

2018 (YEAR 2)

Annual Revegetation Monitoring Report for the Southeastern Creekside Marsh Culvert Replacement and Habitat Enhancement Project

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2. List of Contributors

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3. Executive Summary

3.1. Background

Construction was completed for the Southeastern Creekside Marsh Culvert Replacement and Habitat Enhancement Project in November 2016. The primary goal of the project was to increase the tidal prism in the southern portion of Creekside Marsh by replacing a single bore culvert with three 60-inch culvert pipes. Before construction began in the marsh, the salt marsh vegetation was removed by hand and kept on-site. After construction activities in the marsh concluded, the project area was revegetated.

In December 2017, soil unsuitable for plant growth was removed from the restoration area with the expectation that 200 cubic yards of Young Bay Mud would be available to replace it. Unfortunately, only 100 cubic yards of mud was supplied. It was used to fill part of the restoration area. Excavated soil was replaced in the remainder of the restoration area. The Young Bay Mud was placed at an elevation to promote passive recruitment of salt marsh vegetation. Since this part of the project was completed a year after the culvert construction, it was evaluated based on Year 1 success criteria.

The project area is to be monitored for 5 years, or until final success criteria has been met. This Year 2 monitoring report summarizes the results from the vegetation monitoring as prescribed in *Southeastern Creekside Marsh Culvert Replacement and Enhancement Mitigation and Monitoring and Reporting Plan (MMRP)*.

3.2. Results

The culvert project site had two sampling areas (Eastern Sampling Area, Western Sampling Area) that were monitored using the point intercept method in Year 2. The Eastern Sampling Area had a native plant cover of 94% compared to an adjacent reference site. The Western Sampling Area had a higher native plant cover than the reference area with a cover of 116%. The Year 2 cover criteria have been met at both sampling areas. Both sampling areas had invasive covers of less than 5% meeting the established success criterion.

The restoration area with newly placed Young Bay Mud had a percent cover of 12% compared to an adjacent reference site meeting the Year 1 criterion. The sampling area had an invasive cover of less than 5%. Due to a lack of available Young bay mud during restoration efforts, only half of the proposed 8,290 square feet of salt marsh was replaced with new soil. The other half was left bare and was restored in December 2018. Soil amendments (gypsum and compost) and native plant species were planted and will be monitored next year.

