

State Route 128 Russian River Bridge Bank Stabilization Project



Draft 2010 Annual Report

State Route 128 Russian River Bridge Bank Stabilization Project

On Route 128 at Post Marker 5.4

Sonoma County, California

Department of Transportation District 4

SON-128-PM 5.4

EA 1G810

File Number SPN-2010-00048 N

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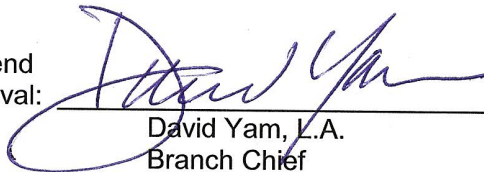
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STATE OF CALIFORNIA
Department of Transportation

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Executive Summary

The Russian River Bridge Bank Stabilization Project Annual Report presents the findings of the first season of post construction monitoring following construction of the improvements during September/October 2010. The Department submits the Annual Report to the resource agencies that issued permits or agreements for construction of the Russian River Bridge Bank Stabilization Project.

The purpose of the Project is to protect the western approach of the Russian River Bridge on State Route 128 from scour during high water winter storm events. The Project incorporated several design elements intended to reduce scour, re-direct channel flow, and provide habitat enhancements for fish and wildlife. These elements include the following:

- Longitudinal Peaked Stone Toe Protection (LPSTP) to reduce bank scour
- Rock vanes to redirect flows and realign the channel
- Willow plantings to shade aquatic habitat and increase roughness within the channel
- Woody material to provide fish habitat
- Overbank area (floodplain) construction above Ordinary High Water (OHW) with cottonwood and willow pole plantings

The Department monitored plantings for survivorship and percent cover. Survivorship is the number of plantings that survived this monitoring period. Absolute numbers or a percentage can express survivorship. Percent cover is a statistical calculation that conveys the relative abundance of plants in a sample population. The following table summarizes the results of the 2010-2011 plant monitoring.

| | | | | | |
|---|------------|---|--------------|---|---------------|
| 1 | Plantings | 2 | Survivorship | 3 | Percent Cover |
| 4 | Willows | 5 | -- | 6 | 95% |
| 7 | Floodplain | 8 | 70% | 9 | 18% |

During the first year after the mitigation project was constructed, the LPSTP structure (including the LPSTP, rock vanes, and upstream/downstream key-ins) performed as designed, in that it successfully re-directed flow away from the west bank of the Russian River, promoted the development of the river thalweg at the tips of the rock vanes, and deflected much of the hydraulic energy toward the middle of the channel. This served to reduce the erosive forces at the scarp during high flow events.

Acronyms

| | |
|-------------|--|
| ac | acre |
| CDFG | California Department of Fish and Game |
| Department | California Department of Transportation, District 4 |
| ft | foot, feet |
| EFH | Essential Fish Habitat |
| ESA | Endangered Species Act |
| FHWA | Federal Highway Administration |
| In. | inch, inches |
| LPSTP | Longitudinal Peaked Stone Toe Protection |
| LSAA | Lake and Streambed Alteration agreement (1602 permit) |
| LSWP | Live Siltation Willow Plantings |
| MMP | Mitigation and Monitoring Plan |
| MSFCMA | Magnuson Stevenson Fishery Conservation and Management Act |
| NMFS | National Marine Fisheries Services |
| NWP | Nationwide Permit |
| OHWM | Ordinary High Water Mark |
| PM | Post Marker |
| RSP | Rock Slope Protection |
| SR 128 | State Route 128 |
| USACE | United States Army Corps of Engineers |
| USGS | United States Geological Survey |
| WGS | World Geodetic System |
| Water Board | North Coast Regional Water Quality Control Board |

10 INTRODUCTION

The Annual Report provides project information, monitoring requirements, monitoring methods, results, discussion, and recommendations for adaptive management. This report provides sufficient background information and data to inform the agencies of the status of the original project and subsequent performance. The report also satisfies specific conditions within each permit.

The report uses the following structure:

- Project Information sets the context and scope of the Russian River Bridge Bank Stabilization Project.
- Resource Agencies and Permits describe the jurisdictional limits and regulatory requirements relevant to the Project.
- Planting and Vegetation Monitoring includes biological mitigation and monitoring objectives.
- Hydraulic Monitoring assesses the performance of the Project design.
- Discussion highlights important outcomes of monitoring.
- Recommendations are included to inform adaptive management decisions.

The report includes appendices with field data and supplemental information.

This is the first Annual Report. The number and content of subsequent reports is set within the terms and conditions of the permits and agreements. These permits and agreements have been included as supplemental information.

11 PROJECT INFORMATION

Large storm events occurred throughout Sonoma County beginning the week of January 18, 2010 that resulted in an increased flow velocity within the Russian River. The high flow volume and velocity eroded 50 to 60 feet into the west bank along a 70-foot length of river, just upstream of the Russian River Bridge or State Route 128 (SR 128) Bridge over Russian River in Geyserville. This portion of the bank has been actively eroding for several years. The bank erosion came within 10 feet of the toe beneath the bridge's western embankment approach. Caltrans' maintenance and hydraulics personnel determined that the approach to the SR 128 Bridge was put at risk from the bank erosion and could suffer structural damage resulting in bridge closure. Therefore, Caltrans determined that emergency repair work was needed.

11.1 Project Purpose and Need

The Project design elements decrease erosion and scour by slowing stream velocity along the bank and redirecting flow toward the mid-channel. Ultimately, the stream thalweg will realign itself away from the banks. In addition, the incorporation of willow and cottonwood plantings and submerged logs (woody material) enhances and restores riparian scrub habitat and fish habitat. The vegetation also serves to create roughness, which will reduce flow velocities as the vegetation matures.

SR 128 provides an important transportation link for Sonoma, Napa and Mendocino counties. The Project protects the Russian River Bridge crossing approach from undercutting through scour and erosion of the bank.

11.2 Project Location

The Project is located on the Russian River in the Town of Geyserville where SR 128 Bridge (Bridge No. 200288) crosses the Russian River at post marker (PM) 5.44 (see Figure 1). The location can be found on the USGS 7.5 minute Geyserville quad map, Township 10N, Range 9W, Section 11. The coordinates for the approximate center of the project are 38° 42'46.13" N, 122°53'47.65" W (World Geodetic System [WGS] 1984).

11.3 Project Description

The Project incorporated several design elements that are intended to reduce scour, modify the stream channel and provide habitat enhancements for fish and wildlife. These elements are described below.

11.3.1 Longitudinal Peaked Stone Toe Protection

Longitudinal Peaked Stone Toe Protection (LPSTP) provides a resistive material (rock) to protect against bank scour. The LPSTP structure allows stones to self adjust by launching well graded and washed rock into scour holes that may form. The rock mix is a combination of larger and smaller size stones that are well integrated with one another to minimize voids and crevices. The design included additional top width to provide

supplemental material when facial rock is lost to the stream bed load. Side slopes were constructed at 4:1 (H:V). The top of the LPSTP is set at the approximate elevation of the ordinary high water mark (OHWM).

