)			
							Sum	Avg	Sum	%	Avg	Min	Max	Avg	Min	Max	Sum	Avg	Min	Max
1	Groups A&B	42,656	35,069	7,587	2012	27	13.16	0.49	1674	22.1%	62	5	249	219	63	545	85.54	3.17	1.18	4.83
2	Group C	27,722	23,909	3,813	2012	9	9.55	1.06	905	23.7%	101	33	271	323	42	931	33.96	3.77	1.11	7.57
3	Group D	17,700	5,500	12,200	*Pre-project channel thalweg survey for Subreach 3 has not been done.*															

The baseline data indicate between 22% and 24% riffle habitat, with a wide range of riffle and pool lengths in both subreaches. Subreach 1 was characterized by lower, shorter, and more-frequent riffles and shorter, shallower pools, while Subreach 2 had fewer, longer, taller riffles and longer, deeper pools.

Streambed slope was also computed from the thalweg surveys. Bed slopes in Subreach 1 ranged from 0.0011 to 0.0069. Bed slopes in Subreach 2 ranged from 0.0008 to 0.0064. At the time of surveying (2012), two beaver dams were encountered in Subreach 2. Both dams backwatered and drowned out upstream riffle habitats; however, since the dams are temporary structures, they were removed from the data. Longitudinal profile plots of the thalweg survey data for Subreaches 1 and 2 are included as **Appendix A**. A pre-project thalweg survey has not been completed for Subreach 3.

4.3 Channel Cross Section Surveys

Channel cross section surveying provides a means of measuring channel adjustment in response to restoration, including changes in channel width, depth, and area, streambed deposition or scour, and streambank erosion. Twenty two cross section survey locations (including two "control" cross-sections located in areas not graded) have been selected for post-project restoration monitoring as shown on **Figure 3**. The first post-construction survey is scheduled to occur following the completion of Project construction, currently expected in 2021. The cross-section surveys will be completed in accordance with a methodology specific to restoration monitoring that includes carefully selected survey points, floodplain elevations, collection of vegetation and substrate data, and installation of multiple

permanent survey monuments. The monuments will allow future re-occupation of the lines-of-section. Re-surveying of the cross sections allows evaluation of changes in channel conditions in response to restoration and will occur at 5-year intervals following the first post-construction survey after completion of the Project.

While pre-project (baseline) surveys of the twenty-two monitoring cross sections were established in 2012 as part of the design phase of the Project, they were not conducting to the monitoring standards previously mentioned. The locations of these baseline cross sections were not permanently monumented and cannot be exactly re-occupied; however, they were surveyed with a total station and therefore accurately mapped. Therefore locating and re-surveying the cross sections to an adequate degree of accuracy is feasible. The previous surveys captured channel geometry only, so although analysis will include pre- and post-project comparison of channel dimension metrics, similar comparisons of vegetation and substrate data at the cross sections will not be possible. Air photo analysis will be used to estimate pre-project riparian vegetation widths, otherwise vegetation and substrate changes at the cross sections will be monitored through time beginning after completion of construction activities.

Cross sections were selected at 2012 survey locations in completed or proposed restoration sites with significant in-channel grading. The 2012 data, collected for restoration design, were re-processed from XYZ coordinate data to two-dimensional channel sections for calculation of the following monitoring metrics:

- Maximum depth = difference between top-of-bank elevation and the thalweg elevation
- Top width = distance across channel at top-of-bank elevation
- Cross-sectional area = channel area at the top-of-bank elevation
- Width-to-depth ratio = top width divided by the maximum depth
- Riparian vegetation width

The cross sections were also classified to reveal the degree of channel confinement and entrenchment as specified in the *Napa River Sediment Reduction and Habitat Enhancement Plan: Oakville to Oak Knoll*, April 2011. According to this document, gravel bar and riffle-pool formation in the Napa River begins to occur at a width-to-depth ratio of approximately 7.5. The classification categories are listed in **Table 7**. **Table 8** presents the cross-section metrics and classifications for the baseline cross sections.

Table 7. Channel confinement and entrenchment classification.

Width-to-Depth Ratio	Classification
5 or Less	Deeply Entrenched
5 – 7.5	Entrenched
7.5 – 10	Approaching Functional Width
10 – 12.5	Functional Width
12.5 – 15	Wide
Greater than 15	Very Wide

Table 8. Pre-project cross section metrics and classifications. Cross sections highlighted in yellow are in the bifurcated channel subreach of the Napa River, where a significant portion of high streamflows are directed into a secondary channel.

Cross Section (RS)	Survey Year	Top-of-Bank Elevation (ft NAVD88)	Thalweg Elevation (ft NAVD88)	Max Depth (ft)	Cross Sectional Area (ft^2)	Top Width (ft)	Width/Depth Ratio	Width/Depth Ratio Classification	Riparian Vegetation Width (ft)
42,170	2012	125.00	103.96	21.04	1,498	113	5.4	Entrenched	205
41,040	2012	120.98	101.31	19.67	2,320	256	13.0	Wide	287
40,560	2012	122.17	99.11	23.06	1,725	138	6.0	Entrenched	160
39,540	2012	120.82	98.78	22.04	2,791	286	13.0	Wide	310
38,570	2012	119.82	96.74	23.08	2,098	137	5.9	Entrenched	190
37,540	2012	117.53	95.09	22.44	1,857	144	6.4	Entrenched	210
35,160	2012	113.02	88.95	24.07	1,745	128	5.3	Entrenched	167
26,540	2012	94.02	72.96	21.06	1,315	95	4.5	Deeply Entrenched	105
26,060	2012	95.14	72.52	22.62	1,827	143	6.3	Entrenched	150
24,610	2012	90.39	70.57	19.82	1,830	153	7.7	Approaching Functional Width	190
23,010	2012	93.80	67.86	25.94	3,627	221	8.5	Approaching Functional Width	265
17,500	2012	82.13	61.51	20.62	1,726	123	6.0	Entrenched	405
16,930	2012	80.19	60.24	19.95	1,482	115	5.7	Entrenched	380
16,500	2012	82.27	56.92	25.35	1,914	121	4.8	Deeply Entrenched	365
11,090	2012	73.10	51.06	22.04	1,171	93	4.2	Deeply Entrenched	125
SC3890	2012	71.45	55.82	15.63	895	105	6.7	Entrenched	120
10,070	2012	69.21	51.68	17.53	1,110	91	5.2	Entrenched	120
9,100	2012	67.76	46.69	21.07	1,086	88	4.2	Deeply Entrenched	100
7,550	2012	64.23	43.18	21.05	1,126	106	5.0	Deeply Entrenched	130
6,990	2012	63.11	39.12	23.99	1,516	110	4.6	Deeply Entrenched	150
6,580	2012	62.95	41.55	21.40	2,054	158	7.4	Entrenched	170
6,100	2012	61.86	40.70	21.16	1,819	160	7.6	Approaching Functional Width	160

These data indicate pre-project channel depths ranging from 15.63 to 25.94 feet and widths ranging from 88 to 286 feet, resulting in width/depth ratios ranging from 4.2 to 13.0. According to the channel confinement and entrenchment classification, 17 of 22 cross sections are classified as entrenched, and only two are above the functional width of 10. This is not surprising since most of these cross sections are in areas selected for restoration treatments.

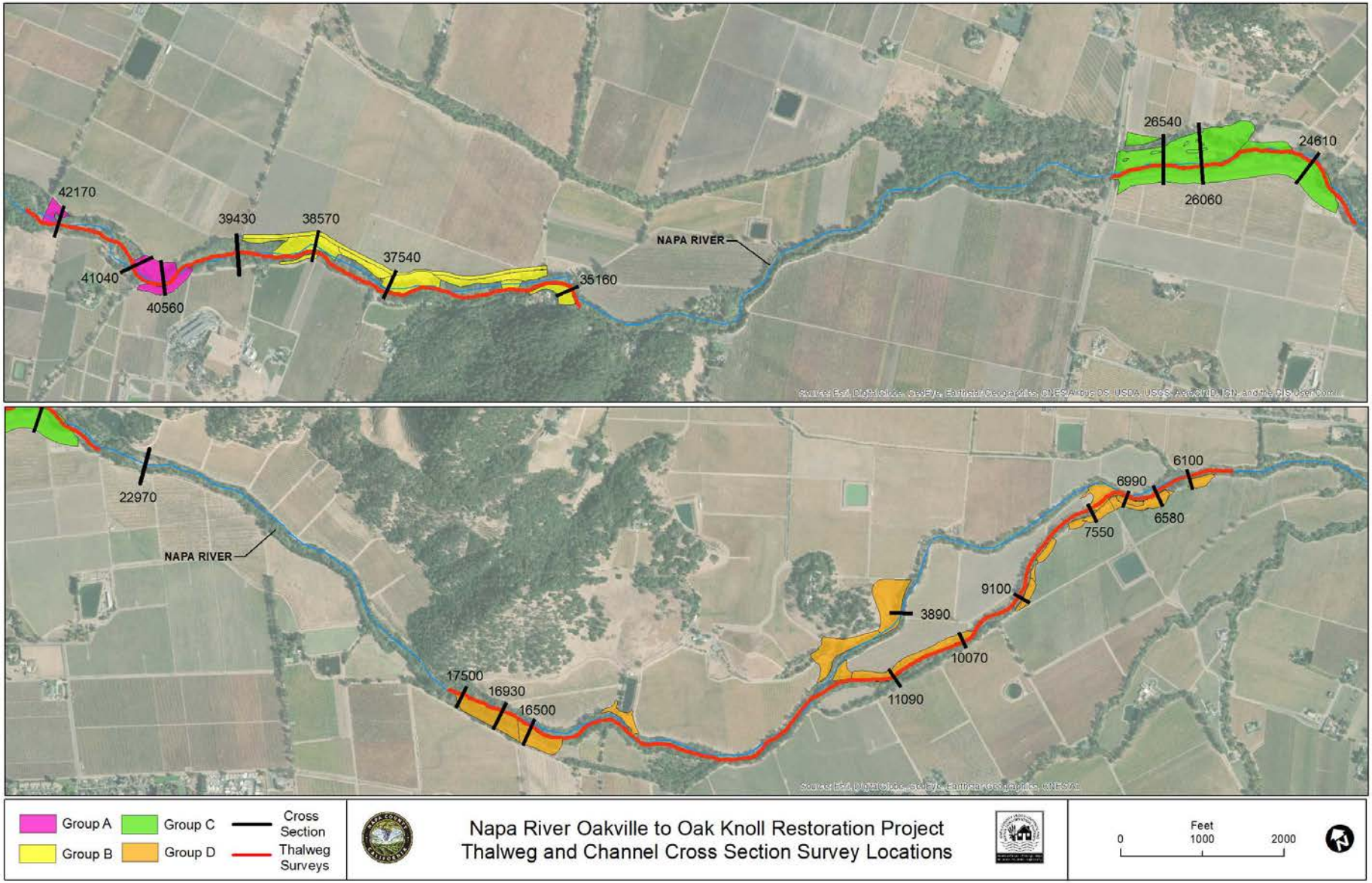


Figure 3: Location of monitoring thalweg and channel cross section surveys

4.4 High- and Low-flow Habitat Assessments

As part of post-construction monitoring, the Napa County RCD conducted a series of high- and low-flow assessments during the winter of 2017/2018 and the spring of 2018. The assessments were completed for recently graded features and installed instream habitat structures at Restoration Sites 13, 14, 21, 22, and 23. High-flow assessments included measuring water velocities, documenting flow direction/patterns, and observing water surface elevations at constructed alcoves and instream benches during high flows. Low-flow assessments included evaluating the function of each installed structure, identifying maintenance needs, measuring water depths around the structure, and making observations of aquatic species. Additional evaluations under low-flow conditions (i.e. snorkel surveys) were used, when possible, to infer salmonid utilization of the Project area. A summary of the results of these surveys includes the following:

- Graded floodplain benches at Restoration Sites 13, 14, 21, 22, and 23 performed as designed during high-flow events, providing areas of reduced water velocity and resting and refuge habitat for adult and juvenile salmonids.
- A total of 65 of the 84 installed habitat structures were confirmed to be intact. Of these, 77% were providing at least one of the ecological or hydraulic functions (high/low-flow refugia, hydraulic constriction, pool scour or gravel recruitment) that these structures were intended to provide.
- Large gravel deposits were present in Sites 13, 14, 21, and 22 that likely buried several installed habitat structures that were not found. Future efforts to find these structures and confirm their location and condition is recommended.
- A snorkel survey to determine juvenile salmonid usage of the installed habitat structures is recommended as spawning conditions for water year 2017 were poor. The survey should be conducted in early spring (March-April) in a year when adult salmon (and/or steelhead) have been documented spawning in the OVOK Project reach.

For additional details and the full Napa RCD report, including site sketches and specific observations and velocities measured at individual Restoration Sites, see **Appendix B.**

4.5 Vegetation Establishment Surveys

Vegetation establishment surveys are conducted for 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 throughout the year. The target restoration goals and success criteria for vegetation establishment and long-term maintenance include:

- Minimum survivorship of 70% for all native plants installed at re-vegetation sites within 3 years after being installed, and at years 5 and 10 should be in good health
- Greater than 70% native vegetative cover will exist at any given re-vegetation site over the *life* of the Project and evidence of natural recruitment will be documented after year 5 at any given site

Plant and irrigation installation at Group A (Sites 21, 22, and 23) was completed in late spring of 2017, plant and irrigation installation for Group C (Sites 12, 13 and 14) was completed in the fall of 2018 resulting in a total of 20.3 acres of restored and enhanced in-channel, riparian, and upland habitat

between both Construction Groups. A summary of the results from the first year of annual vegetation surveys conducted by the revegetation contractors (Handford ARC) at Group A in 2018, including direct count, percent vegetative cover, and invasive plant management is presented herein. **Figure 4** below shows the location of each Restoration Site surveyed in calendar year 2018. First year vegetation surveys for Group C will be conducted in the fall of 2019 and presented in the 2019 annual monitoring report.

Direct Count Vegetation Surveys

During the fall of 2017, contractor staff surveyed all planted Restoration Sites in Group A to determine percent survivorship, cover, and qualitative health of installed and naturally recruited vegetation. Further, within each Restoration Site, plants were installed within 5 different habitat planting zones: river wet edge, lower floodplain bench, lower and upper riparian slope, and transitional upland oak woodland. Survey results indicate that the majority of installed native plants are surviving and thriving, with survivorship ranging between 97%-99%.

Black walnut (*Juglans californica*), big-leaf maple (*Acer macrophyllum*), valley oak (*Quercus lobata*), yarrow (*Achillea millefolium*), foothill penstemon (*Penstemon heteropyllus*), California wild rose (*Rosa californica*), snowberry (*Symphoricarpus albus*), and rushes (*Juncus* spp.) were among the best performing species in regards to survivorship and volunteer recruitment at the Sites. **Table 6** below presents a summary of the percent survivorship by habitat planting zone for Group A, Sites 21, 22, and 23 for monitoring year 2018. Representative photographs of revegetation sites surveyed and additional details, including survivorship of individual plant species, is provided in **Appendix C and D**.

Table 6: 2018 woody vegetation direct count/survivorship survey results, Group A, Sites 21, 22 and 23

Habitat Planting Zone	Site 21		Site 22		Site 23	
	Total Planted	Total % Survived	Total Planted	Total % Survived	Total Planted	Total % Survived
River Wet Edge	Not Applicable		578	88.1%	248	87.1%
Lower Floodplain Bench			640	92.2%	116	93.1%
Lower Riparian Slope	783	100.0%	1979	99.6%	1365	99.9%
Upper Riparian Slope	1785	99.6%	2906	99.7%	1246	99.4%
Transitional Upland Oak Woodland	Not Applicable		442	97.5%	658	98.9%

* Includes original planted stock and naturally recruited species.

Vegetative Percent Cover Surveys

Percent cover of non-native vs. native herbaceous vegetation and percent bare ground was estimated for each habitat planting zone within Sites 21, 22, and 23. **Table 7** below presents a summary of the percent cover by habitat planting zone for Group A, Sites 21, 22, and 23 for monitoring year 2018. Site observations included herbaceous cover at the three sites primarily being native-dominated, especially by perennial grasses, foothill penstemon, and poppies. Bare areas were minimal in most planting zones;

however, the lower riparian slope zone had the most spots with bare areas. Representative photographs of percent cover at the revegetation sites surveyed along with additional details, including survivorship of individual plant species, can be found in **Appendix C**.

Table 7: 2018 vegetative cover estimation survey results, Group A, Sites 21, 22 and 23 2018

Habitat Planting Zone	Site 21			Site 22			Site 23		
	NATIVE	NON-NATIVE	BARE	NATIVE	NON-NATIVE	BARE	NATIVE	NON-NATIVE	BARE
River Wet Edge	Not Applicable			70	2	23	10	1	89
Lower Floodplain Bench				65	5	30	10	1	89
Lower Riparian Slope	75	20	5	60	39	1	45	50	5
Upper Riparian Slope	75	20	5	55	45	0	60	35	5
Transitional Upland Oak Woodland	Not Applicable			50	50	50	50	0	60

As this is the first year of monitoring vegetation establishment for the Restoration Sites, it is difficult to determine trends in relative vegetative cover or long-term survivorship. However, initial results indicate high survivorship of installed native woody vegetation and mixed results regarding cover of native vs. non-native herbaceous vegetation. In general, with proper management of non-native species and regular watering of native installed vegetation over the establishment period, the installed native vegetation is expected to take hold and at natural growth rates under typical, non-drought growing conditions. In addition, natural recruitment is expected to further add habitat value to the Restoration Sites over time.

