Oyster Creek Stabilization Project

Post-construction Monitoring Report – Year 4

Prepared for:

El Dorado Irrigation District

Prepared by:
Horizon Water and Environment
Contact: Robin Hunter
(203) 848-9977
rohunter@montrose-env.com

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MONTROSE ENVIRONMENTAL

1. INTRODUCTION

The El Dorado Irrigation District (EID) completed construction of the Oyster Creek Stabilization Project (Project) in October 2019. The Project used biotechnical techniques to stabilize a portion of Oyster Creek and its North Tributary.

The Project site is located in eastern El Dorado County, California (**Figure 1**). **Figure 2** provides an overview of the Project area. The Project includes two sites, the Oyster Creek and North Tributary restoration sites. Five years of post-construction monitoring are required by the Oyster Creek Monitoring Maintenance and Reporting Plan (MMRP) (EID 2014). This *Year-4 Monitoring Report* documents conditions at the Project sites, including plant survival, vegetation cover, erosion, and photographic documentation during the summer of 2023. The monitoring activities comply with the requirements of the MMRP.

2. METHODS

Year-4 monitoring activities were conducted on August 7, 2023 by Montrose Environmental (Montrose) biologist Brian Piontek. Post-construction monitoring was conducted per the Oyster Creek Monitoring Maintenance and Reporting Plan (EID 2014). Reference sites were established in 2019 near the restoration sites (Figure 2).

2.1 VEGETATION ASSESSMENT

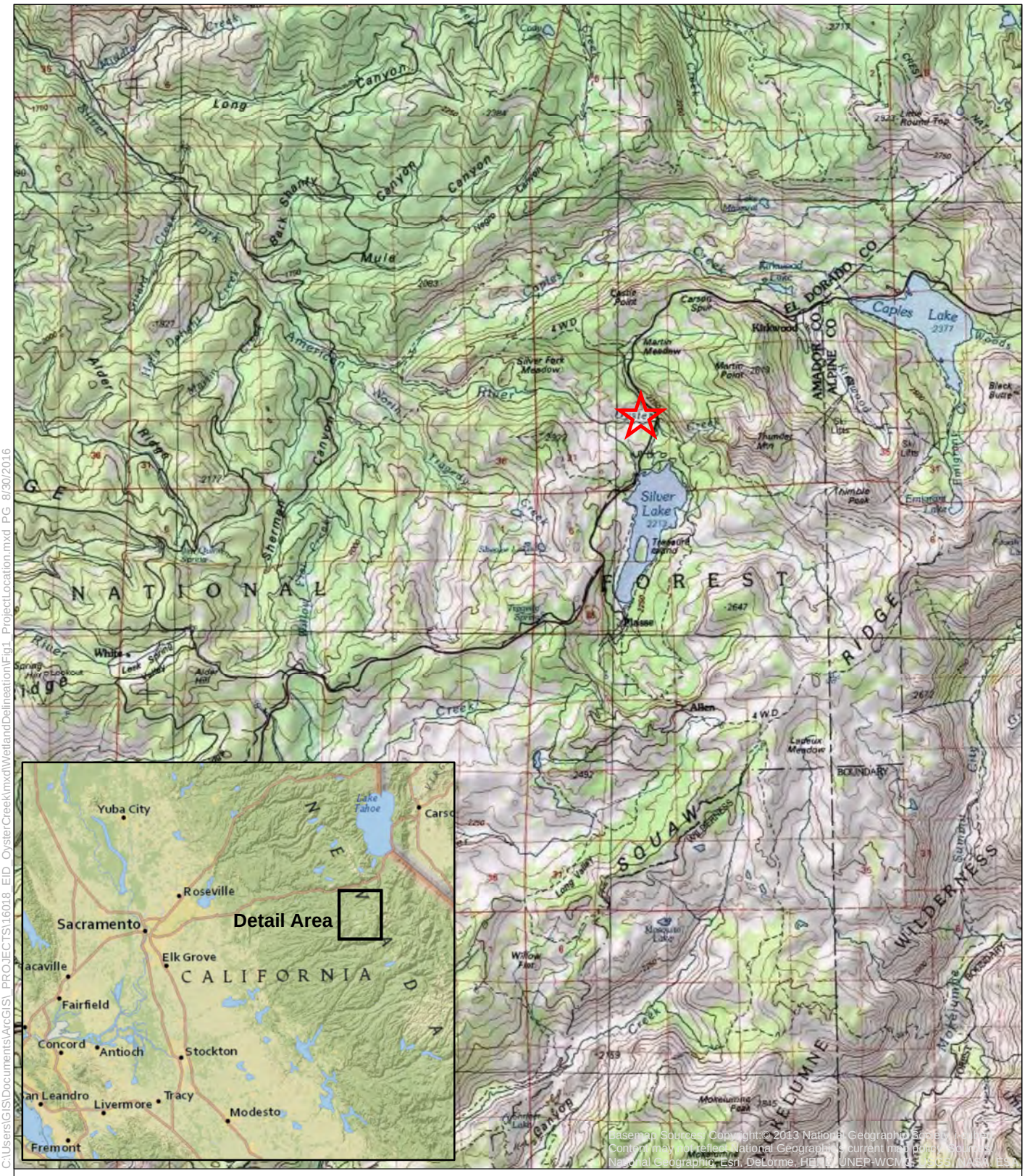
Plant survival was recorded within the Oyster Creek and North Tributary restoration sites for each willow cutting and container plant. Vegetation cover was recorded by strata (i.e., herbaceous cover and shrub/tree cover) at both the restoration sites and reference sites.