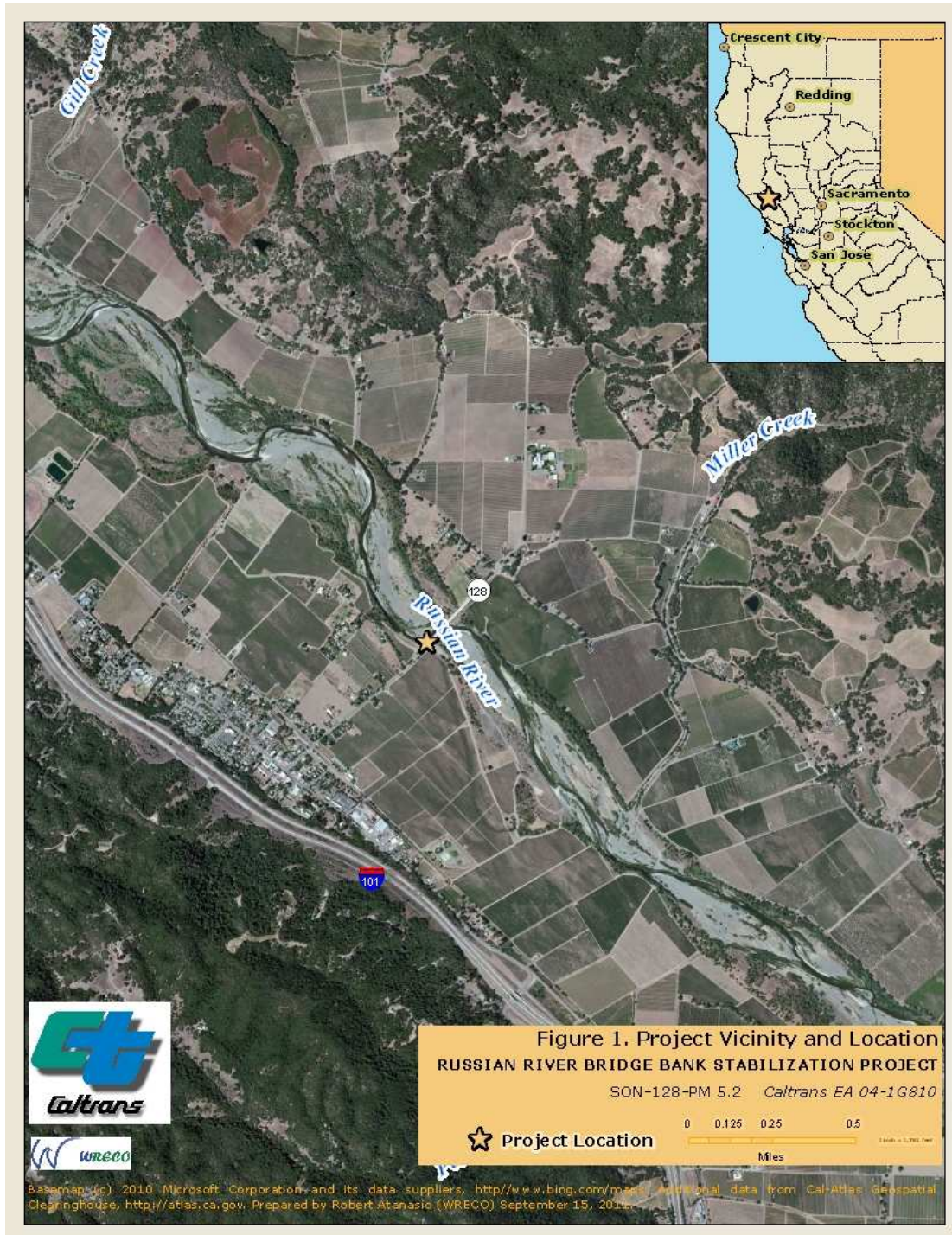


Figure 1. Project Location

Source: Microsoft and Cal-Atlas Geospatial Clearinghouse

11.3.2 Rock Vanes

Rock vanes are used to redirect flows and realign the thalweg of the channel out toward the tip of the vane. This re-direction of the flow creates a zone of quiet, low velocity water behind the vanes that is conducive for sedimentation and recruitment of woody vegetation. Five vanes were installed ranging in length from 33 to 27 feet measured at the downstream side of the vane from the LPSTP to the tip below water. The vanes are angled approximately 30 degrees upstream from the LPSTP and taper in height from the LPSTP so that each vane tip is below the ordinary low water mark. The thalweg will realign over time along a radius defined by the tips of the rock vanes. The quieter, slow water areas behind the vanes provide rearing and feeding habitat for fish. During high flow events, the vanes increase the complexity of the stream bed. This complexity dissipates stream energy and thus provides refuge for fish behind the submerged vanes during periods of increased stream flow (McCullah, John and Donald Gray. 2005. Environmentally Sensitive Channel-and-Bank Protection Measures. Transportation Research Board).

11.3.3 Riparian and Stream Habitat Enhancements

The LPSTP and rock vanes mitigate the physical effects of scour and erosion. Secondly, they benefit aquatic species by providing areas of eddy and back current conducive to resting and feeding. Caltrans also included specific design elements to improve stream and riparian habitat for listed species in the project area. These elements provide shading along the river bank, which benefits salmon and other fish species.

11.3.3.1 Live Siltation Willow Planting

Live siltation is a revegetation technique used to secure the toe of a slope and provide fish rearing habitat. This technique provides vegetative cover at the water level (Riley 1998). Siltation planting of live willow cuttings is continuous along the face of the LPSTP. The willows provide roughness that reduces flow velocities. The willow cuttings were harvested from around the river area. The diameters of the cuttings range from 3/4 inches (in) to 1.5 in. with a minimum length of 6 ft. The cuttings were laid in a 2 ft wide by 4 ft deep trench as shown on the plans. Given the proximity to the river, the bottom of the willows are in subsurface water, ensuring good wetting contact and capillary action. The trench was lined with drain rock and river bar alluvium mix. Larger cobble size rock and drain rock were placed over the bar mix material. Approximately 80% of the length of each willow cutting was buried and 20% exposed following backfilling.

11.3.3.2 Willow and Cottonwood Pole Planting

Caltrans planted 360 cottonwood and willow poles with diameters of 2 to 4 in. and a minimum length of 8 ft were planted in the overbank area (floodplain) behind the LPSTP. Caltrans harvested the poles needed for the revegetation from adjacent riverfront properties. To maintain existing riparian shading, Caltrans used willow and cottonwood poles harvested from above the OHWM. The planting crew left terminal buds on the cottonwood poles in place to maximize vegetative growth.

11.3.3.3 In-Stream Locked Logs (Woody Material)

Caltrans placed logs approximately 8-10 in. in diameter with trunk lengths of 15-20 ft behind the rock vanes. Burying the logs beneath the LPSTP locked them in place. They are angled at about 45° downstream and redirect flows and provide fish habitat and refuge.

11.3.3.4 Overbank Area (Floodplain)

Caltrans graded the existing river bank at a 2% rise to create a floodplain slightly above OHWM behind the LPSTP. Native bar material provided the backfill for the constructed floodplain area. Caltrans then planted the floodplain area with willow and cottonwood poles.

11.3.4 Adaptive Management

The Department developed an approach that addresses design performance issues over time. The objectives are to stabilize the bank and protect the bridge approach. Features are modified when circumstances arise which jeopardize these objectives. All proposed modifications are consistent with the original design and construction techniques used for the bank stabilization.

12 RESOURCE AGENCIES AND PERMITS

The Project required permits or agreements from several resource agencies with jurisdictional and regulatory authority in the project area. The Department secured all permits prior to Project construction. Copies of these permits and agreements are in Appendix A.

12.1 Federal Agencies

12.1.1 National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) is the authorized agency for Federal Endangered Species Act (ESA) Section 7 consultation on listed marine mammals, marine species and anadromous fish species. The Russian River provides spawning and rearing habitat for steelhead salmon and is designated Essential Fish Habitat (EFH). NMFS is also the authorized agency for consultation on EFH under the Magnuson Stevenson Fishery Conservation and Management Act (MSFCMA).

NMFS provided a letter of concurrence under the ESA and MSFCMA that the Project does not adversely affect listed species nor adversely alter EFH. There are no additional reporting requirements for NMFS.

12.1.2 United States Army Corps of Engineers

The United States Army Corps of Engineers (USACE) is authorized under Section 404 of the Clean Water Act (CWA) to issue permits for projects that will add fill or alter Waters of the United States. Under the Nationwide Permit (NWP) Program, USACE authorized the placement of fill within the Russian River for this project under NWP 13- Bank Stabilization.