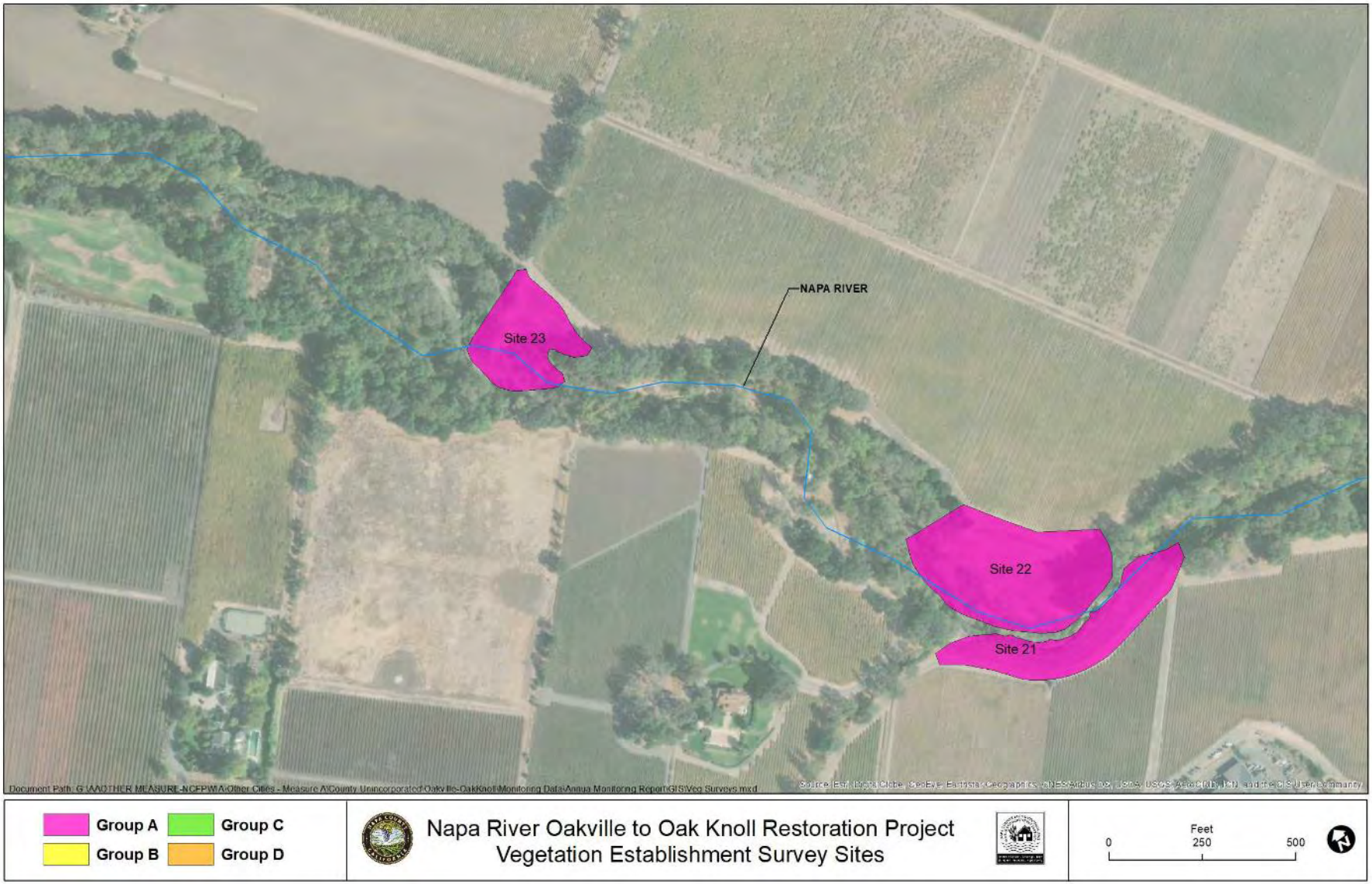


Figure 4: Location of direct count and percent cover vegetation surveys

Invasive Plant Management

A total of 11.19 acres of non-native invasive and Pierce host vegetation was removed or treated in 2018 throughout Sites 21, 22, and 23 (Group A) and Sites 12, 13, and 14 (Group C). Both mechanical and chemical methods were used to remove/treat tree of heaven (*Alianthus altissima*), giant reed grass (*Arundo donax*), Himalayan blackberry (*Rubus armeniacus*), big-leaf periwinkle (*Vinca major*), California wild grape (*Vitis californica*), red sesbania (*Sesbania punicea*), poison hemlock (*Conium maculatum*), and American pokeweed (*Phytolacca americana*).

Previous and ongoing efforts to manage and remove Arundo under the CFD have been successful in significantly reducing the quantity within the Project area; to date 4.96 acres of Arundo have been controlled and show no signs of resprouting. Ongoing treatment of an additional 1.3 acres of Arundo within the project reach also shows signs of success with only minor annual follow-up treatment required in recent years.

4.6 Photo Monitoring

Top-of-bank and in-channel photo monitoring is conducted annually at established monitoring locations within Restoration Sites to document change over time. Photos are also taken opportunistically during periodic high-flow events to document hydraulics and Project performance. Photo monitoring of Restoration Sites creates a visual record of vegetation 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 Groups A and C (Sites 12, 22, 23, 12, 13 and 14) for monitoring year 2018 can be found in **Appendix D.**

5.0 Summary and Conclusions

To date, initial monitoring results indicate that restoration elements implemented thus far (floodplain grading, installed instream habitat strictures, etc.) at the various Restoration Sites are performing as designed. Monitoring has indicated that the restored areas are providing high-flow refuge, instream habitat, and increased ecological and hydraulic function relative to pre-Project conditions. Pre-Project thalweg survey baseline data processed indicates that 22% to 24% of the in channel habitat is comprised of riffles, average residual pool depths is 3 to 4 feet through the Project reach, and average bed slopes are on average approximately 0.002. Pre-Project baseline cross section data analyzed reveal low width/depth ratios indicating that the pre-Project conditions of most of the channel reaches selected for restoration classify as entrenched or deeply-entrenched

Additionally, installed native vegetation survivorship was very high (greater than 87%) at all Restoration Sites, with the majority of planted zones consisting primarily of native cover. The exception appeared to be in the lower riparian slope zones, which had small bare areas. A total of 11.19 acres of non-native invasive and Pierce host vegetation was removed or treated in 2018 throughout Groups A and C. Species managed included Himalayan blackberry, native/hybrid CA grape, Vinca, Mugwart and Arundo.

Overall, the Project is providing important foraging and rearing areas for native aquatic and terrestrial wildlife via the creation of instream, floodplain, and riparian habitat.

6.0 References

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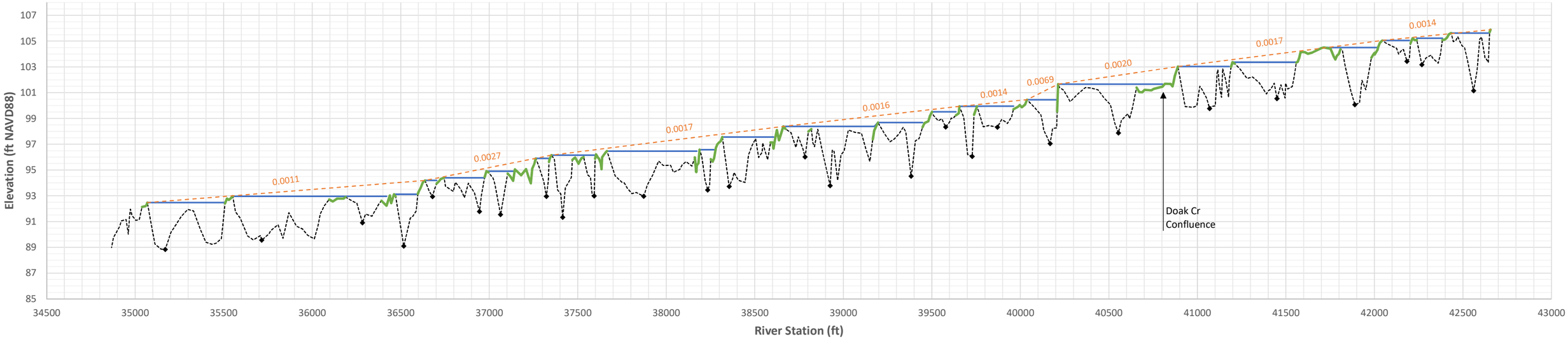
Appendix A

Baseline Longitudinal Profile Thalweg and Cross Section Surveys

OVOK Reach Restoration Project Monitoring

Pre-Project Channel Longitudinal Profile

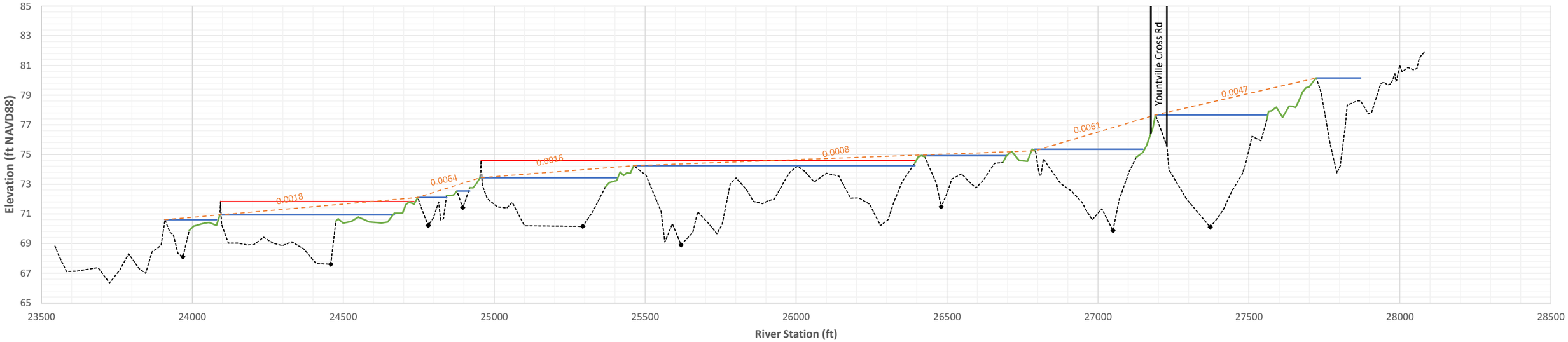
Subreach 1 (Construction Groups A&B)

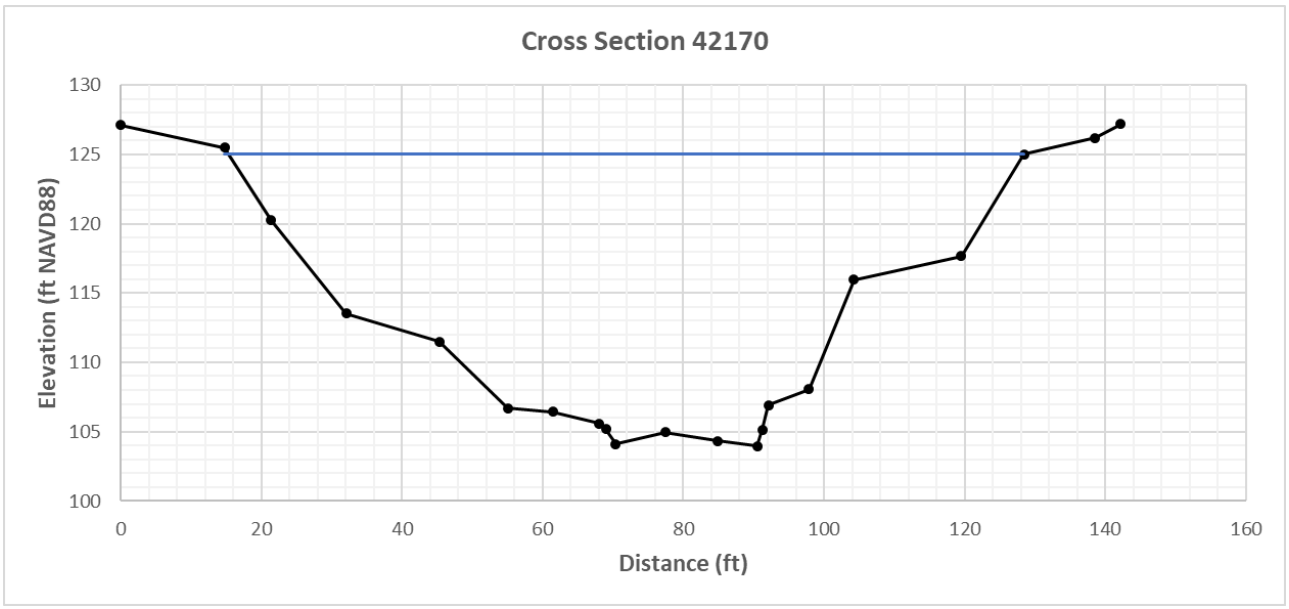


OVOK Reach Restoration Project Monitoring

Pre-Project Longitudinal Profile

Subreach 2 (Construction Group C)