2.2 EROSION ASSESSMENT

Monitoring included measurement of erosion pins placed in the banks of Oyster Creek in 2019 at the restoration and reference sites. The stability of the three head cuts in the North Tributary were measured and visually assessed, and compared to the reference site head cut. The bases of the head cuts were marked in 2019 and compared to 2023 conditions.

2.3 PHOTO-DOCUMENTATION

Photographs were taken from representative point locations established during Project implementation. The photographs document and compare annual vegetative growth and conditions at each site. Photo point locations are shown on Figures 2. Photographs are provided in **Appendix A**.



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0 2.5 5
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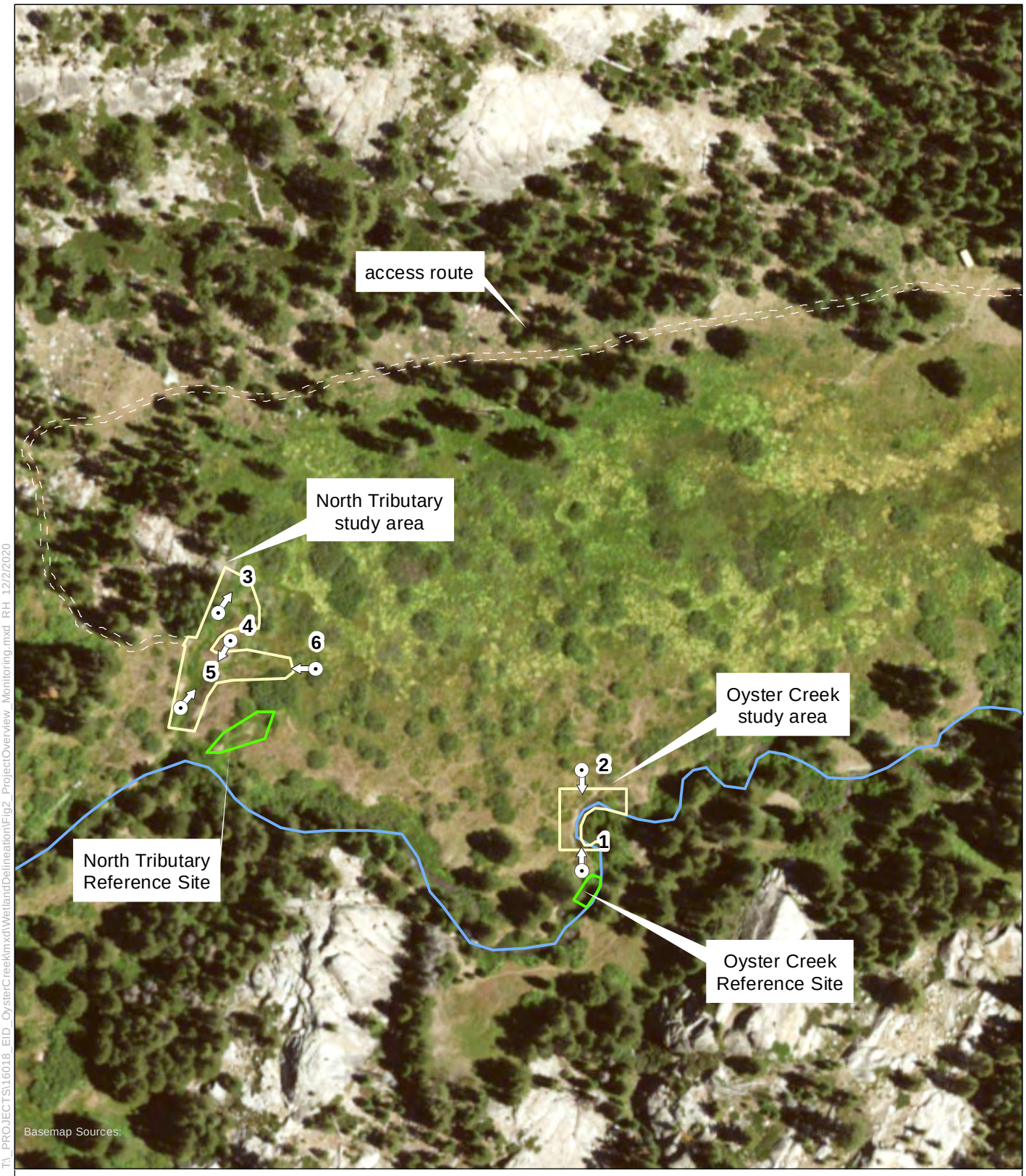
Project Location

