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Fifth Annual Monitoring Report
East Stege Marsh
Monitoring Plan Implementation
Campus Bay
Richmond, California
Permit Authorization #28252S

September 30, 2010
EM0009359.0028.00004

Prepared for
Cherokee Simeon Venture I, LLC,
Zeneca Inc., and
Bayer CropScience Inc.

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September 30, 2010 EM009359.0028.00004

Mr. Mark D'Avignon
South Branch Chief
U.S. Army Corps of Engineers, Regulatory Division
1455 Market Street, 16th Floor
San Francisco, California 94103

Subject: Fifth Annual Monitoring Report, East Stege Marsh, Monitoring Plan Implementation, Campus Bay, Richmond, California, Permit Authorization #28252S

Dear Mr. D'Avignon:

This letter transmits the Fifth Annual Monitoring Report on the monitoring activities, performance criteria, and habitat enhancements that have taken place in East Stege Marsh (ESM) following remediation activities at the Campus Bay site (the former Zeneca Inc. facility), located in Richmond, California ("the Site"). The relevant remedial activities conducted at the Site prior to January 2010 were performed by staff under the company name LFR Inc., which was fully integrated into ARCADIS in January 2010.

The relevant remediation activities were completed in January 2006 and included excavating and refilling approximately 5 acres of tidal wetlands in ESM. Final grading was completed in October 2006. Since then, ongoing follow-up planting and maintenance has occurred regularly through the current date. In addition, site monitoring and reporting continued through the fifth annual reporting period ending August 31, 2010, as required by the terms and conditions of the U.S. Army Corps of Engineers (USACE) permit file authorization #28252S. This report describes the results of follow-up wetland monitoring activities with respect to the performance criteria identified in "Habitat Enhancement Plan for the Marshland Portion of the Meade Street Operable Unit, Subunit 1, Richmond, California," attached as Appendix A of the "Conceptual Remediation and Risk Management Plan for the Habitat Enhancement Area Subunit A, Meade Street," dated October 4, 2002. Revised Table 8, which summarizes the performance criteria, was transmitted to the USACE in a letter dated June 15, 2004 (Appendix A).

Additional monitoring requirements are also set forth in the November 2002 Comprehensive Monitoring Plan for the Site. Remediation work at the Site was completed under Department of Army Nationwide Permit 38 (*Cleanup of Hazardous and Toxic Waste*; 67 Fed. Reg. 2020, January 15, 2002), pursuant to Section 404 of the Clean Water Act (33 U.S.C. Section 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. Section 403). Such work was implemented in accordance with the "Remedial Design Details for Habitat Enhancement Area, Subunit 1, Meade Street Operable Unit, Richmond, California," dated August 1, 2003, with the exception of the remediation of the lower freshwater lagoon, which was stopped by the California

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Environmental Protection Agency, Department of Toxic Substances Control. A detailed summary of the activities completed in the Habitat Enhancement Area (HEA) is included in the "Final Implementation Report for Remediation of Habitat Enhancement Area, Campus Bay, Richmond, California," dated January 11, 2007.

Ongoing establishment of restoration planting and seeding within the HEA has been observed during prior reporting periods and current observations suggest that performance criteria have been achieved throughout the majority of the Site, particularly throughout the tidally influenced portion of ESM. Upslope and transitional upland areas along the ESM perimeter adjacent to the upper salt marsh are also well vegetated but exhibit some partial coverage with non-native ruderal grass species. In 2010, tidal marsh, upland transition, and upland habitat areas showed improved coverage and an increase in native plant cover.

The following tasks were performed during this monitoring period:

- Vegetation monitoring, which included quadrat-based transect analyses, transect demarcation and monitoring, quadrat selection and monitoring, visual monitoring, and photo-documentation
- Sedimentation rate monitoring and sediment accretion monitoring
- Sediment sampling
- Surface-water sampling
- Hydrologic monitoring

Vegetation monitoring results for prior years based on both visual estimates and quadrat sampling indicated that native plant cover criteria had not been met. However, in 2009 and thus far in 2010, a considerable positive trend in noted progress toward the vegetation cover performance criteria was apparent and the performance criteria have now been met in most areas. Currently, large portions of the middle and upper salt marsh zones are well vegetated; however, some small areas remain partially unvegetated and support mudflat habitat in portions of the low salt marsh zone. Coverage of native salt marsh species in these remaining low marsh areas is expected to increase slowly over time and would be associated with aggradation in these areas.

The vegetation performance criteria include 60% native vegetation coverage for wetland areas and 50% native vegetation coverage for upland areas. 2010 monitoring results show that a large majority of restored tidal wetland areas either met or exceeded the 60% native vegetation cover criteria. The extent of native vegetation cover in the upland habitat zones has improved in 2010, but varies depending on the specific location. In general, the restored native shrubs are successful within the coastal scrub zone; most of the grassland, particularly in central portions of the north end and under the restored shrubs, supports a high percentage of natives. However, there are other areas that support fewer native species, such as the grasses on the levee near the Bay Trail. Vegetation management activities including ongoing exotic vegetation removal should continue to occur at the Site.

Year 1 sediment sampling was conducted in June 2006 from SS-1 through SS-20. Two additional locations, SS-21 and SS-22 were collected in June 2007 for Year 2. In Year 5, all 22 locations were re-sampled. The results indicated that arsenic, cadmium, copper, mercury, lead, zinc, and selenium concentrations are within the expected range for the remediated marsh conditions and are below the calculated Site-Specific Target Levels for ESM (see Appendix C-1 for Year 1, and C-2 for Year 2; the Year 5 sediment results are further discussed in Section 5).

Sediment accretion rates within the affected portions of ESM were monitored at four representative locations for Years 2, 3, 4, and 5; the results show minor sediment accumulation at the four monitoring stations in the marsh plain (0.01 to 1.20 inches). A Mann-Kendall trend analysis was prepared in Year 4 due to the accumulation of sufficient data. Those analyses showed all four locations increasing with ranges from -7 (slight) to -17 (significant) at locations SA-3 and SA-1, respectively. The Mann-Kendall trend analysis was again used in Year 5 and it shows increasing trends at all four locations.

The 2007, 2009, and 2010 surface-water sampling involved three sample locations: SW-1, SW-2, and SW-3. The results indicate that the majority of the pH values, total metal concentrations, volatile organic compound concentrations, proprietary pesticide concentrations, and total suspended solid concentrations fall within acceptable ranges. An increase in copper was seen in all three surface-water monitoring points, increasing from the previous year. However, lead and zinc decreased for all locations with the exception of SW-1, which showed a slight increase.

The hydrologic monitoring for Years 1 through 5 confirms that the wetland hydrology performance criteria have been met because the newly graded salt marsh areas experience inundation or soil saturation up to the soil surface on an ongoing basis during regular high tide events.

If you have any questions or comments regarding this report, please contact either of the under signed at (510) 652-4500.

Sincerely,

Lucas W. Paz, Ph.D.
Principal Hydrologist

Enclosure

cc: Distribution List

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1.0 INTRODUCTION

ARCADIS has prepared this Fifth Annual Monitoring Report for the period September 1, 2009 through August 31, 2010 on behalf of Cherokee Simeon Venture I, LLC (CSV), Zeneca Inc., and Bayer CropScience Inc., for the former Zeneca site, now known as Campus Bay, located at 1391 South 49th Street in Richmond, California ("the Site"; Figure 1). This report describes our observations of the implementation of the grading and planting plans developed for East Stege Marsh (ESM) and surrounding areas, located within the Habitat Enhancement Area (HEA) at the Site.

This report provides a discussion of the conditions observed following the excavation and refilling of the tidal marsh area in ESM with imported silty fill and the results of replanting and ongoing site maintenance activities conducted during the five-year growing seasons. The Year 1 reporting period started January 2006. The Year 2 reporting period started September 2006. The Year Three reporting period started September 2007. The Year 4 reporting period started September 2008. The Year 5 reporting period, as is stated above, is September 2009 through August 2010.

The functional tidal marsh area at ESM includes approximately 4.0 acres of remediated and restored tidal marsh area and the creation of approximately 1.2 acres of functional tidal marsh habitat with the removal of fill in areas previously without wetland vegetation or functional non-inundated upland habitat.

ARCADIS provided construction monitoring and general observations to confirm that the work was performed in accordance with site planning and construction documents, the "Conceptual Remediation and Risk Management Plan for the Habitat Enhancement Area Subunit 1" (CRRMP; LFR 2002d), and the "Remedial Design Details for Habitat Enhancement Area, Subunit 1" (LFR 2003b) as required by the terms and conditions of the U.S. Army Corps of Engineers (USACE) permit authorization #28252S and San Francisco Bay Conservation and Development Commission (BCDC) permit number M01-52(a).

The fifth year of monitoring activities includes ongoing site maintenance inspections, visual monitoring and photo-documentation, surface-water sampling, vegetation monitoring, hydrologic monitoring, sediment accretion monitoring, and reporting. The site monitoring is required by the USACE permit #28252S (Army Nationwide Permit 38; July 26, 2004 correspondence), the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) Site Investigation Order 04/05-006, and the BCDC Permit No. M01-52(a). The Comprehensive Monitoring Plan (CMP) describes the procedures and frequencies for gathering chemical, physical, and ecological data necessary to evaluate the effectiveness of the ongoing remediation and revegetation at the Site.[1]

[1] Surface-water and sediment sampling requirements are provided in the CMP.

2.0 ESM REMEDIATION: CONTRACTOR PERFORMANCE AND COMPLIANCE REPORT

Portions of ESM were excavated and reconstructed starting in 2005 with completion in 2006 to maintain hydraulic connectivity to San Francisco Bay, as shown in the Final Implementation Report for Remediation of the HEA (LFR 2007). ESM is subject to varying tidal inundation on a daily basis, consistent with the wetland hydrology performance criteria. The primary channel segment constructed in the remediated portion of ESM was designed with an invert at an elevation of 0.5 foot National Geodetic Vertical Datum (NGVD), below the high tide line (approximately 5.0 feet NGVD). Marsh backfill was constructed within the planting area boundary (Figure 1), which illustrates the intent of the design.