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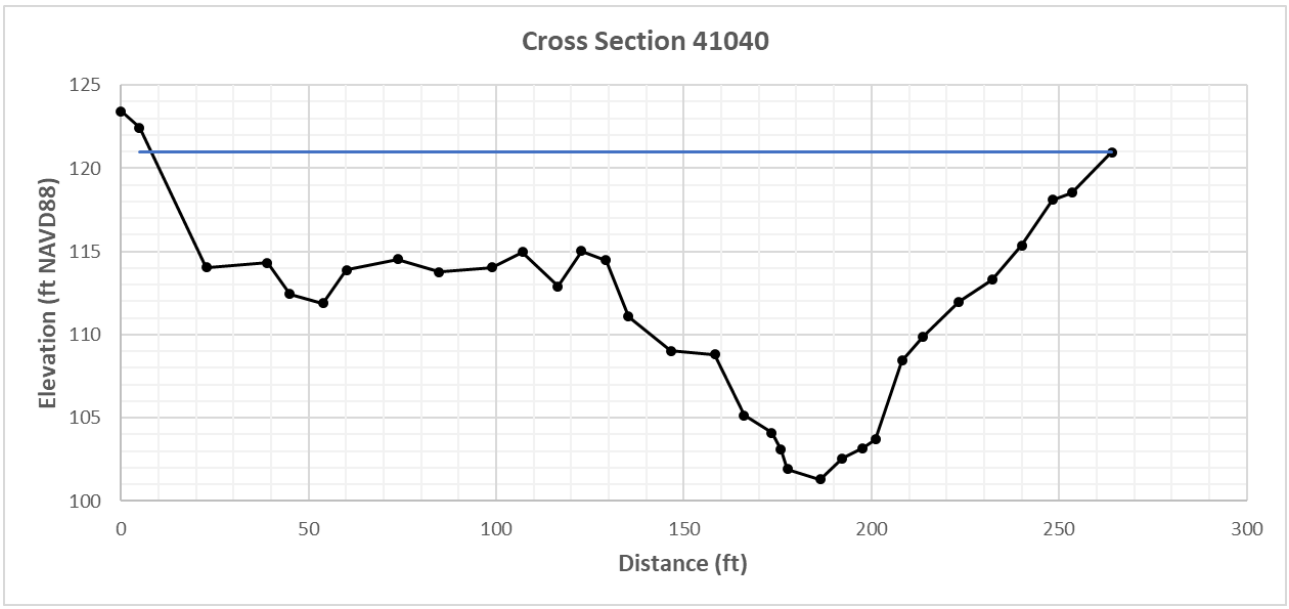
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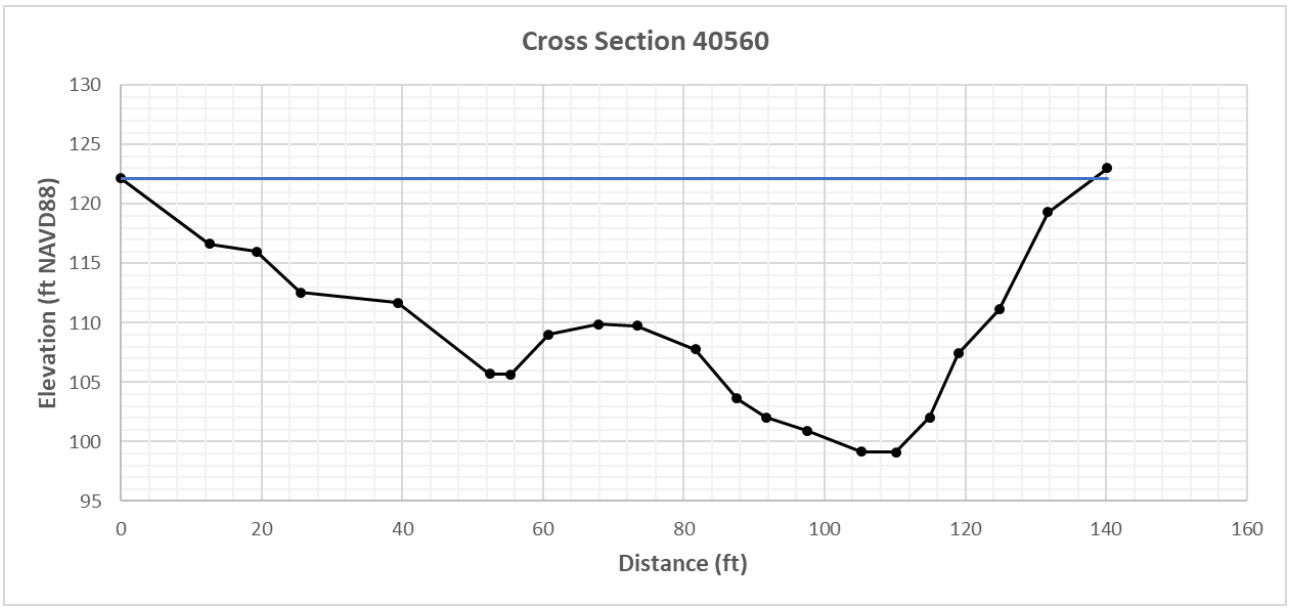
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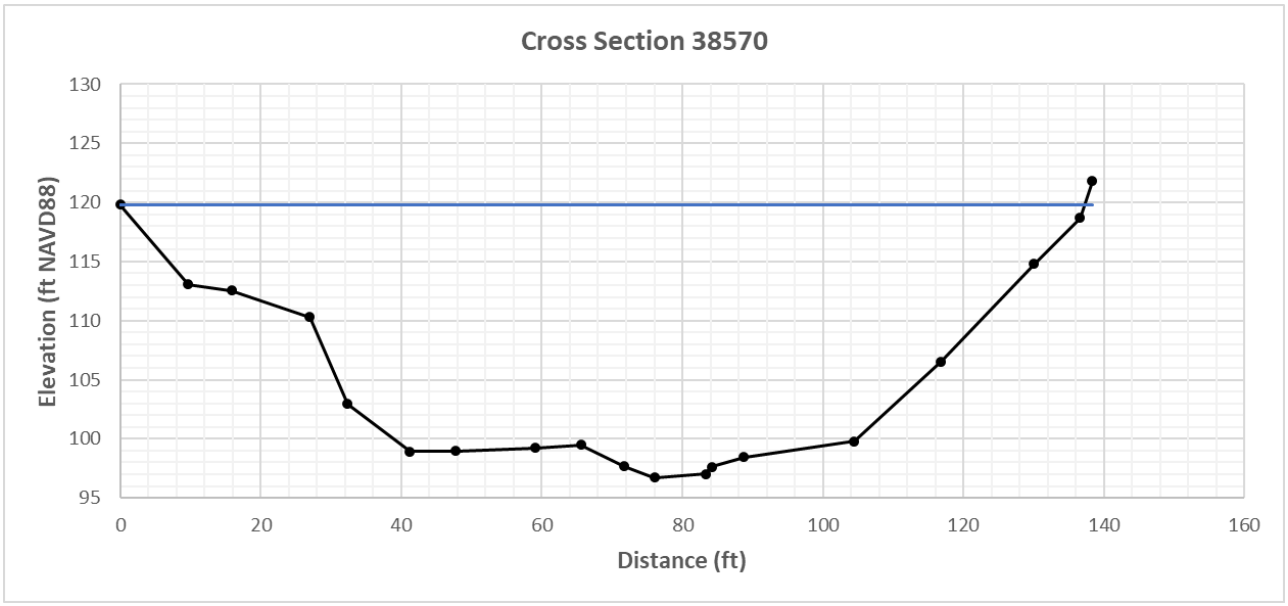
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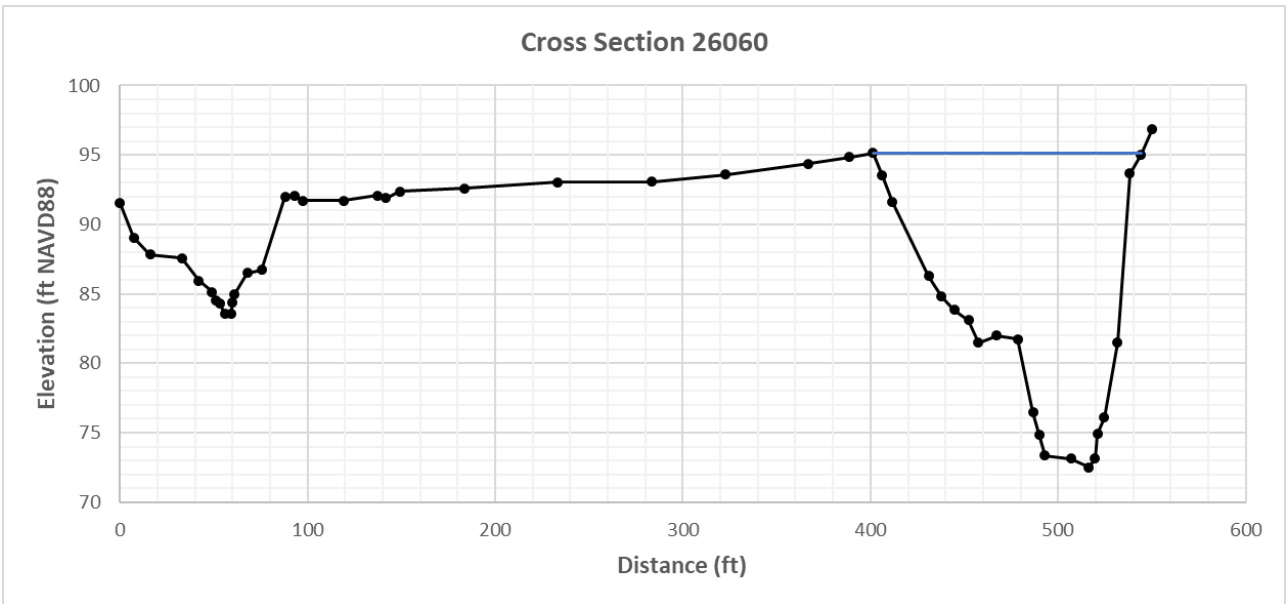
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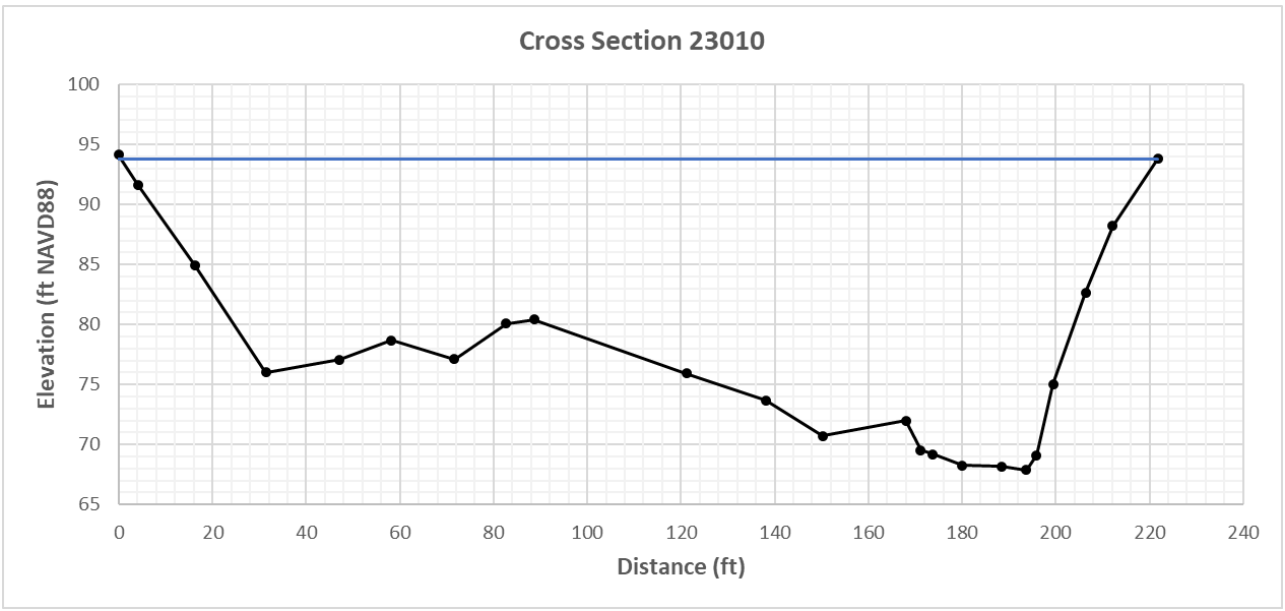
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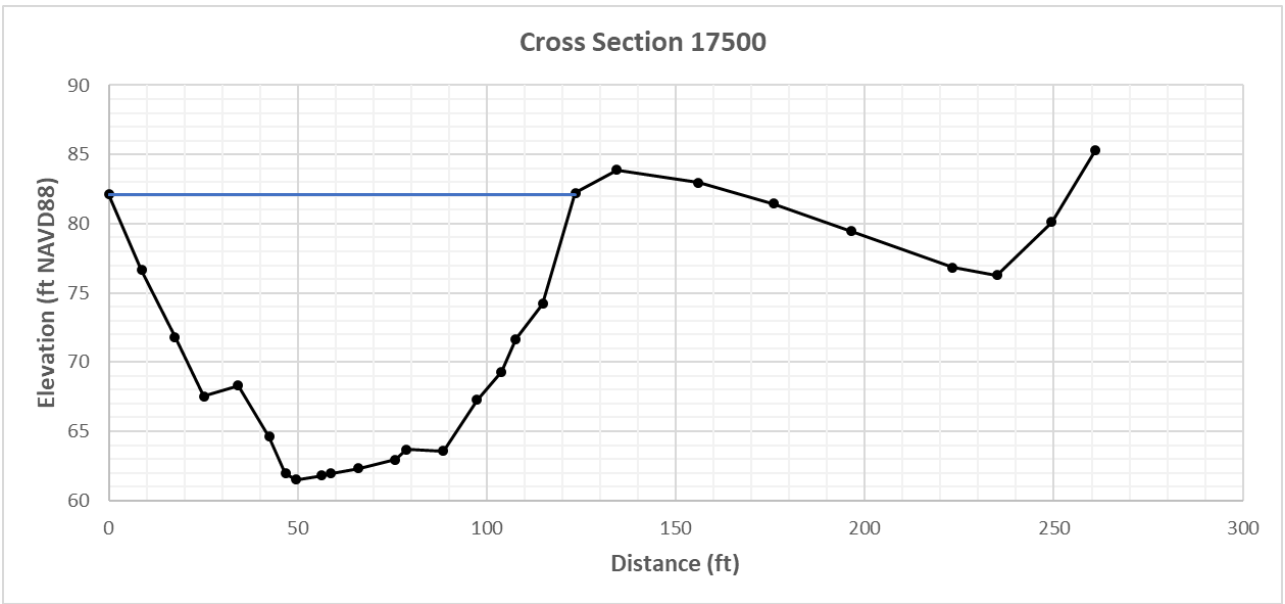
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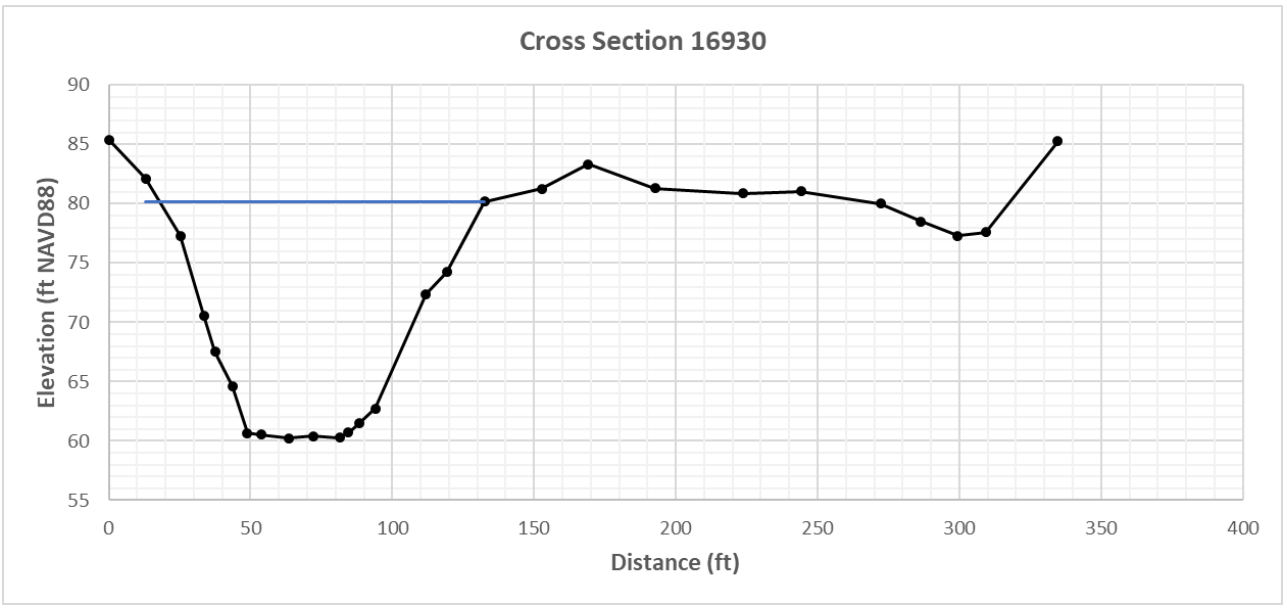
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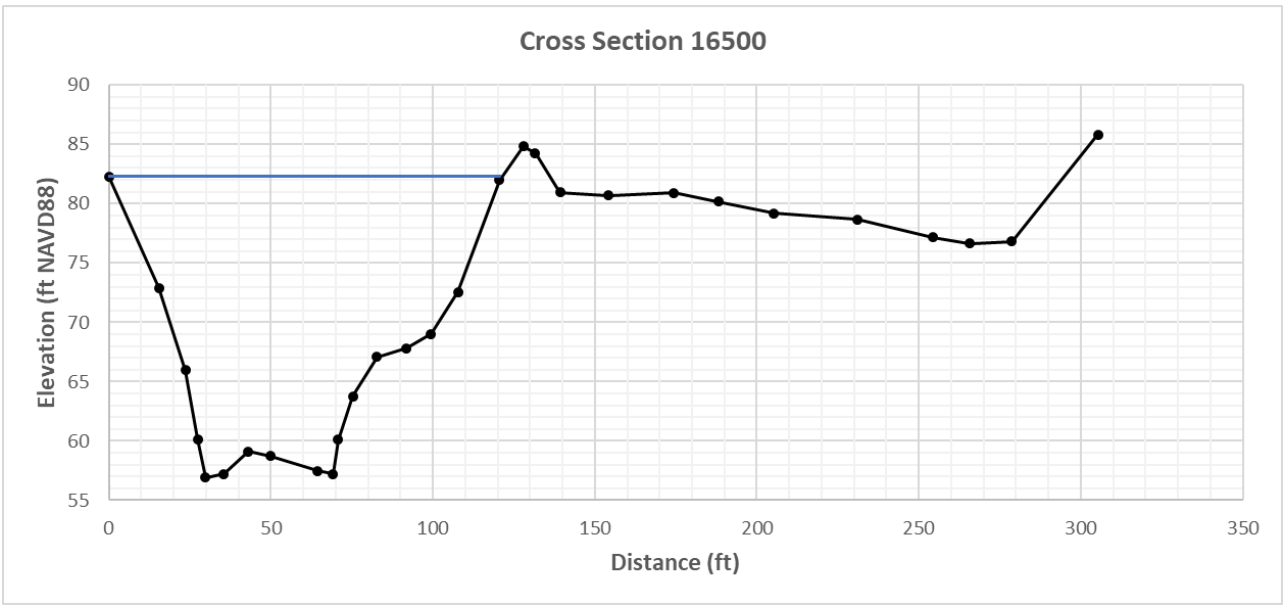
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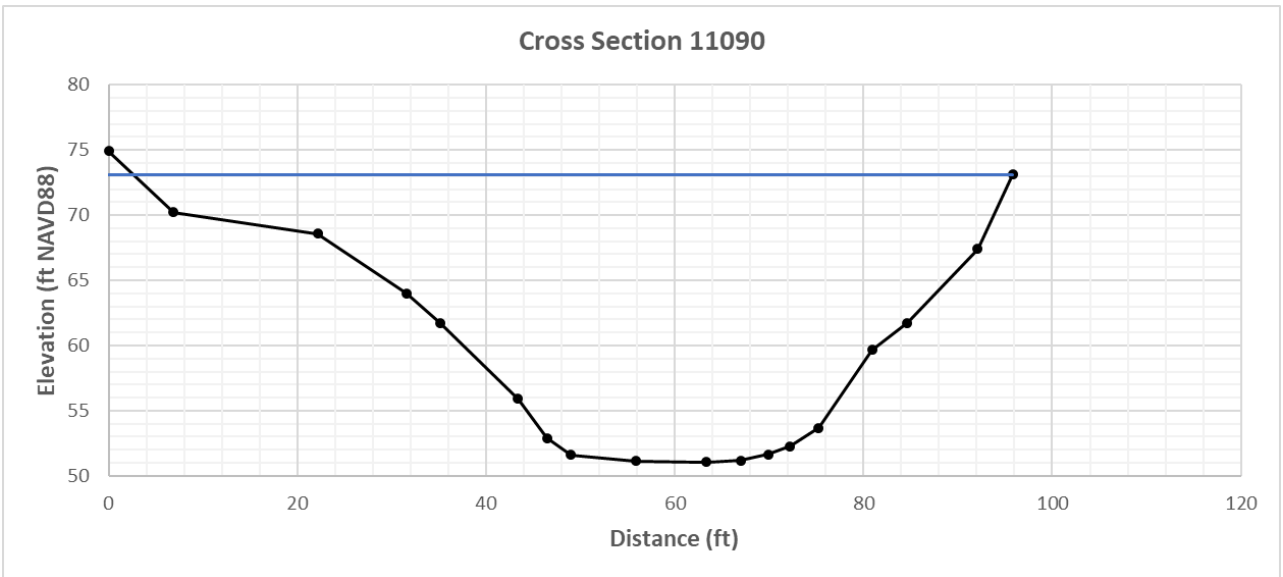
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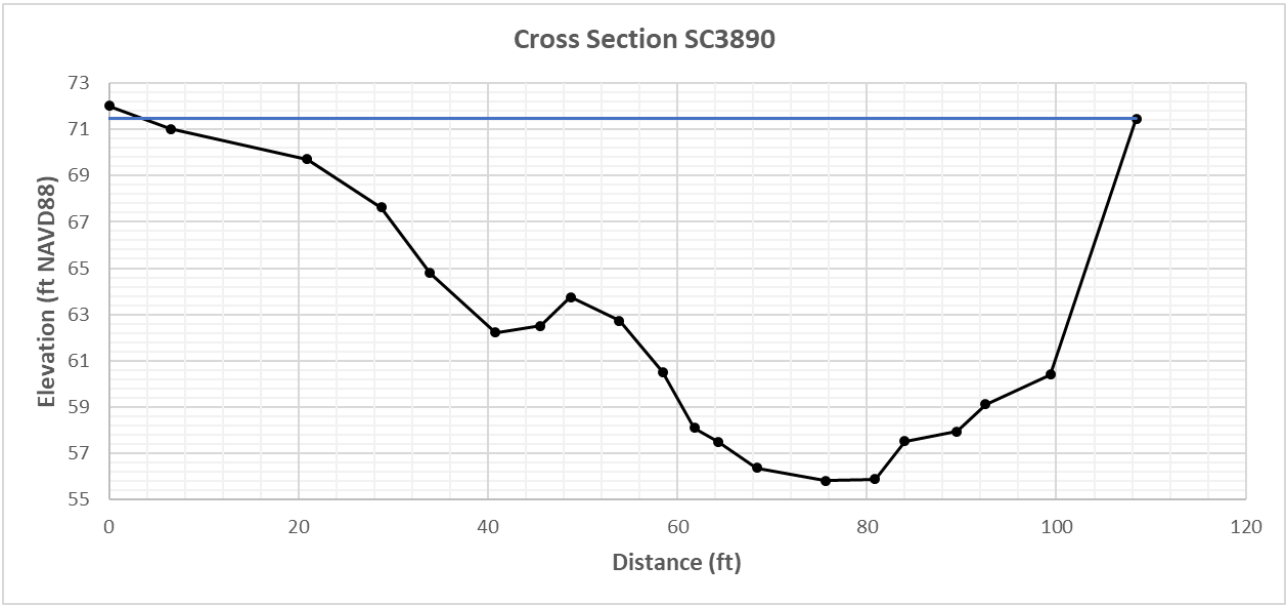
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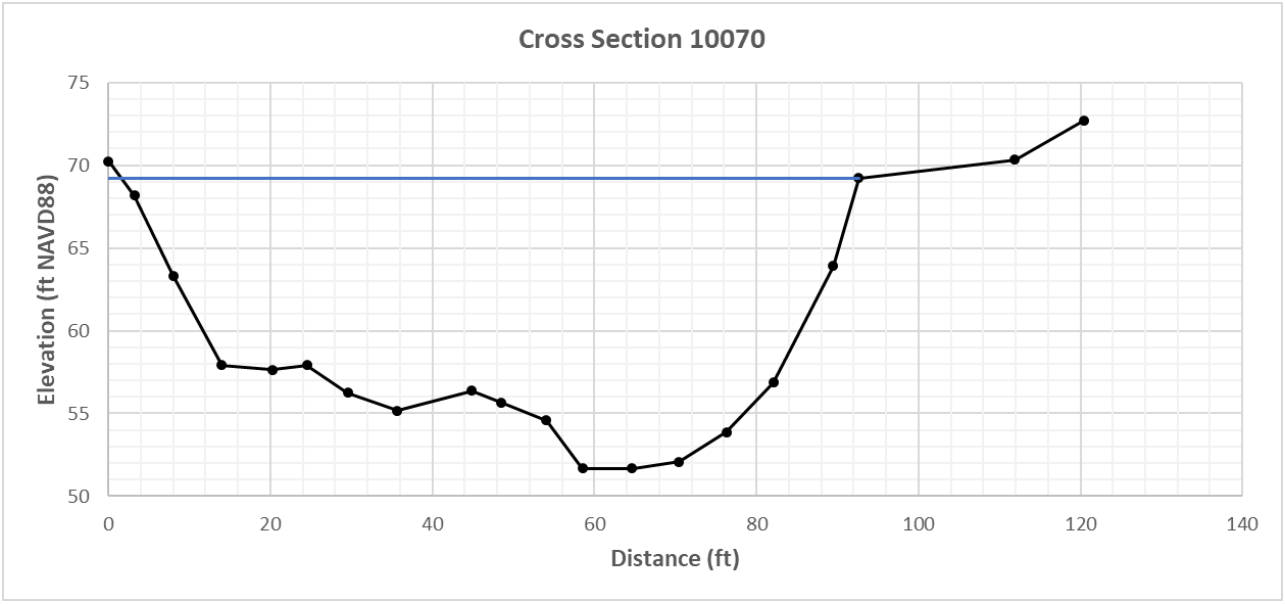
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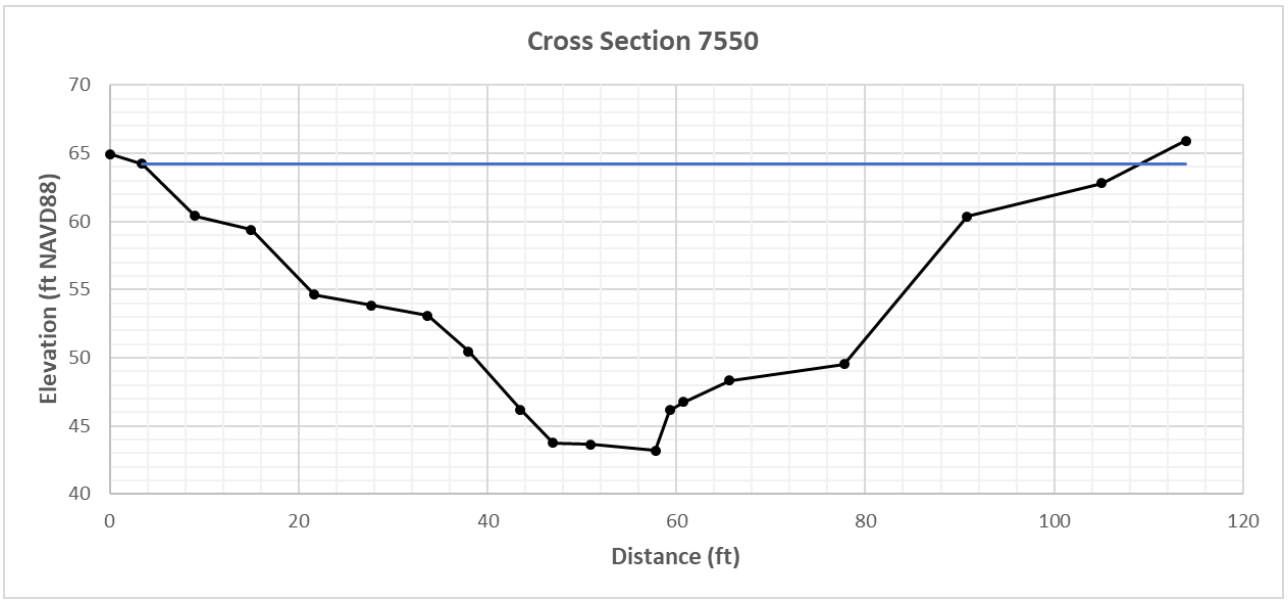
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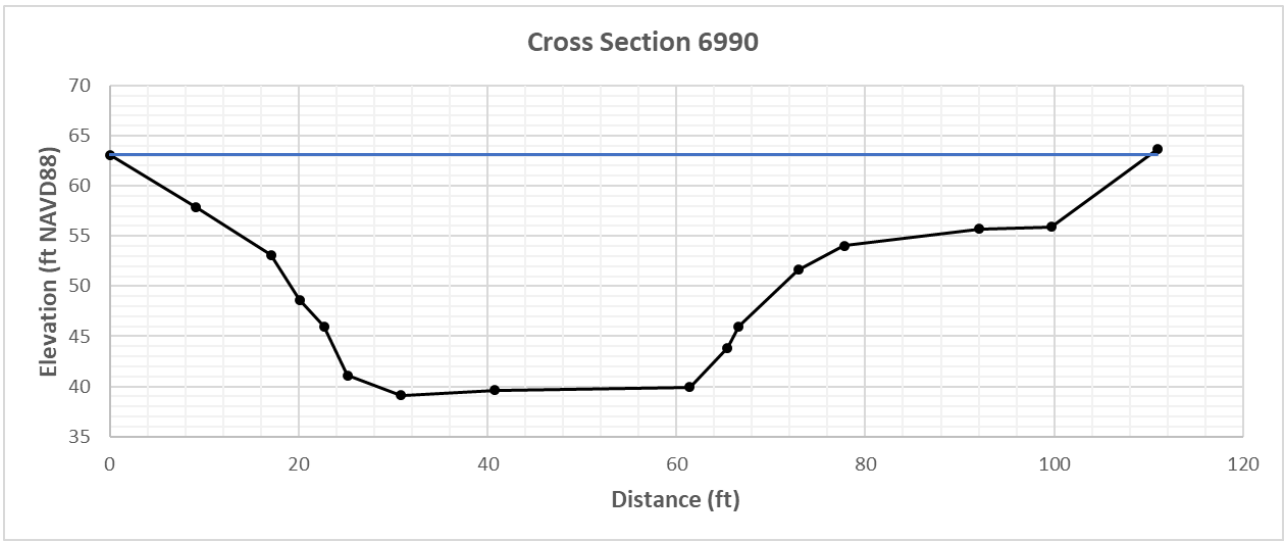
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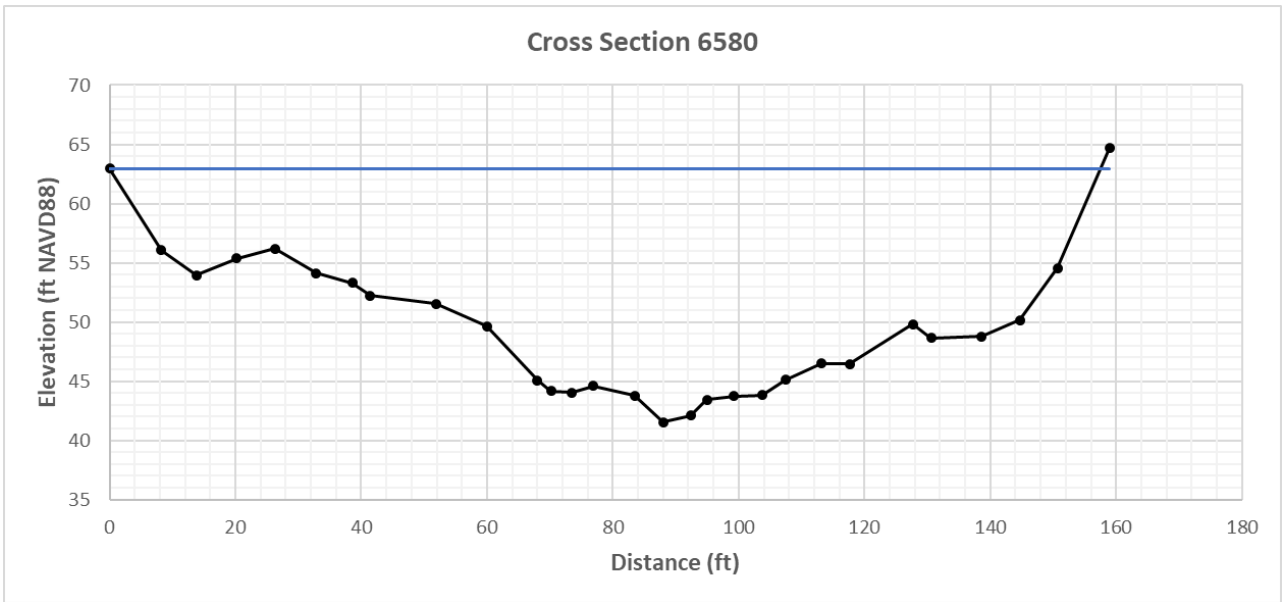
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Distance (ft)