Figure 1
Project Location

Oyster Creek
Stabilization Project

Horizon
WATER and ENVIRONMENT



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N

0 100 200
Feet

Study Area
Reference Sites
Access Route
Photo Points
Oyster Creek

Horizon
WATER and ENVIRONMENT

Figure 2
Project Overview

Oyster Creek
Stabilization Project

3. RESULTS

3.1 VEGETATION ASSESSMENT

Oyster Creek

Revegetation of the Oyster Creek restoration site included planting of locally-harvested Lemmon's willow (*Salix lemmonii*) poles and mountain alder (*Alnus incana* spp. *tenuifolia*) container plants. A diverse assemblage of naturally recruited herbaceous species also contributes to plant cover. **Table 1** shows the vegetation percent cover at the Oyster Creek restoration and reference sites, according to stratum.

Table 1. Vegetation percent cover within Oyster Creek restoration and reference sites.

Oyster Creek Site	Stratum	Year-1 (Percent Cover)	Year-4 (Percent Cover)	Percent Change in Vegetation Cover from Year-1 to Year-4	Performance Standard	Percentage Difference in Vegetation Cover Between Restoration and Reference Sites
Restoration	Herbaceous	25	55	+120%	Restoration +/- 25% Reference	+9%
	Shrub/Tree	5	5	No change		
Reference	Herbaceous	30	35	17%		
	Shrub/Tree	20	20	No change		

Total vegetative cover at the Oyster Creek restoration site is 9% higher as compared to the reference site. Species composition at both the restoration and reference sites are comparable with grasses co-dominant with several other species, such as lupine (*Lupine* sp.), larkspur (*Delphinium* sp.), willow herb (*Epilobium ciliatum*), and corn lily (*Veratrum californicum*). The shrub/tree cover at the restoration site is dominated by young saplings originating from the cuttings. The percent cover for shrub/tree layer at the reference site is the direct result of a single mature pine tree at the northern edge of the site.

Table 2 lists the species installed in 2019 and the number of living plants observed in Year-1 and Year-4 monitoring events**.**

Table 2. Plant species and abundance at the Oyster Creek restoration site.