The design provided for affected portions of ESM to be refilled with local silty fill material suitable for subsequent replanting of native wetland and upland transition plant species suitable for the specific habitat planting zones established for ESM. These planting zones are shown on Figure 2.

LFR staff inspected the excavation and refilling of ESM conducted by Pacific States Environmental Contractors (PSEC) from February 2005 to January 2006 to confirm adequate tidal inundation in the newly graded marsh areas and that the work was performed in accordance with the CRRMP. The reconstructed tidal wetland areas and wetland creation areas initially appeared to be functioning correctly based on direct observations of tidal inundation over a large portion of the constructed wetland areas during high tide events and thorough draining during low tides (with the exception of the bottom of the channel where approximately 3 to 6 inches of ponded water was observed to remain during low tides). However, during later field inspections in 2006, the northwestern portion of ESM appeared to have limited inundation due to slightly higher marsh surface elevations than prescribed in the final grading plan for the Site. In October 2006, PSEC remobilized to the Site and made the necessary marsh surface adjustments to increase tidal inundation in this portion of ESM. LFR observed the final grading activities, including the spreading of previously placed silty fill to widen the span of the 5-foot contour, thereby creating more surface area available for frequent inundation as specified in the original final grading plan. The final topography of the Site following the additional grading activities performed by PSEC is presented on Figure 1.

Following the completion of backfill activities, initial planting activities were conducted by Pacific OpenSpace, Inc. ("Pacific OpenSpace") in March of Year 1. Ongoing maintenance activities that have occurred during Years 2, 3, 4 and 5 include irrigation, replanting, seeding, weeding, and removal of invasive plants by herbicide application and physical removal[2]. At the beginning of the Year 3 growing season, following the initial two-year plant establishment period, the irrigation of upland plantings was

[2] Herbicide application conducted during maintenance activities was approved by the DTSC prior to application.

discontinued. Ongoing vegetation monitoring was conducted as required by the CRRMP and USACE permit authorization #28252S.

ARCADIS believes that the Habitat Enhancement Plan (HEP) wetland mitigation and habitat enhancement elements have been constructed in compliance with the project plans and specifications, and that the performance criteria for successful mitigation will be attained.

ARCADIS staff performed visual site surveys and conducted photographic documentation of site vegetation at eight pre-established photo-monitoring points (PMP-1 through PMP-8) within the HEA on August 22, 2006, June 4, 2007, June 3, 2008, July 29, 2008, November 12, 2008, February 19, 2009, May 26, 2009, September 24, 2009, March 12, 2010, and June 16, 2010 in accordance with Revised Table 8 (see Appendix A). These photo-monitoring locations were initially photographed in 2002. The results of the photo-documentation are provided in Appendix B, and the current status of replanting and vegetation maintenance activities are reported in the following sections.

3.0 SUMMARY OF PERFORMANCE CRITERIA

The CRRMP, the CMP (LFR 2002e), and USACE permits require that ESM monitoring be conducted annually for a total of five years through 2010, or until the mitigation success criteria are attained. Monitoring consists of visual observations, transect-based quadrat vegetation surveys, sediment sampling, and photographic documentation regarding site inundation or saturation, the presence or absence of target species, and the health and abundance of individuals in the tidal mitigation wetland area. Visual estimates of percent vegetation cover and results of detailed vegetation quadrat surveys conducted in Years 3 and 5 are compared to the HEP performance criteria (see Appendix A). Hydrologic monitoring results are compared to the established range of tidal elevations documented in the 2006 tidal study (Figure 3). Monitoring is used to evaluate progress toward the mitigation goals reflected in the performance standards described below.

The project can be considered a success if the Revised Table 8 Performance Criteria (Appendix A) have been met on or before the end of the five-year monitoring period (2010). As discussed below, 2010 monitoring results show that a large majority of restored tidal wetland areas either met or exceeded the vegetation performance criteria. The extent of native vegetation cover in the upland habitat zones has improved in 2010, but varies depending on the specific location. Monitoring trends indicate that the project performance criteria will be met throughout the Site if ongoing vegetation maintenance activities are continued.

4.0 VEGETATION MONITORING, INCLUDING TRANSECT-BASED QUADRAT ANALYSES

The methods used to monitor the project performance criteria proposed in Revised Table 8 are described in this section. Habitat monitoring included: visual estimates of primary parameters including vegetative cover and species composition, detailed transect-based quadrat analyses, field maintenance inspections, and ongoing photo-documentation.

The following is an abbreviated summary of the planting zone target species list and general planting plan objectives:

- Zone A, tidal salt marsh, six species - *Spartina foliosa, Scirpus robustus, Cuscuta salina, Jaumea carnosa, Salicornia virginica, Distichlis spicata*
- Zone B, transitional salt marsh, four species - *Grindelia stricta, Limonium californicum, Distichlis spicata, Frankenia salina*
- Zone C, coastal scrub, eight species - *Baccharis pilularis, Artimisia californica, Mimulus aurantiacus, Heteromeles arbutifolia, Eriophyllum staechadifolium, Lupinus arboreus, Lupinus chamissionis, Salvia mellifera*
- Zone D, freshwater lagoon, two species - *Salix laevigata, S. lasiolepis*
- Target non-native species removal, 12 species - *Myoporum laetum, Bromus madritensis v. rubens, Carduus pycnocephalus, Brassica nigra, Vinca major, Rubus discolor, Hedera helix, Carpobrotus edulis, Foeniculum vugare, Cortaderia selloana, Conium maculatum, Genista monspessulana*

The target species to be planted in each zone include a performance criteria of 60% native cover for wetland areas and 50% native cover for upland areas (after five years). The HEA planting plan also includes an overlapping zone for the herbaceous ground cover seeding area (3.8 acres). In 2010, ten out of twelve quadrats met or exceeded the performance criteria for the wetland and upland areas. Upper Marsh-3 and Low Marsh-12 were 5% and 20% under their goals, respectively.

4.1 Monitoring Methodology

As described in the CRRMP (LFR 2002d) and the revised Table 8 (see Appendix A), the primary vegetation monitoring methods used during Years 1, 2, and 4 consisted of visual observations of the HEA and photo-documentation of eight photo-monitoring points (PMP-1 through PMP-8), as shown on Figure 2. Year 3 and Year 5 monitoring activities also included detailed transect-based quadrat analyses within each of the six habitat zones in addition to the ongoing visual field observations and photo-documentation.

The photo-monitoring points depict conditions within the six established habitat zones, which are presented on Figure 10 of the HEP and on Figure 2 of this report:

- low salt marsh
- middle salt marsh
- upper salt marsh
- transitional salt marsh/upland transition
- upland coastal scrub
- lagoon area willow scrub

4.2 Visual Monitoring and Photographic Documentation

Visual monitoring within the HEA consists of visual qualitative estimation of vegetative cover, species diversity, presence or absence of target and invasive species, and general health and abundance of individual plant species and planting zones within the HEA.

Pre-restoration assessment of the vegetative cover and habitat diversity in the HEA was conducted within the HEP to provide a baseline for post-restoration monitoring of vegetative cover and habitat diversity (LFR 2002b). Eight permanent fixed-point photo stations were established for the HEA (Figure 2), identified as PMP-1 through PMP-8.

A series of photographs for the entire HEA provides photo-documentation of the restoration efforts; the 2002, 2006, 2007, 2008, 2009, and 2010 photographs are included in Appendix B. Two to three color photographs were taken at each fixed-point photo location, generally facing north and northeast (unless otherwise noted on the photo logs), for ongoing photographic monitoring purposes. The photographs were normally taken at low tide (to avoid spring tide and full moon periods) and were labeled with the location code, direction of view, date, time, and tide information.

ARCADIS staff periodically inspected the HEA for damage following events of heavy rainfall (more than 1 inch of rain in 24 hours). These visits were conducted after rainfall events to document erosion damage and plan for repair and debris removal at the earliest possible opportunity. No significant damage as a result of storm activity was observed during the 2010 annual monitoring period.

Based on visual observations as well as photographs taken in 2010, a vegetative cover map was prepared that demonstrates existing vegetative cover in the restored areas (see Figure 4). The map provides the approximate extent of observed vegetative cover for the HEA habitat zones. There are small areas with 0-20% vegetative cover that are slowly reestablishing. In the 30-60% vegetative cover areas, pickleweed (*Salicornia virginica*) and salt grass (*Distichlis spicata*) are the predominant species present with an associated sparser coverage of native cordgrass plantings (*Spartina foliosa*). The 60-80% vegetative cover zone includes a mixture of pickleweed and various herbaceous ground cover species. The 60-85% vegetative cover zone includes herbaceous upland transition ground cover, coastal scrub and various grass species. In the 70-90%

vegetative cover region, cordgrass (*Spartina foliosa*) and pickleweed (*Salicornia virginica*) are the predominant species present.

4.3 Vegetation Maintenance, Planting, and Invasive Species/Weed Control

Throughout 2006, 2007, 2008, 2009, and 2010, Pacific OpenSpace conducted site preparation, planting, and vegetation maintenance activities at the Site following the ESM remediation and grading activities. The vegetation management activities conducted by Pacific OpenSpace commenced with site preparation that included exotic vegetation removal and weed control prior to container plant installation and/or seeding.

In 2010 Pacific OpenSpace established an approximately 20' by 20' test plot for physical soil treatments and replanting efforts in a central isolated portion of East Stege Marsh where re-vegetation has only been partially successful. It was assumed that this area is subject to slightly higher elevations than surrounding areas and that the severely compacted soil conditions in this area has made it difficult for wetland vegetation to become established. The test plot soil surface has been tilled and pickleweed plugs planted in the area, the plot was surrounded by silt fence to protect the new plantings (see Figure 4).

Pacific OpenSpace provided the following general summary of the native and non-native transitional/upland plant species observed to have become established in the HEA in addition to the observed marsh vegetation:

Natives

<u>Grasses</u>

Meadow barley (*Hordeum brachyantherum)*

Blue wildrye (*Elymus glaucus*)

California brome (*Bromus carinatus*)

Salt grass (*Distichlis spicata*)

<u>Broadleafs</u>

Spearscale (*Atriplex triangularis*)

Marsh Gumplant (*Grindelia stricta*)

White sweetclover (*Melilotus alba)*

Coyote brush *(Baccharis pilularis*)

Willow (*Salix sp*.)