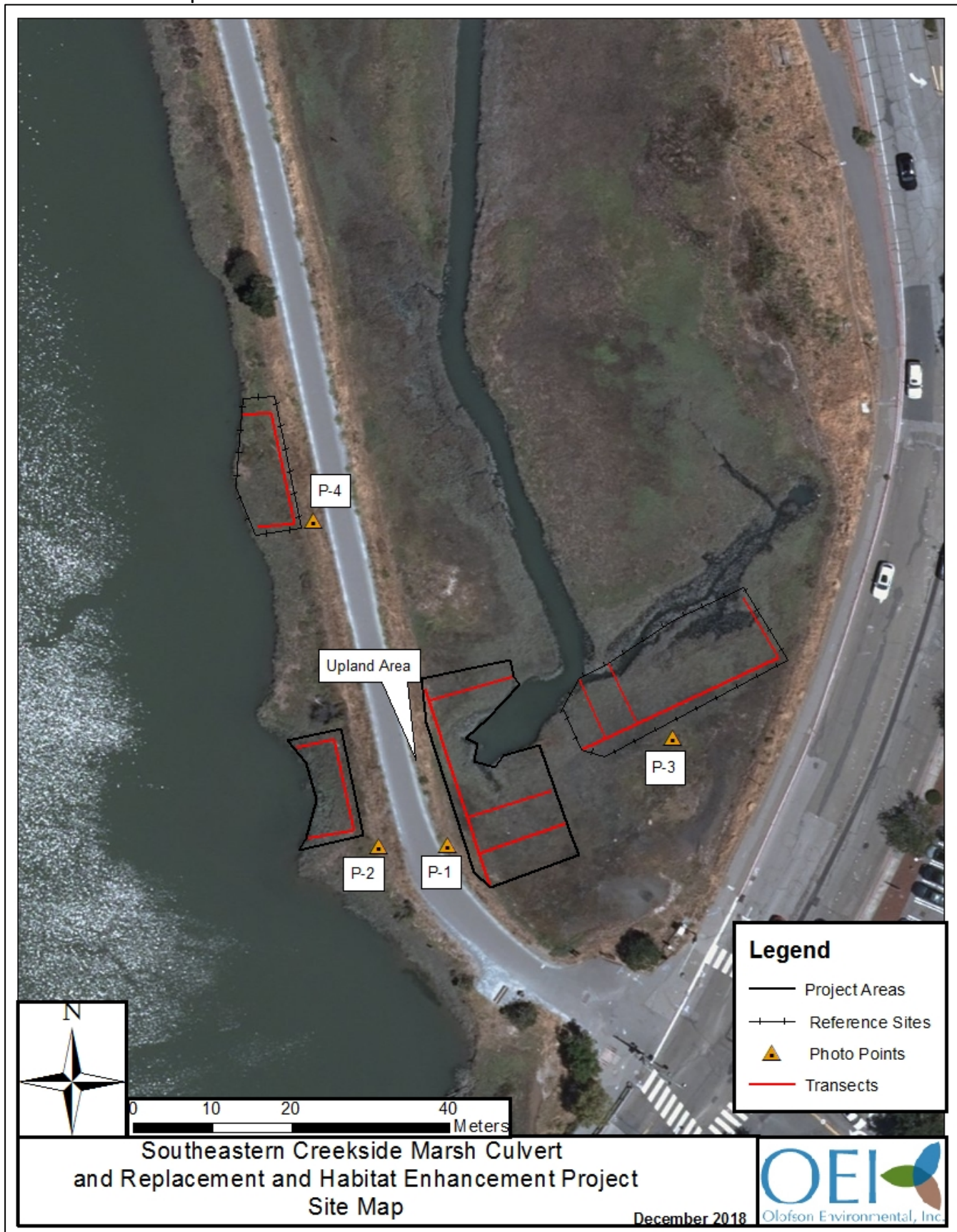
3.3. Remedial Action

No remedial action is required at this time.

