

Annual Revegetation Monitoring Report

for the Southeastern Creekside Marsh Culvert Replacement and
Habitat Enhancement Project

2020 (YEAR 4)

Prepared by:



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Executive Summary

Background

Construction was completed for the Southeastern Creekside Marsh Culvert Replacement and Habitat Enhancement Project, Corte Madera, Marin County (**Figure 1**), 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 intent to replace it with 200 cubic yards of Young Bay Mud. Unfortunately, only 100 cubic yards of mud was available, and it filled only half of the intended restoration area. Since this part of the project was completed in 2017, in 2020 it was evaluated based on the Year 3 success criteria.

The half of the restoration area that did not receive Young Bay Mud was enhanced using soil amendments and active plantings. Soil amendments occurred in August 2018 and native plants were planted by January 2019. This part of the project was initially evaluated in summer 2019 based on the Year 1 success criteria, and in 2020 it was evaluated based on the Year 2 success criteria.

In compliance with permits, the project is to be monitored for 5 years, or until final success criteria have been met. This monitoring report summarizes the results of Year 4 vegetation monitoring, as prescribed in *Southeastern Creekside Marsh Culvert Replacement and Enhancement Mitigation and Monitoring and Reporting Plan (MMRP)*.

Results

The culvert replacement project site (**Figure 2**) met the Year 5 success criteria in 2018. This area was not monitored quantitatively this year. Monitoring included photo points and an invasive species survey to ensure Year 5 success criteria were still achieved.

The soil replacement restoration site (**Figure 3**) had native plant percent cover of 73.5% compared to an adjacent reference site, exceeding the Year 3 criterion. The soil amendment restoration site had a percent cover of 59.6% compared to an adjacent reference site, meeting the Year 2 criterion. Invasive cover was less than 5% in the soil replacement site. In the soil amendment site, invasive cover was above the 5% threshold due to buckhorn plantain (*Plantago lanceolata*) moving into the planted area. *Plantago lanceolata* will be hand removed this fall by Friends of Corte Madera Creek Watershed.

Remedial Action

Hand removal of *Plantago lanceolata* from the soil amendment will take place this fall. Monitoring of treatment efficacy will take place quarterly.

Requested Agency Action

No agency action is requested at this time.

1. Project Description

On September 9, 2016, work began to replace an existing single bore culvert that connects Corte Madera Creek to Creekside Marsh (**Figure 1**). 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 (**Figure 2**).

In December 2017, the second component of the project was completed (**Figure 3**). An area of marsh approximately 8,290 square feet had compacted soil, unsuitable to support salt marsh vegetation. The top eight inches of soil was removed and replaced with Young Bay Mud. The mud was placed at the same elevation as the surrounding marsh. Due to the lack of available Young Bay Mud, only half of the proposed 8,290 square feet restoration site was treated in this way.

In the other half of the restoration area, soil amendments were added to encourage plant growth. Gypsum and compost were added to the soil and native plants were planted by January 2019. This area was assessed initially in the summer of 2019; this report summarizes the Year 2 monitoring of the soil amendment site conducted in 2020.

This Year-4 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).



Figure 1. Project Location Map



Figure 2. Culvert Replacement Project Site Map



Figure 3. Habitat Restoration Site Map

2. Revegetation Efforts

Revegetation has occurred in three areas: the culvert replacement project area (**Figure 2**), the soil replacement area, and soil amendment area (**Figure 3**). First, plants salvaged before the culvert replacement were installed after culvert construction was complete. Second, in restoration areas (**Figure 2**), soil was removed and replaced with Young Bay Mud in late 2017 or amended with gypsum and compost and planted by 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.

Soil Replacement Area: In December 2017, an area of marsh north of the culvert project site was restored by replacing existing soil with Young Bay Mud and left for passive recruitment of salt marsh vegetation. In 2019, pickleweed (*Salicornia pacifica*) was planted to further enhance restoration efforts.

Soil Amendment Area: Due to a lack of Young Bay Mud, the proposed habitat restoration area could not be replaced with suitable soil. Instead, soil amendments and active planting were done to meet restoration requirements. First, large rocks were removed from the existing soil. Then, gypsum and composted green waste were added followed by active planting of native plant species. Native plant species included saltgrass (*Distichlis spicata*), creeping wild rye (*Elymus triticoides*), alkali heath (*Frankenia salina*), cuman ragweed (*Ambrosia psilostachya*), marsh baccharis (*Baccharis glutinosa*), and California mugwort (*Artemisia douglasiana*).