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100
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Distance (ft)

Appendix B

High-Low Flow Habitat Assessments

Napa County Resource Conservation District
1303 Jefferson St., Ste. 500B
Napa, California 94559
Phone: (707) 252-4189
www.naparcd.org

MEMORANDUM

To: Michael Gordon, Napa County Flood Control and Water Conservation District
From: Jonathan Koehler, Senior Biologist
Paul Blank, Senior Hydrologist
Date: October 24, 2018
Subject: Napa River Restoration: Oakville to Oak Knoll Project Monitoring - Sites 13, 14, 21, 22, 23

INTRODUCTION

At the request of the Napa County Flood Control and Water Conservation District (FCD), Napa County Resource Conservation District (RCD) assessed recently-installed in-stream restoration features at Sites 13, 14, 21, 22, and 23 of the Napa River Oakville to Oak Knoll Restoration Project (OVOK Project). The assessments were completed in accordance with Section 5.5 of the Monitoring Plan for this project (NCFCWCD 2015), which prescribes the following:

1. High-flow assessments during a winter flow event large enough to inundate newly-graded areas
2. Low-flow assessments during spring/summer conditions to evaluate ecological functions of installed wood and rock habitat structures
3. Snorkel surveys during spring to evaluate utilization of restoration features by juvenile salmonids

The Monitoring Plan also designates three "Monitoring Areas", each comprised of multiple sites grouped by their general location in the overall OVOK reach. The Monitoring Areas include OVOK_M1, OVOK_M2, and OVOK_M3. Sites 13 and 14 are part of the OVOK_M2 Monitoring Area, and Sites 21, 22, and 23 are part of the OVOK_M1 Monitoring Area (Figure 1).

A snorkel survey was not conducted during this reporting period due to a lack of salmon spawning activity, and therefore juvenile production, in the OVOK Project reach. The absence of adult salmon in water year 2017-18 was attributed to extremely dry conditions and lack of flow throughout the late-fall/early-winter adult migration period, which limited access to upstream portions of the Napa River. Therefore, the monitoring team (RCD and FCD) determined that a snorkel survey would not yield meaningful data on project performance or juvenile salmonid densities in the restoration areas, and it would be best to conduct a future survey in a more typical year.

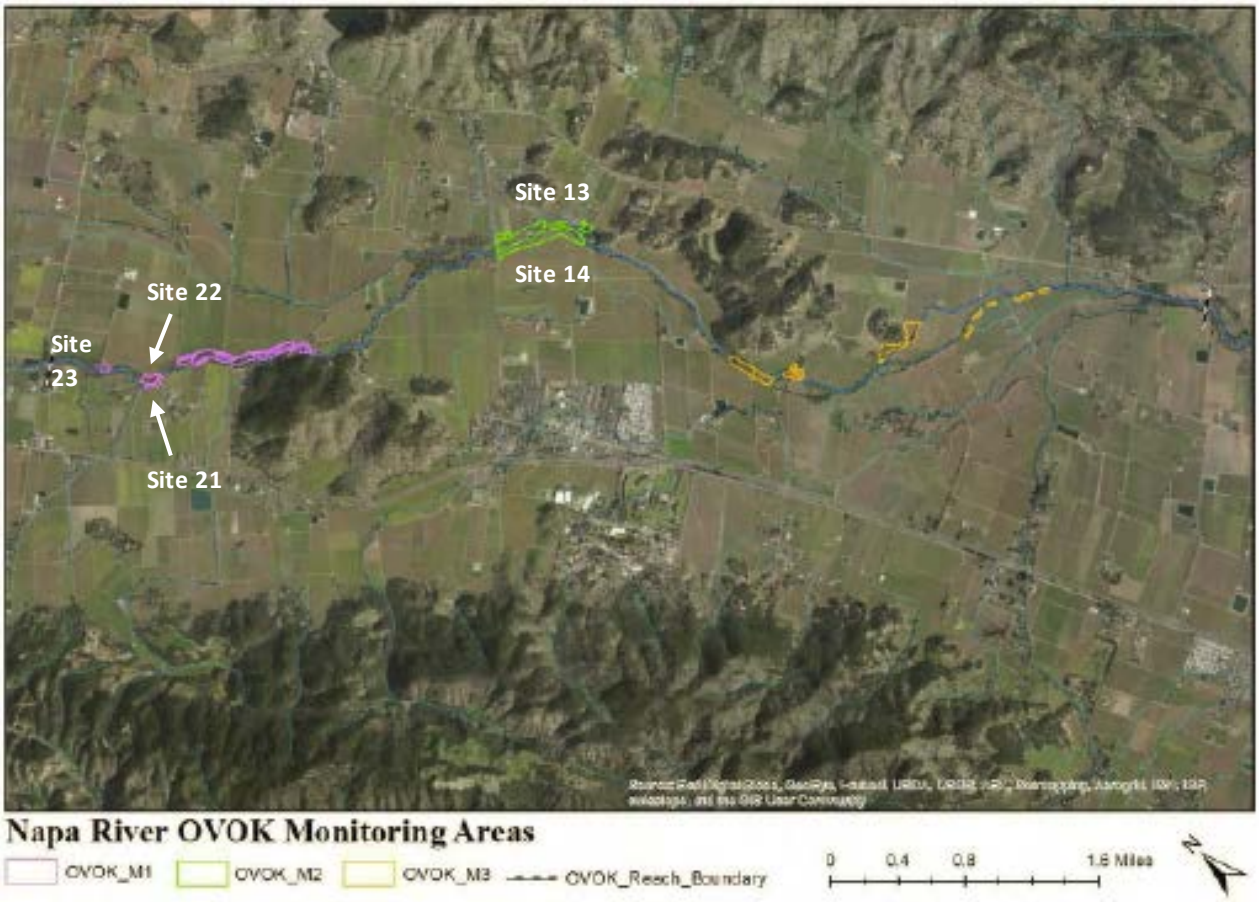


Figure 1. OVOK Project Monitoring Areas (Source: NCFCWCD 2015, Figure 4-1)

HIGH-FLOW ASSESSMENTS

On February 22, 2017, Jonathan Koehler (RCD biologist) and Paul Blank (RCD hydrologist) visited recently-completed graded benches at Sites 21, 22, and 23. According to data obtained from USGS Gauging Station 11458000, located at Oak Knoll Avenue Bridge, streamflow in the Napa River ranged from 2,940 to 2,880 cubic feet per second (cfs) during our visit. This was a common event, the fifth largest of the 2016-17 season, and can be expected to occur multiple times in a typical water year.

On March 22, 2018 RCD visited recently-completed graded benches at Sites 13 and 14. According to data obtained from USGS Gauging Station 11458000, located at Oak Knoll Avenue Bridge, streamflow in the Napa River ranged from 3,010 to 3,780 cfs during our visit. This event was the largest of the 2017-18 season (peak discharge of 4,580 cfs) and approximately equivalent to the statistical mean annual flood for the station.

At each site, a sketch was made depicting the extent of the graded feature and the distribution of slow water habitat (refugia). The sketch included channel flow direction, approximate water surface levels relative to design topography, surface flow patterns, and eddy formations associated with the constructed and natural features at the site. Water velocities were measured around the margins of each bench, where safe to wade, using a USGS Price AA current meter with a wading rod. The maximum depth of each measurement location was noted, and the current meter was then positioned at 60% of that depth (measured from the water

surface) to measure a representative water velocity. Water velocities and measurement locations were recorded on each sketch.

LOW-FLOW ASSESSMENTS

RCD visited newly-installed wood and rock habitat structures at sites 13, 14, 21, 22, and 23 on August 2nd and 3rd, 2018. The low-flow channel was completely inundated at all sites, and a trickle of streamflow was present. According to provisional data obtained from USGS Gauging Station 11458000, located at Oak Knoll Avenue Bridge, streamflow was approximately 0.1 cfs during these two days.

The locations of all structures were provided to RCD in GIS file format from the design consultants, Environmental Science Associates (ESA). Prior to starting the field assessments, RCD assigned names to each installed structure based on its location (i.e. Monitoring Area) and position within the reach. Structures were named according to their Monitoring Area (i.e. M1, M2, M3) starting at the most upstream installation and continuing sequentially in a downstream direction. A GIS mapping application (ESRI Collector) was used to locate and assess each habitat structure in the field using a GPS-enabled tablet computer. During the field assessments, RCD used the GIS file as a starting point and modified the actual locations of each structure as needed based on GPS positions and/or visual landmarks observed in the field.

Structures that were found during the field assessments were assigned a value of "confirmed" in the GIS file. Structures that were not found were assigned a value of "not confirmed" but were kept in the GIS file, assuming they may have been buried or mis-mapped and should be assessed in subsequent years. Photographs were taken of all structures.

The ecological and hydraulic functions of each installed habitat structure were assessed using the following criteria:

- *High-flow refugia* - provides a low-velocity area where juvenile or adult salmonids could safely rest during high flow events
- *Low-flow refugia* - provides physical cover from predation, sunlight, etc. for juvenile salmonids
- *Hydraulic constriction* - increases local water velocities by impinging on streamflow, thus creating feeding lanes for juvenile salmonids
- *Pool scour* - induces bed scour to create pool habitat
- *Gravel recruitment* - induces sorting or storage of bedload material to create salmonid spawning habitat and/or topographic complexity

RESULTS

The results of the high-flow assessments of Sites 13, 14, 21, 22, and 23 are summarized in Table 1. Sketches and photographs from the high-flow assessments are provided as Attachment 1.

Table 1. High-flow assessment results for Sites 13, 14, 21, 22, and 23.

Site	Monitoring Area	Bank (facing down-stream)	Date, Time	Measured Water Velocities (ft/sec)	Flow at USGS Gage11458000[1] (cfs)	Narrative Evaluation
13	OVOK_M2	Left	March 22, 2018 9:50 - 10:15 AM	0.27 - 3.23	3,010 - 3,410	All graded benches observed during this high-flow event were functioning well to provide slow backwater areas (refugia) and complex hydraulics. Water velocities measured around the margins of each graded bench were favorable for juvenile and adult salmonid resting.
14	OVOK_M2	Right	March 22, 2018 9:50 - 10:40 AM	0.17 - 3.62	3,010 - 3,780	All low-elevation graded benches observed during this event were functioning well to provide slow backwater areas (refugia) and complex hydraulics. The high-elevation benches at the upstream portion of this site were not engaged. Water velocities measured around the margins of each low-elevation graded bench were favorable for juvenile and adult salmonid resting.
21	OVOK_M1	Right	February 22, 2017 9:30 AM	0.72 - 2.12	2,940	Graded bench sustained some damage from high flows - erosion noted around installed habitat structures above water line. Extensive areas of slow flow (refugia) observed along margins of graded bank with velocities favorable for juvenile and adult salmonid resting.
22	OVOK_M1	Left	February 22, 2017 10:15 AM	0.67 - 4.03	2,910	Graded bench and secondary channel observed during this high-flow event were functioning very well to provide complex hydraulics and gravel sorting/deposition. Few areas of slow velocity refugia were observed; however, a large backwater gyre was present at the upstream extent of the graded area with nearly slack water conditions
23	OVOK_M1	Left	February 22, 2017 10:40 AM	0.37 - 4.22	2,870	The higher-elevation graded areas of this feature were partially engaged during this high-flow event. Several slow velocity areas were observed along the margins of the lower-elevation areas of this feature with velocities favorable for adult and juvenile steelhead resting. Evidence of silt and sand deposition was observed in the higher-elevation graded areas, suggesting the bench was functioning well (as intended) to retain fine sediments outside of the main channel.

[1] Flow data listed in this table have been "Approved for publication" by USGS. Flow values listed on each site sketch in Attachment 1 were "Provisional" at the time.

During the low-flow assessments, RCD was able to locate and evaluate 65 of the 84 habitat structures installed at Sites 13, 14, 21, 22, and 23. The remaining 19 unfound structures were presumed to be buried or mis-mapped. Results of the low-flow assessments are summarized in Table 2. Photographs and maps of the installed habitat structures observed during the low-flow assessments of Sites 13, 14, 21, 22, and 23 are provided as Attachment 2.

Table 2. Low-flow assessment results for Sites 13, 14, 21, 22, and 23.

Site	Monitoring Area	Low-flow Assessment Date	Number of Structures Installed[1]	Number of Structures Confirmed & Assessed	Types of Structures Assessed (Total # Found / Total # Installed)
13	OVOK_M2	8/3/2018	18	16	Constructed Riffle (4/4), Habitat Log Structure (9/10), Live Wood Structure (3/4)
14	OVOK_M2	8/3/2018	39	30	Boulder Cluster (10/14), Habitat Log Structure (19/24), Live Wood Structure (1/1)
21	OVOK_M1	8/2/2018	10	8	Boulder Cluster (4/4), Habitat Log Structure (4/6)
22	OVOK_M1	8/2/2018	11	5[2]	Boulder Cluster (1/1), Flow Split Log Structure (1/1), Flow Forcing Log Structure (0/4), Habitat Log Structure (3/5)
23	OVOK_M1	8/2/2018	6	6	Flow Forcing Log Structure (3/3), Habitat Log Structure (3/3)

[1] List and geographic coordinates of installed habitat structures provided by ESA

[2] A large deposit of gravel was observed at Site 22, which likely buried many of the installed habitat structures

Of the 65 habitat structures assessed, 50 were found to be providing at least one of the ecological and/or hydraulic functions listed in the methods section above. Of these, 18 were found to be providing a single function, 20 were providing two functions, and 12 were providing three functions. Amongst all sites, the most common function provided was *low-flow refugia* followed by *hydraulic constriction* (Table 3). The functions of each individual habitat structure are provided as attributes of the attached GIS data.

Table 3. Total number of installed habitat structures at each site providing ecological and hydraulic functions. Note: some structures exhibited multiple functions; thus, the totals for each site may exceed the total number of assessed structures.

