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Butano Creek Channel Reconnection & Resiliency Project

Project Completion Report

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Reference Permit IDs

RWQCB: CIWQS Place ID 846937

USACE: Corps File No. 2018-00199S

USFWS: BO USFWS#08ESMF00-2018-F-3038

CADFW: #1600-2018-0137-R3 Butano Creek

NMFS: BO NMFS No. WCR-2018-9858

Butano Reconnection Project Photo Monitoring Summer / Fall 2019

Eight photo monitoring points were established for phase 1 of the Butano Reconnection Project. Each of these points was located on opposite sides of the existing and proposed channel of Butano Creek. At each of these points a photo was taken both upstream and downstream following the vegetation clearing that occurred in September of 2018 (see phase 1 photo monitoring).

For phase 2 an additional 8 photo points were established on the left bank of Butano Creek. At each of these photo points, one photo was taken upstream and another downstream. In addition to these paired photos, 3 other points were established with only one photo taken at each, they are number 17, 18, and 0 (See map below). With the exception of photo point 0, which was established relatively late in the project, the rest of the sites were documented starting on June 18th, and then periodically through October 15th.

In addition to these sites and the photos displayed here, two game cameras were mounted near the pedestrian bridge and adjacent to photo point 10. These cameras took two photos each day for the duration of the project and remain in place. Because of the large number of images these cameras captured they are not presented here, but are available in digital format upon request.

Sites were chosen to provide thorough coverage of the excavation, and due to this distinctive features can often be seen from different angles in more than one photo.

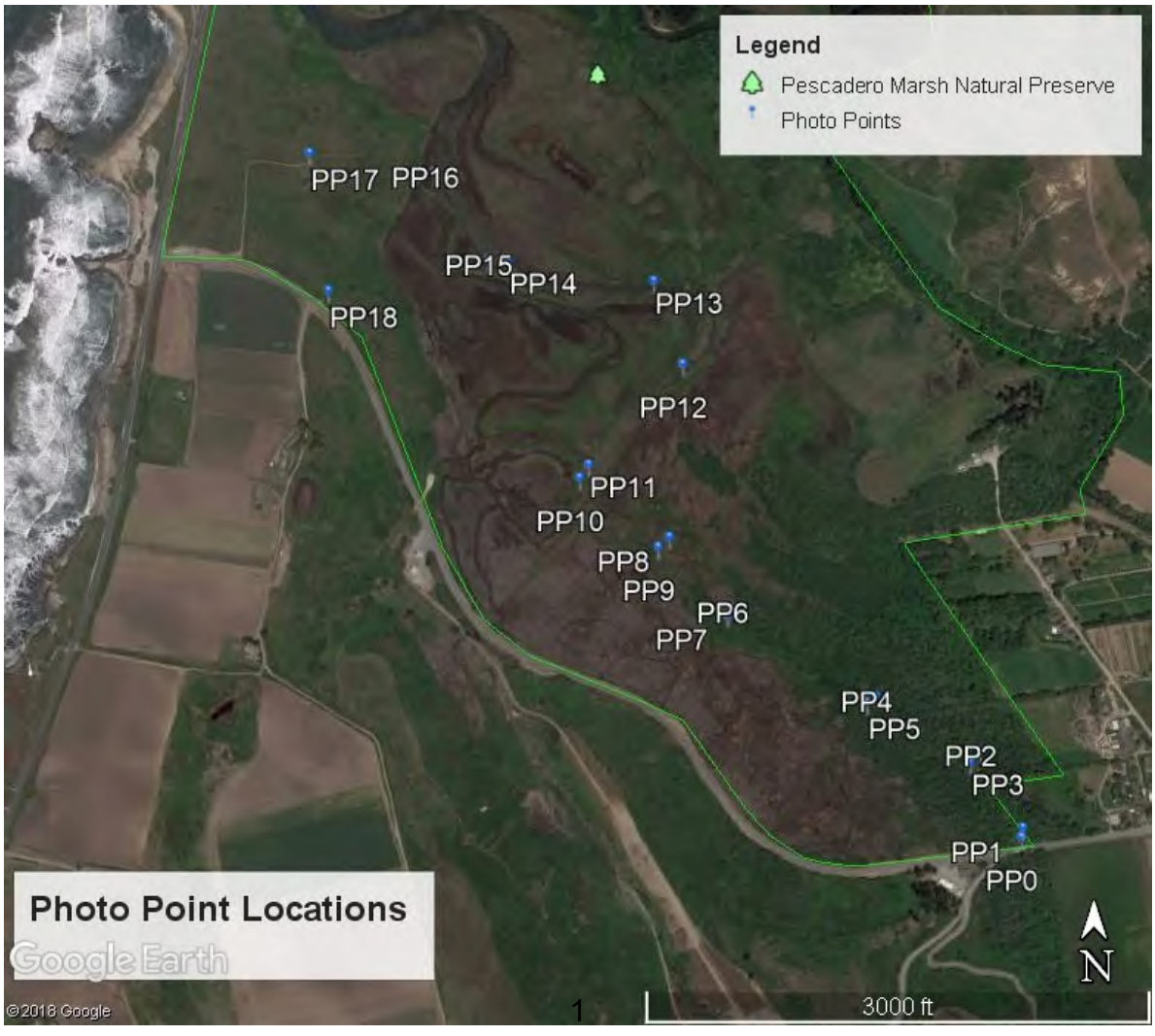

Photo Point Number

0/1

Upstream

Downstream

Photo Point Number

2

Upstream

Downstream

Photo Point Number

3

Upstream

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4

Upstream

Downstream

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Photo Point Number

16

Upstream

Downstream

Photo Point Number

17 /18

Upstream

Downstream

Butano Channel Reconnection Project 2019: Relocation and dispatch of sensitive and exotic species during construction

A significant effort to remove and then exclude sensitive aquatic species from the construction site was undertaken on June 6th. Due to the size and complexity of the project a similar effort was not attempted for terrestrial species. Instead, biological monitors were present for all ground disturbing activities in new locations, all vegetation removal, and installation of exclusion fencing. They conducted sweeps of staging areas and the project site, and were present for the installation of all coffer dams and dewatering.

During the course of this work multiple listed and common species were removed from harm's way and relocated either outside of the bounds of the project, or into areas within the project that were not disturbed. Below is a chronological list of these relocations.

In addition, due to the number of immature American Bullfrogs detected during the project, a focused, nocturnal effort to reduce their numbers was made on two occasions. This resulted in the removal of more than 50 juveniles of this species. No adults were detected.

June 6th, 2019 Animals captured 100' downstream from the boat launch. Relocated to Pescadero Creek below Nunzati Hill.

- 2 Western Pond Turtles Adult Female

June 10th, 2019 Animals captured at junction of reach 2 and 3. Relocated to off channel area in upper portion of reach 3.