3. Success Criteria

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

3.1. Percent Cover

The percent cover criteria for revegetated areas (culvert replacement project site, soil amendment site and soil replacement) shown in **Table 1**.

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%

3.2. 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 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*).

3.3. Establish Reference Sites

To evaluate the percent cover of the project sampling areas, adjacent reference sites must be established. Reference sites were established with following criteria: within 45 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, a reference site was established adjacent to the soil replacement restoration area, and in Year 3, a reference site was established for the soil amendment area.

4. 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.

4.1. Monitoring Schedule

OEI biologists conducted the vegetation monitoring on September 28, 2020.

4.2. Percent Cover of Native Salt Marsh Species

The culvert replacement project site (**Figure 2**) was not evaluated quantitatively this year. Year 5 success criteria were achieved last year for percent cover of native species and presence of invasive species.

The soil replacement habitat restoration was evaluated using the point line intercept method (**Figure 3**). 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 site.

The soil amendment habitat restoration was evaluated using the point line intercept method (**Figure 3**). Three 9m transects were established from low to high elevations and were sampled every half meter. A reference site was established south of the restoration area at a similar elevation.

4.3. 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.

The soil replacement site was evaluated based on Year 3 success criteria, and the soil amendment site was evaluated using Year 2 success criteria.

4.4. 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.

4.5. Plant Survivorship

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

4.6. Photo Point Monitoring

Eight photographs were taken on September 28, 2020 documenting the culvert replacement project site and habitat restoration site. The compass bearing of each and GPS coordinated were recorded for each photo point.

5. Results

5.1. Culvert Replacement Revegetation Results

The culvert replacement project site (**Figure 2**) was not monitored quantitatively because all Year 5 success criteria were reached last year in Year 2. Photo point monitoring, plant survival, and invasive species monitoring were completed this year to ensure no major plant die offs or invasive species occurred that could jeopardize the success of the culvert replacement project site.

5.1.1. Absolute Percent Cover

Year 5 success criteria were achieved in Year 2 as shown below (**Table 2**). Percent cover compared to an adjacent reference site was not evaluated this year. The site was visually assessed to ensure that no major plant mortality occurred since success criteria were achieved. The culvert area appears to have plant cover equal to the surrounding marsh.

Table 2. Percent Cover of native species at the culvert replacement project site.

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site			
Monitoring Year	Success Criteria	Western Sampling Area	Eastern Sampling Area
Year 1 (2017)	≥5	82	72
Year 2 (2018)	≥15	116	93.9
Year 3 (2019)	≥30	Not Measured	Not Measured
Year 4 (2020)	≥50	Not Measured	Not Measured
Year 5 (2021)	≥75		

5.1.2. Photo Point Monitoring

Photo points will continue to be recorded at the culvert replacement project site to monitor the success of the plantings (**Appendix A**).

5.1.3. Invasive Species Cover

The culvert replacement project sites were monitored for invasive species this year. No invasive species were found. Invasive species will continue to be monitored during quarterly site visits.

5.1.4. Plant Survival

Plant survivorship was visually monitored at the culvert replacement site. Plant survivorship was above 90%, and the plantings have completely intermixed with the surrounding marsh.

5.2. Habitat Restoration Results

The following are the results of monitoring conducted on September 28, 2020 at the habitat restoration sites (**Figure 3**). The habitat restoration is separated into two sites: The soil replacement site which was restored using Young Bay Mud in December 2017, and the soil amendment area that was restored in January 2019.

5.2.1. Soil Replacement Area Results

5.2.1.1. Absolute Percent Cover

Absolute cover was determined for the project site and the adjacent reference site. The results were used to calculate the percent cover compared to reference site success criterion (**Table 3**).

Table 3. Absolute percent cover at the soil replacement site.

Cover Type	Absolute Percent Cover (%) of Soil Replacement Area	
	Soil Replacement Site	Reference Site
Bare Ground	33.3	5.6
Wrack	0	0
Target Invasive Cover	0	0
Native Vegetation Cover	66.7	90.7
Absolute Vegetation Cover	66.7	90.7

The soil replacement site was compared to the adjacent reference site. Percent cover had a percent cover of 73.5% compared to the reference site (**Table 4**).

Table 4. Percent cover compared to an adjacent reference site at the soil replacement.

