Appendix I. Annotated Construction Photographs

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This appendix was prepared by Peter Baye.

Contents

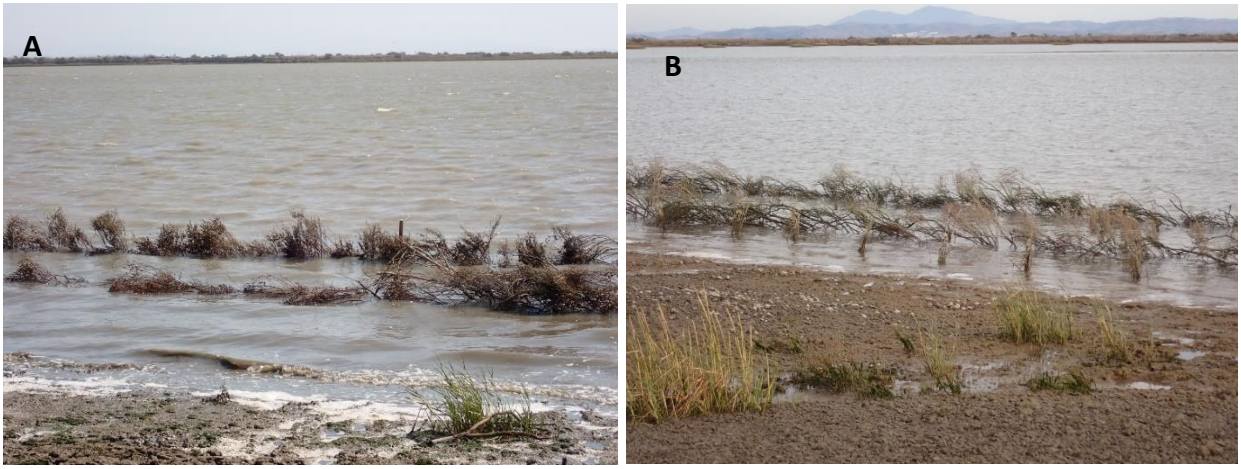
Photographs

Appendix I

1. Brush fence

Photograph 1. Brush fence installation on inner mudflat cordgrass transplant zones

(A) Aluminum sled mobilized at shoreline for loading with cut brush; moved by long-reach excavator along brush fence alignment on mudflat. (B) Two lines of newly installed brush fence, half-submerged mid-tide, bayward of previously established transplanted cordgrass. Note flattening of wind-waves landward of brush fence compared with open water bayward. August 30, 2021



Photograph 2. Brush fence early post-construction functions

(A) Visible damping of small wind-waves mid-tide, filtered through two lines of brush; note small white-caps in open water bayward, lower surface turbulence landward of brush fence. Leaf loss from fresh cut brush condition has thinned density (roughness) slightly since construction. Sept 15, 2021. (B) Brush fence with late summer cordgrass transplants at mid-tide, October 19, 2021.

Photograph 3. Brush fence with variable density in fall 2021

Photographs show after over a month of wind-wave exposure. (A) Brush fence landward of eroded remnant of constructed, both planted with cordgrass plugs late summer, showing thinning of some weaker segments of brush fence. Oct 19, 2021. (B) Brush fence segment with higher density (roughness) persisting Nov 12, 2021. Note density of brush at mudline level (beneficial for sheltering seedlings and transplants) where brush was inserted at low, sub-horizontal angles.