Function	Site 13	Site 14	Site 21	Site 22	Site 23	Total
High-Flow Refugia	0	5	0	0	3	8
Low-Flow Refugia	12	16	4	4	1	37
Hydraulic Constriction	5	11	0	1	2	19
Pool Scour	1	5	3	3	2	14
Gravel Recruitment	0	1	1	0	4	6

CONCLUSIONS & RECOMMENDATIONS

1. Graded floodplain benches at Sites 13, 14, 21, 22, and 23 performed as designed during high-flow events to provide areas of reduced water velocity, and thus resting and refuge habitat, for adult and juvenile salmonids.
2. A total of 65 of the 84 installed habitat structures were confirmed to be intact. Of these, 77% were providing at least one of the ecological or hydraulic functions that these structures were intended to provide.
3. Large gravel deposits were present in Sites 13, 14, 21, and 22 that likely buried several installed habitat structures that were not found. Future efforts to find these structures and confirm their location and condition is recommended.
4. A snorkel survey to determine juvenile salmonid usage of the installed habitat structures is recommended. The survey should be conducted in early spring (March-April) in a year when adult salmon (and/or steelhead) have been documented spawning in the OVOK Project reach.

REFERENCES

Napa County Flood Control & Water Conservation District (NCFCWCD) 2015. Napa River Restoration: Oakville to Oak Knoll Project Monitoring Plan.

ATTACHMENTS

Attachment 1: High-flow assessment sketches and photographs

Attachment 2: Installed habitat structures, low-flow assessment maps and photographs

ADDITIONAL DELIVERABLES

Low-flow assessment GIS data
High-flow assessment site sketches - full resolution (.pdf file format)
Photographs - full resolution (.jpg file format)

ATTACHMENT 1

High-Flow Assessment Sketches and Photographs

Napa River OVOK Restoration Reach Monitoring Area M2 (Group C)

MARCH 22, 2018 10:15 AM

FLOW: 3,410 CFS (PROVISIONAL) @ USGS GAGE OAK KNOLL

J. KOEHLER, P. BLANK (NCRCD)

CONN CR.

BACK WATER

M2-22

FLOODED WETLAND

13-14 13-15 PHOTO

Site 13

13-18 13-19 13-17 13-20 PHOTO 13-21

(SLOW / SLACK)

13-13 PHOTO 13-12

PHOTO 13-16

APPROX. WSEL

F

G

(SLOW BACKWATER)

LAMINAR FLOW

XX WILLOW TOPS XXX

M2-23 M2-24

SWIFT

SWIFT

SWIFT

SWIFT

M2-21

UPWELLING

M2-20

ISLAND

OAKS

M2-25 M2-26 M2-28 M2-31 M2-29 M2-32

FLOW

M2-15 M2-16

FLOODED MATURE WILLOWS

M2-17 M2-18 M2-19

14-8 M2-14 PHOTO 14-9

BACK WATER

A

WILLOW

BACK WATER

B 14-11 C

14-10 PHOTO 14-12

PHOTO 14-13

APPROX. WSEL

14-15 14-16 14-14 14-17 PHOTO

VERY SLOW

~1 FT. DEEP

VERY SLOW

(SLOW BACKWATER)

M2-27 M2-30

(SLACK)

D

E

14-19 14-18 14-20 PHOTO

14-22 14-21 14-23 PHOTO

Site 14

GRAVEL ROAD

SITE 14

Water Depth and Velocity Field Measurements		
Location	Depth (ft)	Velocity (fps)
A	3.0	1.27 U/S
B	2.8	0.79 D/S
C	2.9	0.62 U/S
D	1.5	0.17 D/S
E	3.0	1.30 U/S
SITE 13		
F	3.5	1.30 U/S
G	3.0	1.27 U/S

N

0 50 100 150 200 250 300 Feet

Napa River OVOK Restoration Reach Monitoring Area M2 (Group C)

MARCH 22, 2018 09:50 AM

FLOW: 3,010 CFS (PROVISIONAL)
@ USGS GAGE OAK KNOLL

J. KOEHLER, P. BLANK (NCRCD)

CONN CR.

Site 13

PHOTO 13-2, 13-3

PHOTO 13-1

PHOTO 13-4, 13-5

PHOTO 13-6

PHOTO 13-7, 13-8, 13-9

PHOTO 13-10

PHOTO 13-11

WETLAND

APPROX. WSEL

SLOW BACKWATER

FLOODED SHALLOWS

SLOW

SWIFT

SUBMERGED WILLOWS

WILLOWS

STEEP

BACKWATER

SLOW

OAK

M2-01 M2-02 M2-03 M2-04 M2-05 M2-06 M2-07 M2-08 M2-09 M2-10 M2-11 M2-12 M2-13

FLOW

PHOTO 14-4

PHOTO 14-5, 14-6, 14-7

PHOTO 14-1, 14-2, 14-3

Site 14

GRAVEL ROAD

N

0 50 100 150 200 250 300 Feet

Water Depth and Velocity Field Measurements

Location	Depth (ft)	Velocity (fps)	
A	1.4	0.27	U/S
B	2.6	0.74	U/S
C	3.0	1.34	D/S
D	2.5	0.61	U/S
E	3.2	0.69	U/S
F	3.0	3.23	D/S

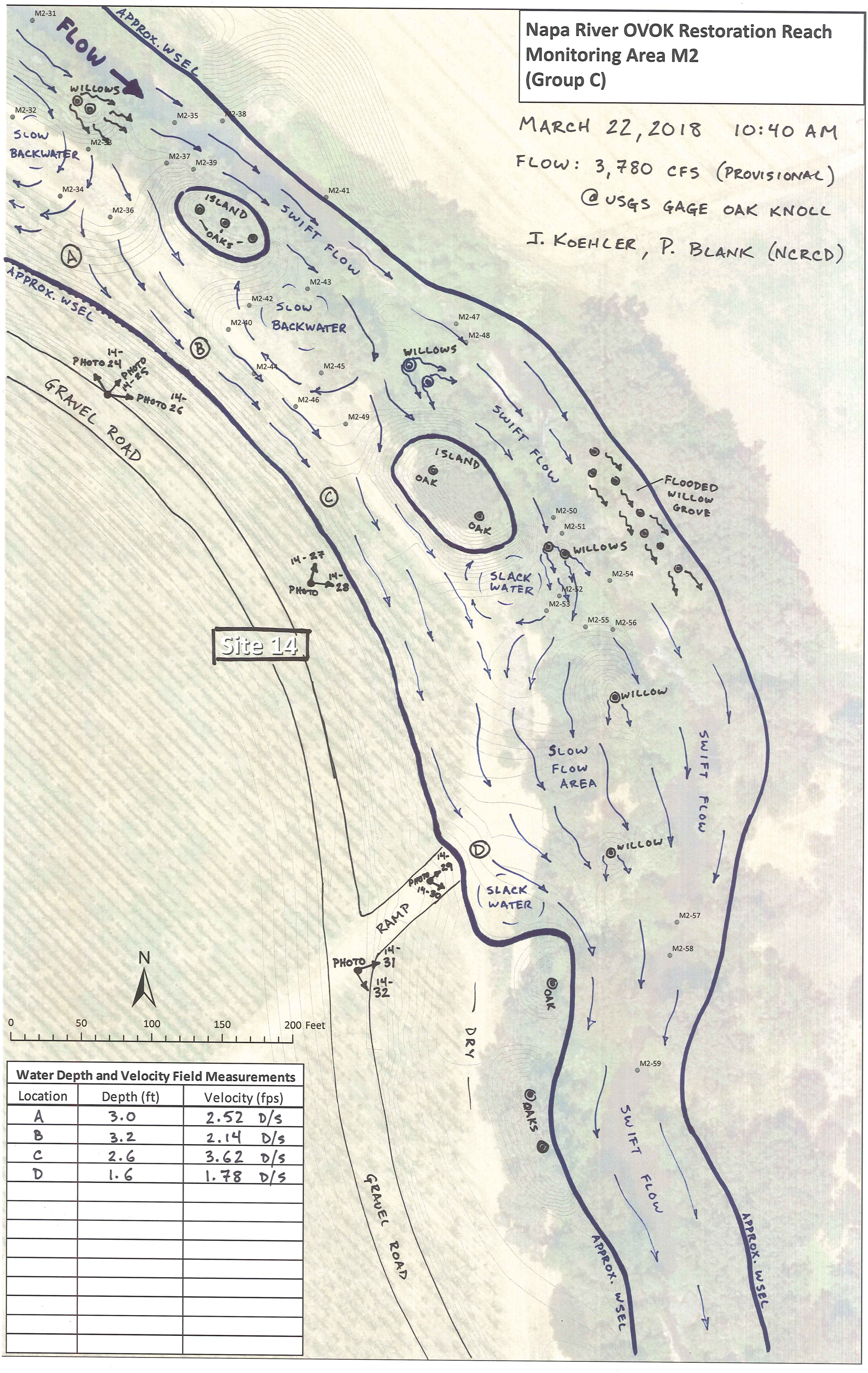
SITE 13

Napa River OVOK Restoration Reach Monitoring Area M2 (Group C)

MARCH 22, 2018 10:40 AM

FLOW: 3,780 CFS (PROVISIONAL)
@ USGS GAGE OAK KNOLL

J. KOEHLER, P. BLANK (NCRCD)



Water Depth and Velocity Field Measurements		
Location	Depth (ft)	Velocity (fps)
A	3.0	2.52 D/S
B	3.2	2.14 D/S
C	2.6	3.62 D/S
D	1.6	1.78 D/S