Non-Natives

Grasses

Ripgut brome (*Bromus diandrus*)

Annual ryegrass (*Lolium multiflorum*)

Foxtail (*Hordeum leporinum*)

Rabbitsfoot grass (*Polypogon monspeliensis*)

Broadleafs

Spearscale (*Atriplex triangularis*)

Mustard (*Brassica nigra*)

Fennel (*Foeniculum vulgare*)

Pepperweed (*Lepidium latifolium*)

Birdsfoot trefoil (*Lotus corniculatus*)

Russian thistle (*Salsola soda*)

Planting, seeding, and weeding activities were implemented according to the following schedule:

March 2006	Remove exotic vegetation
March - April 2006	Spray herbicide (Aquamaster®)
March - June 2006	Plant container stock
	Install irrigation laterals
	Install cordgrass (*Spartina foliosa)*
April - June 2006	Install irrigation mainline
April - October 2006	Weed control maintenance
Fall 2006	Seeding with native grasses in non-tidal areas
October 2006	Seeding and straw mulch of coastal scrub
December 2006 - March 2007	Replace mortality
January 2007	Follow-up spraying and seed application in exotic control area
March - June 2007	Plant cordgrass; Replant salt grass (*Distichlis spicata*
	Plant shrubs and willows

April – May 2007	Weed control maintenance using herbicides (Aquamaster® in tidal areas and Garlon 3 in non-tidal areas); Retreat pampas grass and other weedy plants
May – August 2007	Follow-up herbicide application, irrigation maintenance, and select replanting of cordgrass and salt grass
May 2007	Replant cordgrass plugs and install silt fences Replant pickleweed

Summary of Maintenance Work August 2007 – August 2010

2007

September 4	General maintenance and weed control
September 13 and 17	Replacement planting of 8,000 *Distichlis spicata*
September 26	Weeding
October 2, 22, and 23	Weeding

2008

January 22	Mowing/weeding
February 6 and 14	Mowing/weeding
February 28	Mow and herbicide application
March 3	Mow and herbicide application
March 12 and 13	Mowing, weeding, and site cleanup
March 17	Test planting in dead zone
May 5 and 7	Mowing and weeding
July 8	Herbicide application
July 23	Weeding, herbicide application

2009

January 21	Spread seed and compost
February 24	Mowing, weeding and herbicide application
April 7 and 8	Removal of Lepidium; mowing and weeding
May 11 and 12	Removal of Lepidium; mowing and weeding
July 28 and 29	Removal of Lepidium; mowing and weeding
September 9 and 10	Herbicide spray treatment
October 20	Follow-up spraying to treat pampas grass & broom

2010

May 6 and 11	Mowing and weeding

May 12	Herbicide application
June 15	Installed test plot and silt fence
June 22	Water new plants; treat pampas grass & Lepidium; mow grass; spray broadleaf weeds

Weed control maintenance includes using herbicides (Aquamaster® in tidal areas and Garlon 3 in non-tidal areas)[3]. General maintenance of ESM includes yearly weeding around plants and two mowing events per year. In addition, the plants were re-mulched in 2007 and 2008. Initial on-site implementation activities were completed during 2006, and ongoing maintenance has continued through 2010.

4.3.1 Exotic Vegetation Removal

The first phase of work conducted was exotic vegetation removal to clear the HEA of large woody and herbaceous perennial plants. Large woody debris and dead shrubs, and exotic shrubs such as French broom (*Genista monspessulana*) and pampas grass *(Cortaderia selloana)* were removed in addition to accumulated foliage from perennial exotic weeds, such as fennel and hemlock. Following DTSC approval, these plants are periodically sprayed with herbicide per manufacturer's instructions (Aquamaster®, a re-labeling of Rodeo®) to eradicate them. Pacific OpenSpace added a surfactant to the Aquamaster® that is registered for aquatic use prior to spraying on those days where there was no rain forecast for at least 24 hours and when the wind speeds were at or below 5 miles per hour in order to minimize spray drift.

The mixing rate for the chemicals for each 4-gallon backpack sprayer is the following:

- Aquamaster® (4 ounces)
- No Foam A Surfactant (4 ounces)
- Ammonium sulfate (8 tablespoons)
- Coloring agent (2 ounces)

Where possible, the entire plant was removed, including the roots. In other cases, plants were removed to the soil line and sprayed as they sprouted. Exotic vegetation removed from the HEA was disposed of at a recycling/composting facility.

The major targeted invasive/exotic species (French broom, fennel, pampas grass) should not exceed 20% vegetative cover in the upland transition, upland areas, and lagoon areas; this goal has generally been met for these species. The French broom that had been cut and sprayed during the initial site cleanup at ESM was noted in 2007 and again in March 2008 to be almost completely dead with the exception of a few re-sprouts. Many of the remaining plants were controlled by physical removal, and the

[3] These products were previously approved for use at the Site by DTSC.

others were controlled by herbicides. However, there was some germination of broom seedlings, as expected, each spring season. The seedlings were controlled by herbicide application and/or mechanical removal.

In 2008, 2009, and 2010, it was noted that there had been uneven control of the pampas grass *(Cortaderia selloana)* and the pepperweed (*Lepidium latifolium*). It was also noted that many of these plants had died, some were starting to re-grow, and a few individuals had emerged in new locations. Additional repeated targeted removal of pepperweed was conducted throughout 2009 and 2010.

4.3.2 Weed Control Prior to Seeding and Container Plant Installation

Invasive grasses and broadleaf weeds present in the coastal scrub habitat zone and other non-tidal areas of the Site were sprayed periodically in 2006 through the current date. The first phase of spraying was completed prior to installing the container stock. Invasive grass and weed germination, which was observed in the coastal scrub zone initially, was treated by spraying above ground foliage with glyphosate during the spring, in preparation for seeding. Glyphosate is used prior to seeding to minimize re-growth of invasive non-native species on the Site; the product rapidly translocates to the root system. Annual weeds, including grasses and most broad-leafed plants, are commonly controlled using Glyphosate. This is because they have soft tissue and when growing actively they quickly absorb the application.

Seeding was also prescribed for the exotic control area and a portion of the transition salt marsh zone, which supported dense weed cover. These areas were sprayed in Spring 2006 and again in January 2007, in preparation for additional seeding which occurred in 2008.

Throughout the five years following project implementation, habitat areas were manually weeded from April through November to control and eliminate exotic, invasive, or otherwise non-native plant species that could become established within the Site. Hand weeding and associated vegetation management methods continue to be used as necessary to maintain favorable site conditions. The actual weeding frequency was modified based on field conditions/climate, feasibility, and other potential constraints. These activities were focused in the upland transition and freshwater lagoon areas; however, non-native plant species observed in the marsh area were also removed and select locations were replanted with native species on an as-needed basis.

4.3.3 Container Plant Installation and Irrigation

Planting and replanting conducted by Pacific OpenSpace during the 2006, 2007, and 2008 planting cycles were done in accordance with the attached Planting Plan (Figure 2). The Planting Plan shows each habitat type and the approximate acreage of each habitat zone. Container plants, cordgrass, and pickleweed were installed immediately following the exotic plant removal and weed spraying during early spring 2006, and replanting occurred in select areas throughout 2007. Drip irrigation for individual plants in the transitional salt marsh and the coastal scrub was installed at the Site through installation of a 4-inch main line. Irrigation of upland plantings was discontinued at the end of the 2007 growing season following the initial two-year plant establishment period in the upland transition planting areas. Follow-up herbaceous ground cover seeding of approximately 4.0 acres of upland transition area was also conducted in October to November 2006 and again in 2007.

4.3.4 Weeding Status

During the period between 2007 and 2010, Pacific OpenSpace periodically worked to treat weeds at the Site including a minimum of approximately six site visits per year. In tidal areas, the primary weed that was treated was brass buttons (*Cotula coronopifolia*), and Aquamaster®, which is an herbicide suitable for aquatic areas, was used to treat the brass buttons. In the non-tidal areas, the primary weeds that were treated were: brass buttons (*Cotula coronopifolia*), bristly ox-tongue (*Picris echioides*), mustard (*Brassica spp.*), sweetclover (*Melilotus officinalis*), and thistles (*Cirsium spp.*). In the non-tidal areas, Garlon 3 was used instead of Aquamaster®; Garlon 3 was used because, during the spring, the native grasses that had been seeded during the previous fall were green and growing, which made the grasses vulnerable to Aquamaster®. Garlon 3 was selected over Garlon 4 because Garlon 3 is less vulnerable to drift. Garlon 3 is specific to broadleaf plants and can be used near aquatic areas. Garlon 3 was not used in aquatic areas; a 20-foot buffer between the high tide line and the area treated with Garlon 3 was maintained.

In addition, the pampas grass (*Cortaderia jubata*) and other weedy plants located on the eastern levee were retreated in 2007 and 2008. Pacific OpenSpace noted a large amount of rabbitsfoot grass (*Polypogon monspeliensis*) on the northern grassland. Since rabbitsfoot grass is accustomed to moist soil and freshwater marshes, it is expected to disappear. Thus, these areas were not treated with herbicides.

In the Spring of 2008, it was noted that there was an approximately one-quarter-acre area at the southern end of the HEA planting area where sparse vegetative cover was observed, limited growth of both native and non-native species was observed in this area presumably due to slightly elevated and compacted soils. On March 17, 2008, Pacific OpenSpace transplanted wetland plants into this area by installing five small test plots, and using plant materials from the adjoining marsh. Pacific OpenSpace used a mix of native plants in each test plot, including: Pickleweed (*Salicornia virginica*), Salt grass (*Distichlis spicata*), Jaumea (Jaumea carnosa), and Frankenia (Frankenia salina). The response to the replanting in this area included mixed results. The majority of the test plots resulted in partial establishment of Pickleweed and Salt grass; however, the Jaumea and Frankenia did not successfully establish in these areas. In 2010 Pacific Openspace established an approximately 20’ by 20’ test plot for physical soil treatments and additional replanting efforts.

In 2009 and 2010, Pacific OpenSpace continued to mow and spray broad-leafed weeds. The weeds targeted for spraying included:

- Mustard (Brassica sp.)