- 2 California Red-legged Frog (CRLF)adult
- 3 CRLF larvae
- 1 Aquatic Garter Snake

June 11th, 2019 Animals captured at bottom of reach 3. Relocated to Pescadero Creek

- 1 Steelhead fingerling
- 1 CRLF sub adult
- 4 American Bullfrog larvae (dispatched)

June 12th, 2019 Animals captured 500' downstream of Pescadero Rd. Bridge

- 1 Red-eared Slider adult female (dispatched)
- 1 American Bullfrog sub adult (dispatched)

June 13th 2019 Animals captured 200' downstream of Pescadero Rd. Bridge. Relocated upstream of bridge.

- 1 CRLF adult
- 3 American Bullfrog sub adults (dispatched)

July 9th, 2019 CRLF moved from lower section of reach 3 to Butano Marsh above fill area.

- 1 CRLF

July 25th, 2019 San Francisco Garter Snake (SFGS) moved from 200' above the triple junction to area above the Pescadero maintenance yard (See attached map). CRLF moved from lower section of reach 3 to Butano Marsh above fill area.

- 1 CRLF
- 1 SFGS sub adult male

July 31st, 2019 Animals moved from below boat launch to upper Butano Marsh above fill area.

- 1 CRLF adult

August 6th, 2019 Animals moved from upper staging area to area above the Pescadero maintenance yard. (See attached map)

August 14th, 2019 Animals moved from lower portion of reach 3 to Butano Marsh upstream of the fill area.

- 1 CRLF adult

August 21st, 2019 Animals moved from upper floodplain berm to Butano Creek upstream of the project.

- 1 CRLF adult
- 6 American Bullfrog larvae (dispatched)

August 22nd, 2019 Animals moved from intersection of reach 2 and 3 to upper Butano Marsh above fill area.

- 1 CRLF adult

August 31st, 2019 Animals moved to completed section of reach 3 downstream of Pescadero Road Bridge.

- 1 California Newt
- 2 CRLF adults
- 1 CRLF sub adults
- 3 CRLF young of the year
- 7 American Bullfrogs juveniles (dispatched)

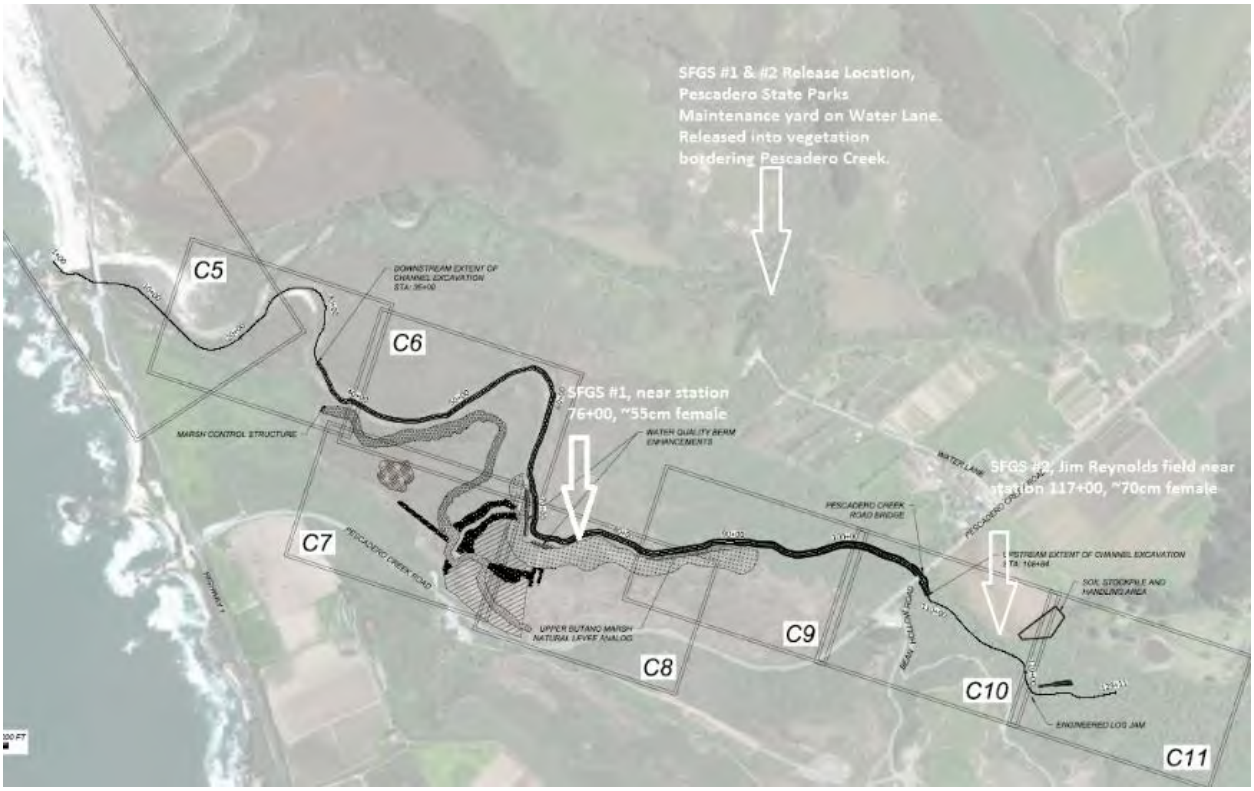
- 1 Crayfish immature (dispatched)

September 17th, 2019 Animals removed from upper staging area. Animals likely removed from creek during excavation just downstream of Pescadero Road Bridge.

- 20 American Bullfrog young of the year (dispatched)

September 18th, 2019 Animals removed from upper staging area. Animals likely removed from creek during excavation just downstream of Pescadero Road Bridge.

- 17 American Bullfrog young of the year (dispatched)



Butano Creek Reconnection Project 2019: Water Quality Report

Summary of water level management

During the course of the Butano Reconnection Project, the contractor Hanford ARC (HARC) actively managed water levels by draining or flooding the work site to meet the needs of the project. On June 18th and 19th, HARC installed two turbidity curtains and a steel sheet pile dam, referred to as water control structure 1a (WCS 1a). WCS 1a was located at the downstream end of the project with two gated culverts positioned at approximately 5.0 ft (NAVD88). Upon completion of WCS 1a, flows from Butano creek began to back up within the project site. HARC actively managed water levels from June 19th to August 15th using two 6" pumps positioned adjacent to WCS 1a. One pump discharged project water onto the "nub" marsh plain (See attached map). While the other pump discharged project water into Butano Creek directly downstream of WCS 1a. From August 15th-Oct. 5th, water levels were passively managed by opening the culverts that conveyed water above 5.0ft through WCS 1a. This maintained an average water depth of 3 feet or more within the project site, which allowed the dredge to operate. On July 5th, HARC installed vinyl sheets at the confluence of Butano channel and Butano creek, referred to as WCS 1b. A single 6" pump was deployed to drain the Butano channel which allowed for the placement and settling of sediment being dredged from the creek. On Sept. 18th, HARC removed WCS 1b, allowing water backing up within the project to spill over the newly installed marsh control structure (MCS) and flood the Butano channel. On Oct. 5th, WCS 1a was removed, allowing creek flows and tidal influence to move unhindered throughout the project site.