2. Aggregate bay mud

Photograph 4. Naturally formed and artificial (aggregate) bay mud clasts

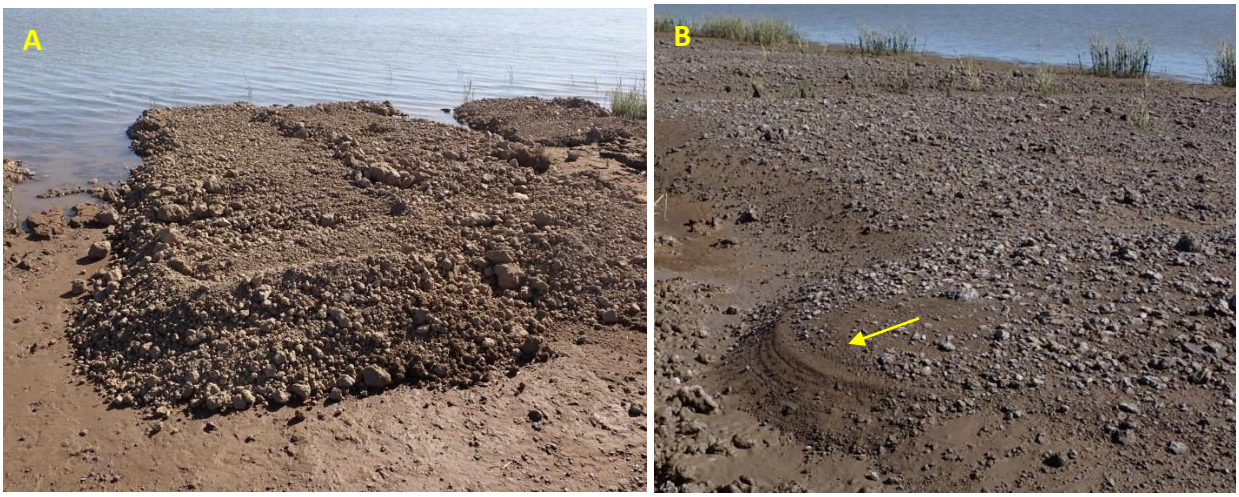
(A) Swash bar composed of flakes and "pebbles" of dried bay mud naturally eroded from upper intertidal levee bench. Bar about 1 ft high is deposited through pickleweed vegetation, migrating landward prior to project construction. June 24, 2021 (B) Artificial dry mud clasts (crushed old drained clay-silt dredged material from Port Sonoma) ranging from coarse gravel to sand-sized clasts, formed by excavation, handling, and transport to stockpile at the project site.

Photograph 5. Placement of aggregate bay mud on eroded wave-cut levee bench

(A) Truckload of aggregate bay mud delivered to reach of excavator on levee road. Long-reach excavator bucket scoops aggregate bay mud directly from truck. (B) Excavator swings around to place aggregate bay mud on eroded surface by slowly lifting moving bucket with precision, avoiding remnant or new patches of pioneer salt marsh vegetation. Oct 12, 2021.

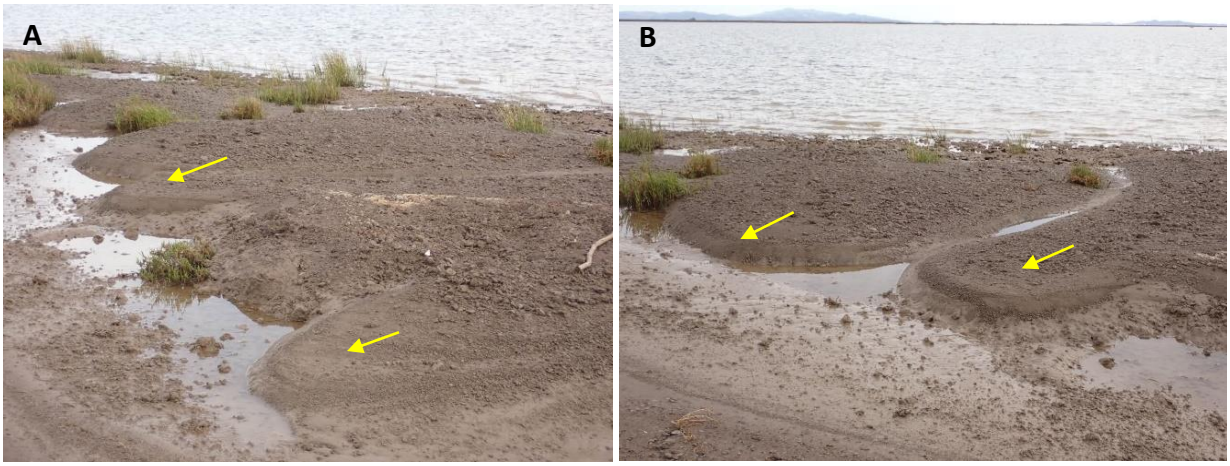
Photograph 6. Aggregate bay mud mound before and after tidal submergence and wind-wave exposure