Site 13 Photo 1
March 22, 2018


Site 13 Photo 2
March 22, 2018

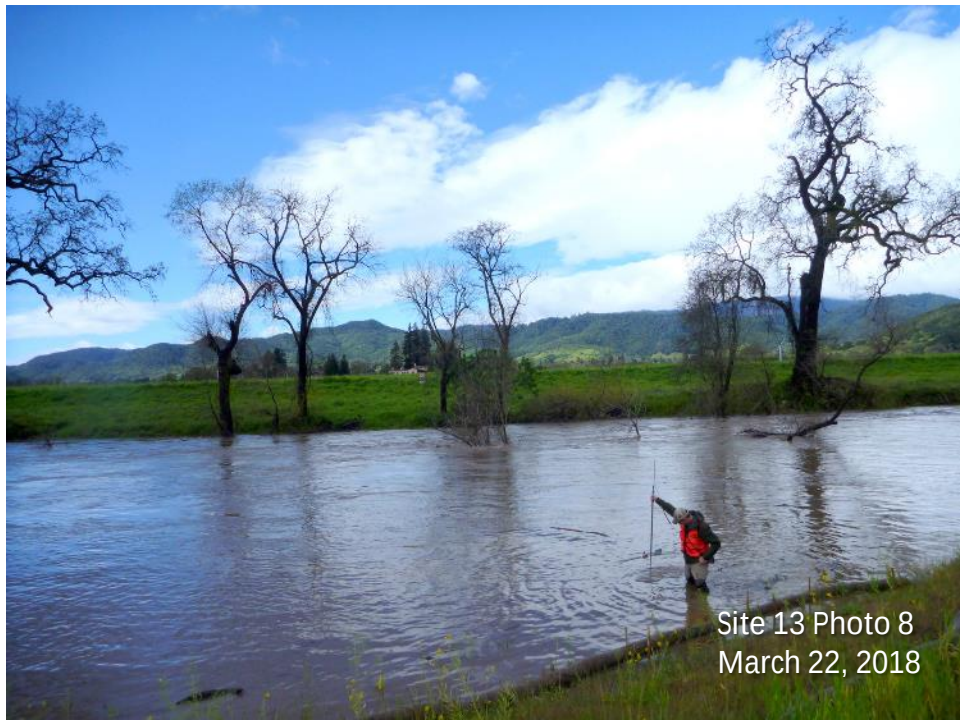

Site 13 Photo 3
March 22, 2018


Site 13 Photo 4
March 22, 2018


Site 13 Photo 5
March 22, 2018


Site 13 Photo 6
March 22, 2018


Site 13 Photo 7
March 22, 2018


Site 13 Photo 8
March 22, 2018


Site 13 Photo 9
March 22, 2018


Site 13 Photo 10
March 22, 2018

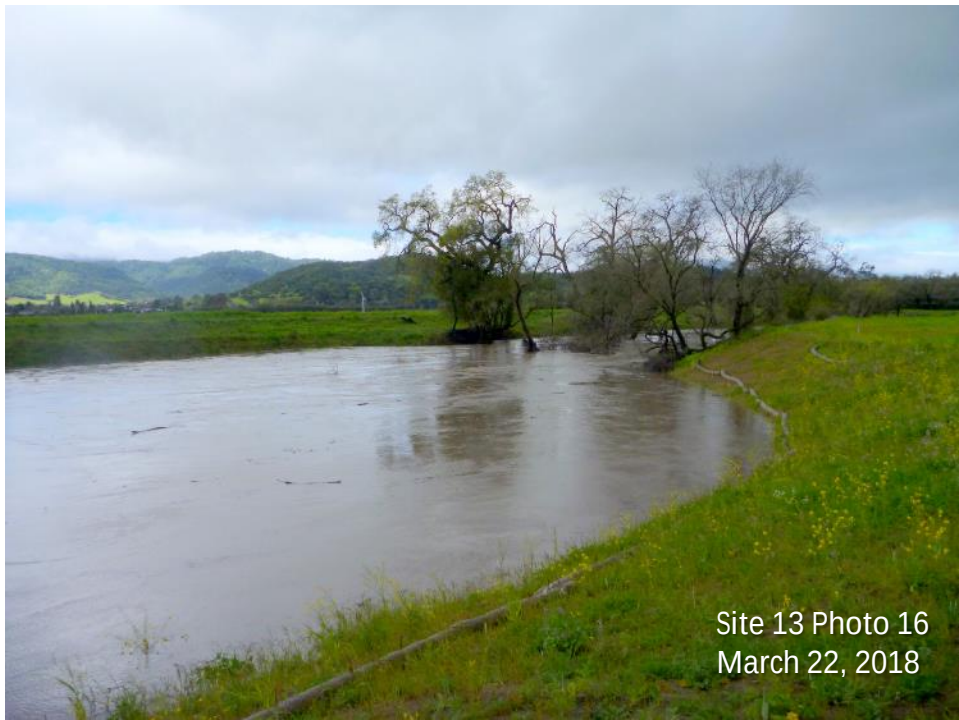

Site 13 Photo 11
March 22, 2018


Site 13 Photo 12
March 22, 2018


Site 13 Photo 13
March 22, 2018


Site 13 Photo 14
March 22, 2018


Site 13 Photo 15
March 22, 2018


Site 13 Photo 16
March 22, 2018


Site 13 Photo 17
March 22, 2018


Site 13 Photo 18
March 22, 2018


Site 13 Photo 19
March 22, 2018


Site 13 Photo 20
March 22, 2018


Site 13 Photo 21
March 22, 2018


Site 14 Photo 1
March 22, 2018


Site 14 Photo 2
March 22, 2018


Site 14 Photo 3
March 22, 2018


Site 14 Photo 4
March 22, 2018


Site 14 Photo 5
March 22, 2018


Site 14 Photo 6
March 22, 2018


Site 14 Photo 7
March 22, 2018


Site 14 Photo 8
March 22, 2018

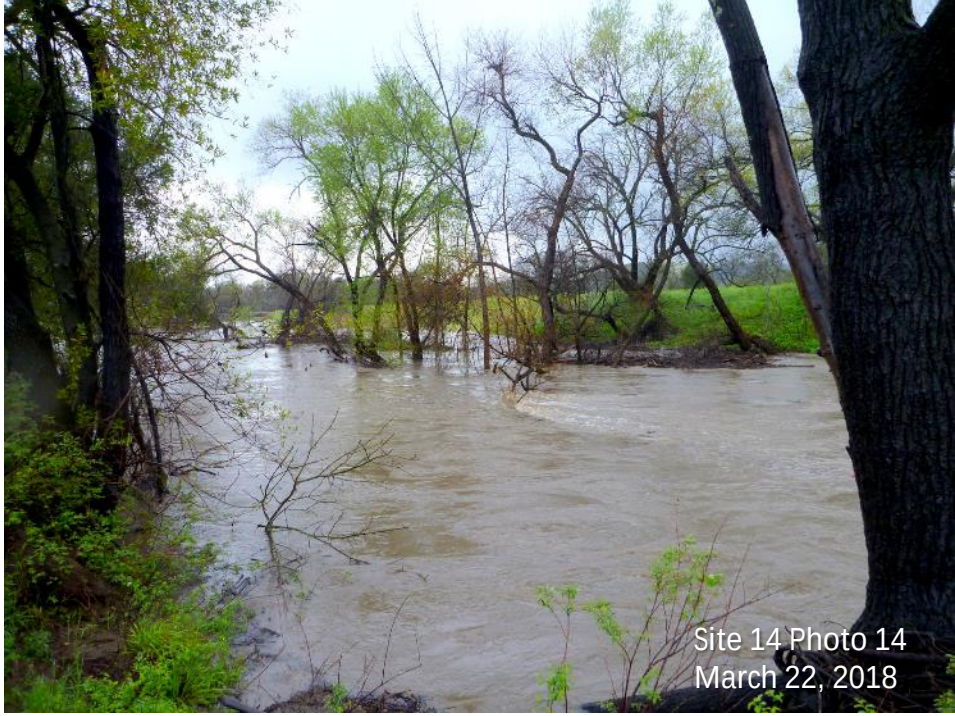

Site 14 Photo 9
March 22, 2018


Site 14 Photo 10
March 22, 2018


Site 14 Photo 11
March 22, 2018

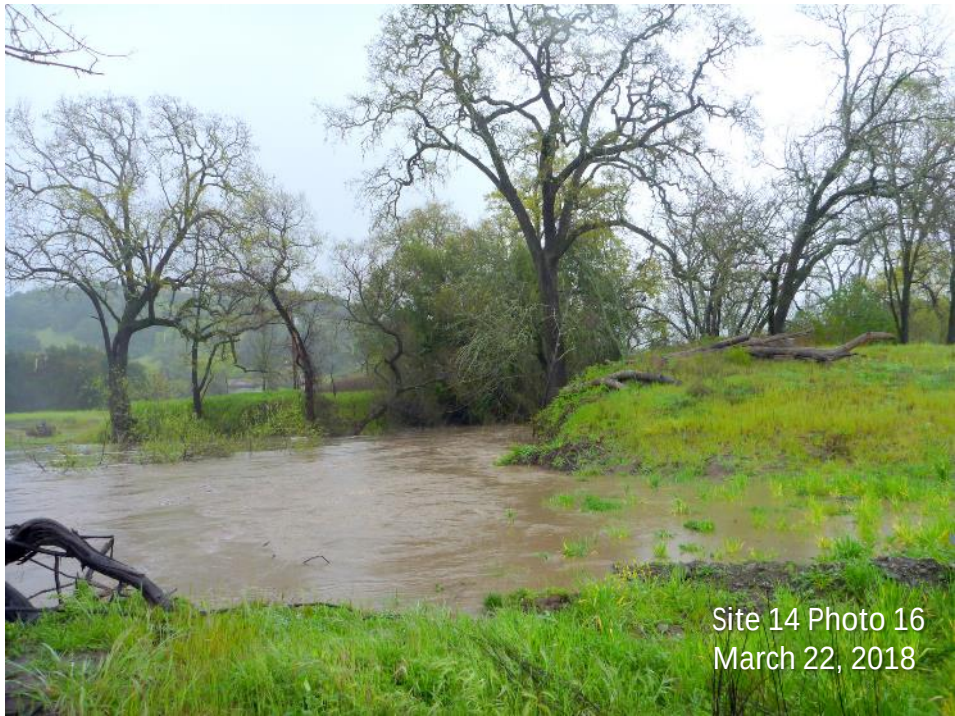

Site 14 Photo 12
March 22, 2018

Site 14 Photo 13
March 22, 2018



Site 14 Photo 14
March 22, 2018

Site 14 Photo 15
March 22, 2018



Site 14 Photo 16
March 22, 2018


Site 14 Photo 17
March 22, 2018


Site 14 Photo 18
March 22, 2018


Site 14 Photo 19
March 22, 2018


Site 14 Photo 20
March 22, 2018


Site 14 Photo 21
March 22, 2018


Site 14 Photo 22
March 22, 2018


Site 14 Photo 23
March 22, 2018


Site 14 Photo 24
March 22, 2018


Site 14 Photo 25
March 22, 2018


Site 14 Photo 26
March 22, 2018


Site 14 Photo 27
March 22, 2018


Site 14 Photo 28
March 22, 2018

Site 14 Photo 29
March 22, 2018

Site 14 Photo 30
March 22, 2018

Site 14 Photo 31
March 22, 2018

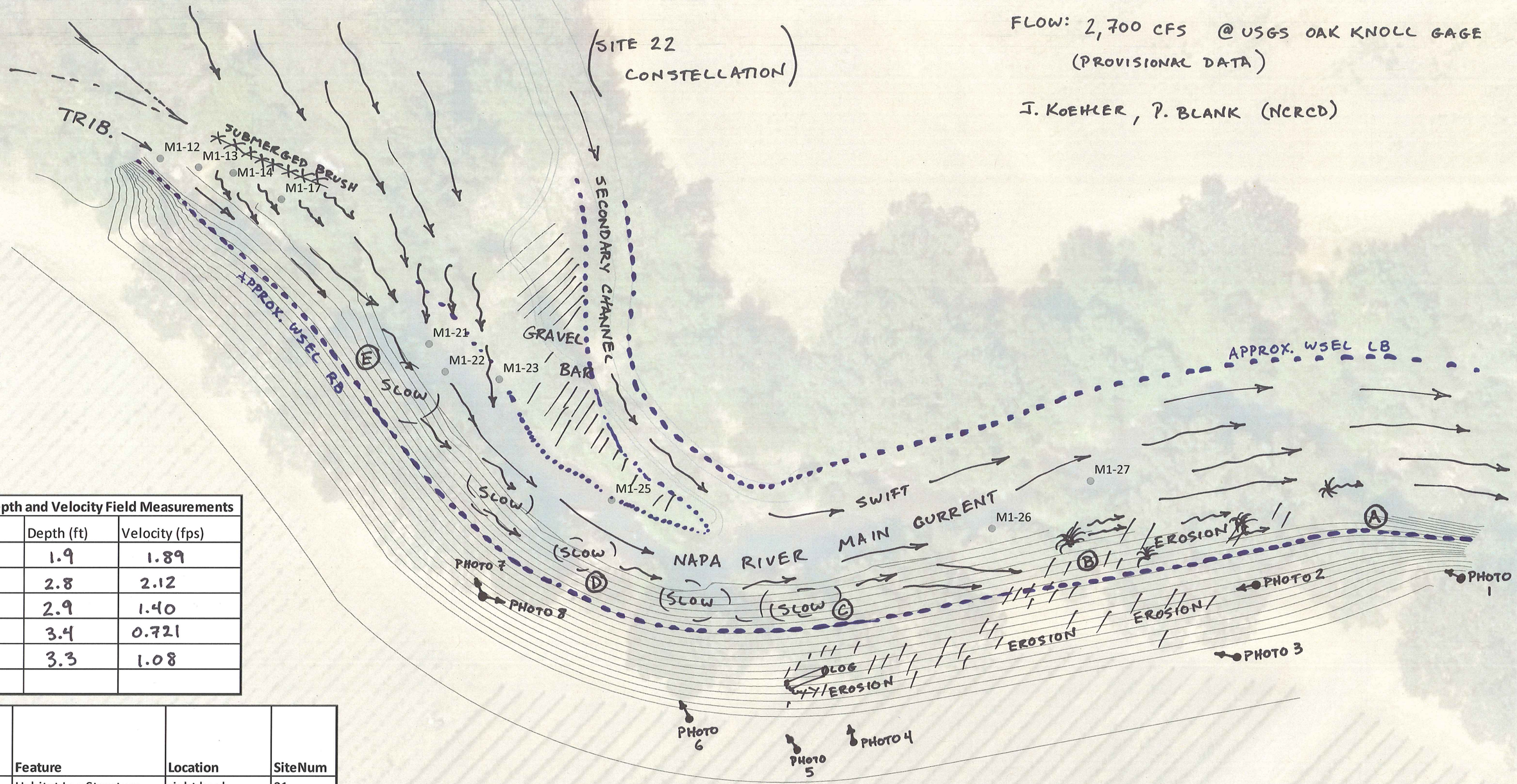
Site 14 Photo 32
March 22, 2018

Napa River OVOK Restoration Reach

FEB. 22, 2017 09:30 AM

FLOW: 2,700 CFS @ USGS OAK KNOLL GAGE (PROVISIONAL DATA)

J. KOEHLER, P. BLANK (NCRCD)



Water Depth and Velocity Field Measurements		
Location	Depth (ft)	Velocity (fps)
A	1.9	1.89
B	2.8	2.12
C	2.9	1.40
D	3.4	0.721
E	3.3	1.08

Installed Structure Name	Feature	Location	SiteNum
M1-12	Habitat Log Structure	right bank	21
M1-13	Habitat Log Structure	right bank	21
M1-14	Habitat Log Structure	right bank	21
M1-17	Habitat Log Structure	right bank	21
M1-21	Boulder Cluster	mid-channel	21
M1-22	Boulder Cluster	mid-channel	21
M1-23	Habitat Log Structure	left bank	21
M1-25	Habitat Log Structure	left bank	21
M1-26	Boulder Cluster	mid-channel	21
M1-27	Boulder Cluster	mid-channel	21

Site 21
Monitoring Area M1

JACKSON FAMILY ESTATES

N

0 50 100 Feet

Site 21 Photo 1
February 22, 2017

Site 21 Photo 2
February 22, 2017

Site 21 Photo 3
February 22, 2017

Site 21 Photo 4
February 22, 2017


Site 21 Photo 5
February 22, 2017


Site 21 Photo 6
February 22, 2017


Site 21 Photo 7
February 22, 2017


Site 21 Photo 8
February 22, 2017

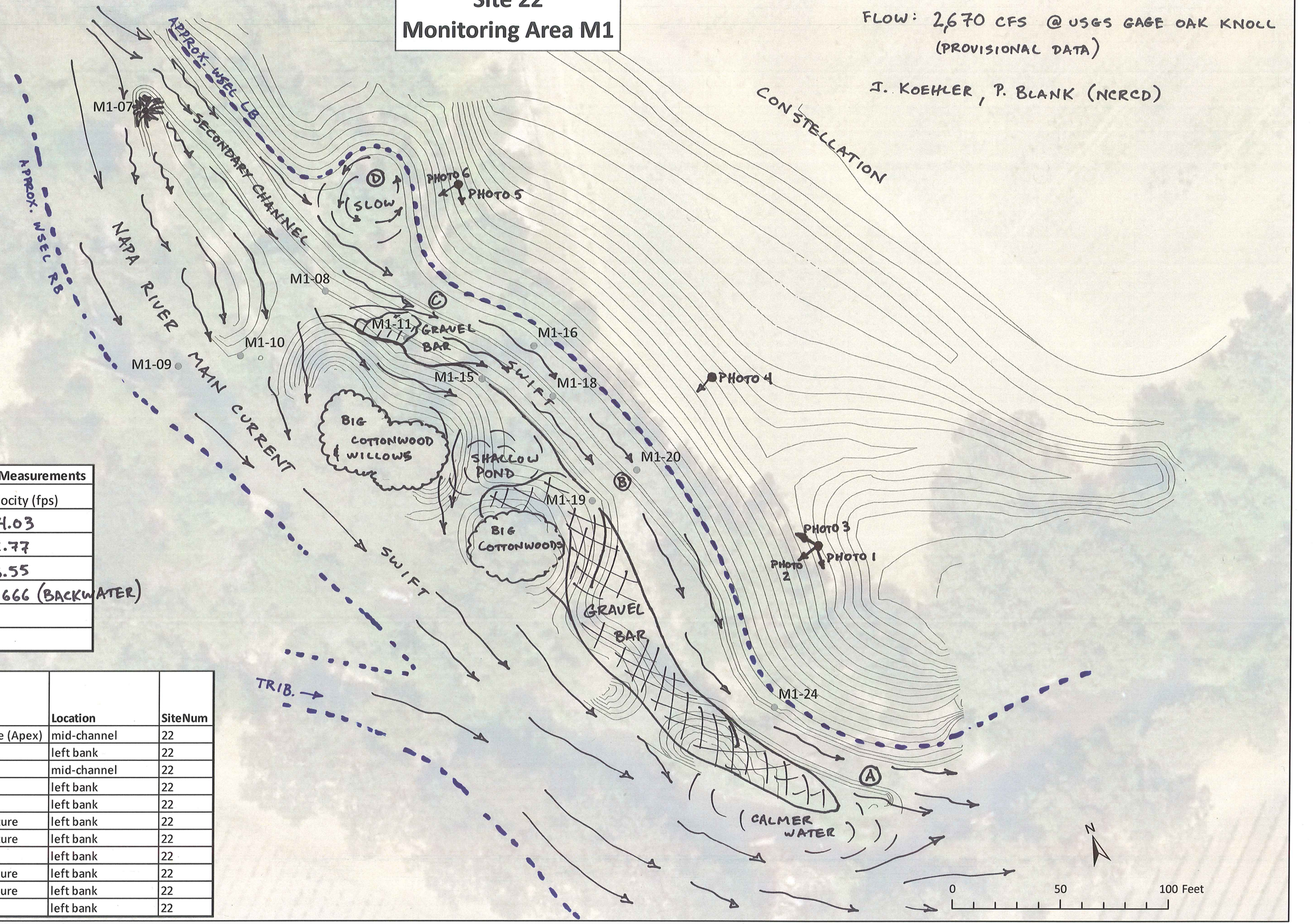
Napa River OVOK Restoration Reach

Site 22
Monitoring Area M1

FEB. 22, 2017 10:15 AM

FLOW: 2,670 CFS @ USGS GAGE OAK KNOLL (PROVISIONAL DATA)

J. KOEHLER, P. BLANK (NCRCD)



Water Depth and Velocity Field Measurements		
Location	Depth (ft)	Velocity (fps)
A	2.0	4.03
B	2.4	2.77
C	1.9	3.55
D	1.2	0.666 (BACKWATER)

Installed Structure Name	Feature	Location	SiteNum
M1-07	Flow Split Log Structure (Apex)	mid-channel	22
M1-08	Habitat Log Structure	left bank	22
M1-09	Boulder Cluster	mid-channel	22
M1-10	Habitat Log Structure	left bank	22
M1-11	Habitat Log Structure	left bank	22
M1-15	Flow Forcing Log Structure	left bank	22
M1-16	Flow Forcing Log Structure	left bank	22
M1-18	Habitat Log Structure	left bank	22
M1-19	Flow Forcing Log Structure	left bank	22
M1-20	Flow Forcing Log Structure	left bank	22
M1-24	Habitat Log Structure	left bank	22


Site 22 Photo 1
February 22, 2017


Site 22 Photo 2
February 22, 2017


Site 22 Photo 3
February 22, 2017


Site 22 Photo 4
February 22, 2017

Site 22 Photo 5
February 22, 2017

Site 22 Photo 6
February 22, 2017

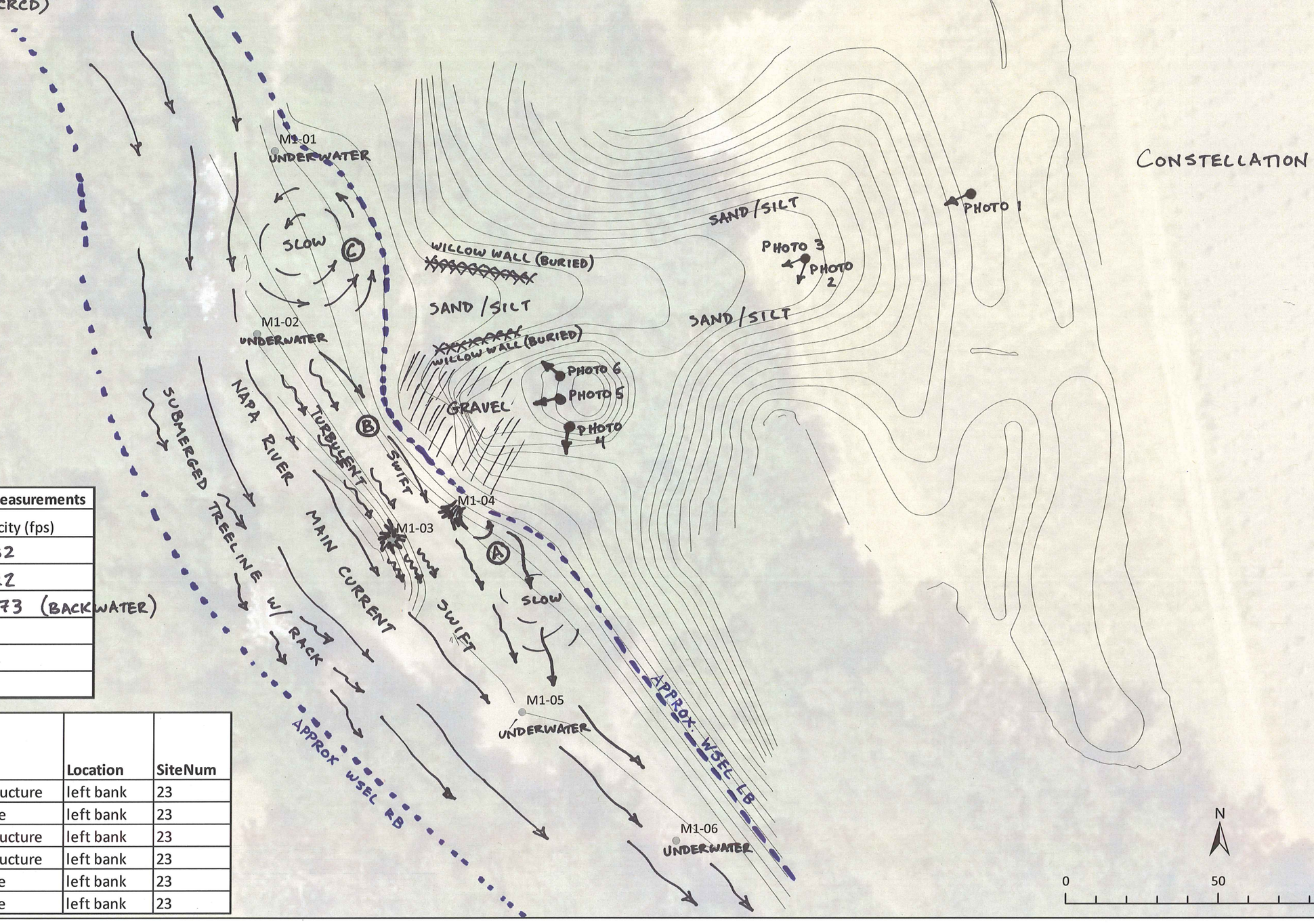
Napa River OVOK Restoration Reach

Site 23
Monitoring Area M1

FEB. 22, 2017 10:40 AM

FLOW: 2,630 CFS @ USGS GAGE OAK KNOLL (PROVISIONAL)

J. KOEHLER, P. BLANK (NCRCD)



Water Depth and Velocity Field Measurements		
Location	Depth (ft)	Velocity (fps)
A	3.1	1.82
B	1.8	4.22
C	1.4	0.373 (BACKWATER)

Installed Structure Name	Feature Type	Location	SiteNum
M1-01	Flow Forcing Log Structure	left bank	23
M1-02	Habitat Log Structure	left bank	23
M1-03	Flow Forcing Log Structure	left bank	23
M1-04	Flow Forcing Log Structure	left bank	23
M1-05	Habitat Log Structure	left bank	23
M1-06	Habitat Log Structure	left bank	23


Site 23 Photo 1
February 22, 2017


Site 23 Photo 2
February 22, 2017


Site 23 Photo 3
February 22, 2017

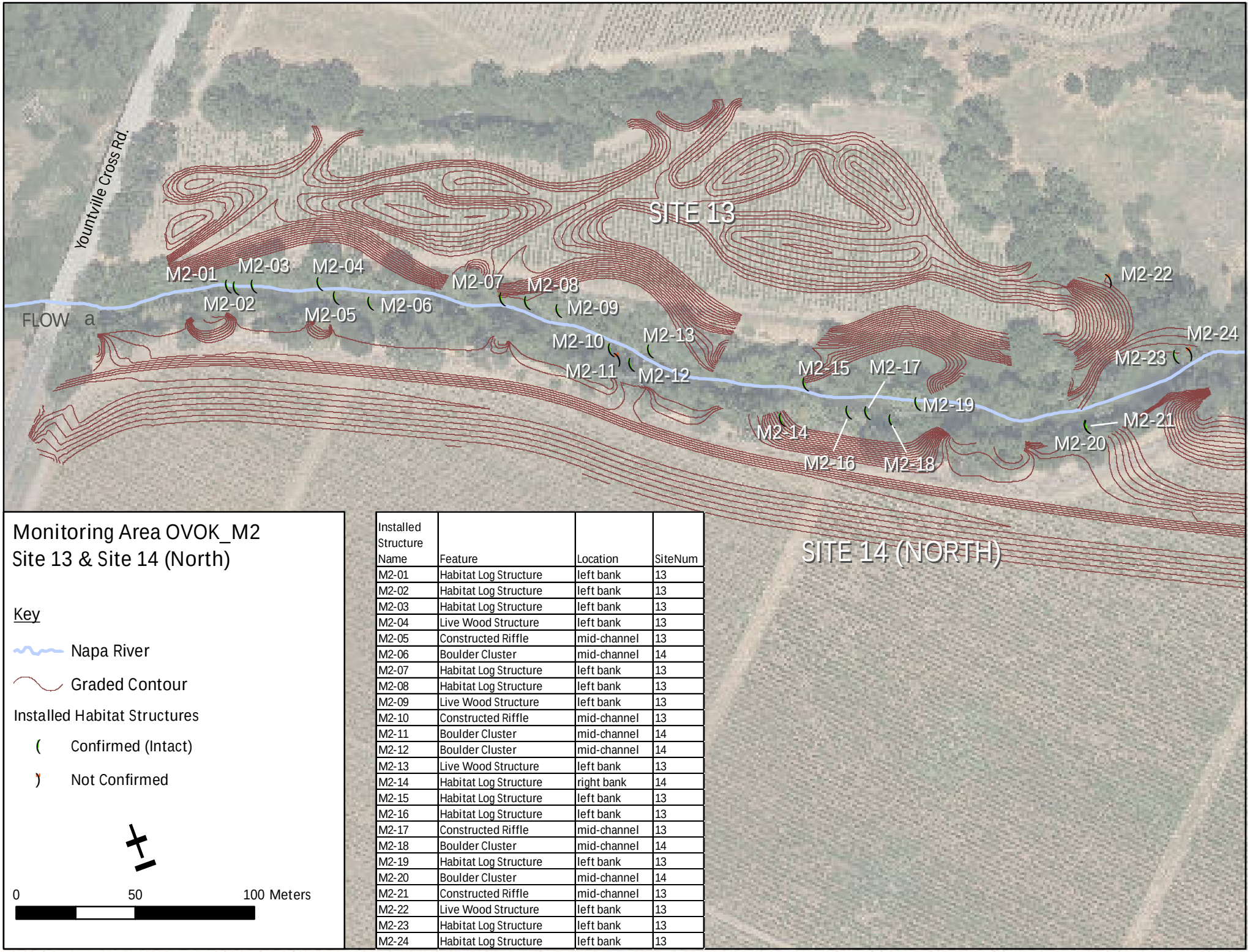

Site 23 Photo 4
February 22, 2017

Site 23 Photo 5
February 22, 2017

Site 23 Photo 6
February 22, 2017

ATTACHMENT 2

Installed Habitat Structures
Low-Flow Assessment Maps and Photographs



Monitoring Area OVOK_M2
Site 13 & Site 14 (North)