Methods

To ensure that the project was not adversely affecting sensitive aquatic resources, biomonitoring staff measured certain water quality (WQ) parameters before, during and after the project. Since 2015, WQ parameters including: dissolved oxygen (DO), temperature (T), and salinity (S), have been recorded within the Pescadero Lagoon Complex (PLC) on a weekly basis by CA Dept. of Fish and Wildlife (CDFW) and Department of Parks and Recreation (DPR) staff. These data were used as a baseline for DO to compare with the project discharge water. DO within the PLC fluctuates drastically in a diurnal pattern. During the day, submerged aquatic vegetation actively contributes DO to the water column with peak concentrations recorded around the evening. After sunset that same vegetation that acted as a DO source then begins to respire and actively consume DO within the water column. Monitoring staff observed this fluctuation throughout the duration of the project and attempted to discern the natural low points in DO from those induced by project activities.

Turbidity measurements, required by the 401 Certification, have never been systematically recorded within the Pescadero lagoon complex. DPR staff recorded baseline turbidity measurements during ebb, flood, and slack tides for two weeks prior to the start of the project to obtain baseline data. Baseline turbidity monitoring revealed large fluctuations ranging from 8.24 – 26.51 NTU. Higher turbidity was associated with ebb tides when water surface elevations were low enough for flows to concentrate in the thalweg thus increasing velocity, scour, and sediment transport.

Site location (Figure 4):

The WQ monitoring site was positioned to sample water draining from both the "nub" and lower delta marsh. This location was downstream of the project, within 150 ft of both marsh plain drainage outlets, and in the thalweg of the creek. The project monitoring site is referred to as BC1Sample (BC1S). Due to the dynamic nature of large scale restoration projects, a second and third site were also chosen as backups should BC1S have proven to be an inadequate representation of discharged WQ. These sites are referred to as BC1 and NCK respectively.

Parameters:

Based on Section 6.5 of the Clean Water Act 401 Water Quality Certification, water discharged from the project was not to exceed the following parameters:

WQ Parameter	**Limit**
Dissolved Oxygen (mg/l)	No less than 5.00 mg/l
Temperature (C^o)	Receiving waters may not increase more than 2.8 C above normal
Turbidity (NTU)	No greater than 31.6 NTU*

*No greater than 5 NTUs above baseline (26.5 NTU)

Equipment:

Turbidity:

Biomonitoring staff used a Hanna 93102 Turbidity meter to measure turbidity within the water column. This meter was later replaced by a LaMotte 2020WE Turbidity Meter. When used side by side, both meters gave readings within 0.5 NTU of each other. Both turbidity meters were calibrated daily with distilled water and monthly with a 0 NTU solution to ensure accurate readings.

Dissolved Oxygen and Temperature:

Biomonitoring staff used a Xylem YSI Pro-Plus handheld that measured DO % saturation and mg/l. This YSI also measured temperature in C^o and salinity in PPT. The handheld meter uses a polarographic DO sensor that requires daily % saturation calibration. The polarographic sensor membrane was replaced every 30 days during the project. The YSI dealer calibrated the salinity and temperature probes prior to the start of the project.

WQ Monitoring Protocol:

Daily:

Upon the start of earth moving activities near the creek channel, WQ was recorded at BC1S once in the morning and once in the evening. Daily monitoring (including baseline) began May 30th and continued until October 7th. If WQ parameters fell outside of acceptable levels, biomonitoring staff immediately notified HARC of the issue. Meanwhile, staff would often

continue monitoring WQ downstream to determine the extent of the issue within the receiving waters. On occasion, WQ measurements were taken within the project site to determine the WQ "signature" of the discharged water and to relate it to effects seen further downstream.

WQ monitoring staff used a canoe or kayak, staged at WCS 1a, to paddle downstream to BC1S. A single T-post was installed to mark the location. During this time, the YSI Pro-Plus handheld was turned on so it could acclimate to current climatic conditions. After 10-15 minutes, the DO % Saturation was calibrated. The watercraft was then tied off to the T-post and a surface level reading was taken with the YSI Pro-Plus handheld and turbidity meter.

Weekly:

Starting May 15th, CDFW and DPR staff began weekly WQ monitoring rounds within the PLC. WQ monitoring sites included areas both within and outside of the project area. While this monitoring was not required for project permit compliance, it is the continuation of a multi-year data set on WQ conditions and was helpful in determining if the project was having a discernible effect on the entire system.

Continuous

CDFW set up 2 sites (PC3 and BC1) with WQ SONDES that record DO, Temp, and Salinity, every hour, 0.25 m below the water surface and 0.25m above bottom substrate. Each site is representative of water entering the main lagoon from Pescadero and Butano creeks. Data recorded in these sites from the past 4 years were compared with daily monitoring data to parse out natural diurnal and seasonal fluctuation in WQ versus project-induced effects. This continuous data set also helped to confirm the data collected via the YSI handheld meter as both methods (YSI and SONDES) have known issues/limits in the extreme fluctuations of an estuarine environment.

Results

Summary

There were 11 occurrences when early morning DO levels were below 5.00 mg/l. All of these readings were taken before 0830 and the subsequent afternoon measurements showed recovery to acceptable levels. Looking at the SONDES data for the top of the Butano Creek 1 site, throughout the 2018 season, there are multiple instances of DO dropping well below 5 mg/l overnight (Figure 1). On 8 separate occasions, turbidity levels exceeded the 31.5 NTU limit. All but one of these events coincided with an ebb tide and water level management activities that could be remedied through discharge manipulation. In general, water quality during the project was acceptable from June through mid-July. Around mid-July, stream flows, began to drop below 8-9 CFS on the Pescadero stream gage. Pescadero creeks' flows trend similarly to Butano creek and were used as a rough indicator of the amount of water coming into the project site.

With diminished flows coming into the project site, suspended sediments became more concentrated in the project's discharged water. In addition, the nub marsh, used as a natural sediment filter, had been saturated for over a month and began to have a strong influence on the DO of discharged water. The effect was indicative of the high chemical oxygen demand (COD) anoxia model. HARC management was notified every time that a WQ limit was reached and the water management technique was adjusted to resolve the problem. Temperature readings at BC1S never exceeded normal levels found within the lagoon in years prior.