(A) Heterogeneous clast size of dry aggregate bay mud, small cobble to gravel and sand-sized. Sept 15, 2021. (B) Sorting and onshore transport of broad aggregate bay mud mound (platform) after over a week of moderate wind-wave exposure: coarser lag of cobble and gravel-sized mud aggregates at flat top of mound, with onshore transport and deposition of small gravel to sand-size mud clasts at the landward edge (incipient bar slip face), Sept 27, 2021.



Photograph 7. Freshly deposited and wave-reworked aggregate bay mud mounds

(A) Freshly deposited aggregate bay mud mound, showing "footprint" of excavator bucket line of movement. Initial thickness prior to consolidation and settlement is less than 1 ft over eroded levee bench. (B) Aggregate bay mud mound partially reworked by wind-waves, forming incipient leading edge of swash bar with delta-like slipface lobe composed of more mobile, smaller sand to small gravel-sized particles winnowed from the surface of the mound, leaving a lag of coarser clasts. Oct 12, 2021.

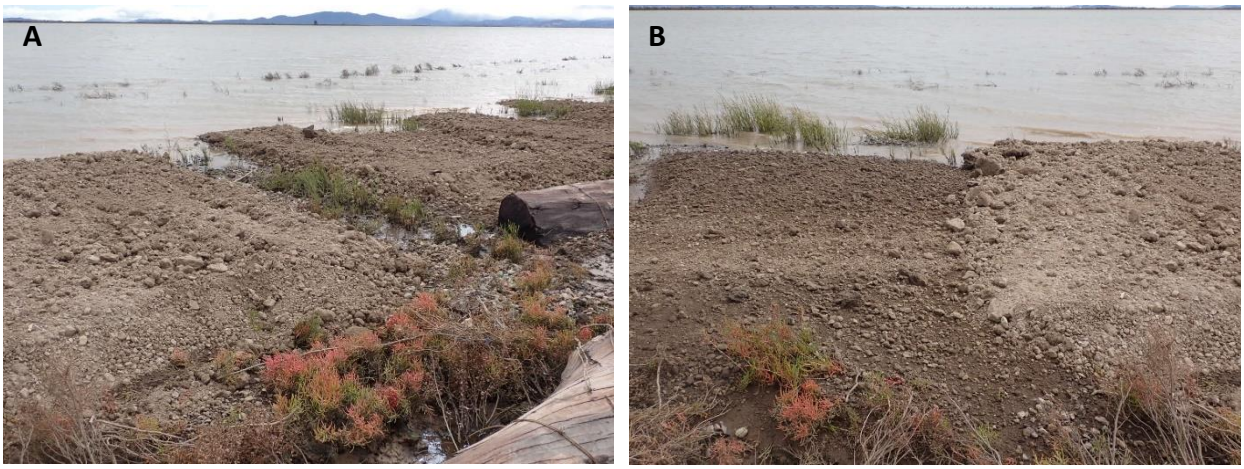


Photograph 8. Rapid wave-reworking and drifting of aggregate bay mud mound deposits into swash bars during construction (1)

(A) Shoreward migration of depositional delta-like lobes of sand-sized to small gravel-sized mud clasts eroded from recently (weeks) placed aggregate bay mud mounds during periods of moderate wind-wave action. Bar height and residual mound height above original surface, after consolidation, is mostly 1 ft or less, lower than the average height of most mature cordgrass and pickleweed. (B) Mud clast swash bars drift shoreward and alongshore, partially choking some of the shore-normal drainage gaps between adjacent aggregate mud mounds. October 19, 2021.