As part of the conditions of the NWP, the Department is required to submit an annual monitoring report on planting and vegetation mitigation. The report is due to USACE on October 1 of each year.

12.2 State Agencies

12.2.1 California Department of Fish and Game

The California Department of Fish and Game (CDFG) provides Lake and Streambed Alteration Agreements (LSAA) for projects that will alter the waters, bed, bank or riparian corridor of a creek, stream or river. The LSAA is also referred to as a 1602 permit, though it is technically an agreement between the State and the project proponent.

The CDFG issued an LSAA for the bank stabilization project with conditions for plant monitoring and reporting and hydraulic monitoring and reporting on the LPSTP and rock vanes. Plant monitoring reports are due annually on December 31. The hydraulic monitoring report will be submitted on March 31, 2012 with the conclusion of two years of design performance under winter conditions.

12.2.2 North Coast Regional Water Quality Control Board

Under California's Porter-Cologne Water Quality Control Act, the North Coast Regional Water Quality Control Board (Water Board) is responsible for maintaining the health and beneficial uses of State Waters and under Section 401 of the CWA, certifying NWP's issued by USACE.

The Water Board issued a Water Quality Certification for the Project with the condition that the Department submit annual monitoring reports on the hydraulic performance of the design and plant monitoring. These reports are due at the end of each calendar year beginning the year after project construction.

13 PLANTING AND VEGETATION MONITORING

The Department submitted Mitigation and Monitoring Plan (MMP) to the agencies in September 2010. The MMP proposed a combination of qualitative and quantitative methods to assess plantings. The qualitative methods include evaluations of health, vigor, and survivorship. The percent cover of pole plantings provides a quantitative measure of success.

13.1 Monitoring Requirements

The MMP states that during an initial three-year plant establishment period, the Department will replace dead or dying cuttings or poles in the live siltation or floodplain planting areas. At the end of five years, at least four poles per linear foot of the siltation plantings will survive. On the floodplain, 70% of the willow/cottonwood pole plantings will survive and demonstrate 70% cover.

The Department will provide annual reports to the permitting agencies according to the conditions of each permit. The reporting schedule and required report content are summarized in Table 1.

Table 1. Permit reporting requirements.

| 14 | Report | Submittal | Permit Condition |
|-------------|------------|-----------|--|
| CDFG | Planting | 12/31/11 | 2.8 ...a [vegetation] monitoring report shall be submitted to CDFG by December 31 of each monitoring year |
| | Hydraulics | 3/31/12 | 2.9 ...permittee shall provide a written [hydraulics] report to CDFG for review by March 30, 2012 |
| Water Board | Planting | 12/31/11 | 5. ...[vegetation] monitoring reports, containing observations and photos taken throughout a three-year monitoring period, shall be submitted to this office annually. |
| | Hydraulics | 12/31/11 | 6. Caltrans shall monitor the LPSTP and rock vein structure...Monitoring reports shall be submitted to this office annually |
| USACE | Planting | 10/1/11 | 4. [Vegetation] Monitoring reports shall be submitted annually to the Corps. The first monitoring report is due October 1, 2011. |
| | Hydraulics | -- | -- |

14.1.1 Methods

Plant monitoring occurred during fall 2010 after construction and again in May and June of 2011. Monitoring was done to qualitatively assess survivorship and to quantify percent cover.

14.1.1.1 Survivorship Assessment

During the fall following construction, Caltrans evaluated plantings for vigor and vegetative growth. An initial assessment of survivorship used the persistence of living leaf tissue on the pole plantings, the formation of new buds or an increase in size of existing buds to qualify survivorship. Supplemental assessments used the presence of new leafy growth, fresh buds or flowering as indicators of survivorship. The table below explains the assessment qualifications.

Table 2. Assessment qualifications for survivorship.

| Condition | Description | Comments |
|-----------|--|--|
| Living | New budding, engorged buds, leafing or flowering evident | All poles evaluated after cutting and shortly after initial placement |
| Dead | No evidence of new growth or indications that buds or leaves have died | Some plantings may lose buds or leaves after planting but the stock remains viable |
| Damaged | Abraded bark, broken stock or leaves shredded | Further assessed as living or dead |
| Missing | Pole not found at planted position | If broken off near ground, the stock may be buried and still viable. |

Monitors applied the assessment criteria to the floodplain pole plantings but not to the live siltation plantings. The density and number of willows in the siltation plantings made survivorship assessments impractical. Monitors determined that coverage would provide better assessment criteria for the willow siltation plantings.

14.1.1.2 Percent Cover Assessment

The percent coverage of pole plantings was calculated using a modified point-line intercept methodology. This point-line intercept uses a transect line placed through a study area and a presence/absence technique. Random points along the line are sampled. If the line crosses vegetation at the sampling point, it is recorded as “present.” A percentage is derived by the ratio of positive sample points to total sample points (Madsen, 1999).

Overbank Area (Floodplain) Pole Plantings. The original planting design consisted of rows of cottonwood and willow poles on the floodplain area with little variation in offset between rows or plantings. This pattern can lead to over sampling or under sampling when doing a transect survey. To minimize these biases, transects were based on randomizing start and end points on two axis that define the floodplain area (Figure 2).

One axis is parallel to the river at the edge of the floodplain. The upstream end of this axis has a value of 0. A second axis originates at the 0 point and follows the bank-ward contour of the floodplain. Pairs of random numbers were generated and measured out along each of the axis. Monitors ran a tape between each number pair and sampled along this line at 1-foot intervals. A total of 17 transects were created and 579 points sampled (Appendix B).

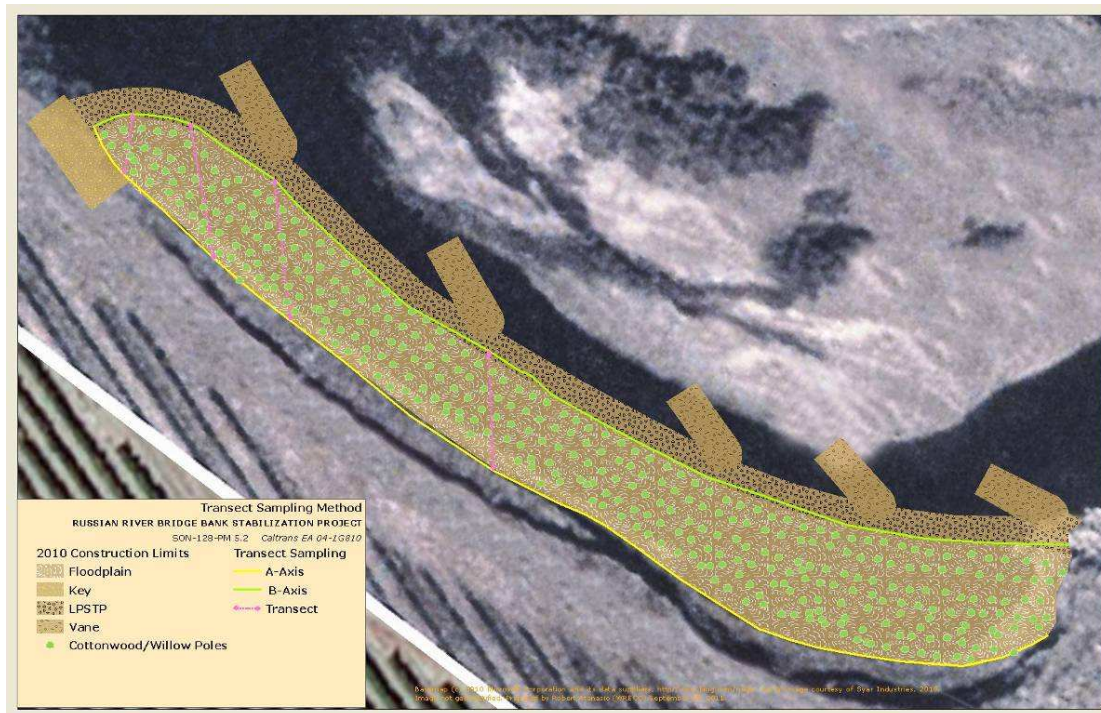


Figure 2. Transect Sampling

Live Siltation Willow Plantings. The siltation willow plantings were done in four dense groups along the channel side edge of the floodplain. The plantings are essentially linear, and more than ten willow cuttings were placed per linear foot. Percent cover of the siltation plantings was calculated using a single transect through the long axis of the planting areas. Samples were taken at 1-foot intervals along this transect. Any point sampled that had a living willow cutting was characterized as cover. Among the 4 siltation planting groups, 317 points were sampled (Appendix B).