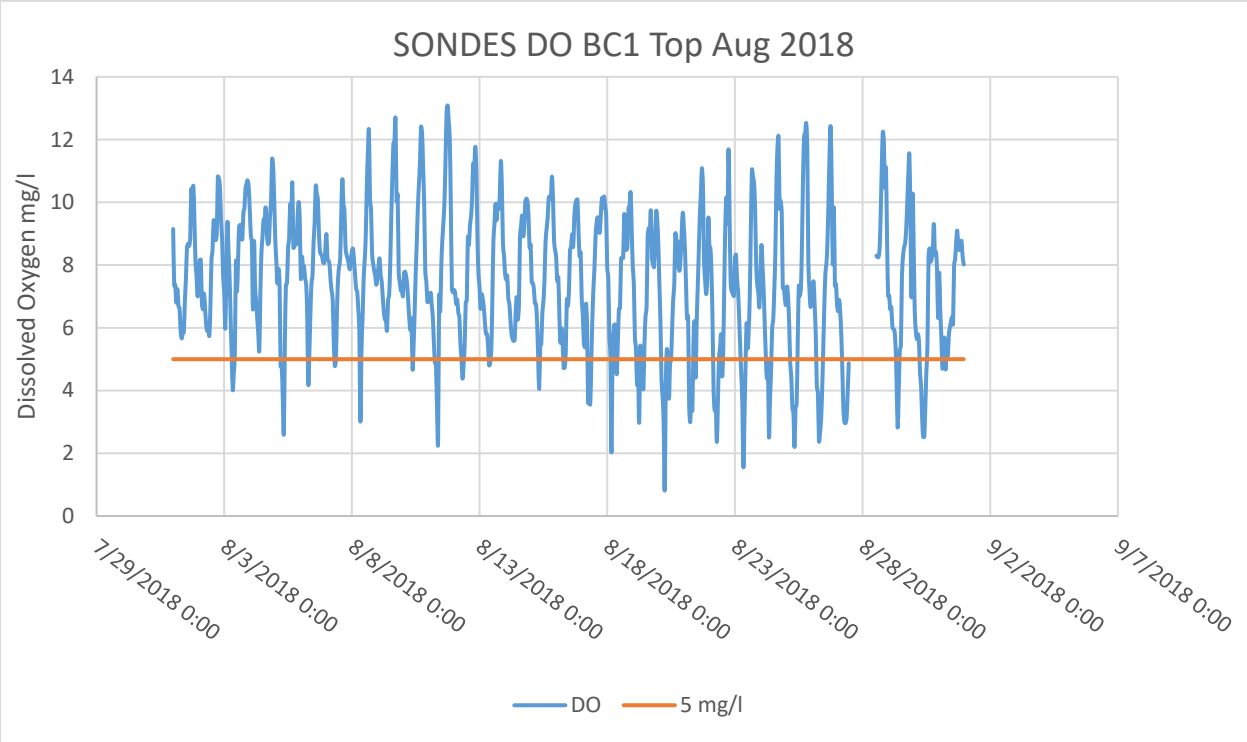


Figure 1. Chart showing the diurnal pattern of dissolved oxygen in Butano Creek (BC1) 0.25m below the water surface during Aug 2018. Of note is the frequency with which the DO drops below 5 mg/l in the late evening/ early morning.

Dissolved Oxygen & Turbidity Data

Date	Time	Site	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Salinity (PPT)	Temperature (C)
6/14/2019	1710	BC1S	**54***	7.21		14.9
7/23/2019	745	BC1S	4.1	**4.5***	3.77	15.8
7/25/2019	730	BC1S	**33.5***	7.22	0.43	15.3
7/26/2019	730	BC1S	**33.8***	8.52	0.69	15.4
7/27/2019	700	BC1S	**34.1***	**4.25***	2.69	16.6
7/30/2019	742	BC1S	**40.3***	5.6	9.5	16.3
8/1/2019	742	BC1S	**36.9***	**4.6***	8.5	17.5
8/5/2019	726	BC1S	8.3	**2.6***	6.4	17.3

8/7/2019	800	BC1S	**35.2***	7.3	4	16.1
8/8/2019	724	BC1S	**53.2***	7.6	4.5	16.5
8/10/2019	715	BC1S	12	**4.38***	1.98	19.6
8/17/2019	738	BC1S	5.09	**4.5***	23.56	16.3
8/19/2019	730	BC1S	5.84	**1.96***	4.7	18
8/30/2019	747	BC1S	5.91	**2.6***	13.33	17.6
9/3/2019	753	BC1S	6.17	**4.82***	5.81	17.8
9/12/2019	748	BC1S	6.16	**3.3***	9.18	17.3
9/14/2019	715	BC1S	4.9	**4.56***	12.92	16.6

Table 1. Data from WQ monitoring showing the occurrences when discharged project water exceeded limits specified in Butano Reconnection Project permits.