Photograph 9. Rapid wave-reworking and drifting of aggregate bay mud mound deposits into swash bars during construction (2)

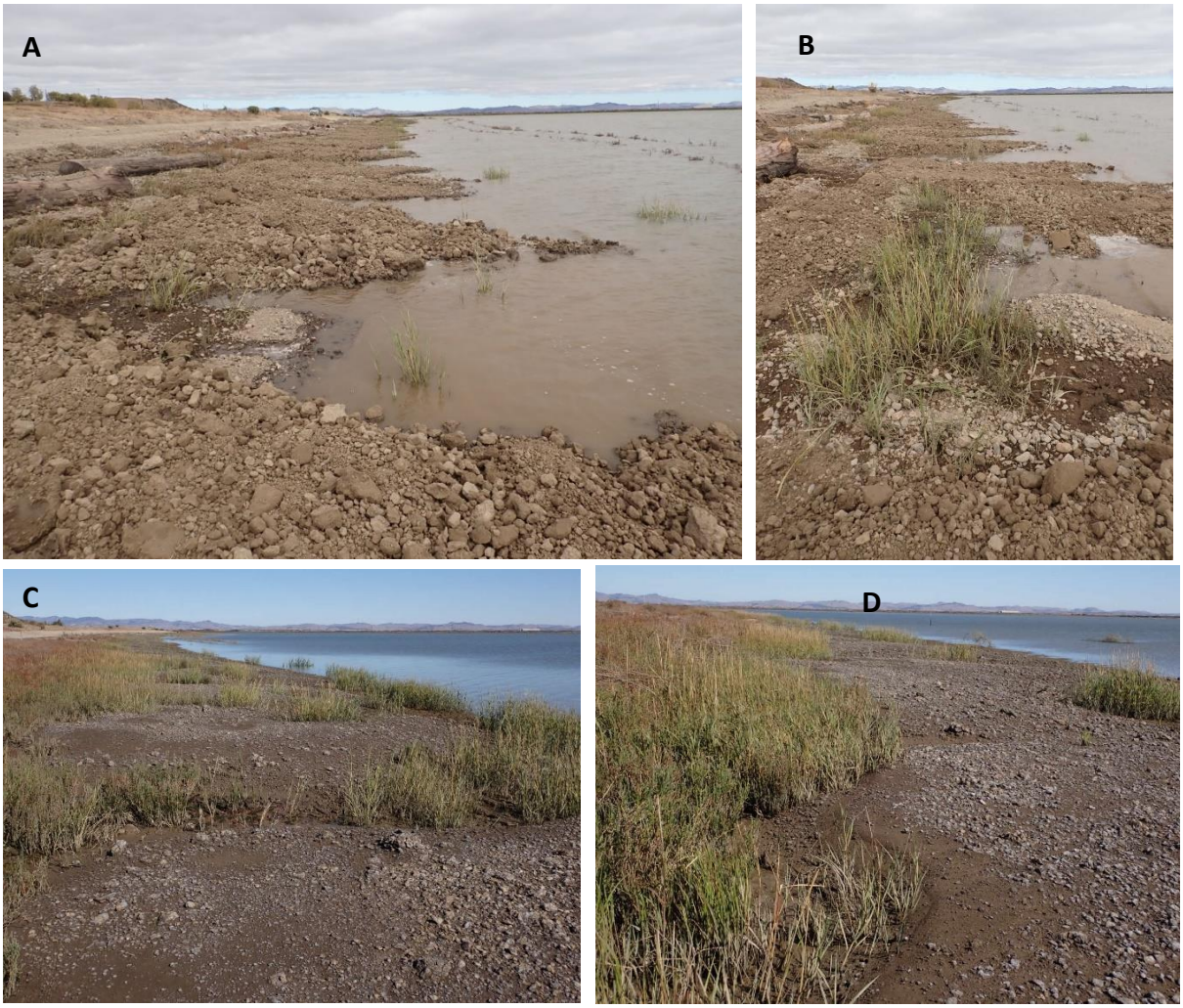
Shoreward migration of incipient swash bars extending landward from placed mounds, coinciding with flattening and settling of consolidating aggregate bay mud mounds. The landward edges of onshore-migrating incipient bars is reaching logs, and forming shallow runnels. Note drainage gaps draining runnels between logs and onshore-migrating leading margins of bars. October 19, 2021.