Key

Napa River

Graded Contour

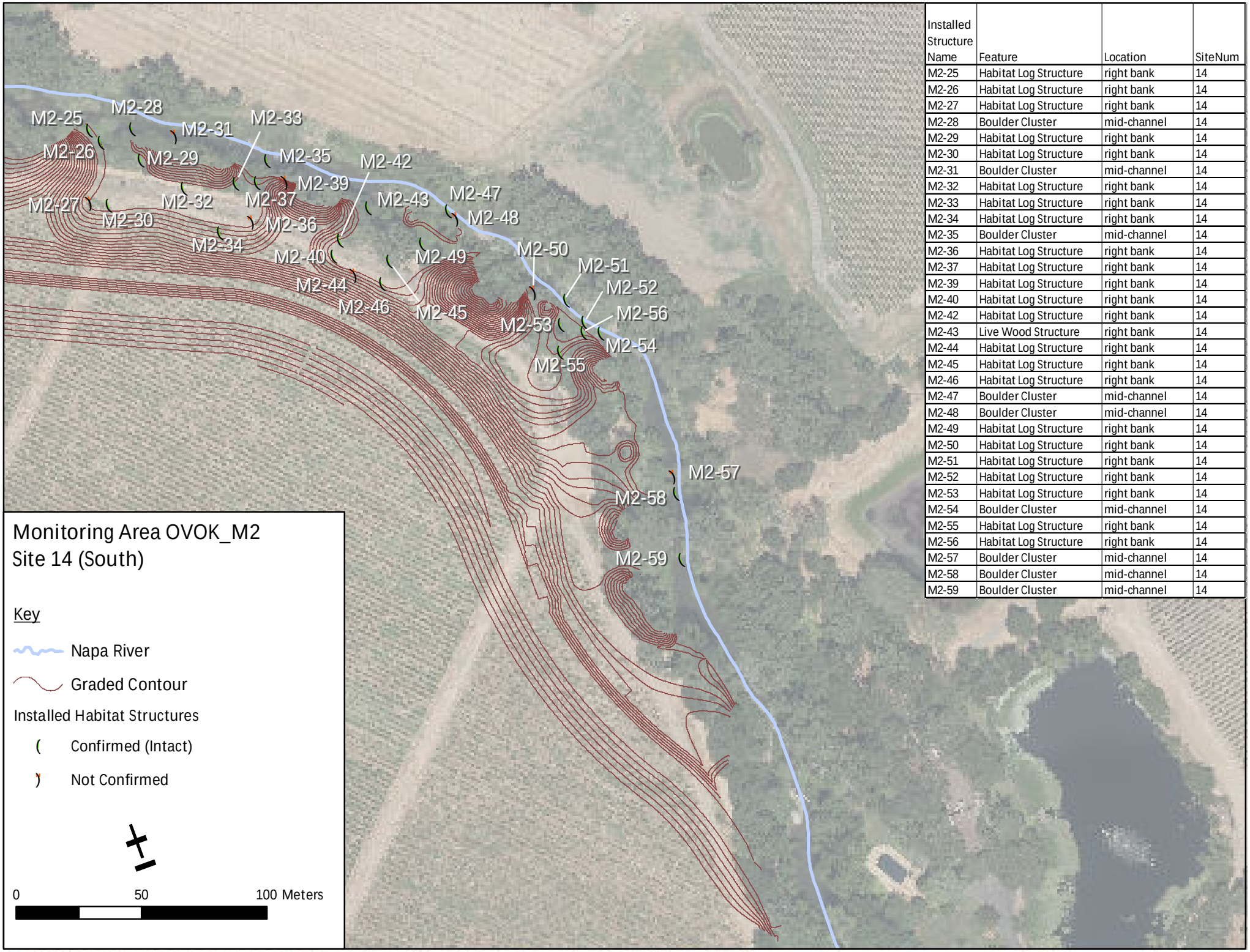
Installed Habitat Structures

(Confirmed (Intact)

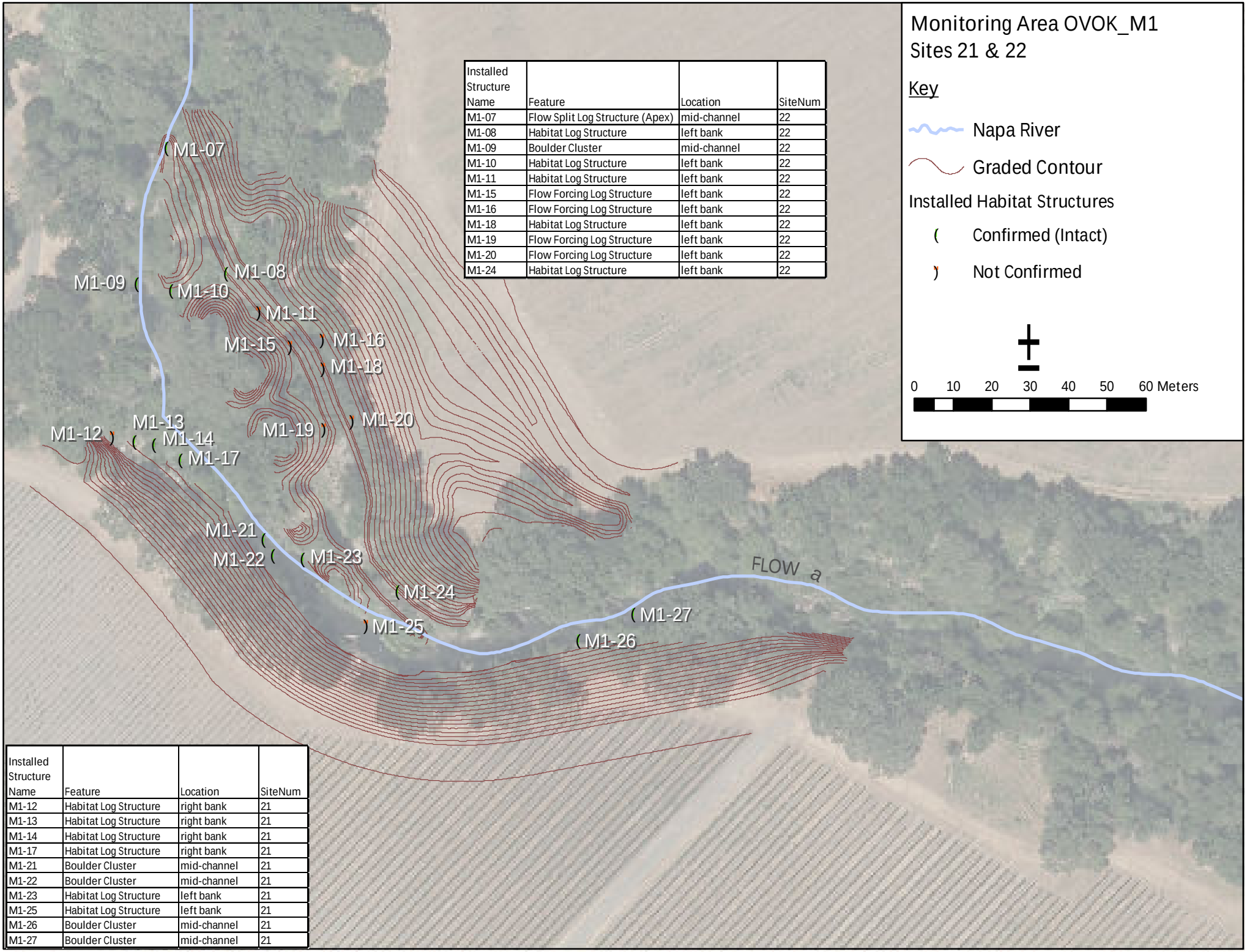
) Not Confirmed

0 50 100 Meters

Installed Structure Name	Feature	Location	SiteNum
M2-01	Habitat Log Structure	left bank	13
M2-02	Habitat Log Structure	left bank	13
M2-03	Habitat Log Structure	left bank	13
M2-04	Live Wood Structure	left bank	13
M2-05	Constructed Riffle	mid-channel	13
M2-06	Boulder Cluster	mid-channel	14
M2-07	Habitat Log Structure	left bank	13
M2-08	Habitat Log Structure	left bank	13
M2-09	Live Wood Structure	left bank	13
M2-10	Constructed Riffle	mid-channel	13
M2-11	Boulder Cluster	mid-channel	14
M2-12	Boulder Cluster	mid-channel	14
M2-13	Live Wood Structure	left bank	13
M2-14	Habitat Log Structure	right bank	14
M2-15	Habitat Log Structure	left bank	13
M2-16	Habitat Log Structure	left bank	13
M2-17	Constructed Riffle	mid-channel	13
M2-18	Boulder Cluster	mid-channel	14
M2-19	Habitat Log Structure	left bank	13
M2-20	Boulder Cluster	mid-channel	14
M2-21	Constructed Riffle	mid-channel	13
M2-22	Live Wood Structure	left bank	13
M2-23	Habitat Log Structure	left bank	13
M2-24	Habitat Log Structure	left bank	13

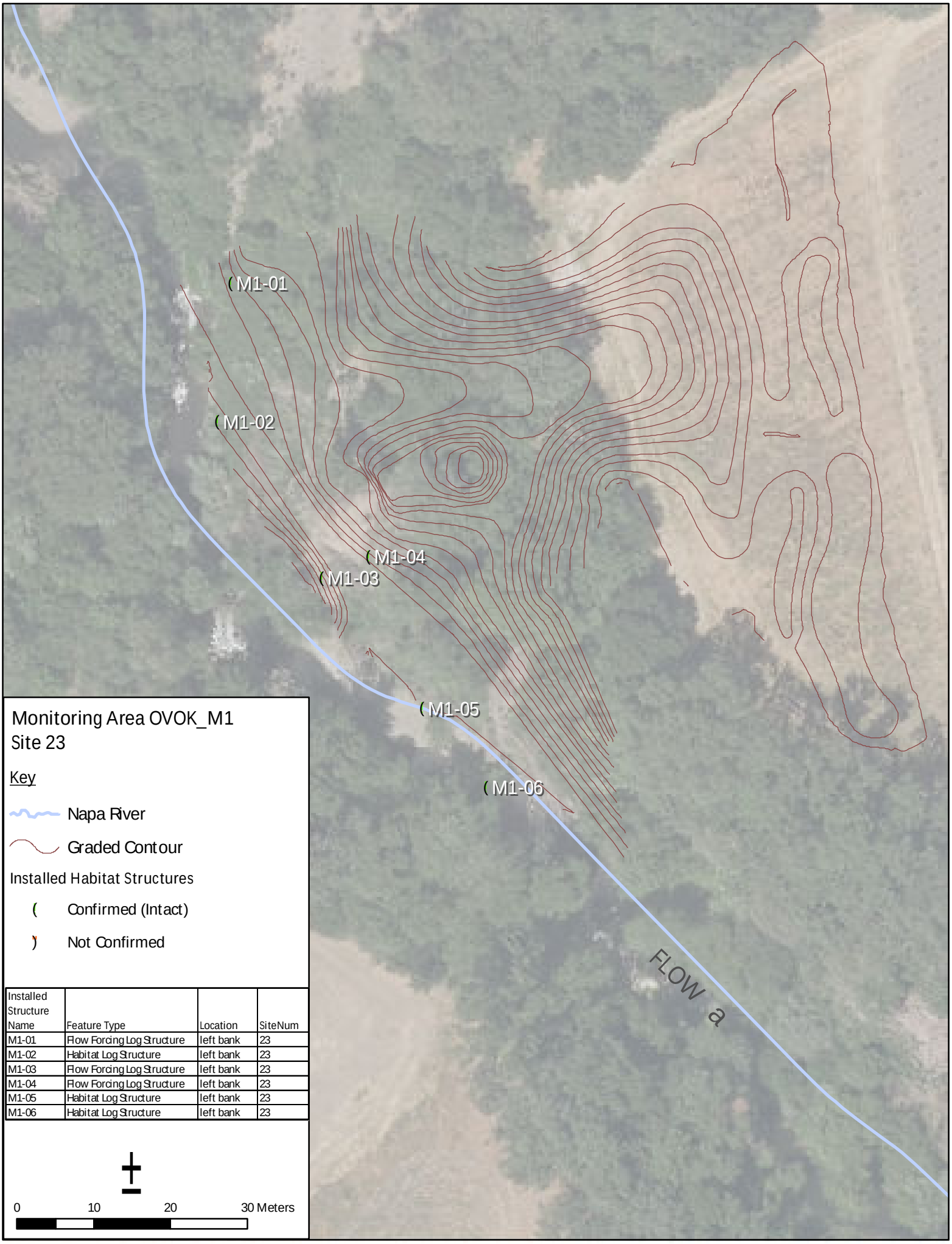


Installed Structure Name	Feature	Location	SiteNum
M2-25	Habitat Log Structure	right bank	14
M2-26	Habitat Log Structure	right bank	14
M2-27	Habitat Log Structure	right bank	14
M2-28	Boulder Cluster	mid-channel	14
M2-29	Habitat Log Structure	right bank	14
M2-30	Habitat Log Structure	right bank	14
M2-31	Boulder Cluster	mid-channel	14
M2-32	Habitat Log Structure	right bank	14
M2-33	Habitat Log Structure	right bank	14
M2-34	Habitat Log Structure	right bank	14
M2-35	Boulder Cluster	mid-channel	14
M2-36	Habitat Log Structure	right bank	14
M2-37	Habitat Log Structure	right bank	14
M2-39	Habitat Log Structure	right bank	14
M2-40	Habitat Log Structure	right bank	14
M2-42	Habitat Log Structure	right bank	14
M2-43	Live Wood Structure	right bank	14
M2-44	Habitat Log Structure	right bank	14
M2-45	Habitat Log Structure	right bank	14
M2-46	Habitat Log Structure	right bank	14
M2-47	Boulder Cluster	mid-channel	14
M2-48	Boulder Cluster	mid-channel	14
M2-49	Habitat Log Structure	right bank	14
M2-50	Habitat Log Structure	right bank	14
M2-51	Habitat Log Structure	right bank	14
M2-52	Habitat Log Structure	right bank	14
M2-53	Habitat Log Structure	right bank	14
M2-54	Boulder Cluster	mid-channel	14
M2-55	Habitat Log Structure	right bank	14
M2-56	Habitat Log Structure	right bank	14
M2-57	Boulder Cluster	mid-channel	14
M2-58	Boulder Cluster	mid-channel	14
M2-59	Boulder Cluster	mid-channel	14



Installed Structure Name	Feature	Location	SiteNum
M1-07	Flow Split Log Structure (Apex)	mid-channel	22
M1-08	Habitat Log Structure	left bank	22
M1-09	Boulder Cluster	mid-channel	22
M1-10	Habitat Log Structure	left bank	22
M1-11	Habitat Log Structure	left bank	22
M1-15	Flow Forcing Log Structure	left bank	22
M1-16	Flow Forcing Log Structure	left bank	22
M1-18	Habitat Log Structure	left bank	22
M1-19	Flow Forcing Log Structure	left bank	22
M1-20	Flow Forcing Log Structure	left bank	22
M1-24	Habitat Log Structure	left bank	22

Installed Structure Name	Feature	Location	SiteNum
M1-12	Habitat Log Structure	right bank	21
M1-13	Habitat Log Structure	right bank	21
M1-14	Habitat Log Structure	right bank	21
M1-17	Habitat Log Structure	right bank	21
M1-21	Boulder Cluster	mid-channel	21
M1-22	Boulder Cluster	mid-channel	21
M1-23	Habitat Log Structure	left bank	21
M1-25	Habitat Log Structure	left bank	21
M1-26	Boulder Cluster	mid-channel	21
M1-27	Boulder Cluster	mid-channel	21



Monitoring Area OVOK_M1
Site 23

Key

Napa River

Graded Contour

Installed Habitat Structures

(Confirmed (Intact)

) Not Confirmed

Installed Structure Name	Feature Type	Location	SiteNum
M1-01	Flow Forcing Log Structure	left bank	23
M1-02	Habitat Log Structure	left bank	23
M1-03	Flow Forcing Log Structure	left bank	23
M1-04	Flow Forcing Log Structure	left bank	23
M1-05	Habitat Log Structure	left bank	23
M1-06	Habitat Log Structure	left bank	23

0 10 20 30 Meters


M1-01, Site 23
August 2, 2018


M1-02, Site 23
August 2, 2018


M1-03, Site 23
August 2, 2018


M1-04, Site 23
August 2, 2018


M1-05, Site 23
August 2, 2018


M1-06, Site 23
August 2, 2018


M1-07, Site 22
August 2, 2018


M1-08, Site 22
August 2, 2018


M1-10, Site 22
August 2, 2018


M1-13, Site 21
August 2, 2018


M1-14, Site 21
August 2, 2018


M1-17, Site 21
August 2, 2018


M1-21, Site 21
August 2, 2018


M1-22, Site 21
August 2, 2018


M1-23, Site 21
August 2, 2018


M1-24, Site 22
August 2, 2018


M1-26, Site 21
August 2, 2018


M1-27, Site 21
August 2, 2018


M2-01, Site 13
August 3, 2018


M2-02, Site 13
August 3, 2018


M2-03, Site 13
August 3, 2018


M2-04, Site 13
August 3, 2018


M2-05, Site 13
August 3, 2018


M2-06, Site 14
August 3, 2018


M2-07, Site 13
August 3, 2018


M2-08, Site 13
August 3, 2018


M2-09, Site 13
August 3, 2018


M2-10, Site 13
August 3, 2018


M2-12, Site 14
August 3, 2018


M2-13, Site 13
August 3, 2018


M2-14, Site 14
August 3, 2018

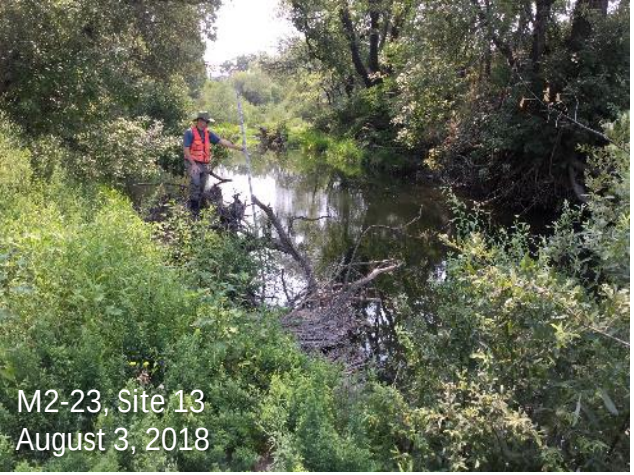

M2-15, Site 13
August 3, 2018


M2-16, Site 13
August 3, 2018


M2-17, Site 13
August 3, 2018


M2-18, Site 14
August 3, 2018


M2-20, M2-21 Sites 13&14
August 3, 2018


M2-23, Site 13
August 3, 2018


M2-25, Site 14
August 2, 2018


M2-26, Site 14
August 2, 2018


M2-28, Site 14
August 2, 2018


M2-29, Site 14
August 2, 2018


M2-30, Site 14
August 2, 2018


M2-32, Site 14
August 2, 2018


M2-33, Site 14
August 2, 2018


M2-34, Site 14
August 2, 2018


M2-35, Site 14
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M2-37, Site 14
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M2-38, Site 14
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M2-40, Site 14
August 2, 2018


M2-41, Site 14
August 2, 2018


M2-42, Site 14
August 2, 2018


M2-43, Site 14
August 2, 2018


M2-45, Site 14
August 2, 2018


M2-46, Site 14
August 2, 2018


M2-47, Site 14
August 2, 2018


M2-49, Site 14
August 2, 2018


M2-51, Site 14
August 2, 2018


M2-52, Site 14
August 2, 2018


M2-53, Site 14
August 2, 2018


M2-54, Site 14
August 2, 2018


M2-55, Site 14
August 2, 2018


M2-56, Site 14
August 2, 2018


M2-58, Site 14
August 2, 2018


M2-59, Site 14
August 2, 2018

Appendix C

Vegetation Establishment Surveys

Napa River Restoration Project
OVOK Group A Sites
Re-Vegetation Project Maintenance and Monitoring
2018 Annual Report Establishment Year 1

I. Discussion of Maintenance Activities

OVOK Group A sites were planted and irrigation installed in late spring 2017. Once the plants and irrigation were installed, Hanford ARC began the first year of plant establishment and maintenance. This report discusses the work that was completed during the first plant establishment and maintenance year as well as the first monitoring event results.