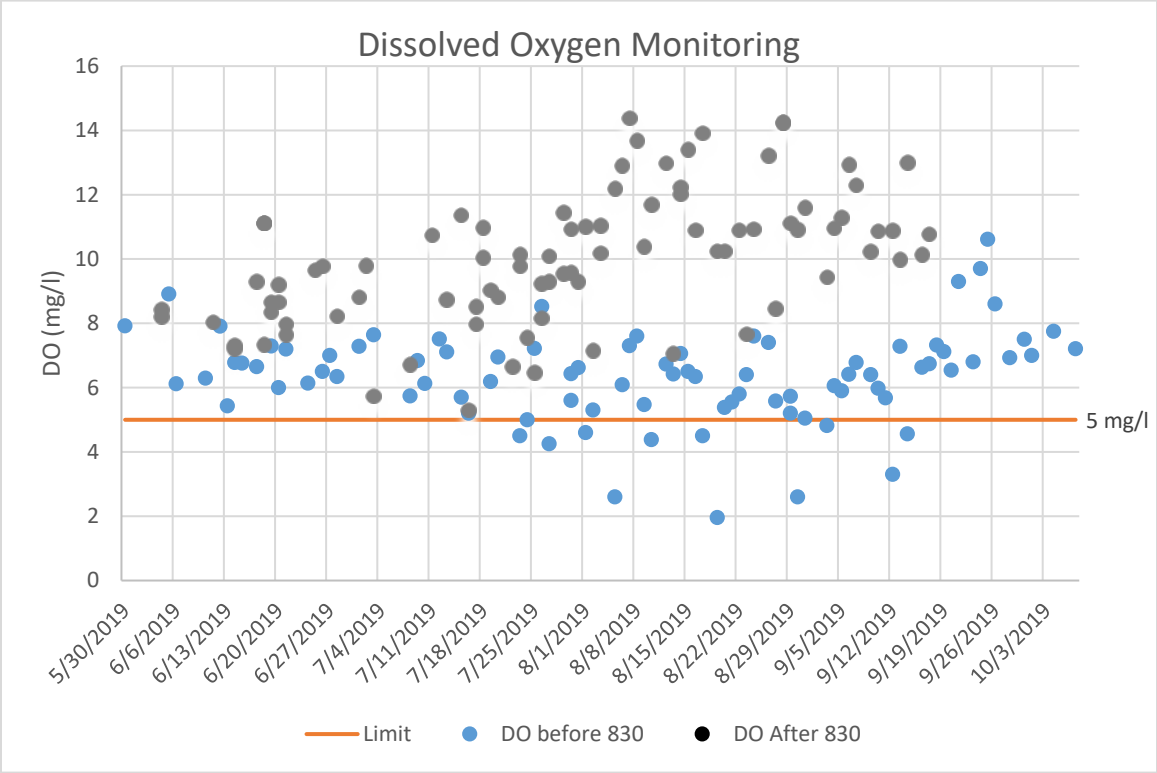


Figure 2. Point data showing dissolved oxygen (mg/l) at site BC1S. Blue points represent readings taken before 0830, when there was often a dense marine layer and no wind. Black points represent points taken after 0830 when sunlight and wind became more prevalent.

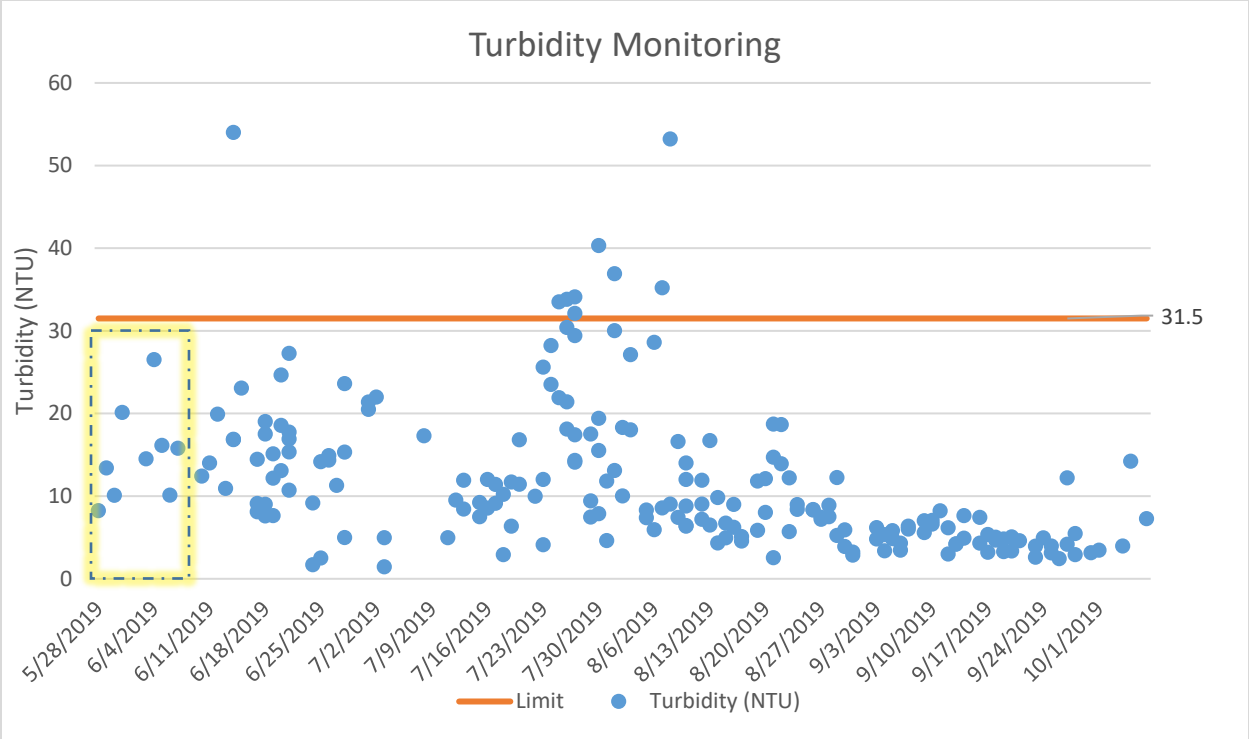


Figure 3. Point data showing suspended sediment concentrations in NTU's at site BC1S. The red line represents the limit set by project permits. Baseline turbidity monitoring is represented by points within the yellow dashed area.

Discussion

6/14/19: Biomonitoring staff recorded a turbidity of 54 NTU at 1710. At this point in the project, WCS 1a had not been installed. HARC had two turbidity curtains installed 50 ft. downstream of the proposed location of WCS 1a and 50 ft. upstream of the fish exclusion fencing. At 1700, HARC was moving the aquatic excavator from the creek channel to an upland area to refuel and stage for the weekend. To exit the creek channel, the equipment had to make a sharp turn, which temporarily created a large plume of sediment. The spike in turbidity was short lived as the plume visibly dissipated within minutes of the WQ reading. However, to ensure that the observed turbidity was an acute problem, the following morning (6/15), DPR staff returned to BC1S at 0817 and recorded a turbidity of 23.05 NTU. No project work was performed over this weekend.

7/23/19: At 0745, the DO was 4.5 mg/l at the surface and showed lower readings at depth within the freshwater column. DPR staff took WQ readings at the “nub” marsh outlet, inundated pools atop the marsh plain, the 6” discharge onto the marsh, and the 6” intake within the project. These readings revealed that water leaving the project site was actually quite suitable and that the DO was dropping precipitously as it sat and slowly meandered over the marsh plain (See figure 3). HARC stopped pumping water onto the “nub” and instead pumped directly around WCS 1a. At 1100, DO had increased to 6.15 mg/l. By 1445, DO was up to 10.15 mg/l.

Figure 4. Visualization of significant water control features of the Butano Creek Reconnection Project and the progression of dissolved oxygen in discharged water.

7/25/19: At 0730, turbidity was recorded at 33.5 NTU. The two 6" pumps were both discharging project water directly around WCS 1a. HARC stopped pumping water out of the project at 0830. At 1200, the pumps were turned back on, both discharging around WCS 1a. Turbidity at 1817 was 21.9 NTU.

7/26/19: At 0700, turbidity was recorded at 33.8 NTU. HARC moved both 6" discharges onto marsh plain. Turbidity at 1030 was 30.4 NTU. Turbidity levels from water coming out of the marsh were 21.4 NTU at 1035. At 1700, turbidity at BC1S was 18.1 NTU. At 2000, at DPR's request, HARC moved one discharge directly around the WCS 1a.