Species	Performance Standard	Number Installed	Number of Living Plants (Year-1)	Number of Living Plants (Year-4)
Mountain Alder *Alnus incana* spp. *tenuifolia*	60% survival	10	8	16
Lemmon's Willow *Salix lemmonii*		121	107	108
Total		**131**	**115**	**124**
Percent Survival			**88%**	**95%**

North Tributary

Revegetation of the North Tributary restoration site included planting Lemmon's willow poles, mountain alder container plants, and quaking aspen (*Populus tremuloides*) seedlings harvested from adjacent to the restoration site. In 2022, aspen root cuttings were also installed throughout the restoration site where willow cuttings had failed. A diverse assemblage of naturally recruited herbaceous species also contribute to plant cover. **Table 3** shows the vegetation percent cover at the North Tributary restoration and reference sites, according to stratum.

Table 3. Vegetation percent cover within North Tributary restoration and reference sites.

North Tributary Site	Stratum	Year-1 (Percent Cover)	Year-4 (Percent Cover)	Percent Change in Vegetation Cover from Year-1 to Year-4	Performance Standard	Percentage Difference in Vegetation Cover Between Restoration and Reference Sites
Restoration	Herbaceous	70	70	No change	Restoration +/- 25% Reference	+21%
	Shrub/Tree	15	15	No change		
Reference	Herbaceous	70	60	-14%		
	Shrub/Tree	10	10	No change		

At the North Tributary restoration site, vegetation in the herbaceous stratum is dominated by various grasses and sedges, as well as corn lily. Vegetation in the shrub/tree stratum is dominated by Lemmon's willow and quaking aspen. Vegetation composition in the reference site is similar, although quaking aspen is not present at this site. Overall, the North Tributary restoration site supported dense herbaceous growth and total vegetative cover was 21% greater than at the reference site.

Table 4 lists the species installed in 2019 and the number of living plants observed in Year-1 and Year-4 monitoring events**.**

Table 4. Plant species and abundance at the North Tributary restoration site

Species	Performance Standard	Number Installed	Number of Living Plants (Year-1)	Number of Living Plants (Year-4)
Mountain Alder *Alnus incana* spp. *tenuifolia*	60% survival	5	1	1
Lemmon's Willow (poles) *Salix lemmonii*		111	87	53
Quaking Aspen *Populus tremuloides*		7	2	55
Total		**123**	**90**	**109**
Percent Survival			**73%**	**87%**

3.2 EROSION ASSESSMENT

Oyster Creek Erosion Pin Monitoring

Erosion pins were installed at various bank elevations in 2019 at the Oyster Creek restoration and reference sites. The erosion pins were measured to determine the rate of erosion at the reference and restoration sites. If restoration sites experience similar erosion rates as reference sites or less (within 25 percent), the restoration will be considered successful. **Table 5** provides results from Year-1 and Year-4 erosion pin monitoring. Erosion pin numbers are from upstream to downstream. Photo 7B in Appendix A shows a reference site erosion pin.

Table 5. Oyster Creek Erosion Pins

Erosion Pin	Length at Installation (inches)	Year-1 Length (inches)	Year-4 Length (inches)	Change from Installation (inches)	Performance Standard
Restoration Site					Restoration erosion ≤25 % of reference erosion
Erosion Pin 1	5.75	--*	--*	-5.75*	
Erosion Pin 2	5.00	5.25	9.75	+4.75	
Erosion Pin 3	6.10	4.00	--*	-6.10*	
Erosion Pin 4	6.00	5.00	--*	-6.00*	
			Average	-3.28	
Reference Site					
Erosion Pin 5	6.00	4.00	4.25	-1.75	
Erosion Pin 6	6.00	5.00	5.75	-0.25	
			Average	-1.00	
*These erosion pins appear to have been buried by fine material from the upper bank that has accumulated behind the coir logs and lower bank vegetation.					

Erosion pins #1 and #3 were not able to be located during Year-3 monitoring. Erosion pin #4 was located during Year-3 but was not detected during Year-4 monitoring activities. It appears that material and vegetation have accumulated above the coir log at those locations and subsequently buried the pins.