- Pepperweed (Lepidium latifolium)
- Fennel (Foeniculum vulgare)
- French broom (Genista monspessulana)
- Pampas grass (Cortaderia jubata)

Pacific OpenSpace sprayed French broom and pampas grass that survived from earlier treatments. They sprayed and mowed other broadleaf weeds, such as mustard and fennel. The numbers of fennel have dramatically decreased as a result of ongoing control. The broadleaf annuals and biennials, such as mustard, have decreased in number, but continue to be an ongoing problem. They are not so dense as to compromise the establishment of the natives, but they are a visual distraction when they flower.

The *Salsola* seedlings are intermixed with the natives, making treatment slow. The *Bassia* and *Salsola* can be a significant visual nuisance, but they are not so large or dense on the Site as to compete effectively with the natives. They are also not amongst the target species listed in the HEP. Additional efforts should be concentrated on weed species that are more likely to compete with the natives or compromise the success of the project. Pacific OpenSpace has advised that *Bassia* and *Salsola* do not appear to be a significant threat to prioritize them for treatment. On the other hand, Pacific OpenSpace has added *Lepidium latifolium* to its management list, because of the significant threat posed by this species.

When herbicide work was interrupted by the wind, the weeds and grasses were mowed by weed trimmers or were removed by hand.

4.3.5 Planting Status

The northernmost upper salt marsh area was re-graded in October 2006, and the area was re-seeded in November 2006. In 2007, 2008 and again in Spring 2009, it was observed that the coastal scrub plants on the slopes of ESM were growing vigorously and mortality was low.

In March 2007, a terrace was noted between the easternmost slope of ESM and the upper salt marsh, north of the former French broom area that was previously mapped as coastal scrub. During a previous site inspection, Dr. Lucas Paz of LFR and Mr. Dave Kaplow of Pacific OpenSpace noted almost no evidence of native scrub in this area; however, some native *Atriplex triangularis* was present, along with islands of weeds, including *Picris echioides* and other types. This area was fully planted with native container stock in March 2006. During installation, the planting crew observed that the area was poorly drained, and that there were salt crystals at the surface.

LFR and Pacific OpenSpace subsequently determined that coastal scrub plants would not survive at this location, and instead planted salt marsh transition plants such as *Grindelia stricta* in this area. It was believed that, due to the presence of the salt crystals, there would generally be enough residual soil moisture from the high tides to make supplemental irrigation unnecessary in this zone. The decision to forego irrigation was incorrect, however, and plant mortality occurred. Since March 2007, this area has been replanted with upper salt marsh species, and supplemental irrigation was supplied throughout 2007 which supported improved survival.

In 2008, 2009, and 2010, it was noted that the pickleweed (*Salicornia virginica*) installation had been generally successful. Many areas had large populations of healthy plants, while some areas did not. The landscape contractor reported that, in his experience, replanted stands of *Salicornia* appear to be bare mud for two to three years, after which the *Salicornia* rapidly expands and covers remaining bare areas. This trend has been clearly observed at the Site (see Figure 4).

Pacific OpenSpace noted that the pickleweed in the northern end of the upper marsh was growing successfully and did not require enhancement or replanting. They also noted that the initial pickleweed planting in the southern part of the restored marsh, which occurred in 2006, was not successful. Possible reasons could be an installation problem or a soil compaction, soil chemistry, or elevation problem. From May 14 to May 29, 2007, this area was replanted with 1,400 pickleweed, 1,000 of which came from supplemental material that was not used during the initial installation in 2006, and the remaining 400 of which came from stock produced at the Pacific OpenSpace nursery. Soil and elevation checks may be necessary if the May 2007 pickleweed planting is not successful. Figure 4 shows that the bare area (0-20% vegetative cover) in the southeastern part of the restored marsh is almost 1 foot higher in elevation than the low marsh area to the west. In 2010, an approximately 20' by 20' test plot was established for physical soil treatments and additional replanting efforts. The test plot soil surface has been tilled and pickleweed plugs planted in the area and the plot was surrounded by silt fence to protect the new plantings.

In 2007 it was initially noted that the majority of the initial cordgrass (*Spartina foliosa*) planted in the marsh failed to become established due to excessive herbivory by Canada geese and their young residing at the Site. On May 9, 10, and 14, 2007, cordgrass plugs were replanted and several silt fences were installed around the cordgrass plugs to deter ongoing geese herbivory. The silt fences were removed in October 2007 because the Canada geese are not active during the winter. In May 2008, it was noted that select areas of planted cordgrass were becoming established interspersed among the extensive pickleweed cover. The silt fence barriers were subsequently removed in spring 2008. Several of the newly established cordgrass specimens within ESM were sampled and provided to the University of California Davis for DNA evaluation to confirm that the cordgrass was indeed the local native species (*Spartina foliosa*) and did not exhibit any hybrid characteristics associated with the invasive cordgrass *Spartina alterniflora*; this was confirmed by the DNA evaluation.

In areas starting at the lower elevation of pickleweed survival, cordgrass (*Spartina foliosa*) was planted in 2007. In areas beginning at the upper elevation of pickleweed survival, 400 salt grass (*Distichlis spicata*) were replanted before the end of June 2007. Pacific OpenSpace expected that the occasional high tides would hydrate the salt grass

(*Distichlis spicata*) and irrigation was not necessary in this area. Additional salt grass (Distichlis spicata) was planted in September 2007. Pacific OpenSpace also noted that the northern part of the marsh is highly unvegetated and follow-up planting of salt grass (*Distichlis spicata*) was conducted in this region.

Pacific OpenSpace noticed that most of the original shrubs were growing robustly but some shrubs showed stress and 20 shrubs had died. The dead shrubs were replaced and new seedlings planted beside the stressed shrubs. In addition, Pacific OpenSpace planted shrubs in the northern costal scrub area and planted 40 willow cuttings in the adjacent transition area (*Salix lasiolepis*).

4.4 Transect-Based Quadrat Analyses

Methods used to monitor the success of vegetation establishment associated with the HEP restoration measures over the five-year monitoring period include detailed transect-based quadrat sampling conducted in Year 3 and Year 5 to quantitatively evaluate vegetative cover, plant height, and species composition. The methodology for transect-based quadrat analyses is described in the following paragraphs. The vegetation monitoring methodology is in accordance with the revised performance criteria transmitted on June 15, 2004 to the USACE, the Regional Water Quality Control Board, and BCDC.

Transect-based quadrat sampling was conducted concurrently with the visual monitoring. Vegetation cover and species diversity were monitored using transect-based quadrat analyses. Each transect consists of a straight line with two well-defined end points repeatedly laid out across the HEA habitat areas to be monitored. Four baseline transects and 12 associated quadrats have been established with the HEA (see Figure 5). A quadrat is a standardized, 1-square-meter monitoring area. Two quadrat locations were selected randomly within each of the six habitat zones where partial segments of each transect overlay a particular habitat zone. A total of 12 monitoring quadrats were located along the four transects within the ESM, ensuring that a minimum of two quadrats would be located in each of the six habitat element/vegetation zones of the HEA. Table 1 details the complete 2010 quadrat monitoring results for each of the 12 quadrats.

4.4.1 Transect Demarcation and Monitoring

The four transect locations are spaced across the ESM and aligned to include primary habitat zones and allow the establishment of at least two quadrats per habitat zone (see Figure 5). Transects run perpendicular to the main channel in a north-south orientation. For each monitoring event, transect endpoints are surveyed and marked in the field at the upland (north) and bayward (south) ends using two stakes. The stakes are removed after all relevant data have been collected.

During monitoring visits, a tape measure was used to mark the baseline transect starting at the upland end. The observer secured the tape measure onto the upland stake or other final object, and walked toward the southward bayward stake. To minimize damage to plants, the observer walked along a diagonal path from the upland marker toward some point a short distance away from the actual bayward marker, to either the right or left. When the observer is in line with the bayward marker, he or she walks to the marker and secures the measuring tape to the stake to establish the transect. Vegetation type and habitat zones occurring along each transect were documented, and quadrat locations along the tape measure recorded.

4.4.2 Quadrat Monitoring

Data was collected from each transect at locations utilizing monitoring quadrats. A quadrat is a standardized, 1-square-meter monitoring area. Data from each quadrat included species composition, total percent vegetation cover, relative percent cover of each species, plant height, and stem density. Two quadrat locations were selected randomly within each of the six habitat zones where partial segments of each transect overlay a particular habitat zone. A total of 12 monitoring quadrats are located along the four transects within the ESM, ensuring that a minimum of two quadrats will be located in each of the six habitat element/vegetation zones of the HEA.

Within a single vegetation zone, quadrats were located a minimum of 1.0 meter apart along the length of the transect. Quadrats were placed randomly along the transect (using a stratified sampling approach) centered at randomly pre-selected intervals within each habitat zone; the quadrat is always laid out directly adjacent to each transect on the eastern side of the transect. Quadrats were always oriented so the western side of the quadrat is directly adjacent and parallel to the transect line. The locations of upland (north) and bayward (south) quadrat boundaries were recorded relative to the transect. Signs of disease, predation, or other disturbance are monitored in each quadrat and along the length of the transect, and observations were recorded in the field. Each quadrat was photographed at the time of sampling (see Appendix B).

The observer divided each quadrat into four 0.25-square-meter sections for evaluation of vegetation cover, plant height, and plant stem density. All live stems of any plant species found within the quadrat were counted and measured from the base of the plant to the top of the stem. The observer recorded plant height and stem density data.

Total vegetation coverage in Year 3 (2008 monitoring) within the 12 monitored quadrats ranged from 20% to 100% cover with an overall average of 69.9% cover. Total vegetation coverage in Year 5 (2010 monitoring) within the 12 monitored quadrats has increased ranging from 40% to 100% cover with an overall average of 82% cover. Table 1 details the complete 2010 quadrat monitoring results for each of the 12 quadrats. All of the areas, with the exception of Upper Marsh-3 and Low Marsh-12, met or exceeded the restoration criteria of 60% for wetland and 50% for upland areas. Upper Marsh-3 was 5% below the criteria and Low Marsh-12 was 20% below the criteria. The area surrounding Low Marsh-12 is topographically higher than other points in the restored portions of ESM and the sediment is compacted. As discussed above, a test plot area was established in this area and the soil was tilled and replanted to discern whether the compacted soils could be the cause for the slower recovery (2010 Test Plot, Figure 4).