7/27/19: At 0500, HARC turned both pumps off. At 0700, turbidity was 34.1 NTU and DO was 4.25 mg/l. DPR staff continued monitoring at BC1 (0710, 29.4NTU, 6.33mg/l) and NCK (0720, 17.4NTU, 6.50 mg/l). The aerators requested at the start of the project showed up at 0830 and were installed downstream of the "nub" marsh outlet by 1130. At 1250, BC1S was reading at 14.3 NTU and 9.24 mg/l. HARC waited until project work had ended for the day before pumping onto the marsh plain over the weekend.

7/30/19: At 0742, turbidity was recorded at 40.3 NTU. At BC1, turbidity was 7.85 NTU. The abnormal spike in turbidity was likely due to sampling error. However, HARC was informed and pumping stopped at 0830. Pumping resumed at 1100. Turbidity recorded at BC1S at 1350 and 1511 was 19.4 and 15.5 NTU respectively.

8/1/19: At 0742, turbidity was recorded at 36.9 NTU and DO was 4.6 mg/l. Since 7/28, one pump discharged water onto the marsh while the other discharged directly around WCS 1a. This was an attempt to find the balance between using the marsh as natural sediment filter and taking advantage of the high DO found within water coming from the project area. However, prolonged inundation of the marsh had once again begun to influence DO. The aerators did little to lift DO concentrations, further

reinforcing the hypothesis of a strong chemical oxygen demand in the water inundating the marsh plain. At 0752, WQ at BC1 was showing 30 NTU and 5.2 mg/l. By 1400, at BC1S, turbidity had dropped to 13.09 NTU and DO was 9.3 mg/l. After this event, HARC began pumping around WCS 1a overnight and pumping onto the marsh plain during the day. Overnight, when no work was being done, turbidity was not an issue and so the water did not need to settle out. During the day, water exiting the marsh with a high COD was met with a channel full of aquatic vegetation actively pumping O_2 into the water column. This water management strategy became the standard for the remainder of the project when the pumps were being used.

8/5/19: On Saturday, 8/3, there was a miscommunication between monitoring staff and HARC. The pump discharge outlets were left on the "nub" marsh over the weekend. At 0726, DO at BC1S and BC1 was 2.6 and 3.96 mg/l respectively. HARC turned off the pumps and let water back up within the project site until midday when they began pumping around WCS 1a. By 1700, DO was back to 10.18 mg/l at BC1S.

8/7/19: At 0800, turbidity was 35.2 NTU. The night prior, pumps were discharging directly around WCS 1a and water was visibly murky. The area directly upstream of WCS 1a, where water normally backs up and sediment drops out, was reading 40+ NTU. This is thought to be caused by HARC currently having 3 different excavators working simultaneously moving heavy clays with fine sediments that do not readily drop out of the water. HARC stopped pumping at 0900 and by 1636, turbidity had dropped to 8.55 NTU.

8/8/19: At 0724, turbidity was 53.2 NTU. HARC stopped pumping at 0800. At 1200, HARC moved a 6" pump upstream to BC3. This pump discharged turbid project water onto the delta marsh in an attempt to have some of the fine sediment filter through the vegetation before coming back into the project area. In this way, HARC could address turbidity issues within the project site. Monitoring staff recorded turbidity of water at the pumps intake (38.4 NTU) and where the water re-entered the project through an old agricultural ditch (18.1 NTU). From looking at the data, this method of turbidity mitigation seemed to be effective.

8/10/19: At 0715, DO was recorded at 4.38 mg/l. The pump discharge had been on the "nub" marsh overnight in an attempt to deal with turbidity concerns. HARC diverted the pump discharge around WCS 1a at 0830. By 1430 DO was back up to 10.38mg/l.

8/17/19: At 0738, DO was recorded at 4.50 mg/l. As of 8/15, HARC was no longer using the 6" pumps and water was being passively managed by opening the two culverts built into WCS 1a. There was no project related activity that could explain the drop in DO. The "nub" marsh plain had not been inundated since 8/10 and there was no residual flow coming from the channel besides normal tidal fluctuations. Looking at the SONDES data for the top of the Butano Creek 1 site, throughout the 2018 season, there are multiple instances of DO dropping well below 5 mg/l overnight (Figure 4). At 1427, DO was 10.9 mg/l.

8/19/19: At 0730, DO was recorded at 1.96 mg/l. Culverts on WCS 1a were open over the 1-day weekend. There was no obvious project related reason for the low DO. Weather since 8/17 had been noted as overcast with little wind. At 1730, DO was recorded at 13.91 mg/l.

8/30/19: At 0747, DO was recorded at 2.60 mg/l. Since 8/27, HARC had to monitor the overnight high tides and adjust their water management techniques. Culverts were closed after work ceased and the

pumps were turned on. One discharge was put on the "nub" marsh and one was directed around WCS 1a. The pumping was done overnight and was monitored by HARC staff. The pumps were turned off every morning at 0500 and the culverts were opened. This was done to stop the high tides from flooding the upper reaches of the project and creating issues with the terrestrial excavation work. By 1740, DO was 11.11 mg/l.

9/3/19: At 0753, DO was recorded at 4.80 mg/l. There was no pumping overnight and the gated culverts were open. The low tide that morning made the sample site shallower than normal. The DO probe was noted to have been dragging along the bottom and disturbing sediment. At 1715, DO was 11.60 mg/l.

9/12/19: At 0748, DO was recorded at 3.30 mg/l. There was no pumping overnight and the gated culverts were open. At 1705, DO was 10.87 mg/l.

9/14/19: At 0715, DO was recorded at 4.90 mg/l. At 0730, project water coming out of the culverts was 8.66 mg/l indicating that project activities were not causal. At 1435, DO was 7.62 mg/l.

Conclusion

By using an adaptive management approach, water quality issues related to the project proved to be traceable and solvable. Monitoring staff were able to communicate the issues in real time to HARC and immediately adjust water management strategies. HARC's willingness to cooperate and adjust their workflow was paramount to the success of this management approach.

Every instance of breaching a WQ threshold turned out to be acute in nature and was resolved by the time the next sample was taken. No issue ever persisted throughout an entire work day and often was resolved in a few hours. While the project was underway, CDFW sampled the main embayment of the PLC for steelhead. Project monitoring staff assisted during these events and discussed project impacts on the fishery with CDFW, NOAA, and NMFS staff. The project work produced no observable negative effects on the fishery as experienced by the real time sampling of steelhead within the system. In addition, monitoring staff noted fish activity daily while sampling WQ and reported no obvious impacts from acute WQ issues.