14.1.1.3 Photo-documentation

Caltrans biologists established 18 photo-monitoring points in the floodplain and along the top of bank (Figure 3). Monitors used 14 photo-points to document the overall planting area while four photo-points specifically target siltation planting groups. One wide-angle photo was taken of the floodplain from each of photo-points 1-14. Monitors took up to two photos each at photo-points 1 and 15-18 to capture the siltation plantings adjacent to the point in both the upstream and downstream direction. The arrows in the figure indicate the approximate bearing of the photographs relative to the photo-point.

14.2 Planting and Vegetation Monitoring Results

The assessments indicate positive trends for survivorship and cover. In addition, the site shows recruitment of herbaceous plant species from local plant populations. These recruitments are similar in composition and distribution to adjacent sites.

14.2.1 Survivorship Assessment

The survivorship data is included in Appendix B and is summarized in the table below. Based on the criteria used, 70% or 246 of the pole plantings survived from the initial planting. Of the numbers that were assessed as dead, 36 were missing and are believed to have been destroyed during high water events during winter 2010-2011. Some pole plantings had been damaged, possibly during the high water events. Damage included stripped or abraded bark, snapped pole, and stripped leaves, buds or branches. The damaged poles were assessed as dead if no new growth was evident. However, these poles may still be viable and were simply dormant at the time of the assessment. Monitors will assess these individual poles during the fall 2011 monitoring to confirm whether the planting has failed.

Table 3. Survivorship assessment for pole plantings.

| Assessed Status | Count | % of Total Plantings |
|-----------------|------------|----------------------|
| Living | 246 | 70 |
| Dead | 60 | 17 |
| Damaged | 7 | 2 |
| Missing | 36 | 10 |
| TOTALS | 349 | 99* |

* Total is not equal to 100% due to rounding.

14.2.2 Percent Cover Assessments

Floodplain Pole Plantings. Data collected from transects is included in Appendix B. Based on the samples, the average coverage of the pole plantings across all transects is almost 19%. Herbaceous cover, which is a result of recruitment of local species, is 26%. Bare ground represents about 55% of cover. Table 4 summarizes the data across all transects and by individual transects.

Table 4. Percent cover results for pole plantings.

| Transect | Number of Sample Points | Cover Type ¹ | | | Percent Cover | | |
|--------------|-------------------------|-------------------------|------------|------------|---------------|--------------|--------------|
| | | C/W | H | BG | Plantings | Herbaceous | Bare Ground |
| 1T | 1 | 0 | 1 | 0 | 0.00 | 100.00 | 0.00 |
| 2T | 22 | 3 | 2 | 17 | 13.64 | 9.09 | 77.27 |
| 3T | 31 | 1 | 7 | 23 | 3.23 | 22.58 | 74.19 |
| 4T | 36 | 2 | 4 | 30 | 5.56 | 11.11 | 83.33 |
| 5T | 35 | 3 | 8 | 24 | 8.57 | 22.86 | 68.57 |
| 6T | 33 | 6 | 8 | 19 | 18.18 | 24.24 | 57.58 |
| 7T | 36 | 4 | 3 | 29 | 11.11 | 8.33 | 80.56 |
| 8T | 36 | 10 | 1 | 25 | 27.78 | 2.78 | 69.44 |
| 9T | 28 | 9 | 1 | 18 | 32.14 | 3.57 | 64.29 |
| 10T | 29 | 3 | 9 | 17 | 10.34 | 31.03 | 58.62 |
| 11T | 33 | 9 | 8 | 16 | 27.27 | 24.24 | 48.48 |
| 12T | 36 | 6 | 9 | 21 | 16.67 | 25.00 | 58.33 |
| 13T | 44 | 12 | 10 | 22 | 27.27 | 22.73 | 50.00 |
| 14T | 47 | 28 | 5 | 14 | 59.57 | 10.64 | 29.79 |
| 15T | 52 | 9 | 26 | 17 | 17.31 | 50.00 | 32.69 |
| 16T | 52 | 2 | 28 | 22 | 3.85 | 53.85 | 42.31 |
| 17T | 28 | 2 | 20 | 6 | 7.14 | 71.43 | 21.43 |
| Total | 579 | 109 | 150 | 320 | 18.83 | 25.91 | 55.27 |

1. Cover types: BG= bare ground, H= herbaceous, C/W= cottonwood or willow pole plantings.

Live Siltation Willow Plantings. Data collected from these transects is included in Appendix B. Total coverage of the willow plantings averages approximately 85.5%. Table 5 summarizes these results. However, a large section of the planting group furthest upstream (Group 1) appears to have been destroyed during the 2010-2011 winter high water events. Cover within this group was less than 30%.

Table 5. Live Siltation Willow Planting Percent Cover

| Group | Location | % Cover |
|---------|-----------------------|--------------|
| 1 | Upstream of Vane 1 | 28.57 |
| 2 | Between Vanes 1 and 2 | 93.75 |
| 3 | Between Vanes 2 and 3 | 98.76 |
| 4 | Between Vanes 3 and 4 | 95.32 |
| Average | | 85.48 |

14.2.3 Photo-documentation

The results of photo monitoring along with a map showing the locations of the photo-points are included in Appendix C.

15 HYDRAULIC MONITORING

15.1 Monitoring Requirements

As part of the mitigation project, the hydraulic condition of the project site had been monitored to observe physical characteristics of the installed LPSTP and bank restoration project to help evaluate the effectiveness and hardiness of the project. The observations compared the post project physical characteristics as they changed over time due to the evolving stream bed and bank conditions. Changes to the riverine conditions are expected as the rock vanes help to migrate the low flow channel away from the western bank, and the establishment of vegetation helps to slow overbank flow velocities. The following sub-sections discuss the various monitored items.

15.1.1.1 Inner Beds

The inner bed area is composed of bar material with sand backfill and willow stakes. The monitoring would need observation of survival rate of the willow stakes, potential debris accumulation at the willow stakes after storm event, and type of soil exposed on the ground.

15.1.1.2 Velocities

Based on the two-dimensional hydraulic analysis, local flow velocity where the willow stakes are planted should be less than 4 ft/sec. Monitoring of the local flow velocity during the high-intensity storm event will be required to verify that willow stakes will reduce the local flow velocity.

15.1.1.3 Thalweg Position

The LPSTP and angled rock vanes were installed at the Project location to help shift the shear stress associated with the low flow channel away from the western bank. The observations before the winter storm event showed a relatively shallow channel of limited width bordered to the west by the recently installed rock vanes and to the east by gravel bars with some willow vegetation. Observations during and after winter storm events showed the channel becoming deeper and wider toward the east with erosion of the eastern gravel bar material.

15.1.2 Methods

15.1.2.1 Field Visit

WRECO participated in site monitoring, which will be scheduled to coincide with or shortly after wet season high flow events. The five field trips in December, January, and March were performed either during the wet season high flow event or shortly after the high flow event. The field visits were also performed during the dry season to observe the vegetation growth of the willow stakes and cottonwoods installed on October 2011.