5.0 SEDIMENT MONITORING

As described in Appendix A of the CMP (LFR 2002e), sediment sampling was conducted in ESM in accordance with the CMP and as required by the DTSC, USACE (file number 28252S), and BCDC (permit number M01-52(a)).

On June 29, 2006 (approximately six months after marsh remediation activities had been completed and tidal inundation returned), soil parameters were evaluated at nine locations in the planted area and 11 locations in the unplanted areas of the HEA. Of these 20 sample locations, six are located in the tidal channels and 14 are located in the marsh plain.

Table 7 of the CMP detailed the parameters for which each sample was analyzed, along with the sampling method, sampling frequency, and habitat element. Each sample was analyzed for pH and the following metals: arsenic, cadmium, copper, mercury, lead, nickel, zinc, and selenium.

Additionally, three of the sample locations from the marsh plain and one from the tidal channel network were analyzed for the following parameters: salinity, total organic carbon, grain size distribution, and general nutrients/minerals.

Sediment samples were collected from an approximate depth of 10 centimeters using a disposable plastic spade. Sediment samples from the tidal channels were collected at or near low tide. Sediment samples were stored at 4 degrees Celsius in a cooler and sent to a California-certified analytical laboratory for analysis. The surficial sediments sampled have the greatest chance for recontamination and are the sediments with the greatest potential for exposure to potential ecological and human receptors. The sediment samples are considered representative of existing conditions at the time of sampling.

Sediment sampling is used to evaluate the mass removal and reduction in potential exposure concentration in ESM and to evaluate the sediment characteristics of the tidal marsh substrate. This sampling was repeated after five years to evaluate the long-term stability of the remediation and recovery of the tidal marsh. Appendix C-1 presents the evaluation of the 2006 Sediment Sampling Results and includes statistical summary results of the data collected. Figure 2 shows the sediment sample locations in ESM.

Additional sediment samples were collected on June 6, 2007 at locations SS-21 and SS-22, which are located within the tidal channel and shown on Figure 2. These two sampling locations were added to the modified CMP to provide data to conduct trend analysis for chemical concentrations in the surface sediments of the channel material. These samples were located in the same location where previous samples had been collected since the early 1990s. The sampling locations SS-21 and SS-22 provide additional sediment data in the easterly section of the channel. The two sediment samples were analyzed for pH and the following metals: arsenic, cadmium, copper, mercury, lead, nickel, zinc, and selenium. These samples were collected from a depth of 10 centimeters by qualified ARCADIS personnel at or near low tide (Appendix C-2).

Recently, sediment samples were collected on June, 15, 2010 utilizing a consistent methodology with respect to previous efforts at all of the previous sampling locations, SS-1 through SS-22, shown on Figure 2. These sediment samples were analyzed for pH and the following metals: antimony, arsenic, barium, beryllium, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. Four samples, SS-1, SS-3, SS-4, and SS-6, were sampled for additional analytes: Alkalinity, Nitrogen as Nitrate, Salinity, Sulfate, and Total Organic Carbon. All samples were collected from a depth of 10 centimeters by qualified ARCADIS personnel at or near low tide (data are presented in Table 4a for sediment quality and Table 4b for metals and further discussed in Section 5.2).

5.1 Sediment Removal and Replacement

During removal actions conducted in ESM during the periods from October 2004 through February 2005 and from December 2005 through January 2006, extensive removal of sediments from ESM was conducted in the areas shown on the site topography map (Figure 1). These activities are summarized in the "Final Implementation Report for Remediation of Habitat Enhancement Area, Campus Bay, Richmond, California" (LFR 2007).

Comparison of the original sediment quality conditions and expected post-remediation sediment quality conditions to the actual conditions (post-remediation) is summarized in the 2006 Sediment Sampling Results presented in Appendix C-1 and in the following sections.

5.2 Sediment Quality Monitoring

As discussed above, following removal actions (marsh sediment removal/remediation activities and regrading), in situ sediment samples were collected in 2006, 2007 and 2010 at four representative locations in ESM (SS-1, SS-3, SS-4, and SS-6) to characterize marsh soil properties with respect to overall marsh habitat enhancement goals. Samples were collected to characterize grain-size distribution, total organic carbon, total alkalinity, chloride, total nitrogen, nitrogen as nitrate, phosphorus, salinity, and sulfate. Samples SS-1, SS-3, and SS-6 were collected from the marsh plain, and sample SS-4 was collected within a primary tidal channel.

The grain-size distribution analysis shows that samples from the marsh plain exhibit similar physical characteristics and can be classified as predominantly silt and clay (>50%). However, the tidal channel sediment sample is characterized as a fine to medium sand presumably due to the higher energy environment that would be expected in that location. These results are generally consistent with what would typically occur within a natural salt marsh environment.

Appendix C-1 summarizes post-remediation marsh sediment conditions with respect to total organic carbon, salinity, general nutrients, and minerals for Year 1. The results of sediment monitoring indicate that, similar to organic carbon, observed salinity, total alkalinity, and chloride levels in the marsh sediment samples were also consistent with what would be expected in a typical salt marsh environment. Tidal channel sediment samples show elevated levels for these three parameters, as would be expected due to the effect of direct inflows of saline water from San Francisco Bay (LFR 2006b).

Marsh sediment sampling results for general nutrients (total nitrogen, nitrogen as nitrate, phosphorous, and sulfate) exhibit values that are lower than would be expected in a highly productive natural marsh (Kadlec and Knight 1996). However, observed nutrient levels in marsh plain and tidal channel sediment samples are within acceptable ranges for a recently constructed salt marsh environment. It is expected that nutrient levels in marsh sediments will increase over time as re-vegetation and associated accretion occurs in the newly constructed marsh areas.

The 2007 sediment sampling for SS-21 and SS-22 resulted in the following metal concentration ranges:

- 24 to 57 milligrams per kilogram (mg/kg) for arsenic
- 0.46 to 0.90 mg/kg for cadmium
- 69 to 160 mg/kg for copper
- 0.58 to 0.95 mg/kg for mercury
- 32 to 49 mg/kg for lead
- 24 to 35 mg/kg for nickel
- 0.62 to 1.1 mg/kg for selenium
- 210 to 410 mg/kg for zinc

Moreover, the sediment pH ranged from 7.1 to 7.4 for SS-21 and SS-22. The sediment results for these samples can be found in Appendix C-2. These results indicate that concentrations pre- and post-remediation at location SS-21 are similar and that concentrations pre- and post-remediation at location SS-22 show a significant reduction after completion of the remediation.

Appendix C-1 contains the letter to the DTSC "Evaluation of Year 1 Sediment Monitoring Results from the East Stege Marsh in June 2006." In this report, the objectives of the sediment sampling were stated to be: (1) evaluate the effectiveness of the mass removal of sediment from ESM; (2) assess whether the potential exposure concentrations in ESM were reduced; and (3) evaluate the sediment characteristics as tidal marsh substrate. Sample results were used to evaluate the long-term stability of the remediation and recovery of the restored tidal marsh areas.

Year 5 Sediment Contaminant Monitoring

The 2010 (Year 5) sediment samples collected from locations SS-1 through SS-22 resulted in the following metal concentration ranges:

- 4.2 to 55 mg/kg for arsenic
- 0.28 to 0.88 mg/kg for cadmium
- 6.9 to 190 mg/kg for copper
- 0.058 to 4.5 mg/kg for mercury
- 11 to 49 mg/kg for lead
- 17 to 45 mg/kg for nickel
- 1.3 to 3.8 mg/kg for selenium
- 33 to 230 mg/kg for zinc

Sediment pH ranged from 5.0 to 7.8 for the Year 5 sampling event. Year 5 sediment sampling results are summarized below and details are presented in Table 4a.

As in Appendix C-1, a comparison of the original conditions and expected post-remediation conditions to the current 2010 post-remediation conditions is summarized in the following table:

CONTAMINANT	CURRENT CONDITIONS		EXPECTED CONDITIONS[1]		POST-REMEDIATION CONDITIONS[2]		SITE-SPECIFIC TARGET LEVELS[3] Human	Ecological	
	Mean Conc. mg/kg	RME Conc. mg/kg	Mean Conc. mg/kg	RME Conc. mg/kg	Mean Conc. mg/kg	RME Conc. mg/kg	Human mg/kg	Marsh Plain mg/kg	Channel mg/kg
Arsenic	16.04	261	49.2	55	36.6	61.3	110	246	246
Cadmium	0.45	8.0	1.2	1.4	0.9	1.1	NC	2.29	17.3
Copper	44.86	681	141	152	138	212	NC	2104	2104
Lead	26.05	160	69.2	75	72.7	112	NC	157	157
Mercury	0.61	5.6	1.1	1.3	1.1	1.8	NC	7.0	7.0
Selenium	2.60	14	1.6	1.8	1.7	2.7	NC	2.3	2.3
Zinc	117.91	1995	363	432	291	417	NC	3,953	3,953

Notes:

NC = Not Calculated; mg/kg = milligram/kilogram; Conc. = Concentration; RME = Reasonable Maximum Exposure

[1] Derived from data presented to and approved by the Regional Water Quality Control Board (RWQCB) in May 2003 submittal for Remedial Alternative RA-4a (modified; LFR 2003a)

[2] Reasonable Maximum Exposure concentrations are calculated as the 95% Upper Confidence Limit on the mean as calculated by PRO-UCL; non-detection were given the value of their detection limit to most closely mimic the values used in the original calculations. Output from PRO-UCL.

[3] Site-Specific Target Levels are specific to human health or ecological health; ecological site-specific target levels are specific to the habitat type (channels or marsh plain) and are the lower of the values calculated for the Salt Marsh Harvest Mouse and California Clapper Rail considering bioavailability if it was calculated in the Human and Ecological Risk Assessment (LFR 2002a).