Photograph 10. Tidal drainage and consolidation of newly deposited aggregate bay mud mounds

(A) Freshly deposited dry flat-topped aggregate bay mud mound, with shore-normal gaps left around larger patches of pioneer salt marsh vegetation (perennial pickleweed, green; annual pickleweed, reddish), serving as tidal drainage and wind-wave rip circulation outlets for runnels

(troughs) between mounds and logs. (B) Adjacent successive mounds showing rapid consolidation and settlement after tidal wetting under low wind-wave action. Darker mound at left is a day older than the dry, freshly deposited mound at right. Compare mound height with height of cordgrass immediately bayward.



Photograph 11. Fine-scale minimization and avoidance of pioneer salt marsh vegetation by precise mechanical placement of aggregate mud mounds

(A-B) Freshly deposited dry aggregate bay mud placed mostly around pioneer patches of cordgrass (mostly current year seedling-juvenile transition), but also over standing live vegetation which remains upright during grainfall deposition (precipitation of dry mud clasts) from gradual excavator bucket release. Note relative height of aggregate mud mounds and cordgrass shoots. September 27, 2021. (B) Incipient onshore migration of mud clast swash bars derived from wave-reworked aggregate mud mounds, transported into stands of mixed mature cordgrass and pickleweed. Non-destructive partial burial of upright salt marsh vegetation to about one half shoot height or less (mostly emergent canopy) is evident. October 12, 2021.

3. Embedded log placement

Photograph 12. Natural, pre-construction model examples of embedded driftwood on site
Driftwood sedimentation-erosion dynamic patterns are shown: log acts as local wavebreak with mud clast sediment deposition in wave-shadow, forming high salt marsh mounds. Deposition occurs in sheltered wave-shadow of driftwood, contrasting with erosional scour around ends. The embedded rootwad (trunk) anchored the windward end of the driftwood. August 30, 2021

Photograph 13. Raw logs stockpiled on-site for shoreline placement as artificial analogs of driftwood
(A) drying blue gum eucalyptus logs 1-2 (3) ft diameter. July 27, 2021. (B) douglas-fir logs 1-2 ft diameter. March 19, 2021.

Photograph 14. Placement operations for embedded logs

(A) Short-reach excavator working from wood mats excavates shallow trenches along flagged positions of logs, while crews place brush and anchor newly placed logs with cables and duckbills. Oct 5, 2021. (B) Excavator bucket with “thumb” directly places log in shallow trench. Sept 15, 2021. (C) Individual installed eucalyptus log with brush (roughness), cabled and anchored in place, and backfilled with additional dry aggregate bay mud. September 27, 2021.

Photograph 15. Series of installed embedded logs

Series of installed embedded logs, backfilled, cabled, and anchored, with gaps between them. Note slight shore-oblique orientation, parallel with prevailing wind-wave crests. September 27, 2021

Photograph 16. Cabled and anchored embedded eucalyptus logs

Photograph 17. Staked embedded eucalyptus log

Stake tops are cut to minimize potential attractiveness of raptor (harrier) perches.

4. Gravel berms and rapid swash bar evolution

Photograph 18. Freshly deposited, dry, unconsolidated sacrificial gravel berms

Berms are placed along the recent high tide line (wave runup zone of spring high tides) to be eroded and re-deposited by wind-waves at high tides, to form natural onshore-migrating gravel swash bars. September 27, 2021.