15.1.2.2 Webcam

A webcam was installed on the SR 128 bridge to monitor the condition of the project location from downstream. The webcam was replaced in January 2011 to provide a higher resolution image and to allow the camera to change its viewpoint. The webcam information was used concurrently with the USGS stream flow gaging stations in Cloverdale and Healdsburg, which provided real-time flow data to calculate the flow rate of Russian River at the Project location.

15.2 Hydraulic Monitoring Results

15.2.1 Vanes

The rock vanes installed at the Project location were composed of graded rock of various sizes ranging from $\frac{3}{4}$ Ton to smaller rock. Gravel was placed to fill in the voids and crevices at the surface of the vanes during installation. The smaller rocks, which were visible at the completion of the installation (see Photo 1) were washed away during the winter storm events (see Photo 2). The tips of the rock vanes were also washed away during the winter storm events. The live staked willows installed along the trench in front of the LPSTP structure survived the winter storm events and covered the top of the rock vanes during the site visits in August and September 2011.



Photo 1. Vane 2 (October 7, 2010)



Photo 2. Vane 2 (April 13, 2011)

During year one, the rock vanes fulfilled their purpose of shifting the low flow channel away from the western bank. This was even evident during construction when the opposite bar underwent scour due to re-directed flow. Previously, the summer low flows that were in contact with the western bank before construction (see Photo 3) were not in contact with the low flow after completion of the Project (see Photo 4).



Photo 3. West Overbank during the Construction (September 28, 2010)



Photo 4. West Overbank, Looking Upstream (September 17, 2011)

The low flow channel also shifted away from the western bank after the completion of construction in October 2010. The gravel bar on the middle of the channel has slightly shifted towards away from the rock vanes (see Photo 5 and Photo 6). In addition, the created overbank area was not eroded except for a portion between Vanes 1 and 2 at the upstream-most end of the constructed overbank area. The erosion was not excessive.



Photo 5. Low Flow Channel, Looking Upstream (October 09, 2010)



Photo 6. Low Flow Channel, Looking Upstream (September 17, 2011)

Based on the field visits, the extent of the thalweg shift caused by the vanes appears to be limited at the downstream key-in of the LPSTP where the channel makes a bend. Based on the field observations in October 2010 and September 2011, the direction of the flow downstream of the LPSTP did not change significantly during the wet season in year one (see Photo 7 and Photo 8).



Photo 7. Direction of Flow Downstream of LPSTP (October 09, 2010)



Photo 8. Direction of Flow Downstream of LPSTP (September 17, 2011)

Although the thalweg appears to angle toward the eastern bank downstream of the bridge, based on the aerial images dated 2003 and 2009, this direction of flow was present before the installation of the LPSTP and rock vanes (see Figure 4 and Figure 5). The thalweg location in the vicinity of SR 128 Bridge has not changed significantly between 2003 and after completion of construction in October 2010 (see Figure 4 through 7).



Figure 4. Aerial Image of SR 128 Bridge over Russian River, October 2003

Source: Google Earth



Figure 5. Aerial Image of SR 128 Bridge over Russian River, October 2009

Source: Google Earth



Figure 6. Russian River Upstream of SR 128 Bridge, October 13, 2010

Source: Caltrans



Figure 7. Russian River Downstream of SR 128 Bridge, October 13, 2010

Source: Caltrans

The monitoring will continue through year two to further observe the change in rock vanes and characteristics of low flow channel at the Project vicinity. The conditions of the rock vanes observed during the field visits throughout year one are shown on the following pages.

15.2.1.1 Vane 1

16



Photo 9. Vane 1 (October 7, 2010)



Photo 10. Vane 1 (January 11, 2011)



Photo 11. Vane 1 (April 13, 2011)



Photo 12. Vane 1 (September 17, 2011)

16.1.1.1 Vane 2



Photo 13. Vane 2 (October 7, 2010)



Photo 14. Vane 2 (April 13, 2011)



Photo 15. Vane 2 (September 17, 2011)

16.1.1.2 Vane 3



Photo 16. Vane 3 (October 09, 2010)



Photo 17. Vane 3 (April 13, 2011)



Photo 18. Vane 3 (May 10, 2011)



Photo 19. Vane 3 (September 17, 2011)

16.1.1.3 Vane 3a



Photo 20. Vane 3a (October 2010)



Photo 21. Vane 3a (April 13, 2011)



Photo 22. Vane 3a (September 17, 2011)

16.1.1.4 Vane 4



Photo 23. Vane 4 (October 7, 2010)



Photo 24. Vane 4 (January 11, 2011)



Photo 25. Vane 4 (April 13, 2011)



Photo 26. Vane 4 (September 17, 2011)

16.1.2 Western Bank

In the pre-project condition, the western bank of Russian River was in direct contact with the summer low flows. The project filled the existing low flow channel with bar material, sand backfill to create an overbank area (floodplain), and the overbank area was planted with willow and Cottonwood poles (see Photo 27). During the winter storm events, the western bank area (overbank area) was fully submerged (see Photo 28 and Photo 29). The channel flow velocities in the overbank area were generally slower than the flow velocity on top of the low flow channel. The smaller grain particles exposed at the surface were washed away during the winter storm events at the upper end of the west overbank area from Vanes 1 to 2, while deposition occurred along the lower bend of the overbank area from Vanes 3 to 4. The overbank area was stable throughout the field visits in spring and summer 2011, but the bar materials were exposed on the surface (see Photos 28 through 32).



Photo 27. West Bank, Looking Downstream (October 13, 2010)



Photo 28. West Bank, Looking Downstream (December 20, 2010)



Photo 29. West Bank, Looking Downstream (December 27, 2010)



Photo 30. West Bank, Looking Downstream (January 11, 2011)



Photo 31. West Bank, Looking Downstream, (April 13, 2011)



Photo 32. West Bank, Looking Downstream (May 10, 2011)



Photo 33. West Bank, Looking Downstream, (July 7, 2011)



Photo 34. West Bank, Looking Downstream (September 17, 2011)

16.1.3 Upstream Key-in (Access Backfill) – Brush Layering

The upstream access into the site was backfilled (keyed-in) as the final grading component of the summer 2010 improvements. The purpose of the key-in was to secure the upstream end of the LPSTP into the existing bank. The backfill was composed of layers of rock slope protection (RSP), native soil and layered willow stakes (mostly Arroyo willow) (see Photo 35). There is existing vegetation on the upstream side of the upstream key-in (see Photo 36 and Photo 37). The channel flow velocity of the upstream key-in area during the winter storm events was approximately 4 ft/sec when the main channel flow velocity was over 10 ft/sec. Because of the reduced flow velocity and dense vegetation upstream of the access backfill, no major damage to the RSP and layered willows was observed during the field visit after the winter storm events (see Photo 37 and Photo 38). The willows are growing and appear to have been established within the embankment backfill.



Photo 35. Upstream Key-In (October 13, 2010)



Photo 36. Upstream Key-In (December 17, 2010)



Photo 37. Upstream Key-In, (April 13, 2011)



Photo 38. Upstream Key-In, (July 07, 2011)

17 DISCUSSION

17.1 Planting and Vegetation

The results of first year monitoring suggest that the success criteria are likely to be met by year five. However, the plantings remain vulnerable to winter high water events. Recruitment of herbaceous plant species onto the project site can provide additional roughness to the overbank area (floodplain) and vanes. This roughness may be beneficial during high flow events because it serves to slow and dissipate stream flow.

Monitoring in fall 2011 will focus on evaluating the health and vitality of existing plantings and recruitment of vegetation from surrounding areas. Other shortcomings of the first year monitoring will also be addressed.

17.1.1 Plant Mortality and Natural Recruitment

The Department will evaluate the need for replacing pole plantings that were assessed as dead or missing during the June 2011 survivorship survey. As part of adaptive management, the site is revegetating readily and adjusting to new flow conditions. In addition, natural recruitment of riparian vegetation is occurring and will continue to populate the site. Monitors will conduct a second survivorship survey in fall 2011. If plants assessed as dead in 2010 exhibit new budding, leafing or new stem emergence from the stock, they will remain in place and be recorded as living. Monitors will not revise data sheets from the June survey, but will note the reason for the change in assessment in the fall survey data sheets.