The 2010 data indicate that all of the contaminants of concern were observed below previous levels. Arsenic, cadmium, copper, mercury, and zinc were down by a factor of 10. The average concentration of selenium was below the post-remediation RME but slightly above the Site-Specific Target Levels. The remaining averages were below their respective target levels.

Year 5 Sediment Quality Monitoring

There were four locations (SS-1, SS-3, SS-4, and SS-6) that were also tested for sediment quality which included: alkalinity, nitrogen (as nitrate), total Kjeldahl nitrogen, total organic carbon (TOC), salinity, sulfate and grain size analysis. Samples SS-1, SS-3, and SS-6 were taken from the marsh plain and sample SS-4 was taken within a primary tidal channel. A comparison of current post-remediation conditions to typical ranges reported in the literature is summarized in the following table:

ANALYTE	SAMPLE LOCATION				MEAN	TYPICAL[1] RANGE
	SS-1	SS-3	SS-4	SS-6		
Total Organic Carbon (%)	0.48	0.55	0.80	0.32	0.54	0.2 – 7.7
Alkalinity, Total as $CaCO_3$ (μg/kg)	4,200	2,100	3,500	1,800	3,075	
Nitrogen, as Nitrate (μg/kg)	0.6	<0.5	<0.5	<0.5	0.6	$10 - 1.4x10^4$
Total Kjeldahl Nitrogen (μg/kg)	780	1,100	760	910	888	$4x10^5 - 5.3x10^6$
Salinity ECe (*dS*/m)	4.8	3.0	3.4	2.6	3.5	$1.6x10^4 - 6x10^4$
Sulfate (μg/kg)	4,400	670	810	1,100	1,745	$2x10^3 - 12.9x10^3$
Mean Grain Size (Descriptive)	Fine Sand	Silt	Silt	Silt	Silt	
Mean Grain Size (mm)	0.034	0.023	0.013	0.019	0.022	

Notes:

μg/kg = micrograms per kilogram; $CaCO_3$ = calcium carbonate; ECe = Electrical Conductivity of a saturated soil extract; *dS*/m = deciSiemens per meter; mm = millimeter

[1] Reported data range summaries for North American wetland sediments derived from the following sources: Stolt et al., 2001; Kennedy and Murphy, 2004; Childers et al., 2003; and Dunne et al., 1998.

The 2010 results indicate that SS-1 decreased in % TOC and nitrogen (as Nitrate and Total Kjeldahl) from the previous sampling; however, it increased in alkalinity, salinity, and sulfate. SS-3 also decreased in TOC, salinity and sulfate. It increased in alkalinity and total Kjeldahl nitrogen. Nitrogen as nitrate was not detected above the reporting limits in this sample. SS-4 decreased in concentration of TOC, alkalinity, salinity and sulfate. It increased in total Kjeldahl nitrogen and was not detected above the reporting limit in nitrogen as nitrate. Sample SS-6 increased in % TOC, alkalinity, salinity, and sulfate. It decreased in total Kjeldahl nitrogen and was below laboratory detection limits for nitrate. To date, with respect to the sediment quality analytes examined, only Total Organic Carbon was observed to be in the typical range defined in Appendix C-1. It is expected that over time as the restored marsh areas and associated substrate continues to develop and evolve the other analytes will exhibit levels within the typical ranges as noted above.

The grain size distribution was observed to be predominantly silt and clay (>50%) in all of the samples. SS-1 was the only sample to contain a significant amount of fine-grained sand. The zone where SS-1 was collected is periodically dry in the low tide seasons and this could account for the accumulation of coarser grained materials. SS-4, which is in the tidal channel, was found to be finer grained than the previous sampling event. These particle size results are generally consistent with what would typically occur within a natural salt marsh environment.

5.3 Sedimentation Rate Monitoring

Revised Table 8 (Appendix A) prescribed sediment accretion rate monitoring following remediation (backfilling) and subsequent restoration activities. Sedimentation pins were not initially installed in 2006; however, visual observations showed relatively insignificant deposits throughout 2006. Sedimentation pins were established on the surface of ESM at four locations, the locations are shown on Figure 2.

Formal sedimentation monitoring was conducted during low tide on March 26, 2009 for Year 4 and on June 16, 2010 for Year 5. The readings taken at SA-1, SA-2, SA-3, and SA-4 are provided in the following table.

Date	Sedimentation Pins			
	SA-1	**SA-2**	**SA-3**	**SA-4**
4/25/2007	32.88	41.75	-	37.81
6/4/2007	32.50	41.75	39.00	38.00
6/3/2008	31.00	40.60	37.40	37.50
7/29/2008	32.64	42.00	37.80	37.80
11/12/2008	30.50	40.50	37.00	37.50
2/19/2009	29.90	39.70	37.40	37.50

Date	Sedimentation Pins			
	SA-1	SA-2	SA-3	SA-4
5/26/2009	29.30	40.00	37.00	37.30
9/24/2009	28.50	39.00	37.00	37.00
3/12/2010	26.00	37.00	37.00	37.00
6/16/2010	25.50	38.00	37.00	37.00

The overall trend following the May 26, 2009 readings indicate that the surface sediments at SA-1 have accumulated 3.58 inches since April 25, 2007; surface sediments at SA-2 have accumulated 1.75 inches since April 25, 2007; surface sediments at SA-3 have accumulated 2.00 inches since June 4, 2007; and surface sediments at SA-4 have accumulated 0.51 inch since April 25, 2007. These results show alternating periods of accretion and erosion at SA-1, SA-2, and SA-3 and fairly stable accretion at SA-4. It is noted that additional ongoing data collection will provide a more reliable estimate of sedimentation rates for the ESM marsh plain. The time period between these readings is two years; these results show an aggradation trend but are not considered to be entirely conclusive.

The overall trend following the 6/16/10 readings indicates that since the Year 4 May 25, 2009 readings the surface sediments at SA-1 through SA-3 have accumulated; surface sediments at SA-1 have accumulated 3.80 inches, surface sediments at SA-2 have accumulated 2.00 inches, surface sediments at SA-3 had no growth, and surface sediments at SA-4 have accumulated 0.30 inch. These results show alternating periods of accretion and erosion at SA-1, SA-2, and fairly stable elevations at SA-3 and SA-4.

A Mann-Kendall analysis was performed on the data from 2007, 2008, 2009, and 2010 and presents the previous changes in accretion in each of the monitoring points. The Mann-Kendall analyses are presented in Table 5.

The Mann-Kendall trend test involves listing the analytical data results (i.e., sediment accretion measurements) in temporal order, and computing all differences that may be formed between each of the measurements and earlier measurements. The test statistic (sum of trend, S) is the difference between the number of strictly positive differences and the number of strictly negative differences. At least four data points are required to conduct the Mann-Kendall statistical analysis. If there is an underlying upward trend, the differences will tend to be positive. The greater the positive number, the stronger the upward trend; conversely, the lower the negative number, the stronger the downward trend. In this case since the data was a measurement of the length of the sediment accretion pins, a negative value shows that the length of the pin above ground is decreasing, this is from an accumulation of sediment therefore an increasing trend. A positive value would have more of the pin was exposed therefore an increase of exposure of the pin over time would be a decreasing trend.

The trends for 2009 show values from -7 in SA-3, to as much as -17 in SA-1. SA-2 and SA-4 have trends of -11. This means that all four sediment accretion pins have increasing trends. The trends for 2010 show values from -21 in SA-3, to as much as -41 in SA-1. SA-2 and SA-4 indicate trends of -34 and -30, respectively. This means that all four sediment accretion pins have increasing trends; SA-3 is showing signs of stabilization.

6.0 SURFACE-WATER SAMPLING

As prescribed in the CMP, surface-water sampling was performed to evaluate current conditions in ESM and the potential transport of chemicals of potential concern (COPCs) from within ESM and from ESM to the San Francisco Bay or vice versa. Surface-water samples were originally to be collected during Year 1 activities; however, this task was not completed within the USACE reporting timeframe for Year 1. Samples were taken in May 2007 (Year 2), in July 2009 (Year 4), and in June 15, 2010 (Year 5) to further examine surface-water conditions in ESM.

6.1 Year 2 Surface-Water Sampling Event (2007)

On May 2, 2007, surface-water sampling was performed at three locations (SW-1, SW-2, and SW-3; Figure 2). The surface-water samples were collected during an ebb tide immediately following a high tide. The samples were analyzed for pH, California Assessment Manual (CAM) 17 metals, volatile organic compounds (VOCs), proprietary pesticides, and total suspended solids (see Appendix E-1).

The surface-water results for pH range from 8.0 to 8.2 for the three samples (SW-1, SW-2, and SW-3).

The surface-water results for total metals (unfiltered) indicate the presence of arsenic, barium, copper, nickel, thallium, and zinc in the three samples (SW-1, SW-2, and SW-3); chromium in the sample for SW-2; and molybdenum in the samples for SW-1 and SW-3. The results are summarized as follows:

- arsenic concentration ranges from 15 to 27 micrograms per liter (μg/L)
- barium concentration ranges from 32 to 43 μg/L
- chromium concentration is 5.3 μg/L for the sample for SW-2
- copper concentration ranges from 11 to 15 μg/L
- molybdenum concentration ranges from 5.4 to 6.1 μg/L
- nickel concentration ranges from 6.5 to 8.2 μg/L
- thallium concentration ranges from 15 to 16 μg/L
- zinc concentration ranges from 23 to 25 μg/L

The surface-water results for dissolved metals indicate the presence of arsenic, barium, and copper in the three samples (SW-1, SW-2, and SW-3); molybdenum in the samples for SW-1 and SW-3; nickel in the samples for SW-1 and SW-2; and thallium in the samples for SW-1 and SW-3. The results are summarized as follows:

- arsenic concentration ranges from 6.1 to 14 μg/L
- barium concentration ranges from 27 to 43 μg/L
- copper concentration ranges from 7.4 to 10 μg/L
- molybdenum concentration ranges from 5.5 to 6.5 μg/L
- nickel concentration ranges from 5.6 to 8.4 μg/L
- thallium concentration ranges from 12 to 13 μg/L

With the exception of copper and nickel, sample results are below the continuous criteria for salt water habitats in the Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic for the State of California (U.S. EPA 2000); and Federal Register 40 CFR Part 131 (the California Toxics Rule [CTR]). Copper and nickel criteria are 3.1 and 8.1 μg/L, respectively.