Photograph 19. Dry and wet pea gravel with interstitial sand and mud (fines) composing gravel berms

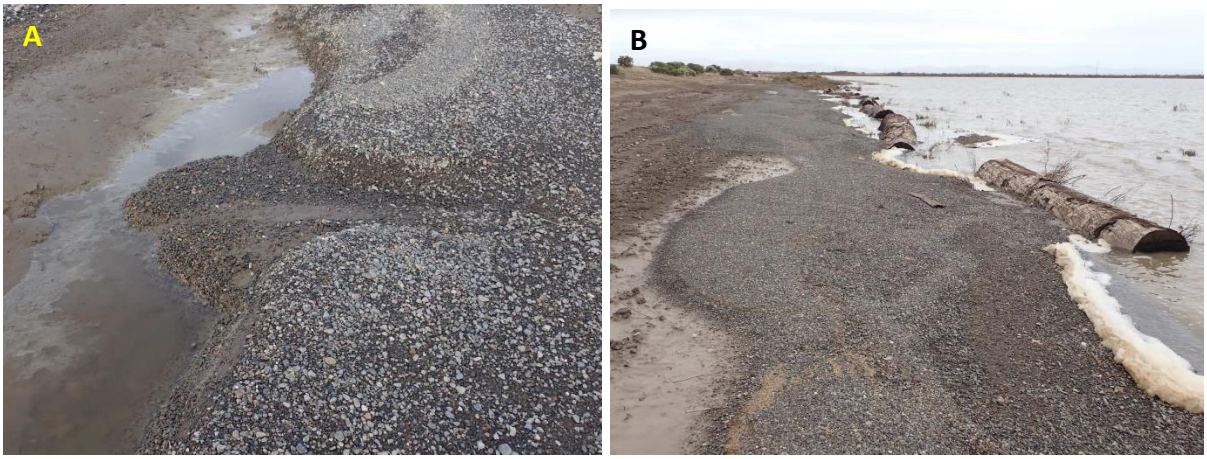
(A) dry pea gravel and silty sand interstitial matrix. (B) Pea gravel mix wetted at first high tide, forming muddy gravel sorted by wave action (concentrating coarse sediment, dispersing suspended silt). Initial swash slopes formed by muddy gravel are flatter than pure gravel because pore spaces (voids) are saturated with mud, inhibiting infiltration of backwash. Sept 27, 2021.

Photograph 20. Initial partial wave-reworking of sacrificial gravel berms

Incipient evolution of gravel swash bars from sacrificial berms days after placement. Bayward sides are eroded by waves, forming flatter swash slope, concentrating pea gravel and sand at the surface, winnowing fines. Sept 27, 2021

Photograph 21. Near-complete wave-reworking of sacrificial gravel berms into swash bars
Within two weeks of placement (A, September 27, B October 5, 2021), artificial gravel berms near the high tide line evolve into natural gravel swash bars with natural wave-deposited morphology.

Photograph 22. Rapid onshore migration of gravel swash bars
Newly formed gravel swash bars undergo “rollover” migration landward (bayward erosion, landward deposition). Landward depositional edges exhibit slipfaces (angle of repose) where troughs pool water at high tide, or convex lobes where backwash flows through the bar (infiltration) or over the bar crest. October 12, 2021.



Photograph 23. Morphology of gravel swash bars during rapid initial onshore migration
Deltaic fans, washover lobes, and spit-like bar ends form during rapid onshore migration occurring in high tide cycles with significant wind-wave action (visually estimated 6-8 inch breaking wave height at shore). (A) October 19, 2021. (B) November 5, 2021.

Photograph 24. Evolution of gravel swash bars in late fall, weeks after gravel placement
Longshore drift and flattening of gravel bar swash slopes occur during late fall wind-wave action and onshore migration. November 5, 2021. (A) low-angle landward edge of thin gravel swash bar spread over widened swash zone after high tide series with high wind-waves. (B) drift of thin spit-like swash bar eastward where no gravel was mechanically placed.