North Tributary Headcut Monitoring

Table 6 shows Year-1 and Year-4 monitoring results for the base of the three North Tributary headcuts, and the reference site headcut.

Table 6. North Tributary Headcuts

Headcut Location	Performance Standard	Headcut Advancement	
		Year-1 (inches)	Year-4 (inches)
Restoration Site			
Main Portion North Tributary (Brush Pack)	Headcuts do not advance more than 24 inches	0	0
Upstream Tributary		6	12
Downstream Tributary		12	14
Reference Site			
Reference		12	22

4. DISCUSSION

This section discusses the results of the monitoring in the context of the performance standards and conditions listed in the MMRP. The MMRP stipulates a 60 percent survivability target for plantings throughout the five-year monitoring period. It also stipulates that the restoration sites shall provide similar vegetative cover as the reference sites (+/- 25 percent). Finally, it stipulates that restoration sites experience similar erosion rates as reference sites or less (within 25 percent). If the survival, cover, and/or erosion requirements are not achieving these goals, adaptive management techniques (e.g., replacement plantings, additional watering) may be necessary to meet the success criteria.

Oyster Creek Restoration Site

The Oyster Creek restoration site is meeting the performance standard for tree survivorship and vegetative cover, and erosion rates.

The streambank along the Oyster Creek restoration site appears to be naturally adjusting laterally as the site is evolving to a more stable condition. This is supported by the unchanged position of the coir log along the bank toe, the calving of hanging vegetation along the upper edge of the bank, and burying of three of the four erosion pins along the restoration site (see Table 5). In 2022, adaptive measures were taken including cutting overhanging vegetation into 1-foot by 1-foot (minimum) sod blocks, positioning the sod on the mid- and lower bank slopes above the existing coir log, and staking the sod blocks into place. The intent of this action was to: (1) control the loss of densely vegetated overhanging sections that may have otherwise naturally sheared off and dropped into the creek channel to be washed away; (2) more effectively revegetate bank slopes otherwise void of vegetation; (3) reduce the potential for erosion (e.g., splash and sheet erosion) on the exposed bank; and, (4) create a lateral step across the bank with the intent of holding material at an intermediate level behind the sod blocks and thereby reducing material losses to the creek.

All of the approximately 25 linear feet of sod blocks repositioned along the bank remained intact and appeared to be functioning as intended by increasing the vegetation cover along the mid- and lower bank and increasing the stability of the lower bank and toe. Fine materials appear to be accumulating behind the coir log allowing herbaceous vegetation to establish around the sod blocks and create a near-continuous band of vegetation along the lower bank through the restoration site (see **Appendix A**, Photos

1C and 2C). As shown in Table 1, the restoration site is exceeding the performance criteria for vegetative cover.

Due to bank calving of the overhanging vegetation in 2019 and 2022, sections of the coir log at the toe and many willow stakes along the mid- and lower bank were buried. While this accumulation of material behind the coir log was beneficial in terms of creating a more gradual slope angle and increasing bank stabilization, the loss of plants lowered over the overall number of plants available to meet performance standards for plant survivorship. To ensure the restoration site met the performance criteria for plant [number] survivorship, as well as help increase bank stability, EID staff installed approximately 40 willow poles and 10 alder cuttings in the restoration area in October 2022. Planting concentrated on the mid- to lower slopes, where water availability was most suitable for willow growth and previous cuttings showed the highest rate of survival.

During the Year-4 monitoring, the additional 2022 plantings were generally in good health. The mountain alder cuttings in particular appeared robust and healthy where present. As shown in Table 2, the restoration site is exceeding the performance criteria for tree survivorship.