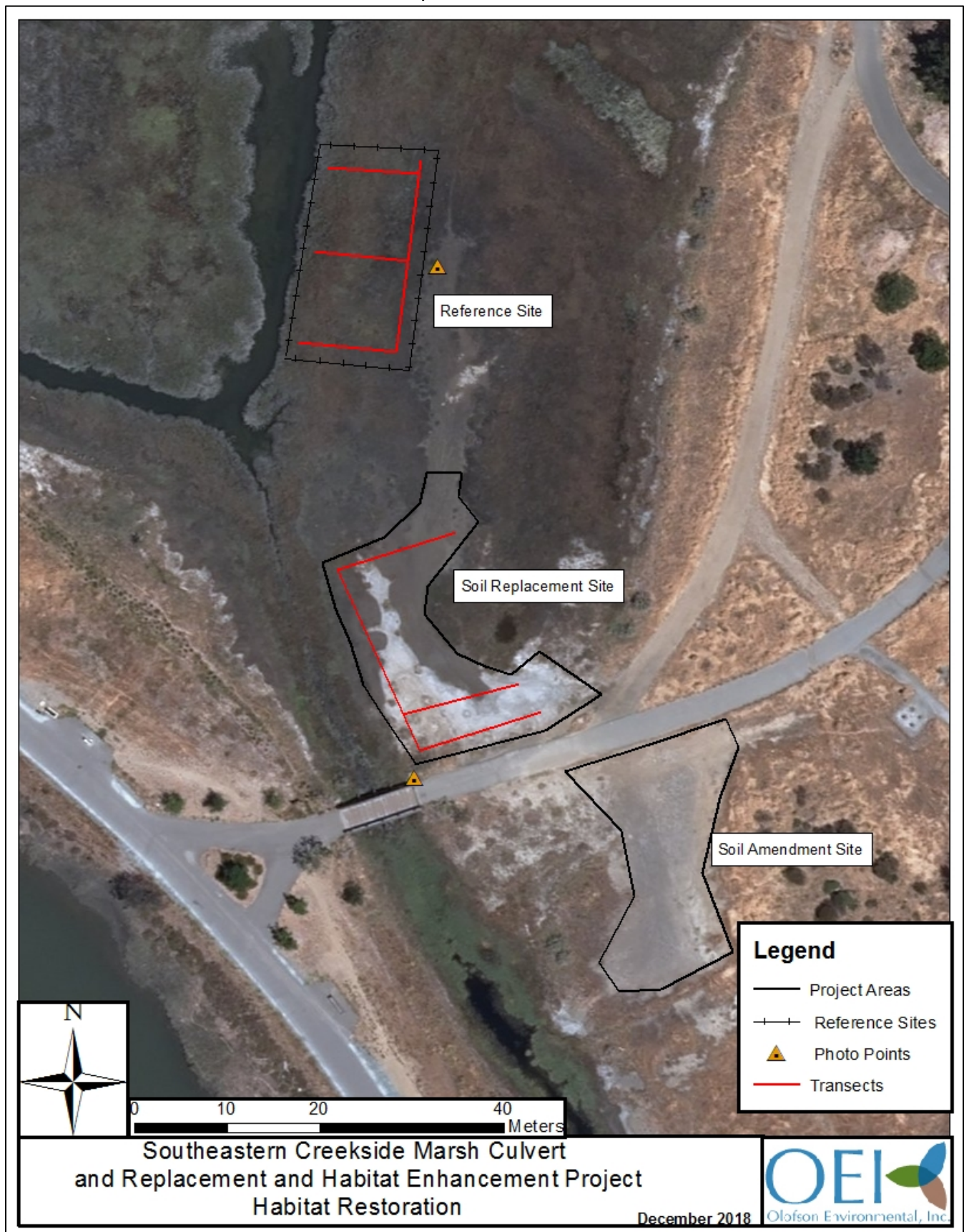
3.4. Requested Agency Action

No agency action is requested at this time.

3.5. Site Map



3.6. Habitat Restoration Site Map



4. Project Description

On September 9, 2016, work began to replace an existing single bore culvert that connects Corte Madera Creek to Creekside Marsh. The goal of the project was to increase the tidal prism in the southeastern portion of Creekside Marsh. Cofferdams were constructed, the berm was excavated, and the existing culvert was removed and replaced with three 60-inch culverts. In addition, the project closed a path north of the project area by placing soil in these areas as well as signs and fencing to discourage people from using the path.

The project area encompasses salt marsh habitats on both sides of the berm where construction occurred. Temporary impacts, including removal of salt marsh vegetation, occurred in 0.14 acre of estuarine wetland in Creekside Marsh and Corte Madera Creek. The salt marsh vegetation was replanted in the project area. In addition, upland areas removed by berm excavation were seeded with native grasses (3.5. Site Map).

In December 2017, the second component of the project was completed that involved habitat restoration in Creekside Marsh (3.6. Habitat Restoration Map). An area of marsh approximately 8,290 square feet had soil that was compacted and unsuitable to support salt marsh vegetation. The top eight inches of soil was removed and replaced with Young Bay Mud in about half of the restoration area. The mud was placed at the same elevation as the surrounding marsh. Due to the lack of available Young Bay Mud, approximately half of the proposed 8,290 square foot restoration area was treated. In the other half of the restoration area gypsum was dug into the soil in August 2018. Compost was added and native plants were planted in mid-December 2018 and January 2019.

This Year-2 Monitoring Report summarizes the results of our biological monitoring, as was specified in the *Southeastern Creekside Marsh Culvert Replacement and Enhancement Mitigation and Monitoring and Reporting Plan* (MMRP).

5. Revegetation Efforts

Revegetation has been done in two areas. First, plants salvaged before culvert replacement were installed after culvert construction was complete (3.5. Site Map). Second, in Restoration Areas, shown on 3.6. Habitat Restoration Site Map, some soil was either removed and replaced with Young Bay Mud in late 2017 or amended with gypsum and compost and planted December 2018 and January 2019.

Culvert Area: Prior to excavation of the berm, the salt marsh vegetation was removed from the project site. The removal began at the upland edge and continued towards higher quality habitat at the lower elevations. The salt marsh vegetation was removed with six inches of soil underneath.