While dissolved oxygen is seen as one of the most critical components to the survivability of aquatic ecosystems, the diurnal pattern of oxygen availability brings into question how certain species handle low DO environments. While having a set limit for DO levels is an important part of permit language, it is worth noting that without proper baseline monitoring, a given project could be unduly impacted due to naturally occurring environmental factors.

Similarly to DO, monitoring turbidity without a proper baseline in an estuarine environment is fraught. The push and pull of the tides in the PLC would often create its own sediment plumes that were unrelated to project work. It has been noted in past reports on the PLC that turbidity is used by lagoon-rearing steelhead as cover in the absence of aquatic or streamside vegetation. Due to our own efforts to understand turbidity prior to the project's start, monitoring staff were able to get a signature on "normal" turbidity levels and juxtapose them with project-induced events. However, further exploration of this subject could facilitate the planning, implementation and monitoring of future projects in the PLC.

Date:	February 24, 2020
To:	Jim Robins (Alnus Ecological/SMRCD), Andrew Hall (SMRCD)
From:	Sam Diaz, Rafael Rodriguez, Jai Singh and Chris Hammersmark (cbec inc.)
Project:	16-1027-4 – Butano Creek Channel Reconnection and Resilience Project
Subject:	As-Built Survey and Variances from Design

INTRODUCTION & BACKGROUND

At the request of Jim Robins of Alnus Ecological and Andrew Hall of the San Mateo Resource Conservation District (SMRCD), cbec, inc. eco engineering (cbec) has prepared this brief technical memorandum documenting as-built conditions for the Butano Creek Channel Reconnection and Resilience Project (Project). The memorandum describes constructed variances from the design that were recorded in as-built surveys and included in development of a topographic surface based on those surveys. cbec performed construction observation and limited grade checking of the contractor's work during 2019 construction activities in addition to performing as-built surveys and developing the as-built surface and drawings.

AS-BUILT SURVEY OVERVIEW

cbec performed as-built surveys for the project between August 15, 2019 and November 14, 2019. As-built surveys of some project elements were conducted after earthwork and construction activities in specific project areas had been completed (yet before overall construction ceased) while other features were surveyed after the completion of all construction activities. Topographic surveys and shallow bathymetric surveys were conducted primarily with RTK GPS. Topographic data were also obtained on October 30, 2019 with a DJI Phantom 3 Pro Quadcopter with a 12.4 MP camera (UAS). Topographic data were generated by post-processing the UAS imagery using Structure from Motion (SfM) methods and calibrated using with ground control points surveyed with RTK GPS. Bathymetric surveys of the constructed Butano Creek channel were also conducted with an Ohmex Sonarmite single beam echosounder unit integrated with an RTK GPS mounted on a remote-control boat where depths were adequate for echosounder capture and prohibitively deep for wading surveys by RTK GPS. All survey data sets were corrected to Project control points that were established by cbec at the beginning of Project construction. These control points use a local horizontal projection and vertical datum that approximates NAD 1983 California State Plane Zone 3 (ft) and NAVD88 (GEOID09, ft).

AS-BUILT SURFACE AND DRAWINGS PREPARATION

Following the completion of as-built surveys, cbec developed an as-built surface and as-built drawings that reflect the post-project topography and identify significant variances from the project design. Topographic and bathymetric survey data from various collection methods and dates described above were combined to develop the most representative as-built topography. Specific deliverables associated with the as-built survey, surface and drawings work include the following:

1. As-built drawings
2. As-built surface for construction footprint only
3. Composite as-built surface combining as-built surface within construction footprint with the pre-project existing conditions DEM for undisturbed areas

It should be noted that the elevations shown outside of the construction (or disturbance) footprint were sourced from the pre-project existing conditions DEM. Development of this DEM was documented in a technical memorandum submitted to SMRCD by cbec in 2017. In developing the existing conditions DEM, zonal offsets were applied to LiDAR data based on average differences with ground-based topographic data collection in Butano Marsh. In some instances, the different offset zones exhibit a minor step at their boundaries.

AS-BUILT PROJECT VARIANCES FROM DESIGN DRAWINGS

Noteworthy variances in how the project was constructed relative to the designs are documented below and shown in the accompanying as-built drawing set. None of the variances described below are expected to have a noteworthy impact (either positive or negative) on the intended performance of the project design with respect to its three primary goals: fish passage, water quality (and associated fish kills) and flooding at Pescadero Creek Road.

Butano Creek Variances

1. Butano Creek Alignment Deviations

There are several deviations in the as-built Butano Creek dredging alignment relative to the design. The most prominent is between Sta. 37+00 and Sta. 39+60 where the constructed Butano Creek channel alignment was straightened to avoid excavating the existing Butano Creek banks. There are also minor changes to the Butano Creek dredging alignment along Reach 3 between Sta. 74+00 and 78+20 that were similarly performed to avoid excavating existing banks. The variances in dredging alignment were intended to preserve vegetation on the banks, thereby improving bank stability and neither alter nor diminish the Project's anticipated function or evolution.

2. Butano Creek Downstream Excavation Extent

The downstream extent of Butano Creek channel dredging does not extend as far downstream as provided for in the design. Actual channel dredging stops approximately 90 feet upstream of the downstream extent of grading shown in the plans. This variance was allowed to avoid additional mobilization and damage to Butano Creek banks and vegetation and it will not significantly impact long-term Project performance.

3. Butano Creek Excavator Tracks

The final walk out of the contractor's pontoon excavator along Butano Creek resulted in track marks (longitudinal depressions) in the channel bed between Sta. 35+50 and Sta 38+00. These track marks are reflected in the as-built survey data collected by cbec. They are not expected to have a noteworthy impact on design performance.

Butano Marsh Control Structure Variances

4. Marsh Control Structure Variances

The finished central weir elevation of the Marsh Control Structure (MCS) was 6.5' and is higher than the design of 5.9'. The weir elevation was increased to match the weir elevation of the prior sand bag dam, which was originally designed and constructed to an elevation of 5.9' and was then modified by State Parks to a 6.5' elevation. Because the modified 6.5' crest elevation of the sand bag dam functioned well, the project team decided to replicate that elevation in the new MCS.

The MCS was also constructed and repaired three times by the contractor before final acceptance. In the final reassembly, the MCS was disassembled to several feet below the design elevation and constructed up to its final elevation. As a result, the reconstructed structure slopes may be slightly steeper than designed. Although the MCS slopes may be steeper than 2:1 (horizontal:vertical) for approximately the top half of the structure, this design variance is acceptable because the rock was reported to have been placed carefully and adjusted by hand. This placement method is acceptable for constructing stable riprap at slopes up to 1.5:1. Berm slope on the Butano Channel side is not verifiable because the structure was constructed and backfilled prior to the as-built survey. Crushed gravel was added to riprap voids to reduce seepage through the berm. This design variance at the MCS was requested to improve the ability of the MCS to retain anoxic marsh waters. Large woody debris (LWD) was intended to provide habitat in the MCS by installing three Redwood rootwads in the structure. On the recommendation of the contractor, the design was modified to include two rootwads and to install large boulder ballast with pinned connections to each log to prevent flotation.