As shown in Table 3, erosion pins #1, 3, and 4 were not located while bank erosion continued to occur at erosion pin #2. Quantitatively, the average length of exposed erosion pins decreased more at the restoration site (3.3 inches) compared to the reference site (1 inch) and the restoration site is currently meeting the performance standard for erosion. However, as previously discussed, the streambank along the restoration site appears to be naturally adjusting laterally as the site evolves to a more stable condition. As a result of this natural process, it is assumed erosion pins #1, 3, and 4 were buried as material from the upper bank has accumulated on top of and behind the coir logs installed along the lower and middle bank and further stabilized with sod blocks, as was the intended function and purpose of those treatments. While measurements at erosion pin #2 appear to indicate the bank is retreating at this location, this data is misleading as erosion pin #2 is located at a slightly higher elevation on the bank slope and material from the upper bank (where the pin is set) is accumulating behind the coir long along the lower bank. Visual evidence of this process is clearly visible when comparing the photo series from 2019 to 2023 (see Appendix A, Photo Nos. 1 and 2). Additionally, when qualitatively assessing the overall geomorphic stability of the restoration site, no excessive erosion or sedimentation areas were observed and the streambank appears to be progressing to a more stable and resilient condition.

Conditions at the Oyster Creek reference site remained relatively similar to previous years in terms of erosion and species composition, but with a slight decrease in overall herbaceous cover site (see Appendix A, Photos 7A and 7B).

Streambank erosion was noted directly downstream of the restoration site with a short segment of the creek bank near vertical. This process is unrelated to the restoration activities and is the result of a naturally occurring geomorphic processes where the creek curves around a point bar on the right bank but dense willow and alder growth on the left bank restrict lateral movement in that direction. Subsequently, streamflow energy remains concentrated on the right bank creating an eddy near the head of the point bar. It's assumed that the process will continue to progress until the channel avulses and/or the point bar is eroded to a degree that the channel geometry conveys flow in a more direct downstream

path. This erosion area is outside of the restoration footprint. However, although not anticipated at this time, there remains a potential that the progression of this fluvial process may affect the bank stability and planting survivorship along the downstream extent of the restoration area as the channel evolves. The condition of the bank and point bar at this location shall be noted during future site visits.

North Tributary Restoration Site

Significant sedimentation has occurred behind several fascines in the upstream and downstream tributaries and in the main tributary downstream of the rocked channel. These fascine features are performing as designed by creating sediment sinks and aggrading the channel thus creating a more gradual bed slope. However, this aggradation has buried significant portions of the willow fascines. In general, the tributary channels are densely vegetated with herbaceous species, as shown in Table 3, but the aggradation has unintentionally lowered the survivorship of the live willow cuttings (see Appendix A, Photos 3C, 4C, 5C, and 6C).

In 2022, EID staff supplemented the existing tree plantings by installing approximately 14 willow poles and 6 aspen cuttings along the North Tributary site. Despite this effort, the planted Lemmon's willow poles and fascines survivorship at the North Tributary restoration site were noticeably lower compared to previous monitoring years. However, aspen cuttings and natural recruitment was significantly higher, especially along the right (south) bank and center of the channel near the rocked channel closest to the native aspen stand (see Appendix A, Photos 3B and 3C). As such, the total plant survivorship together with the natural aspen recruitment exceeds the performance standard, as shown in Table 4.

The performance standard for erosion at the North Tributary is that headcuts do not advance headward (upstream) by more than two feet into the meadow following completion project activities (i.e, Year-0). For comparison, the headcut at the North Tributary reference site has migrated upstream approximately 22 inches since Year-0.

No upstream advancement has occurred in the headcut in the main portion of the North Tributary, where the brush pack was installed. The brush pack has remained stabled and sediment aggradation is visible (Photos 3c and 4c in Appendix A). However, a 2-foot wide by 2-foot long by 18-inch deep hole was observed at the downstream end of the rock channel at the transition point to earthen streambed. The rock itself appeared to be in stable condition and no erosion was apparent in the channel downstream of the scour hole. The scour hole was repaired on November 2, 2023 to prevent the potential for future undercutting of the upstream rock riprap. Repairs were made using a mixture of rock and native soil under the supervision of Montrose biologist Jessica González. See Appendix A, Photos 8A and 8B.

The headcut at the upstream tributary at the North Tributary restoration site has partially migrated upstream of the repair with minor gullying observed. However, the willow fascine installed at this location was intact and appeared to be controlling grade with minor gullying visible for approximately 8 feet upstream of the fascine and fine material deposited on the downstream side of the fascine. This gullying was considered minor as it was only a few inches deep over a 12-inch horizontal width. A similar process was observed at the downstream tributary at the North Tributary restoration site, but at a lesser degree, with minor gullying extending upstream of the repair but over a more diffuse area.