17.1.2 Transect Methodology

The original transects were not geo-referenced as part of the survey protocol. In order to provide consistency for future assessments and surveys, the start and endpoint as well as the pathway of both transects will be established in the field and identified with durable markers. To insure consistency, the original monitors will assist in re-establishing transect axis.

17.1.3 Photo-documentation

The initial photo-points were not geo-referenced, which could lead to inconsistency in future documentation efforts. To correct for this short-coming, the photo-points will be geo-referenced during fall 2011 surveys. Consistency with the original photo-points will be maintained by using the same model camera and settings and comparing the framing of a live shot with a printed image taken for the June 2011 monitoring.

17.1.4 Adaptive Management

In the winter of 2010-2011, high water events continued to scour a crescent shaped area at the bridge approach approximately between Vanes 3a and 4. The Department proposed a design to address the scour and erosion. The work was permitted in July 2011 and completed in August 2011. Appendix D provides a description of this work.

Essentially, the embankment reconstruction implemented during the end of the 2010 work was implemented at the scoured crescent area. Rock, native soil and layered willows were installed in an alignment to smooth out the hook-shaped bend and to restore the embankment to a 2:1 (H:V) slope.

17.2 Hydraulic Performance

During the first year after the mitigation project was constructed, the LPSTP structure (including the LPSTP, rock vanes, and key-ins) performed as designed, in that it promoted the development of the river thalweg at the tips of the rock vanes, and it deflected much of the hydraulic energy toward the middle of the channel. This served to reduce the erosive forces at the scarp during high flow events. The bathymetry of the channel was recently surveyed and will be discussed later in this report. Site inspections were performed periodically during the year including one on December 29, 2010 during an estimated two-year event when the water surface elevation was approximately 20 inches below the top of the bank. Oranges were thrown at various points between the upstream and downstream ends of the site, and velocities were calculated. The velocities were slower closer to the west bank, showing that the vanes were performing as intended. As vegetation matures and plant density increases, the additional roughness is expected to slow the flow velocities over time.

17.2.1 Rock Vanes

The rock vanes performed as intended throughout the first year of monitoring. However the tips of the vanes, and the smaller rocks within the vanes were observed to deteriorate and wash away during the high flow events. The deterioration was expected and is a sign of the adjacent thalweg developing in depth and breadth as the vanes adjust to yearly flows. The condition of the vanes is not expected to experience further significant degradation, as the remaining structure of the vanes is made up of primarily large rocks, and the thalweg has developed. The vanes will continue to be monitored and observed from the winter of 2011 to spring of 2012 following high flow events to document further changes in conditions and identify any concerns that may arise. The need for further work to enhance or restructure the rock vanes with RSP will be assessed following review of recent bathymetry surveys. If the vanes appear to have uniformly shifted and settled into the river bed, then the need to perform any further work may not be necessary.

17.2.2 LPSTP

For the most part, the LPSTP embankment was unchanged from the post construction. One area, between Vanes 1 and 2 at the upstream end, did see some changes, where the LPSTP angles out from the bank at the upstream key-in location. The changes observed include some erosion of the fine materials and development of an approximately 10 ft diameter, 1-3 foot deep bowl within the planted overbank area, adjacent to the upstream curve of the LPSTP. This depression was observed early in the 2010/2011 wet season, and it did not develop significantly. The condition of the LPSTP should continue to be monitored and documented.

17.2.3 Upstream Key-in (Access Backfill)

Aside from the development of the vegetation, the upstream embankment reconstruction, located at the upstream end of the LPSTP, appears to have little or no change over the 2010/2011 wet season. This would indicate that the bank at this location was sufficiently protected from scour and deterioration. The upstream key-in will continue to be monitored. Willows are growing readily without any irrigation.

17.2.4 Scarp (Downstream Crescent Area)

During the 2010/2011 wet season, the scarp was observed to lay back further from the pre-project condition. The slope of the layback appeared to be approximately 1:1 (H:V) and flatter, while the height of the slope ranged from 3-7 ft. The remaining vertical scarp height ranged from 2 to 5 ft. From observation, the top of the slope correspond closely to the observed winter high water mark. The laid-back slope below the scarp appears to be made up of primarily deposited material, including woody debris, sand and gravel, while the vertical scarp material appeared to be mostly clayey material. This corresponds with the slow velocity flows observed at the scarp during high flows. During the summer of 2011, additional bank stabilization work was performed, and the scarp for much of the project area was removed from the Project location. The new key-in and new work will be monitored to document its performance over the remainder of the mitigation monitoring period.

17.2.5 Upstream Key-in and 2011 Downstream Embankment Reconstruction

The upstream key-in was observed to function adequately throughout the 2010/2011 wet season, despite the significant high waters and high velocity flows it experienced. During the summer of 2011, additional bank stabilization work was performed downstream at the scoured crescent area as described earlier. The modification included an embankment reconstruction and a new key-in to the existing bank above the OHWM. The 2011 work will be monitored to document its performance over the remainder of the mitigation monitoring period. See attached for Summer 2011 design plans. (As-builts are to be developed).

17.3 Stability of Existing RSP at Abutment

The existing RSP currently protecting the west abutment and west approach of the SR 128 Bridge over the Russian River was installed in late January 2010 under emergency conditions without engineered backing or geotextiles (Photo 39 and Photo 40). The existing RSP appears to be shifting, and it has voids that allow water to freely circulate behind. This allows the in-situ fines below and behind the RSP to be eroded, particularly during the drawdown after high flow events. The existing RSP is not considered stable or sufficient during high flow events.



Photo 39. Existing RSP (October 9, 2010)



Photo 40. Existing RSP (September 17, 2011)

Although the Project has successfully diverted the main force of the Russian River away from the western escarpment during high flows, the steep ungraded RSP extending from the SR 128 Bridge abutment to the LPSTP is a concern for failure. Slope failure will result in exposure of erodible material and shifting of flow patterns. If a wide scale failure of the RSP slope occurred, some energy of flow during high flow events may divert to the west and put the recent bank stabilization work and bridge approach at risk. Preliminary design work is under way to assess alternatives for reconstruction at this location. Early analysis shows that RSP re-engineering could result in an approximately 25 to 30 ft encroachment further into the river channel (see Figures 8 and 9). This may not be an acceptable preferred solution due to the extent of encroachment into the channel. Other alternative options are being explored.

17.3.1 Adaptive Management Alternative Options

The overall objectives of the improvements are to stabilize the bank and protect the bridge approach. Based on site monitoring, the LPSTP, rock vanes, and revegetation efforts have made significant progress in attaining the bank stabilization objective. The 2011 Adaptive Management – Streambank Repair and Stabilization Project -- further advanced the stabilization and rehabilitation of the channel banks. As discussed, the steep ungraded RSP extending from the SR 128 Bridge abutment to the LPSTP is a concern for failure. Should this RSP fail in a high flow event, there is a potential for erosive forces to get behind the abutments and potentially erode the western approach to the SR 128 Bridge. As such, the overall protection of the bridge approach is still of concern, and design options for construction work in summer 2012 are being considered. These options include: a) Replacement of the existing RSP Revetment, and b) Extension of the upstream bridge abutment wingwall.

17.3.1.1 Replace Existing RSP Revetment

As discussed, replacement of the existing RSP revetment with an engineered RSP revetment may provide stable long-term protection, but it would also result in a significant incursion into the channel. The preliminary engineering of an RSP revetment determined that the design would include 2-Ton rock revetment with either a mounded or

embedded toe. The installation would include an inner layer of ½ Ton RSP, overlaid on a Backing No. 1 with RSP fabric. Figures 8 and 9 indicate a cross section of the existing thalweg and RSP revetment based on bathymetric and topographic surveys performed in early 2011.