During construction, the salt marsh vegetation was kept on-site until it could be replanted at the completion of the project. The vegetation was stored in a shady area; the low elevation plants (*Spartina foliosa* and *Jaumea carnosa*) were stored in small plastic pools and maintained with several inches of fresh water, and the mid elevation plants (*Salicornia pacifica*, *Distichlis spicata*) were placed on plastic

sheeting and watered daily. The salt marsh vegetation had an approximate survivorship of 90% while out of the marsh.

On October 26, 2016, the salt marsh vegetation was replanted in the work area. The plants were placed based on species and elevation. Vegetation was not placed higher than where existing salt marsh vegetation was observed on site. Planting was completed using hand tools over a four-hour period at low tide. A coir mat was placed on the upland area, and native grass seed mix was spread over of the impacted upland transition zone.

Restoration Areas: In December 2017, an area of marsh north of the culvert project site was restored by replacing existing soil with Young Bay Mud and was left for passive recruitment of salt marsh vegetation. Due to a lack of Young Bay Mud, only half of the area had the unsuitable soil replaced. The other half of the restoration area will be completed in January 2019.

6. Success Criteria

The MMRP established success criteria for percent cover, invasive species cover, and plant survival in the project area.

6.1. Percent Cover

For Year 2, vegetation coverage must be at least 15% compared to the reference site and have an absolute vegetation cover of at least 20% or active planting must occur.

Table 1. Success Criteria for Salt Marsh Species

Year	Average Total Plant Cover Compared to Adjacent Reference Site	Average Absolute Cover of Native Species Compared to Adjacent Reference Site	Absolute Cover Undesirable Exotic Species
One	≥10%	≥5%	≤5%
Two	≥20%	≥15%	≤5%
Three	≥35%	≥30%	≤5%
Four	≥55%	≥50%	≤5%
Five	≥80%	≥75%	≤5%

6.2. Target Invasive Species

The target invasive species shall not exceed 5% absolute cover in any year. Undesirable exotic species are defined as having a Cal IPC Inventory Rating of High or in some circumstances newer weeds identified to be invasive and not yet updated on the Cal IPC lists.

In the upland areas, non-native annual grass species that dominate the site prior to project impacts are not considered target invasive species requiring control because they meet pre-construction conditions.

The target exotic species of note called out in the MMRP are invasive cordgrass species (*Spartina alterniflora*, *Spartina densiflora*) and perennial pepperweed (*Lepidium latifolium*).

6.3. Establish Reference Sites

To evaluate the percent cover of the project sampling areas, two adjacent high-quality reference sites must be established. Reference sites were established with following criteria: within 25 meters of the project sampling area, having marsh species that grow at a similar elevation as the adjacent sampling area, are located on the same channel or creek as the adjacent sampling area, and are the same size as the adjacent sampling area. In Year 2, another reference site was established adjacent to the soil replacement restoration area.

7. Monitoring Methods

To evaluate the progress of restoration in the project site, percent vegetation cover was evaluated quantitatively using the point line intercept method. Plant growth and survival were determined visually on-site. Photo points were established to track revegetation progress in the project area.

7.1. Monitoring Schedule

OEI biologists conducted the vegetation monitoring on October 11, 2018.

7.2. Percent Cover of Native Salt Marsh Species

The average percent cover of vegetation at the project site was evaluated using the point line intercept method. Because a raised pedestrian trail intersected the salt marsh habitats at the project site, two sampling areas were established: The Western Sampling Area located west of the berm/trail, and the Eastern Sampling Area located on the east side of the berm (3.5. Site Map). Three permanent transects were established in each sampling site.

The Western Sampling Area had one 14m long primary transect with two secondary transects of 7m perpendicular to it. The primary transect was placed south to north in the mid-marsh elevation where a majority of the revegetation occurred. The two secondary transects were placed perpendicular to the primary transect to allow low marsh species to be represented in the sampling. Both primary and secondary transects were sampled by dropping a pin every 0.5m and recording the species the pin intersects. The total length of transects were 27m yielding 54 data points.