The two smaller headcuts (the upstream and downstream tributaries) are currently meeting the performance standard, and headcut advancement is less than or equal to headcut advancement at the reference headcut.

5. SUMMARY OF YEAR-4 FINDINGS AND RECOMMENDATIONS:

- The Oyster Creek restoration site is currently exceeding performance standards for plant survival, vegetative cover, and erosion. No adaptive management actions are recommended at this time.
- Year-5 monitoring efforts should include a qualitative assessment of geomorphic conditions along the Oyster Creek restoration site. The assessment should focus on visual evidence of excessive erosion or sedimentation, the apparent stability along the bank toe, condition of the log coir, and evidence of undercutting of the upper/middle bank below the root zone of the adjacent meadow grasses.
- The North Tributary restoration site is exceeding performance standards for plant survival and vegetative cover. No adaptive management actions are recommended at this time.
- The North Tributary restoration site is currently meeting performance standards related to erosion, despite observed gullying and minor erosion. Observed erosion is considered within the limits of natural processes as the restoration site adjusts to find an equilibrium.

REFERENCES

El Dorado Irrigation District. 2014. Oyster Creek Monitoring Maintenance and Reporting Plan. December.

Appendix A

Photographs

Appendix A: Site Photographs

Photo No. 1A		Photo No. 1B		Photo No. 1C	
Date: 10/24/2019	**Year:** 0	**Date:** 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: Oyster Creek post-construction, facing north.		**Description:** Oyster Creek facing north.		**Description:** Bank vegetation density has increased along the lower bank.	
					

Photo No. 2A		Photo No. 2B		Photo No. 2C	
Date: 10/24/2019	**Year:** 0	**Date:** 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: Oyster Creek post-construction, facing south.		**Description:** Oyster Creek facing south.		**Description:** The bank toe appears to be aggrading with the upper slope stable.	
					

Appendix A: Site Photographs

Photo No. 3A		**Photo No. 3B**		**Photo No. 3C**	
Date: 10/24/2019	**Year:** 0	**Date:** 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: North tributary, main head cut, post-construction. Facing northeast.		**Description:** North tributary, main head cut, facing northeast.		**Description:** The main head cut on the north tributary remains stable at Year-4.	
					

Photo No. 4A		**Photo No. 4B**		**Photo No. 4C**	
Date: 10/24/2019	**Year:** 0	**Date:** 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: North tributary, pre-construction, facing southeast.		**Description:** North tributary, facing southeast.		**Description:** North tributary – dense herbaceous vegetation covers both banks.	
					

Appendix A: Site Photographs

Photo No. 5A		Photo No. 5B		Photo No. 5C	
Date: 10/24/2019	**Year:** 0	**Date:** 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: North tributary, pre-construction, downstream extent of project, facing upstream.		**Description:** North tributary at the downstream extent of project, facing upstream.		**Description:** An aspen stand continues to expand on the right bank and into the main tributary.	
					

Photo No. 6A		Photo No. 6B		Photo No. 6C	
Date: 10/24/2019	**Year:** 0	**Date:** 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: North tributary, post-construction, facing east.		**Description:** North tributary, facing east.		**Description:** North tributary is densely vegetated with a mix of native herbaceous species.	
					

Appendix A: Site Photographs

Photo No. 7A		**Photo No. 7B**	
Date: 8/28/2020	**Year:** 1	**Date**: 8/7/2023	**Year:** 4
Description: Oyster Creek reference site. Erosion control pin location is circled in red.		**Description:** Conditions at the reference site appears relatively unchanged in Year-4 as compared to Year-0.	
			

Appendix A: Site Photographs

Photo No. 8A		Photo No. 8B	
Date: 11/2/2023	**Year:** 4	**Date**: 11/2/2023	**Year:** 4
Description: North tributary scour hole.		**Description:** Repaired north tributary scour hole.