The surface-water results for purgeable organics indicate the presence of acetone in the samples for SW-1, SW-2, and SW-3 and chlorobenzene in the sample for SW-1. The acetone concentration ranges from 5.4 to 7.3 μg/L and the chlorobenzene concentration for SW-1 is 0.5 μg/L.

The surface-water results for proprietary pesticides indicate the presence of EPTC in the samples from SW-1 and SW-2 and pebulate in the sample from SW-1. The EPTC concentration ranges from 1.1 to 5.2 μg/L and the pebulate concentration for SW-1 is 2.5 μg/L. These detections are less than the ambient water-quality criteria (AWQC) for proprietary pesticides developed using existing proprietary aquatic toxicity data (RWQCB 2008).

The 2007 surface-water results for total suspended solids range from 30,000 to 32,000 μg/L for the samples for SW-1, SW-2, and SW-3. The 2007 surface-water results for pH range from 8.2 to 8.0 for SW-1, SW-2, and SW-3.

6.2 Year 4 Surface-Water Sampling Event (2009)

On July 8, 2009, follow-up surface-water sampling was performed at the three established sample locations in ESM (SW-1, SW-2, and SW-3; Figure 2). The surface-water samples were collected during an ebb tide immediately following a high tide. The samples were analyzed for CAM 17 metals, VOCs, and proprietary pesticides. The 2009 surface-water results for the samples SW-1, SW-2, and SW-3 are summarized in Tables 3a, 3b and 3c and in Appendix E-2.

No VOCs or pesticides were detected above laboratory detection limits in any of the samples. Surface-water results for total metals (unfiltered) showed the presence of arsenic, barium, copper, lead, thallium, and zinc. Other metals were not detected above laboratory detection limits. The results are summarized as follows:

- arsenic ranged from 19μg/L (SW-3) to 22μg/L (SW-2)
- barium ranged from 21μg/L (SW-3) to 37μg/L (SW-1)
- copper was measured between 5.5μg/L (SW-3) and 10μg/L (SW-2)
- lead ranged from 5.7μg/L (SW-1) to 9.4μg/L (SW-2)
- thallium was detected in SW-1 and SW-3 at 11μg/L (just above the method detection limit)
- zinc was detected only in SW-2 at 22μg/L

These concentrations average lower than the previous detections in the 2007 sampling event.

The 2009 surface-water results for total suspended solids range from 32,000 to 45,000 μg/L for the samples for SW-1, SW-2, and SW-3. The 2009 surface-water results for pH range from 8.6 to 8.2 for SW-1, SW-2, and SW-3.

6.3 Year 5 Surface-Water Sampling Event (2010)

On June 15, 2010, surface-water sampling was performed at the three established sample locations in ESM (SW-1, SW 2, and SW-3; Figure 2). The surface-water samples were collected during an ebb tide immediately following a high tide. The samples were analyzed for CAM 17 metals, VOCs, and proprietary pesticides. The 2010 surface-water results for the samples SW-1, SW-2, and SW-3 are summarized in Tables 3a, 3b, and 3c.

No VOCs or pesticides were detected above laboratory detection limits in any of the samples. Surface-water results for total metals (unfiltered) showed the presence of arsenic, barium, copper, lead, thallium, and zinc. Other metals were not detected above laboratory detection limits. The dissolved metals (filtered) showed the presence of arsenic, barium, copper, molybdenum, nickel, and thallium. Detections in molybdenum and thallium were slightly above the reporting limit; because these detections are so close to the reporting limits their detections could be a result of the variability of the lab equipment. The filtered thallium samples were detected in higher concentrations than that of the total as well. The total and dissolved concentrations were close and also could be accounted for due to the variability of the laboratory equipment. Arsenic filtered samples were noticeably less than that of the total (unfiltered) sample. Other metals were not detected above the laboratory limits. The results are summarized as follows:

- Total arsenic ranged from 14 μg/L (SW-3) to 22 μg/L (SW-1). Dissolved concentrations were observed from 5 μg/L (SW-3) to 12 μg/L (SW-1). The total arsenic at location SW-1 was slightly higher than the previous year (Section 6.2); all of the other locations had lower observed concentrations than Year 4.

- Barium ranged from 17 μg/L (SW-3) to 41 μg/L (SW-1), which is lower than the previous year.
- Copper was measured at 23 μg/L (SW-2 and SW-3) and 26 μg/L (SW-2). All the copper concentrations were higher than observed in Year 4.
- Lead was not detected above the laboratory reporting limit of 5 μg/L in any of the locations, similar to the Year 4 results.
- Thallium was detected at concentrations ranging from 17 μg/L (SW-1) to 24 μg/L (SW-2).
- Zinc was not above the laboratory detection limit for any of the samples.

With the exception of SW-1, with respect to arsenic, and all three locations, with respect to copper, the results demonstrate lower concentrations for all other analytes when compared to the previous sampling data. The Year 5 surface-water sampling results are influenced both by San Francisco Bay tidal inflows and on-site sediments within the ESM. However, as discussed in Section 5, sediment contaminant sampling results demonstrate significantly lower levels than those observed in previous sampling events. Presumably the observed concentrations in surface-water samples are also influenced by off-site sources including the influence of the greater San Francisco Bay.

Year 5 surface-water results for total suspended solids were 40,000 μg/L, 43,000 μg/L, and 44,000 μg/L for the samples for SW-1, SW-2, and SW-3, respectively, higher relative to levels observed in the previous year. The results for pH were 8.3, 8.1, and 8.0 for SW-1, SW-2, and SW-3, which is slightly lower than levels measured in Year 4.

7.0 HYDROLOGIC MONITORING

The successful development of hydrophytic salt marsh vegetation and hydric soils will be dependent on sufficient tidal inundation within ESM. Sediment removal and replacement areas within the HEA have been resurveyed following remediation activities to confirm that appropriate design elevations have been obtained. A survey of the as-built site topography is presented as Figure 1.

The study was conducted as part of the CMP and was prepared to further meet the requirements outlined in the DTSC's Site Investigation and Remediation Order No. 06/07-005 for the Site.

The CMP provided for quarterly monitoring of tidal inundation to be measured by two staff gauges installed in the low marsh plain/tidal channel (ESM-1 and ESM-2), one staff gauge to be installed in the upper freshwater lagoon (ULSG), and two pressure transducers to be installed at staff gauge locations ESM-1 and ESM-2 for the continuous collection of tidal elevation data within ESM during the 2006 tidal study.

Figure 2 shows the transducer and staff gauge locations. Staff gauge observations include photo-documentation and/or visual observations and comparison to local tidal data.

The summer quarterly tidal monitoring event was conducted during a two-week period from July 31 through August 13, 2006, during a period of spring tides (a series of below average low tides and above average high tides). Prior to the monitoring event, LFR installed a pressure transducer at both channel staff gauge locations. Monitoring during other times of the year consisted of staff gauge readings during high tide to confirm inundation frequency.

The quarterly monitoring of tidal inundation was performed during the first quarter of 2007 (March 2, 2007 and March 6, 2007), second quarter of 2007 (April 25, 2007 and June 4, 2007), third quarter of 2007 (July 31, 2007), second quarter of 2008 (June 3, 2008), third quarter of 2008 (July 29, 2008), first quarter of 2009 (February 19, 2009), second quarter of 2009 (May 26, 2009), third quarter of 2009 (September 24, 2009), first quarter of 2010 (March 12, 2010), and second quarter of 2010 (June 16, 2010). Staff gauge readings and associated water level elevations for these periods are detailed in Table 2.

The specific objectives of the data collection field activities at ESM are to:

- Compare tidal patterns observed at ESM during the summer quarterly event to the initial tidal study to verify sufficient tidal inundation to support intended habitat goals.
- Compare as-built topography to pre-remediation topography and associated tidal inundation in ESM.

The following sections provide a summary of the 2000 and 2006 tidal studies and the 2007, 2008, 2009, and 2010 follow-up hydrologic monitoring conducted at ESM, including the objectives, procedures, and results of the studies.

7.1 East Stege Marsh Tidal Hydrology

The East Bay Regional Park District Bay Trail forms the southern boundary of ESM and separates the marsh from San Francisco Bay. The surface water in ESM is connected to San Francisco Bay via a culvert (“ESM Culvert”) located in the eastern portion of the Site (Figure 2). The ESM Culvert runs through the levee that forms the southeastern boundary of ESM (“the Southeast Levee”) and separates ESM from Carlson Creek (also known as Baxter Creek; Figure 2). Water from Carlson Creek may enter ESM through the culvert as it mixes with the incoming tides.

The ESM channel system consists of two main channels, approximately 10 feet wide and 3 to 4 feet deep. The extent, duration, and depth of inundation in ESM are dependent on the diurnal tidal cycle.

7.2 Initial Tidal Study Conducted in 2000

An initial tidal study to characterize tidal patterns for surface water within ESM was conducted during summer 2000. The study included the collection of continuous tidal water surface elevation data for a period of 40 days. The study was conducted using water level data collected from several strategically located points within ESM. The study, which included a detailed topographic survey of the Site and an evaluation of tidal dampening, lag times, and the tidal prism, was conducted to provide data for use in development of this remediation and restoration plan for ESM. The 2000 Tidal Study has been included as Appendix D for reference.

As part of the 2000 Tidal Study, four water level recorders (In Situ Troll model SP-4000 pressure transducers) were installed in ESM. Water levels were recorded at 12-minute intervals. Recorded water level data at each tidal monitoring location were compared to data from National Ocean Survey (NOS) Station 941-4863, located on the Chevron Oil Pier in Richmond, California. The Richmond reference station, located approximately 1 mile from the Site, has operated this NOS station since 1979. Data have been collected at this station continuously (every six minutes) since 1996, and monthly tidal mean data have been collected since 1979.

Tidal dampening, the reduction in tidal water levels with increasing distance from the tidal source (i.e., San Francisco Bay), can generally be attributed to friction for tidal marsh settings as the water travels through the channels and across the open marsh surface. Data collected in ESM indicate little tidal dampening in the marsh (LFR 2002c). Tidal heights in the channels closely match tidal heights at the reference station, which is located in relatively open water near San Francisco Bay.