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site		
Monitoring Year*	Success Criteria	Soil Replacement Site
Year 1 (2018)	≥5	12.7
Year 2 (2019)	≥15	45.1
Year 3 (2020)	≥30	73.5
Year 4 (2021)	≥50	
Year 5 (2022)	≥75	

*The soil replacement restoration took place in December 2017. In 2020 it was evaluated with Year 3 criteria.

5.2.1.2. Invasive Species Cover

No invasive species were found in the soil replacement site (Table 6).

Table 5. Invasive species cover at the soil replacement site.

Year 3 Absolute Cover (%) of Invasive Species at Habitat Restoration Site	
Success Criteria	Soil Replacement Site
≤5	0

5.2.1.3. Species Composition

Two plant species were documented at the soil replacement site, Pickleweed (*Salicornia pacifica*), and salt grass (*Distichlis spicata*) (**Table 7**). Pickleweed was the major colonizing species, and is the dominant species in the surrounding habitat. Both species were found at similar density as the reference site.

Table 6. Species composition at the soil replacement site and adjacent reference site.

Cover Type	Species Composition (%)	
	Soil Replacement Site	
	Project Site	Reference Site
<i>Salicornia pacifica</i>	61.1	63.2
<i>Jaumea carnosa</i>	0	1.3
<i>Spartina foliosa</i>	0	0
<i>Distichlis spicata</i>	38.9	35.5
<i>Grindelia stricta</i>	0	0
<i>Frankenia salina</i>	0	0
<i>Limonium californicum</i>	0	0
<i>Atriplex spp.</i>	0	0
Target Invasive Species	0	0

5.2.1.4. Plant Survival

Plant survivorship was visually estimated where active plantings had taken place. Plant survivorship at the soil replacement site was 80-90% The soil replacement site is a mix of planted pickleweed and passive recruitment. These areas have intermixed, and plant survival is high.

5.2.2. Soil Amendment Area Results

5.2.2.1. Absolute Percent Cover

Absolute cover determined at the soil amendment sites and the adjacent reference sites is shown in **Table 8**. The calculated percentage cover of native marsh vegetation for 2020 was 59.6 % (**Table 9**), above the minimum cover criterion of 15%.

Table 8. Absolute percent cover at the soil amendment site.

Cover Type	Absolute Percent Cover (%) of Soil Amendment Area	
	Soil Amendment Site	Reference Site
Bare Ground	36.9	11.7
Wrack	0	0
Target Invasive Cover	17	11
Native Vegetation Cover	46.1	77.3
Absolute Vegetation Cover	62.9	87.3

Table 9. Percent cover compared to an adjacent reference site at the soil amendment site.

Percent Cover (%) of Native Salt Marsh Species Compared to Reference Site		
Monitoring Year*	Success Criteria	Soil Amendment Site
Year 1 (2019)	≥5	43.3
Year 2 (2020)	≥15	59.6
Year 3 (2021)	≥30	
Year 4 (2022)	≥50	
Year 5 (2023)	≥75	

* The soil amendment site was planted in January 2019 and evaluated for the first time in Summer 2019. Monitoring in 2020 is thus compared to Year 2 criteria.

5.2.2.1. Invasive Species Cover

Plantago lanceolata was found above the acceptable percent cover at the soil amendment site (**Table 10**). This species is found in areas adjacent to the restoration site and easily invades disturbed areas. This will be hand removed and monitored for treatment efficacy.

Table 10. Invasive species cover at the soil amendment site.

Year 3 Absolute Cover (%) of Invasive Species at Habitat Restoration Site	
Success Criteria	Soil Amendment Site
≤5	17

5.2.2.1. Species Composition

Marsh baccharis (*Baccharis glutinosa*), western ragweed (*Artemisia douglasiana*), and pickleweed (*Salicornia pacifica*) are growing successfully in the soil amendment site (**Table 11**). Invasive *Plantago lanceolata* was found in the project site this year and will be removed by hand and monitored quarterly.

Table 11. Species composition at the soil amendment site and adjacent reference site.

Cover Type	Species Composition (%)	
	Soil Amendment Site	
	Project Site	Reference Site
<i>Distichlis spicata</i>	8.3	45.0
<i>Salicornia pacifica</i>	23.2	7.5
<i>Frankenia salina</i>	3.0	12.5
<i>Elymus triticoides</i>	9.1	0
<i>Ambrosia psilostachya</i>	18.2	0
<i>Baccharis glutinosa</i>	21.2	0
<i>Artemisia douglasiana</i>	0	0
<i>Symphotrichum chilense</i>	0	0
<i>Grindelia stricta</i>	0	0
Annual Upland Grass	0	32.5
<i>Limonium californicum</i>	0	2.5
Invasive <i>Plantago lanceolata</i>	17.0	0

5.2.2.1. Plant Survival

Plant survivorship was visually estimated where active plantings had taken place. Plant survivorship at the soil amendment site was 60-70%.