5. Gravel lag armor veneer

Photograph 25. Pre-existing examples of gravel lag armor shoreline features

Wave erosion of levee exposed remnants of old road base entrained in levee grading. Relatively immobile gravel and small cobbles are concentrated at the surface (resistant lag armor) as mobile fine sediment is winnowed out by wave action. These spontaneous lag armor features were models for artificial gravel lag veneer. July 27, 2021.

Photograph 26. Newly placed lower gravel lag veneer

Angular gravel (drain rock) was placed in thin (mostly 1 clast thick) veneers over wave-eroded levee bench surfaces to increase resistance to wave erosion and establish safe sites (surface stability) for salt marsh pioneer seedlings to develop anchor roots and clonal spread before they are excavated by waves. Note the retention of upright, intact seedling plants and established salt marsh vegetation patches, and the extent of residual interspersion of mud substrates for seedling colonization within the gravel veneer. Veneer underlies subsequently placed sacrificial aggregate bay mud. September 15, 2021.

Photograph 27. Cross-shore distribution of all dynamic, interacting "nature-based" shoreline stabilization elements in Cell 6 with completed construction

Bay to shore: brush fence, cordgrass transplants, sacrificial aggregate bay mud mounds, embedded logs and gravel veneer (buried under mounds), gravel berm/swash bar. Oct 19, 2021.

6. Creeping wildrye sod

Photograph 28. Creeping wildrye sod harvest and placement

(A-B) Long-reach excavator mechanically harvests 6 inch thick dormant sods of creeping wildrye from extensive dense borrow stands at the east end of the site, and loads them on a flatbed

truck. (C-D) Fresh wildrye sods are transported within minutes to transplant sites during cool weather to minimize desiccation injury to roots. Short-reach excavator has worked ahead of delivery excavating series of shallow pits for sodding. (E-F) Crews manually place 1.5-2 ft wide sod mat fragments into pit. (G) Excavator bucket backfills shallow (4-6 inch) soil deposit over sod and tamps (pounds) to ensure root and rhizome contact with surrounding soil, and minimize voids that result in injurious root desiccation during winter-spring droughts. November 5, 2021.

Photograph 29. Staggered series of planted, buried large creeping wildrye sod mat fragments on levee slope above the high tide line

Clonal spread from these patches will stabilize soil (sod) upslope and downslope below the high tide line. Nov 5, 2021

7. Pacific cordgrass transplanting

Photograph 30. Pre-construction cordgrass plug transplanted colonies

Cordgrass plugs planted at about 6-7 ft intervals on mudflats near Mean Tide Level, below the natural local limit (tidal elevation) of colonization. Large, tall cordgrass plug transplants established 1 year old incipient colonies (A; July 27, 2021) and approximately 2- to 3-year old colonies (B; June 24, 2021). Note the local wave-shadows (damped wave zones) in the lee of establishing colonies in (B), contrasting with spilling waves adjacent to them.

Photograph 31. Pre-construction cordgrass plug transplants

(A) Cordgrass plugs planted at about 6-7 ft intervals on mudflats near Mean Tide Level, below the natural local limit (tidal elevation) of colonization, are aimed at accelerating the development of critical width of fringing cordgrass zones to attenuate wave energy, at cell 1. Note the spread of daughter shoots around the older (year 3) shoreward line transplants in March 19, 2021. (B) Wave-exposed cordgrass plug transplants on the lower edge of the eroded levee bench, slightly above (lower wave energy) mudflat elevation. March 19, 2021.

Photograph 32. Pre-construction pioneer cordgrass plug transplant colony clonal spread on mudflats

March 19, 2021. Daughter shoots connected to mother transplants by rhizomes formed the previous growing season begin shoot emergence in spring, at mudflat elevations near Mean Tide Line, below natural observed local tidal elevation range for seedling establishment of cordgrass, and below the line of established local natural fringing cordgrass marsh.