Due to the larger size of the Eastern Sampling Area, a primary transect of 30m was established south to north but not sampled. Three secondary transects of 9m each were randomly placed perpendicular to the primary transect. The three secondary transects were sampled every 0.5m using the point intercept method. The three transects sample from high to low marsh elevation. The total length of transect sampled was 27m yielding 54 data points.

The transects at the Western Reference Site were established identically to the Western Sampling Area. The Western Reference Site transects were established with one 14m long primary transect and two secondary 7m transects. The secondary transects were placed perpendicular to the primary transect.

Both primary and secondary transects were sampled yielding a total transect length of 27m yielding 54 data points.

The transects in the Eastern Reference Site were established using the same protocol as the Eastern Sampling Area. A primary transect of 30m was placed east to west parallel to the main channel. Three secondary transects of 9m were randomly placed along the primary transect running from high to low marsh elevation. Only the secondary transects were sampled yielding a total of 54 data points.

The habitat restoration north of the culvert site that had soil excavated and replaced was also evaluated with point line intercept method (3.6. Habitat Restoration Site Map). A primary transect of 30m was established and 3 secondary transects of 9m each were placed perpendicularly to it. The three 9m transects were sampled every half meter yielding 54 data points. A reference site was established north of the area at similar elevation to compare the percent cover of the restoration area.

The area south of the soil replacement site was not restored at the time of Year 2 monitoring. Gypsum was dug into the soil in August 2018. Compost will be added, and native plants installed in mid-December 2018. This occurred two months after monitoring and will be monitored next season.

7.3. Data Analysis

Absolute cover of each species was calculated using the point intercept data. Species composition was calculated by dividing the number of hits of a species by the total number of data points (54) taken along that transect. This is multiplied by 100 to yield a percentage of each species.

Absolute cover of vegetation was calculated as the number of hits of vegetation divided by the total number of points recorded along the transect and multiplied by 100.

Cover of invasive species was calculated as the number of hits of invasive species recorded along the transect divided by the total number of points and multiplied by 100.

7.4. Presence of Invasive Species

In addition to invasive species recorded using the point intercept method, all invasive species were visually estimated at the project site. Visual surveys were conducted for invasive species including cordgrass species (*Spartina alterniflora*, *Spartina densiflora*) and perennial peppergrass (*Lepidium latifolium*). Due to the small size of the project area, any invasive species found were recommended for removal.

7.5. Plant Survivorship

Due to the small size of the project area, plant survivorship of the salt marsh species was visually estimated.

7.6. Photo Point Monitoring

Four photographs were taken on October 11, 2018 documenting the two sampling sections as well as the adjacent reference sites. The compass bearing of each and GPS coordinated were recorded for each

photo point. Two additional photo points were taken at the soil replacement site and the adjacent reference site in Year 2 (see Figures 3.5 and 3.6 for photo point locations).

8. Project Site Results

The following are the results of the vegetation monitoring survey that took place 10/11/18.

8.1. Absolute Percent Cover

Absolute percent cover of each sampling area as determined using the point intercept method is detailed in Table 2.

Table 2. Absolute Percent cover

Cover Type	Year 2 Absolute Percent Cover (%)			
	Project Site		Reference Site	
	Western Sampling Area	Eastern Sampling Area	Western Sampling Area	Eastern Sampling Area
Bare Ground	21.7	13	31.5	7.4
Wrack	0	0	0	0
Target Invasive Cover	0	0	0	0
Native Vegetation Cover	79.3	87	68.4	92.6
Absolute Vegetation Cover	79.3	87	68.4	92.6

Absolute cover was determined at the Project Site and Reference Site sampling areas. The absolute cover of the reference areas was used as a baseline for the Project Site vegetation cover. The percent cover of the Project Site compared to the adjacent reference site is detailed below in Table 3.

Table 3. The Percent Cover of the Project Site Compared to the Adjacent Reference Site

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site			
Monitoring Year	Success Criteria	Western Sampling Area	Eastern Sampling Area
Year 1	≥5	82	72
Year 2	≥15	116	93.9
Year 3	≥30		
Year 4	≥50		
Year 5	≥75		

The success criteria for Year 2 were met at both sampling areas. In the Western Sampling Area, the percent cover of native vegetation was higher in the project site than the reference site.