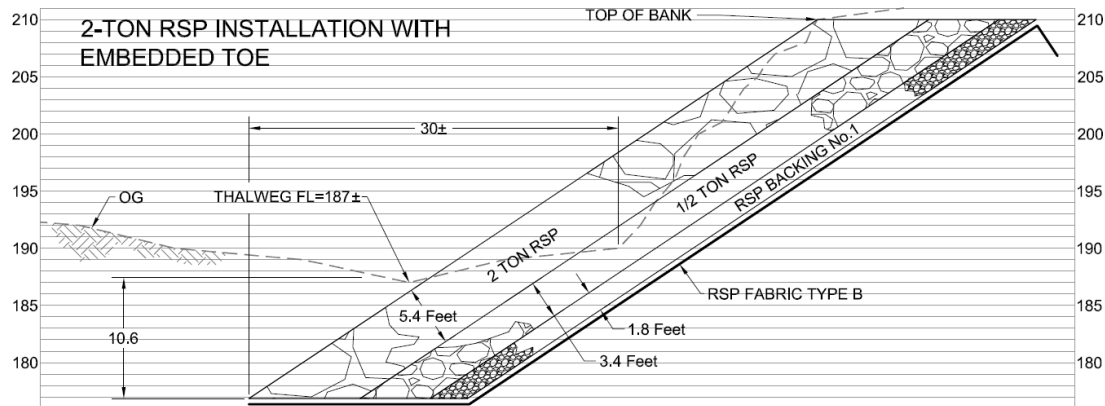


Figure 8. Engineered RSP with Embedded Toe

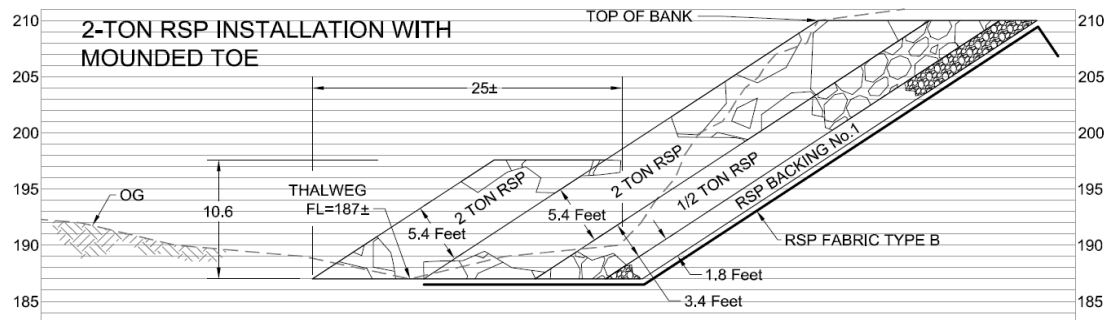


Figure 9. Engineered RSP with Mounded Toe

Holding the approximate top of bank is important to retain as much of the existing embankment so that any slope improvements do not encroach any closer to the roadway prism of SR 128. As indicated in the figures, an engineered RSP slope installed at 1.5:1 (H:V) slope would intrude approximately 30 feet into the channel in the embedded toe design, and 25 feet in the mounded toe design.

Other options for reinforcing this slope have been considered:

- Tree revetments
- Live stakes
- Vegetated biogrids
- Rock gabions

Because of the submergence of existing rock, instability of the RSP face along the slope and potential for very high flows, flow depths and velocities, the biologically engineered options are not suitable. The rock gabion option would allow for steeper slope

installation, but the wire mesh of gabion baskets has environmental drawbacks such as risks to fish and wildlife.

17.3.1.2 Wingwall Extension and Buried Rock

To achieve a similar level of protection as the RSP revetment replacement, another option was considered: The existing upstream wingwall at the west approach can be extended behind the existing RSP revetment in a manner to provide a last line of defense for the SR 128 Bridge approach against scour and erosion. As the installation would be out-of-the-water work, the environmental impacts would be low and would still provide an efficient and effective protection of the roadway approach against scour and erosion.

The extended wingwall will be formed by concrete beam, precast concrete blocks, and concrete cap. The wingwall will be extended by approximately 150 feet. The top of extended wingwall elevation will be at 212.0 ft, roughly matching the natural grade in the vicinity of the bridge approach. The wall depth will conform to the bottom of existing wing wall. A total of 18 30-inch cast-in-steel-shell (CISS) piles with 8 ft interval will be used as a foundation to support the proposed wingwall structure. CISS concrete piles are driven pipe piles that are filled with cast-in-place concrete with a reinforcing steel section no deeper than the shell tip elevation. The CISS pile depth would be up to 40 ft below the bottom of the extended wingwall.

The CISS piles are typically installed by high torque fixed mast rigs. For the extension of the wingwall, it is proposed that 30-in.diameter shafts will be installed at 96-in. centers. This pile installation method is particularly suitable for excavations close to roads and bridges.

The wingwall extension was identified by the Department as one alternative for long term protection of the roadway approach to the western abutment of the SR 128 Bridge. Installation of this design in the summer of 2012 would be advancing future strategies for long term protection. We will also investigate implementation of compaction grouting of the soil prism on the road side of the extended wingwall. The investigation will look into the suitability of compaction grouting to slow or eliminate the risk of subsidence of supporting soil in the event the wingwall extension is exposed to undermining forces.

As discussed, the existing RSP will eventually fail and self launch into the river. However, with the recent embankment reconstruction in place, and proposed installation of a buried rock wall perpendicular to the extended bridge wingwall that conforms to the recently reconstructed embankment, any redirected flow due to self launching into the river will resist flows that may seek to scour the embankment to the west (see Figure 10).