Butano Marsh Fill Variances

5. Type 2 Fill (Jupiter Pond) Not Filled

Per guidance from State Parks, the project team decided to not fill the Type 2 Marsh Fill area (also referred to as the Jupiter Pond). Instead, small drainage channels from the Jupiter Pond to Butano Channel were

filled in for approximately 100 feet adjacent to Butano Channel as Type 1 fill. In a construction site walk, the design team observed the Jupiter Pond to be significantly shallower than anticipated during the design process, therefore presenting less of a reservoir for low-quality water, and hence deemed it a less significant driver of anoxia. Filling in the smaller channels should serve as an acceptable means for reducing connectivity between the Jupiter Pond and Butano Channel and stabilizing Butano Channel fill elevations at the channel confluences. Upon reviewing the overall marsh, the Jupiter Pond was observed to potentially be a legacy salt pan feature that occurs in coastal wetlands and is not well represented in Butano Marsh, so retaining it was viewed as beneficial for marsh habitat diversity. This variance from the design is not expected to have a noteworthy impact on project performance.

6. Marsh Fill Area Along Butano Creek Left Berm Not Utilized

The Vegetation Dispersal Area was intended as an optional placement area for vegetation and rooted soils. The Vegetation Dispersal Area lies within Butano Marsh, extending 50 feet from the toe of the berm running alongside Butano Creek's left (when looking downstream) bank. This fill area was not utilized by the contractor.

7. Marsh Fill Area Transitions Elongated

Where plans showed an abrupt transition between Type 1 and Type 3 fill types, the transitions were elongated to create a smoother transition. The areas of Type 1 fill shown on plans were maintained and the elongated transitions were extended into Type 3 fill areas. Transitions between Type 1 and Type 4 fill areas were not modified in this manner.

8. Type 4 Fill Area in Middle Butano Marsh Converted to Type 1 and Type 3 Fill

The borrow ditch feature along a berm with an east-west orientation in the Middle Butano Marsh and Triple Junction area (see plan sheet C7) was converted from a Type 4 fill area (target elevation of 7.4 ft) to a Type 1 (target elevation of 4.9 ft) fill area, transitioning to a Type 3 fill area (target elevation of 5.8 ft) for approximately the eastern 200 feet of the ditch. These changes were made to avoid filling the channels to elevations that would have exceeded the adjacent marsh plain.

9. Type 4 Fill Area in Middle Butano Marsh Converted to Type 3

Similar to #8, a channel in the Middle Butano Marsh that was designated as Type 4 fill was converted to Type 3 fill. This change was made to avoid filling the channels to elevations that would have exceeded the adjacent marsh plain. This channel appears on plan sheets C7 and C8 and has a north-south orientation. Additionally, the transition from Type 1 to Type 3 that is shown on plan sheet C7 was made more gradual and occurs over the Type 3 fill area shown on as-built sheet C7.

10. Type 4 Ditch Not Filled

The ditch along the western toe of Lower Butano Marsh (see Sheet C7) was not filled to avoid impacts to marsh vegetation. Based on field exploration, this feature was determined to slope from north to south and was not considered to pose the water quality concerns to Pescadero Lagoon that the project team anticipated when developing the project design. The decision to not fill this feature is not anticipated to notably influence project performance relative to the three project goals.

11. Middle Butano Marsh Type 3 Fill Area Converted to Type 1 Fill

The Type 3 fill area in the Middle Butano Marsh (see plan sheet C7) that was expected to be an extension of a historic slough feature shown on USGS T Sheets was changed to a Type 1 fill area. This reduced the target elevation from 5.8 ft to 4.9 ft. This change was made to retain marsh drainage through this historical feature.

12. Extent of Type 5 and Type 6 Fill Areas

The spatial extents of Type 5 and Type 6 fill are smaller than the footprint permitted in the design. The footprint of Type 5 fill was reduced, and Type 6 fill was not implemented. The extent of horizontal fill placement was intended to be elected at the contractor's discretion based on available fill material from Butano Creek excavation and could extend out to (but not beyond) the perimeter shown in the plans. The as-built extent of the Type 5 fill placement is shown in the accompanying as-built drawings.

13. Additional Type 1 Fill Area

Type 1 Fill area was added to an existing channel south of the MCS. Fill was installed for approximately 100 yards south of Butano Channel at the toe of the existing west slope. This fill is intended to provide resilience to the Type 1 fill in Butano Channel and to the long-term stability of the MCS.

Water Quality Berm Enhancement Variances

14. Water Quality Berm Enhancement #1 Realignment

The alignment of Water Quality Berm Enhancement #1 was modified slightly relative to the designs. The straight design alignment was modified to curve to the west at its midpoint to tie into the existing Middle Marsh Berm. The alignment modification was implemented to avoid impacts to an area of wetland vegetation and to relocate the berm to an area with more stable foundation soils. The new alignment is shown on sheets C7 and C8 of the as-built drawings and is not expected to alter the intended performance of the project.

Engineered Log Jam Variances

15. Modifications to Log Alignments, Length and Elevations

The alignment of the Logs 2 and 3 was altered to form more of an "X" relative to the alignment shown in the plans. The length of Log 1 was shortened from 30 feet to 23 feet, the length of Log 2 was shortened from 35 feet to 22 feet, and the length of Log 3 was shortened from 26 feet to 23 feet. Log endpoint elevations were also changed as indicated on the as-built plans. While the changes in log orientation, length and elevations may affect how debris racks on the log jam, the changes are not anticipated to have a noteworthy impact on project performance relative to the design goals.

Upper Floodplain Berm Variances

16. Additional Fill Placement

The Upper Floodplain Berm is an extension of a well-vegetated historical berm. The berm's form was altered relative to the design to widen the crest of the berm and to include a longer (less steep) back slope to accommodate more fill material from the site and potentially increase longevity of the feature. The west end of the berm was not constructed because the existing ground elevation was equal to or greater than the design elevation of the berm. Additionally, a plug of fill was placed at the upstream end of the berm where a previously undocumented minor secondary channel feature split off from the main channel and served as a preferential high flow path for flows moving over the Level Lea farm field and Pescadero Creek Road. This plug of fill was implemented to add resilience to the structure and discourage reformation of the secondary flow path. The extent of erosion control blanket (coir fabric) was reduced to only cover the back (north) hinge of the berm where model-predicted shear stress was noted to be greater. The as-built Upper Floodplain Berm is expected to perform as designed.