8.2. Invasive Species Cover

Table 4. Invasive Species Cover at Project Site

Year 2 Absolute Cover (%) of Invasive Species		
Success Criteria	Western Sampling Area	Eastern Sampling Area
≤5	0	0

No invasive species were found within the sampling area. Just outside the project area there was one *Spartina densiflora* plant that was removed.

8.3. Species Composition

Table 5. Species Composition of Salt Marsh Vegetation

Cover Type	Year 2 Species Composition (%)			
	Project Site		Reference Site	
	Western Sampling Area	Eastern Sampling Area	Western Sampling Area	Eastern Sampling Area
<i>Salicornia pacifica</i>	2.2	13.3	28	31.6
<i>Jaumea carnosa</i>	56.5	57.8	46	0
<i>Spartina foliosa</i>	6.5	8.9	0	0
<i>Distichlis spicata</i>	30.5	20	18	47.4
<i>Grindelia stricta</i>	0	0	0	10.5
<i>Frankenia salina</i>	4.3	0	0	7.9
<i>Limonium californicum</i>	0	0	8	0
<i>Atriplex spp.</i>	0	0	0	2.6
Target Invasive Species	0	0	0	0

Each species was recorded along the transects at each sampling area, and the percentage of each species was determined. The project site sampling areas had high percentages of *Jaumea carnosa* and *Distichlis spicata*.

8.4. Plant Survival

Plant survival was estimated visually at the project sites. OEI biologists monitored planting areas for signs of plant mortality. The visual survey found that survivorship of planted vegetation was above 90% at both sampling areas. The plantings have grown together and are indistinguishable from each other.

8.5. Upland Seeded Areas

After construction, the upland berm between the bike path and the marsh was seeded with native grass species. Due to the small area, percent cover was visually estimated. The cover of the upland areas was

30% unknown grass species presumed to be non-native annual grass species that dominate the site (3.5. Site Map).

8.6. Photo Point Monitoring

Four photo points were established in Year 1 at the culvert replacement project site. In Year 2, two more photo points were established to document the soil replacement restoration site. A single photo was taken at each of the sampling areas and the adjacent reference sites. The photographs are provided in Appendix A.

9. Habitat Restoration Results

The following are the results of monitoring done at the habitat restoration where unsuitable soil was replaced with Young Bay Mud in December 2017. Monitoring took place on 10/11/18.

9.1. Absolute Percent Cover

Table 6. Absolute percent cover at the soil replacement site.

Cover Type	Absolute Percent Cover (%) of Soil Replacement Area	
	Soil Replacement Area	
	Soil Replacement Site	Reference Site
Bare Ground	88.9	13
Wrack	0	0
Target Invasive Cover	0	0
Native Vegetation Cover	11.1	87
Absolute Vegetation Cover	11.1	87

Absolute cover was determined at the soil replacement site and the adjacent reference site. The absolute cover of the reference site was used as a baseline for the soil replacement site vegetation cover.

Table 7. Percent cover compared to an adjacent reference site at the soil replacement site.

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site			
Monitoring Year	Success Criteria	Soil Replacement Area	Soil Amendment Area
Year 1	≥5	12.7	0
Year 2	≥15		
Year 3	≥30		
Year 4	≥50		
Year 5	≥75		

The soil replacement restoration took place in December 2017, so it was evaluated with Year 1 criteria. The area where soil was replaced with Young Bay Mud had a percent cover of 12.7% compared to a reference area. Due to a lack of Young Bay Mud, half of the area was not restored with new soil. This area will be restored with soil amendments and planting in December 2018 and January 2019. At the time of monitoring, the Soil Amendment Area had a cover of 0%. It will be monitored next year.

9.2. Invasive Species Cover

Table 8. Invasive species cover at the soil replacement site.

Year 2 Absolute Cover (%) of Invasive Species at Habitat Restoration Site		
Success Criteria	Soil Replacement Site	Soil Amendment Site
≤5	0	0

During a site visit in the spring, OEI biologists found *Salsola soda* colonizing the bare mud and advised removal. During the Year 2 monitoring, no *Salsola soda* plants were found.