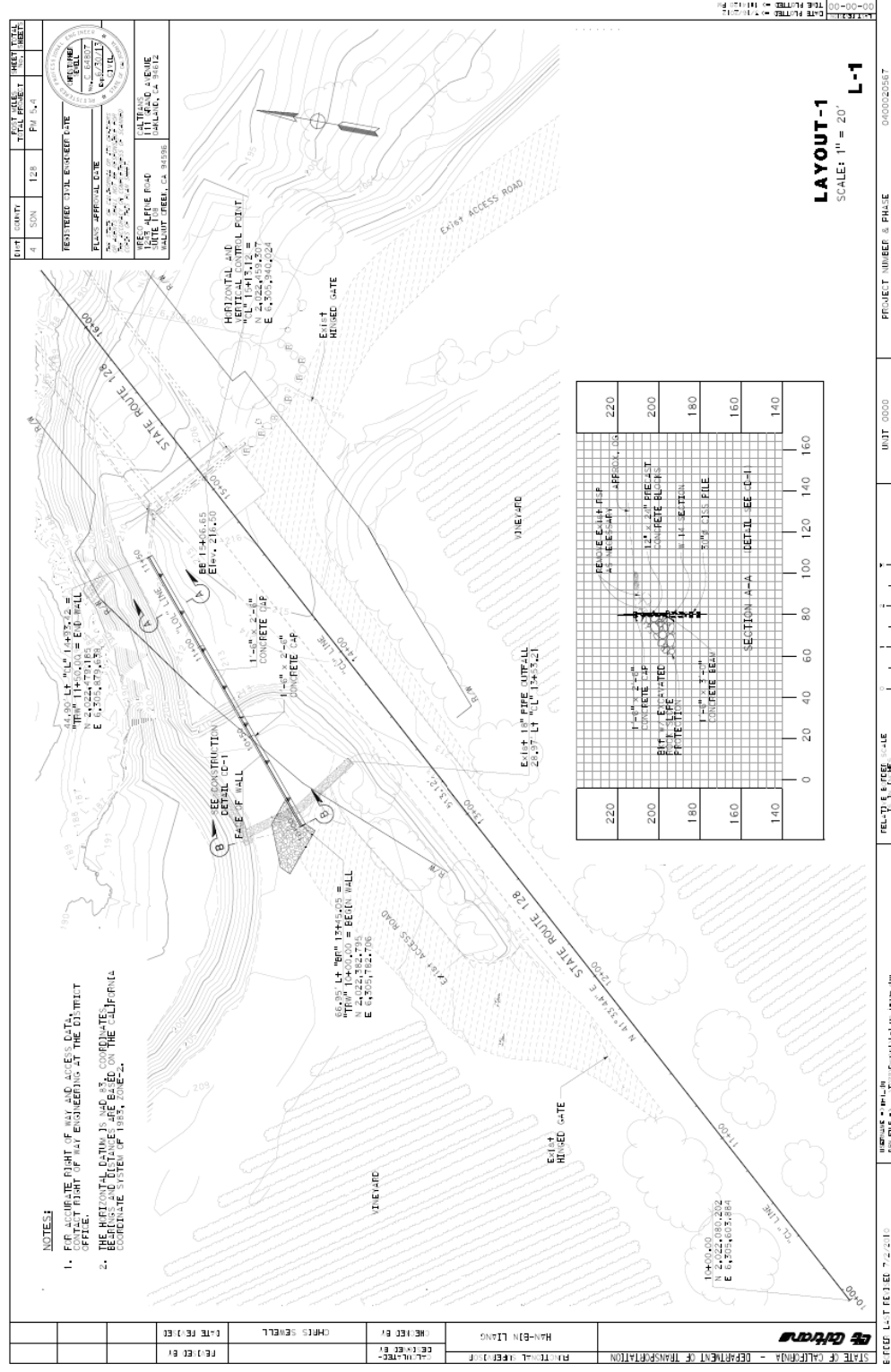


Figure 10. 2011 Reconstructed Embankment and Proposed Wingwall Extension

17.4 September 2011 underwater monitoring

The Department conducted underwater surveys to assess the bathymetric changes to the river bottom following 2010/2011 high water flows. The results indicate that flow line adjustments have occurred which show the flow line maintaining its location just beyond the tips of the existing vanes, but shifts back to the bank quickly past the last downstream vane as shown in Figure 11. A deepening of the river bottom occurs below where the existing RSP is located, which is evident in the blue coloration also shown in Figure 11. Based on this information, it is presumed that the existing RSP will eventually fail during high flows and rock will self launch into the deepened area . .

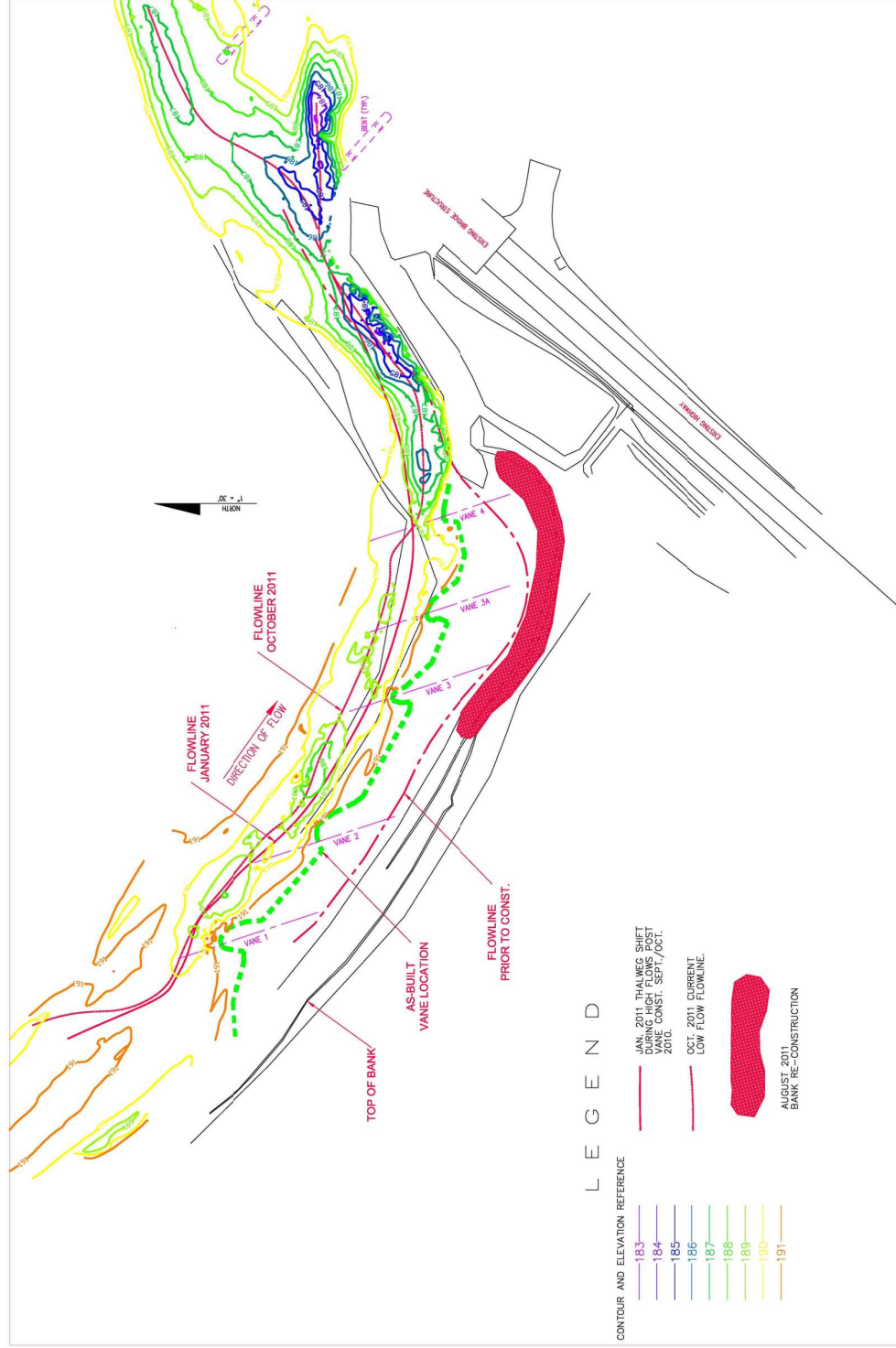


Figure 11. Comparison of January 2011 and October 2011 Thalweg

18 RECOMMENDATIONS

Aside from continued monitoring and documentation of the evolving conditions at the mitigation site, some adaptive management strategies could be adopted to promote the long term success of the State Route 128 Russian River Bridge Bank Stabilization Project.

The overall survival rates of approximately 70% for the pole plantings and 85% for the live siltation willows meet the performance criteria indicated in the MMP.

Although portions of the rock vanes at the tips are designed as somewhat sacrificial, the observed degradation could be repaired to promote the eastward migration of the thalweg. However, the benefit of enhancement may not be warranted, as the river has already been re-directed away from the west bank. The vanes will be monitored accordingly to assess any further degradation.

Replacing existing RSP with an engineered RSP revetment, extending upstream of the abutment and vertically below the toe of slope within the river will result in approximately 25-30 feet of encroachment further into the channel. This kind of impact may not be acceptable as a viable solution.

The wingwall extension behind the existing RSP would provide additional protection to the roadway approach to the west abutment of the bridge. Installing a buried rock wall that connects to both the wingwall extension and the reconstructed embankment in 2011 will help to prevent any further bank scour to the west by self launching of the proposed RSP.

Our current interpretation of recent monitoring, underwater surveys and preliminary re-engineering of the existing RSP suggests that the combination of a wingwall extension behind the existing RSP along with a buried rock wall is the preferred recommended work for summer 2012. This recommendation would involve no in-water work.

19 REFERENCES

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