6. Discussion

The following sections discuss the results of the monitoring that occurred on September 28, 2020.

6.1. Percent Cover of Salt Marsh Species

The Year 3 success criterion of $\geq 30\%$ native vegetation cover was met at the soil replacement site (**Figure 3**). The site had a native vegetation cover of 73.5% compared to the adjacent reference site. Pickleweed had been planted by Friends of Corte Madera Creek Watershed in 2018 that helped boost percent cover of native species. The Young Bay Mud was become firmer and is at an elevation suitable for mid and upper elevation marsh plants to recruit.

Year 2 success criterion of $\geq 15\%$ native vegetation cover was met at the soil amendment site as well (**Figure 3**). The site had a native vegetation cover of 59.6% compared to a reference site. This area was actively planted and irrigated which has allowed plant survival to be approximately 60-70%.

The culvert replacement project site (**Figure 2**) was visually monitored to ensure that the percent cover of salt marsh species was still at the Year 5 success criterion. The plantings continue to be successful and net cover appeared similar to the surrounding marsh.

6.2. Invasive Species Cover

Invasive species cover was greater than 5% in the soil amendment site. Invasive *Plantago lanceolata* was found invading the planted area. This species is found throughout the upland areas surrounding the site and grows well in disturbed soils. The University of California Cooperative Extension's Weed Research & Information Center suggests hand pulling as an effective method for controlling this species. Removal of this species is recommended immediately as well as follow up monitoring that will be conducted quarterly by OEI biologists.

No invasive species were found in the soil replacement site or the culvert replacement project site.

6.3. Species Composition

At the soil replacement site, *Salicornia pacifica* and *Distichlis spicata* made up the largest percentage of the species composition. The species composition of the soil replacement is similar to the adjacent reference site. These two species are found throughout the site at mid marsh elevation. Passive recruitment has been successful in revegetating this area.

At the soil amendment site, *Salicornia pacifica*, *Ambrosia psilostachya*, and *Baccharis glutinosa* were the most successful upland plantings. Installing irrigation has been vital to the initial survivorship of the upland plantings. At lower elevation, *Salicornia pacifica* was the most abundant species and will

hopefully fill in the area through passive recruitment. Invasive *Plantago lanceolata* made up a significant part of the species composition and has been recommended for removal by hand.

6.4. Plant Survival

Plant survival at the soil amendment site appeared to be 60-70%. The plantings have spread and are now intermixed with plants that have recruited passively. *Ambrosia psilostachya* and *Baccharis glutinosa* were the most successful species. Plants appear to be healthy, but small. This may be due to the harsh soils they were planted in.

Plant survival at the soil replacement site was very high. It was impossible to distinguish what was planted by Friends of Corte Madera Creek and what had been passive recruitment. All established plants in this area appeared healthy.

6.5. 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 100m north of the soil replacement site.

7. Adaptive Management and Remedial Actions

7.1. Removal of *Plantago lanceolata*

OEI recommends hand removal of all *Plantago lanceolata* found in the soil amendment site. Removal will take place this fall by Friends of Corte Madera Creek Watershed.

7.2. Quarterly Site Visits

OEI will conduct quarterly site visits throughout 2021 and will make additional recommendations as needed to ensure project goals are met. OEI biologists will monitor the treatment efficacy of invasive *Plantago lanceolata* and recommend further treatment if necessary.

7.3. Annual Vegetation Monitoring

OEI will conduct the next vegetation monitoring in fall 2021.

8. References

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

Appendix A- Photo Point Monitoring

Photo point monitoring was conducted on 9/28/20.



P-1. Project Site: Eastern Sampling Area



P-3. Reference site: Eastern Sampling Area

APPENDIX A – PHOTO POINT MONITORING



P-2. Project site: Western Sampling Area



P-4. Reference site: Western Sampling Area

APPENDIX A – PHOTO POINT MONITORING



P-5. Project Site: Soil Replacement Site



P-6. Reference Site: Soil Replacement Site

APPENDIX A – PHOTO POINT MONITORING



P-7. Project Site: Soil Amendment Site



P-8. Reference Site: Soil Amendment Site