9.3. Species Composition

Table 9. Species composition at the soil replacement site and adjacent reference site.

Cover Type	Species Composition (%)	
	Habitat Restoration Site	
	Soil Replacement Site	Reference Site
<i>Salicornia pacifica</i>	83.3	70.2
<i>Jaumea carnosa</i>	0	8.5
<i>Spartina foliosa</i>	0	0
<i>Distichlis spicata</i>	0	21.3
<i>Grindelia stricta</i>	0	0
<i>Frankenia salina</i>	16.7	0
<i>Limonium californicum</i>	0	0
<i>Atriplex spp.</i>	0	0
Target Invasive Species	0	0

Pickleweed (*Salicornia pacifica*) was the major species colonizing the soil replacement site. The site is at the same elevation as the surrounding marsh where pickleweed is the dominant species.

10. Discussion

The following sections discuss the results presented above.

10.1. Percent Cover of Salt Marsh Species

The Year 2 success criterion of $\geq 15\%$ native vegetation cover was met at both Western and Eastern Sampling Areas. The Western Sampling Area had a cover of 116% compared to the adjacent reference site, meeting the Year 5 success criteria. The project area had a higher percent cover due to wrack that had deposited along the creek in the reference site. The Eastern Sampling Area had a native species cover of 94% compared to the reference site, meeting the Year 5 success criteria.

Both the Eastern and Western Sampling area continue to have high percent cover of native species in Year 2. The plantings continue to have high survivorship, and passive recruitment appears to have played a large factor in the high native plant cover.

At the soil replacement site, the Year 1 success criterion of $\geq 5\%$ was met where the soil was replaced with Young Bay Mud. The site where the soil was not replaced had no plant cover and was restored after monitoring occurred. This will be monitored next year when the plants have had one year of growth (3.6. Habitat Restoration Site Map).

10.2. Invasive Species Cover

The success criterion of less than 5% invasive cover was met at all sampling sites. No invasive plants were found within the project area. One *Spartina densiflora* plant was removed just outside the culvert project area.

10.3. Species Composition

Jaumea carnosa and *Distichlis spicata* made up a large percentage of the species composition at the project sampling sites. When replanted in the project area, *Jaumea carnosa* allowed for rapid revegetation. The surrounding area and reference sites have slightly higher cover of pickleweed (*Salicornia pacifica*) compared to the project site because survivorship of pickleweed was moderate during construction of the culvert.

At the soil replacement site, pickleweed is colonizing the bare mud through passive recruitment due to large amounts of surrounding pickleweed.

10.4. Plant Survival

Vegetation that was replanted into the project site had $\geq 90\%$ survivorship and appeared robust. The plantings have spread and are now intermixed with plants that have recruited passively.

10.5. Wildlife Observations

Species observed in or adjacent to the project site were documented during onsite vegetation monitoring. One Ridgway's rail (*Rallus obsoletus*) was heard calling approximately 50m north of the project site.

11. Adaptive Management and Remedial Actions

11.1. Upland Vegetation

The upland seeded areas will be monitored in winter and spring for percent cover and invasive species.

11.2. Quarterly Site Visits

OEI will conduct quarterly site visits throughout 2019 and will make additional recommendations as needed to ensure project goals are met.

11.3. Annual Vegetation Monitoring

OEI will conduct the next vegetation monitoring in fall 2019 to determine if success criteria are met for Year 3.

12. References

California Native Plant Society. 2010. Jaumea Carnosa Water Requirement. Accessed November 2017;
[http://calscape.org/Jaumea-carnosa-\(\)](http://calscape.org/Jaumea-carnosa-())

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Marin County Parks, Southeastern Creekside Marsh Culvert Replacement and Enhancement Mitigation and Monitoring and Reporting Plan.

13. Appendix A—Photo Point Monitoring

Photo point monitoring was conducted on 10/18/18.



P-1. Project Site: Eastern Sampling Area



P-3. Reference site: Eastern Sampling Area



P-2. Project site: Western Sampling Area



P-4. Reference site: Western Sampling Area



P-5. Project Site: Soil Replacement Site



P-6. Reference Site: Soil Replacement Site