Irrigation

All of the OVOK Group A sites irrigation systems have water provided by adjacent private landowners either by tying directly into their existing irrigation system such as at sites 22 or 23 or via a water tank that is filled with water provided by the vineyard at site 21.

All of the sites have a combination of overhead spray irrigation for seeded areas, and drip irrigation for container plants. These systems were generally installed according to plans. Some field adjustments were made with approval from the County. One adjustment that was made was to use perforated spaghetti around the smaller plug plants such as *Elymus triticoides*. Another alteration was to an erosive slump at site 21 that was re-graded and seeded. This area was added to the irrigation system via the overhead spray irrigation.

Watering events are scheduled as noted in notes 12 and 14 on page R02 of the project plans. Per Hanford ARC's observations no adjustments to the timing and quantity of water were needed in the 2017 water season.

Invasive Plant Management

Non-native invasive plants, both listed within the specifications and those that are problematic to the success of natives, were routinely removed from the planting sites. The most intensive non-native removal efforts will occur in the early part of the year, between March and May. This is the period of rapid growth and pre-flowering/pre-seed formation stages of plant development. Removed biomass is disposed of away from native plantings and is adequately uprooted so as to prevent re-establishment.

The Vegetation Management Zones were managed in accordance with the timeline provided in General Considerations, Management and Removal Guidelines (Sheet RO2 from the Plans and per sections 21-29 of the technical specifications), first with the objective of eradicating all non-native invasive plant species and second with allowing for establishment of natives. In many cases the areas were treated with herbicide or cleared by hand in order to adequately control non- natives. Over the plant establishment period, the non-native population will be controlled and re-growth of a much smaller distribution is expected leading to a reduction in re-treated plants.

The Invasive Vegetation Management (IVM) Zones A and B were managed in accordance with the General Revegetation notes in the plans on R02, and the Pierce' disease host plant treatment recommendations on R03 of the plans. The host plants identified for removal are tree of heaven

(*Alianthus altissima*), giant reed grass (*Arundo donax*), Himalayan blackberry (*Rubus armeniacus*), big-leaf periwinkle (*Vinca major*), California wild grape (*Vitis californica*), red sesbania (*Sesbania punicea*), poison hemlock (*Conium maculatum*), and American pokeweed (*Phytolacca americana*). Hanford did not observe giant reed grass in the invasive and planting vegetation management zones. In fact, the level of invasive and host plants cover in the IVM zones was less than anticipated. Under the direction of the County, Hanford applied the Year-2 Maintenance Wildflower seeding mix that was left over from spraying the IVM zones to bare areas within the planting sites.

Certain invasive plant species not removed by hand (e.g., Himalayan blackberry, periwinkle) were treated with Roundup Custom®. This chemical is an aquatic formulation of glyphosate without surfactants. Glyphosate is applied at between 3-5% depending on the available target foliage, plant species and whether the treatment is initial or follow-up. Spray mix includes an indicator dye (at 1% solution) and non-ionic vegetable oil surfactant (at 1.5%). Water for dilution was sourced from the irrigation system via quick coupler.

Herbicide applications are a last resort measure and always conducted by personnel with experience in handling and applying chemicals, knowledge of flora in Northern California, and experience in invasive plant management. Only personnel who are qualified applicators as certified by the California Department of Pesticide Regulation conduct or oversee herbicide applications. In 2017, after the initial mechanical removal of Peirce's disease host and invasive plant species, two herbicide spot treatment events occurred. The primary species that require herbicide spot treatments were periwinkle (*Vinca major*), Himalayan blackberry (*Rubus armeniacus*), poison hemlock (*Conium maculatum*), and crabgrass (*Digitaria ischaemum*) were targeted with herbicide applications. Overall there were less observed invasive species identified in the area. The targeted treatments appear to be successful.

Monthly Establishment Records

Maintenance is ongoing and is conducted between March and October per Establishment Year. Maintenance activities consisted of:

- Hand removing weeds from the direct vicinity of native plant basins to reduce competition.
- Running irrigation systems. Calling private landowners, coordinating with winery personnel, opening and closing station/gate valves, and checking for functionality across entire system.
- Hand watering willow benches and sections using supplemental overhead sprinklers or hose.
- Fixing line breaks or replacing clogged drip emitters in irrigation systems.
- Applying herbicide to specific stands of non-native plants within Vegetation Management Zones.
- Monitoring (plant counts, photo points, surveys).
- Winterizing (capping) the overhead sprinkler system.

II. Monitoring Results – All Sites

On September, 25 2018 the second vegetation monitoring survey of the three primary sites and the riparian enhancement zone (REZ) was completed. Hanford ARC observed that the herbaceous cover at the three sites is primarily native-dominated, especially by perennial grasses, foothill penstemon, and poppies. Bare areas were minimal in most zones; however, the lower riparian slope zone have the most spots with bare areas. See Appendix A for the photo monitoring points. See Appendix B for a summary table of the results of the monitoring visit. Also included with this report is the excel spreadsheet of the

results.

Progress toward Plant Establishment

The four planting sites, Site 21-23 and the (REZ), were planted in April-May of 2017. The five planting zones were installed per plan except for the River Wet Edge and the Lower Floodplain Bench. These zones were combined after the 2016-2017 winter season greatly transformed the gravel bars in this stretch of the river.

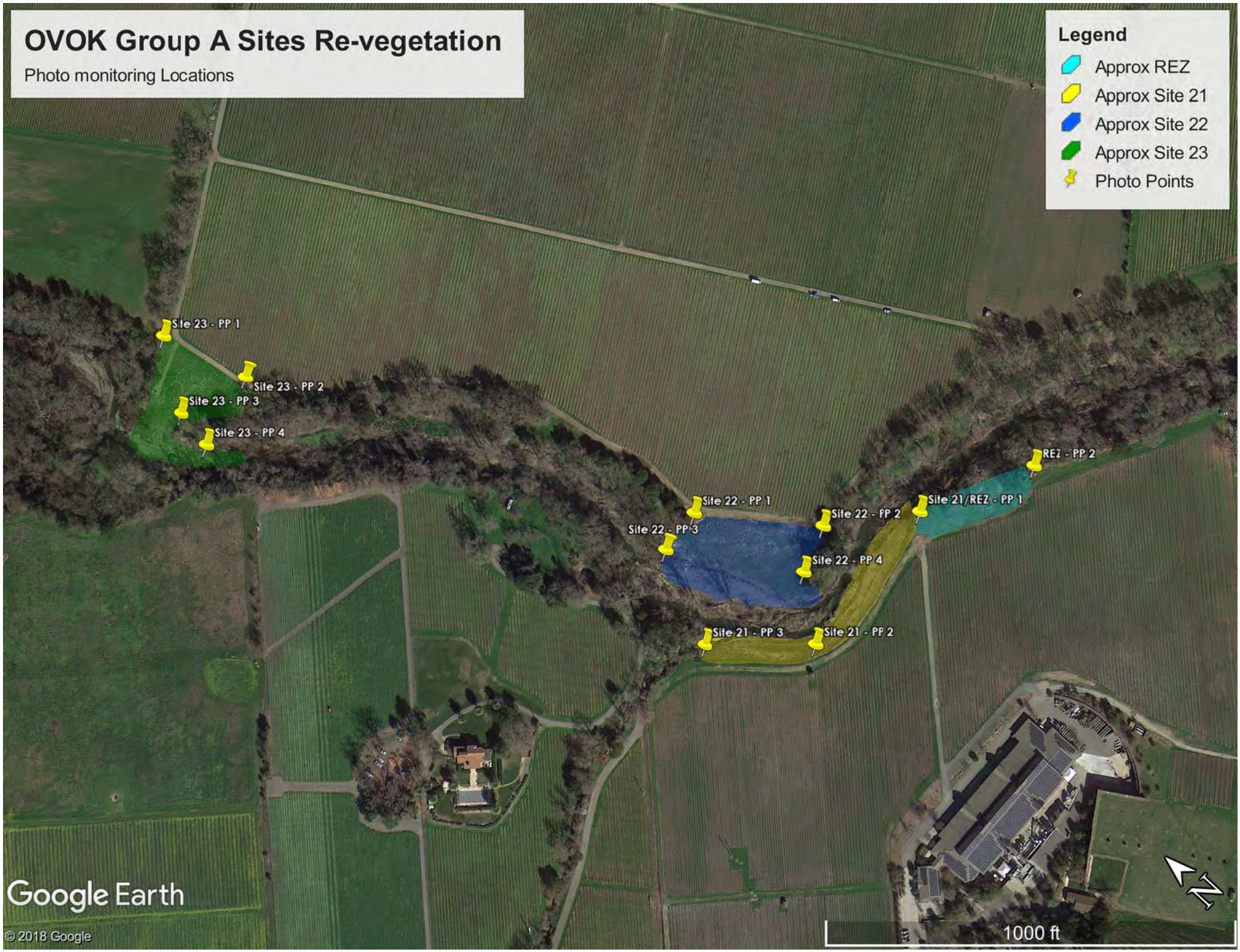
Monitoring results indicate that the majority of installed native plants are surviving and thriving. Black walnut (*Juglans californica*), big-leaf maple (*Acer macrophyllum*), valley oak (*Quercus lobata*), yarrow (*Achillea millefolium*), foothill penstemon (*Penstemon heteropyllus*), (*Rosa californica*), snowberry (*Symphoricarpus albus*), and rushes (*Juncus* spp.) are among the best performing species in regards to survivorship and volunteer recruitment at the site.

Adaptive management to facilitate the recruitment of volunteer species and success of installed plants is ongoing and includes:

- Minimizing large-scale disturbance events (clearing, grading) to the site, as this typically facilitates the establishment and spread of non-native invasive plants.
- Maximizing the amount of water provided directly to natives (minimizing run-off to non-target plants).
- Maximizing water retention by replenishing/refreshing wood chip mulch around plantings or by reconstructing berms and plant basins on slopes.
- Focusing weed abatement efforts on target list species only with secondary priorities on problematic invasive plant species that have the tendency to spread.
- Reducing populations of non-native invasive plant species by trimming/cutting flowering or aboveground structures when they cannot be fully eradicated – by temporarily reducing the ability to spread and/or reproduce, or by continually stressing these plant species, it increases the chances of later controlling them fully.

Plant Replacements

During the monitoring visit on September 25, 2018, Hanford ARC observed that overall, the sites had maintained survivorship throughout. Hanford ARC did not observe additional empty plant basins. The native grasses observed in the spring monitoring event were not as evident during the fall monitoring event causing the observation of bare areas to seem higher. Hanford ARC recommends proceeding with tine re-planting plant proposed in the May 2018 report.


OVOK Group A Sites Re-vegetation
Photo monitoring Locations
Legend
Approx REZ
Approx Site 21
Approx Site 22
Approx Site 23
Photo Points
Site 23 - PP 1
Site 23 - PP 2
Site 23 - PP 3
Site 23 - PP 4
REZ - PP 2
Site 22 - PP 1
Site 22 - PP 2
Site 21/REZ - PP 1
Site 22 - PP 3
Site 22 - PP 4
Site 21 - PP 3
Site 21 - PP 2
Google Earth
© 2018 Google
1000 ft
N

Riparian Enhancement Zone (REZ) - Photo Point 1 TOP: May 9, 2018 BOTTOM: September 25, 2018

Riparian Enhancement Zone (REZ) - Photo Point 2 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 21 - Photo Point 1 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 21 - Photo Point 2 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 21 - Photo Point 3 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 22 - Photo 1 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 22 - Photo Point 2 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 22 - Photo Point 3 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 22 - Photo Point 4 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 23 - Photo Point 1 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 23 - Photo Point 2 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 23 - Photo Point 3 TOP: May 9, 2018 BOTTOM: September 25, 2018

Site 23 - Photo Point 4 TOP: May 9, 2018 BOTTOM: September 25, 2018

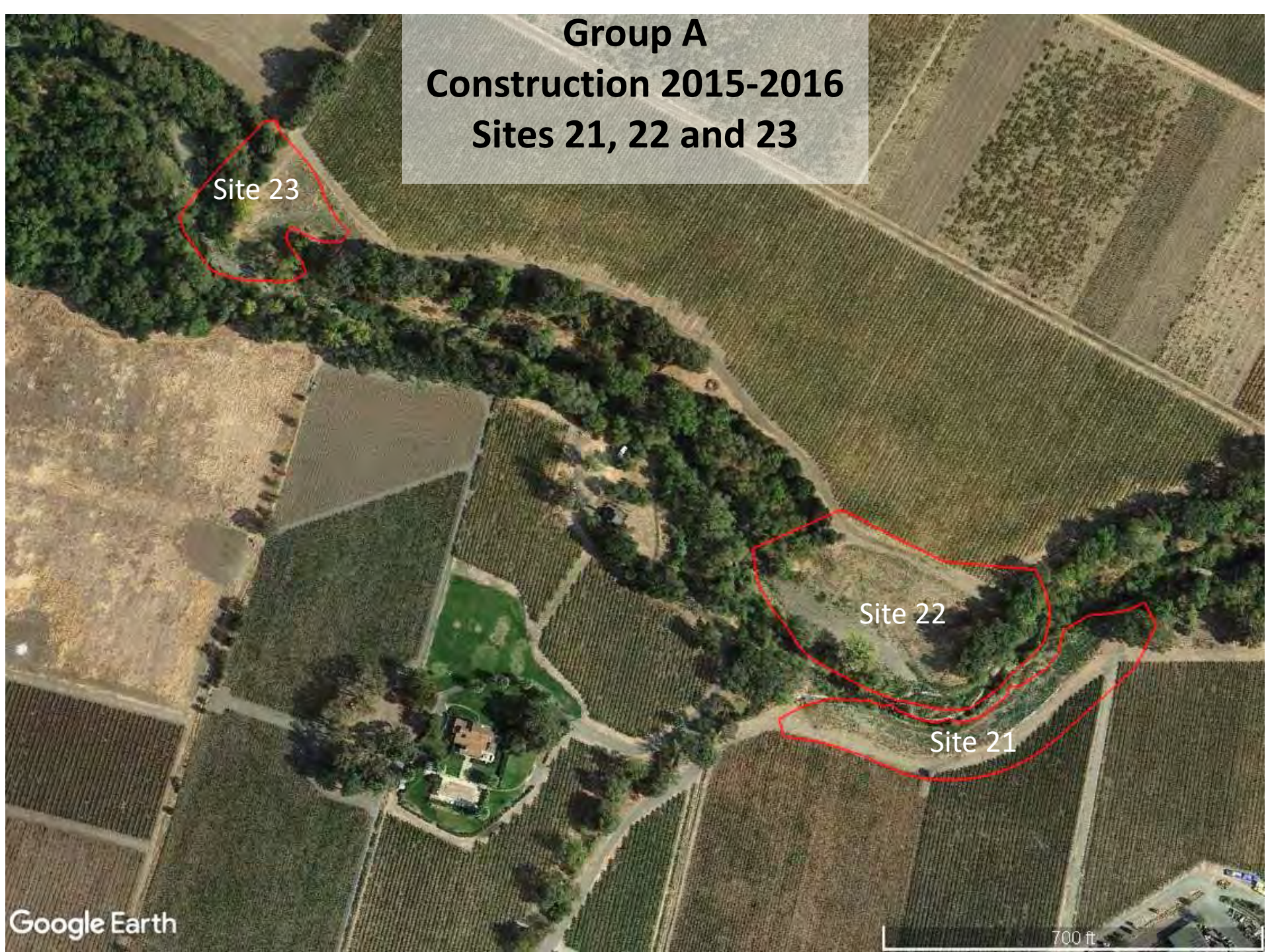
Table 1.0 – September 2018 Monitoring Even – Percent Cover Results

HABITAT	SITE 21 - % COVER			SITE 22 - % COVER			SITE 23 - % COVER			REZ - % COVER		
	NATIVE	NON-NATIVE	BARE	NATIVE	NON-NATIVE	BARE	NATIVE	NON-NATIVE	BARE	NATIVE	NON-NATIVE	BARE
River Wet Edge	Not Applicable			50	20	30	40	20	40	Not Applicable		
Lower Floodplain Bench				70	20	10	60	20	20			
Lower Riparian Slope	75	10	15	60	35	5	65	25	10			
Upper Riparian Slope	60	20	20	70	20	5	65	25	10			
Transitional Upland Oak Woodland	Not Applicable			50	15	5	65	25	10	60	40	0

Table 2.0 – September 2018 Monitoring Event – Total Survivorship Per Site and Habitat Type

HABITAT	SITE 21		SITE 22		SITE 23		REZ	
	Total Planted	Total % Survived	Total Planted	Total % Survived	Total Planted	Total % Survived	Total Planted	Total % Survived
River Wet Edge	Not Applicable		578	88.1%	248	87.1%	Not Applicable	
Lower Floodplain Bench			640	92.2%	116	93.1%		
Lower Riparian Slope	783	100.0%	1979	99.6%	1365	99.9%		
Upper Riparian Slope	1785	99.6%	2906	99.7%	1246	99.4%		
Transitional Upland Oak Woodland	Not Applicable		442	97.5%	658	98.9%	593	100.0%

Appendix D
Photographic Monitoring
2018


Group A
Construction 2015-2016
Sites 21, 22 and 23
Site 23
Site 22
Site 21
Google Earth
700 ft

Group A, Site 21

July 2016

September 2016

January 2017

May 2018

Group A, Site 21

July 2016

January 2017

May 2018

Group A, Site 21 and 22

Group A, Site 22

July 2016

July 2016

March 2017

September 2016

Group A, Site 22

September 2016

January 2017

July 2016

March 2018

Group A, Site 23

May 2017

September 2017

September 2018


Group C
Construction 2017-2018
Sites 12, 13 and 14
Site 13
Site 12
Site 14
Google Earth
1000 ft

Group C, Site 12 and 13

September 2017

November 2017

April 2018

September 2018

Group C, Site 13

September 2017

November 2017

April 2018

Group C, Site 13

September 2017

April 2018

April 2018

Site 13-Construction of Biotechnical Features

Live wood structure

Willow baffles

Bank stabilization-willow mattress

Floodplain feature

Group C, Site 14

September 2016

November 2017

May 2017

Group C, Site 14

September 2016

November 2016

September 2017

April 2018

Group C, Site 14

November 2016

April 2017

April 2018

Group C, Site 14

April 2017