A tidal reckoning analysis was completed as part of the initial 2000 Tidal Study to quantify the relationship between tidal heights in the marsh and tidal heights at the reference station.

7.3 2006 Tidal Study

ESM is regularly inundated by the diurnal tides in San Francisco Bay. The extent, frequency, and depth of inundation are dependent on the tidal cycle. A 14-day Tidal Study was conducted within ESM from July 31 through August 13, 2006 (during a period of spring tides) to coincide with the period of anticipated highest high and lowest low tides for the year. This was conducted to evaluate tidal response in the marsh during extreme tidal conditions, and evaluate marsh inundation following remediation and replanting activities conducted at the Site.

7.3.1 Field Activities and Objectives

It is desirable that created manmade wetland areas be inundated for 15% of the growing season (55 days of the year) to satisfy the general minimum wetland hydrology criteria. To determine marsh inundation for comparison to the previous values obtained during the initial tidal study conducted in 2000, a similar methodology was used in collecting and analyzing the tidal data (LFR 2002c).

Pressure data for the 2006 tidal study were collected using vented MiniTrollPro® pressure transducers from InSitu® Inc. Electronic data were collected at five-minute intervals. The interpretation of pressure transducer data requires several corrections, including barometric pressure and water density. For this study, vented pressure transducers were used that automatically compensate for changes in barometric pressure.

The results were used to calculate minimum, maximum, and average values for the tidal ranges.

Readings taken from the staff gauges installed adjacent to the transducer stilling wells were recorded before the beginning of the test, once during the test, and prior to removing the transducers at the end of the test. The staff gauge readings were used to calibrate the pressure transducers.

7.3.2 Field Data

Field data collected for the 2006 tidal study are described in the following subsections:

- Water level recorder installation (Section 7.3.3)
- Water level recorder calibration (Section 7.3.4)
- Water level recorder data downloading (Section 7.3.5)
- Water level recorder data conversion to water surface elevations by survey and datum conversion (Sections 7.3.5 and 7.3.6)

7.3.3 Water Level Recorder Installation

Water level recorders (vented MiniTrollPro® pressure transducers from InSitu® Inc.) were installed at two locations within the channel of ESM (ESM-1 and ESM-2). The locations of these instruments are shown on Figure 2. Water levels were recorded from July 31 through August 13, 2006. The water level recorders took readings at five-minute intervals throughout the time period.

The instruments were installed in stilling wells constructed of 1-inch-diameter Schedule 40 polyvinyl chloride (PVC) piping with the lowest 1 foot of the casing constructed of screened PVC to permit water to flow in and out of the stilling well.

7.3.4 Instrument Field Calibration to Reference Vertical Datum

The elevations of the water level recorders could not be surveyed directly because of the stilling wells. A staff gauge was installed directly onto the PVC casing with the bottom of the gauge lightly touching the ground surface of the channel. The distance from the top of the PVC casing to the water surface was measured with a water level meter at the same time that the water level recorder was taking an initial measurement of the water level. These data were used to correlate the absolute pressure readings collected by the transducers to a height of the column of water above the sensor.

The water surface elevation relative to the reference datum was then calculated as the elevation of the top of the PVC casing minus the distance down to the water surface. The difference between the synoptic measured water surface elevation and the instrument reading was used to calibrate the recorded water level data to the reference vertical datum. Calibration measurements were taken on four different dates (July 31 and August 10, 11, and 13, 2006) and the average of these calibration measurements was used to convert the data to reference 1929 NGVD.

Uncertainty associated with converting the data to the reference datum may be related to the following:

- Waves on the water surface can cause noise in the data downloaded by the pressure transducer;
- The distance between the survey marker and the water surface was measured with an electronic water level meter to an accuracy of 0.01 foot;
- The time that the distance from the survey marker to the water surface was measured and when the water level was recorded by the pressure transducer may have differed by as much as five minutes; or
- A slight disturbance of either the instrument or the water surface while field personnel checked on the instrumentation.

7.3.5 Instrument Downloads and Conversion

Using a laptop computer, data from the water level recorders were downloaded in the field without interrupting data collection. Data downloads were conducted on July 31 and August 4, 7, and 11, 2006. The instruments were also downloaded in the field on August 14, 2000, before the instruments were removed from the stilling wells. Once the data were downloaded, the average calibration measurement for each tidal monitoring station was applied to convert the data to reference 1929 NGVD.

7.3.6 Surveying of Transducer Locations ESM-1 and ESM-2

Surveys of both transducer locations within ESM (Figure 2) were completed by surveying the ground surface at the transducer location, the top of casing of each stilling well, and the 1-foot demarcation of each staff gauge. These survey data were incorporated into the existing grading plan that was completed based on survey work of the topography of the marsh plain and channels conducted at the Site following ESM remediation activities in early 2006. The survey was done based on the 1929 NGVD vertical datum. Topographic survey data were collected by PLS Surveys, a California-licensed surveyor.

8.0 HYDROLOGIC RESULTS AND ANALYSIS

This section describes the result of analysis of the water level data gathered from July 31 through August 13, 2006, as well as the hydrologic monitoring for Years 2, 3, 4, and 5. Figure 3 shows the tidal fluctuation at ESM-1 and ESM-2 plotted with the reference station data set during the monitoring period.

8.1 Site and Richmond NOS Station Time Series Data

Figure 3 displays a comparison of the recorded water level data at both tidal monitoring locations and data from NOS Station 941-4863 located on the Chevron Oil Pier in Richmond, California, during the monitoring period.

The Richmond reference station is approximately 1 mile from the Site. NOS have operated this station since 1979. Continuous (every six minutes) data are available for 1996 through the present and monthly tidal mean data since 1979. Data from the station are available over the internet (co-ops.nos.noaa.gov/data_options.shtml?stn=414863 +Richmond,+CA). The data collected at the Richmond NOS 9414863 are relative to 1988 NAVD. Therefore, the data were converted to NGVD (the datum used at the Site for topographic surveys) and are shown on Figure 3. As discussed in the June 18, 2009 letter to DTSC (Subject: Response to Comments from the DTSC Regarding the Results of the 2008 Pore Water and Sediment Sampling Analysis Report for the ESM), modifications to the 2006 Tidal Study were made to address a minor inaccuracy in the conversion from NAVD to NGVD. However, the conclusions of the 2006 Tidal Study have not changed; Figure 3 has been corrected in accordance with this modification.

Tidal dampening is the reduction in tidal water levels as distance from tidal source increases. In tidal marsh settings, the height of the tides can be reduced by friction through a combination of water traveling through channels and across open marsh surface. A simple visual analysis of the graphed data (Figure 3) reveals that there is slight water level height dampening in the marsh. The bottom of each tidal data curve for ESM-1 and ESM-2 becomes flat as the channel empties, and the transducer records no value. Therefore, the low tides shown in the reference data set do not have the same characteristics of the low-tide transducer curves at ESM-1 and ESM-2. The data also show time lags in the high-tide peaks observed at locations ESM-1 and ESM-2. The average time lags were approximately 43 to 45 minutes, respectively, behind the high tides at the Richmond reference station (9414863).

8.2 Monitored Extent and Duration of Tidal Inundation

The 2006 tidal study showed that the highest high tides almost completely inundate ESM, while lower high tides only inundate the marsh channels. Tidal fluctuations (e.g., low tide to low tide) occur approximately every 12 hours. The highest water elevation recorded in ESM during the 14-day tidal study was approximately 4.4 feet NGVD, which is approximately 3.5 feet above the lowest part of the marsh channel (LFR 2006a). During higher high tides, ESM is generally inundated while, during smaller high tides, only the channels are filled with water. Higher water surface elevations (>4.4 feet NGVD) will be experienced during larger tides and during winter storm surges.

During lower high tides, the water level in ESM rises to between 1.5 and 3 feet NGVD, equivalent to approximately 0.6 to 2.1 feet above the lowest part of the marsh channel. During low tides, water generally drains out of ESM and associated channels. The average elevation of water in ESM, calculated over the 14-day tidal period, was approximately 2.02 feet NGVD. Tidal influence in the marsh channel generally lags behind tides in San Francisco Bay by an average of approximately 43 to 45 minutes, as previously noted.

The cumulative percent of water level readings exceeding a given elevation was calculated, starting with zero percent for the highest water level and increasing in percent as water level decreases (i.e., the lower the elevation the greater amount of time of inundation). The results of this analysis illustrate the total duration of time that a given elevation was inundated during the period monitored. Duration of inundation is represented as a percent of the total time monitored over the tidal study. These tidal inundation durations represent slightly higher than average values because measurements were taken during a spring tide series (LFR 2006a).

The following table shows a simple interpretation of the duration of time that each type of tide (lowest, average, and highest) would have an effect of inundation of the marsh. These values may be used as a proxy to roughly estimate the total percentage of time that the marsh is inundated throughout the entire year.

	Feet NGVD	Duration (Minutes)	Percentage of Time
Low	≥ 0.969	20,160	100
	≥ 1.000	19,839	98.4
~Average	≥ 2.000	8,389	41.6
	≥ 3.000	4,137	20.5
High	≥ 4.000	653	3.2

8.3 Monitoring Tidal Inundation: Staff Gauge Readings at ESM-1, ESM-2, and ULSG

Table 2 provides the 2007, 2008, 2009, and 2010 staff gauge water level readings in feet and the associated water level elevations in feet NGVD at three staff gauges identified as ESM-1, ESM-2, and ULSG. The locations of the staff gauges are shown on Figure 2.

Staff gauge monitoring was normally conducted during approximate high tides, and supplemental staff gauge monitoring was conducted during approximate low tides. The times selected to observe the high and low tides were based on the tidal data for the Richmond reference station (414863).

In Year 2 the observed high tide elevations at ESM-1 ranged from 0.57 to 2.77 feet NGVD; in Year 3 the high tide elevations at ESM-1 ranged from 1.77 to 2.22 feet NGVD; in Year 4 the high tide elevations at ESM-1 ranged from 3.07 to 3.89 feet NGVD; in Year 5 the high tide elevations at ESM-1 ranged from 3.01 to 3.37 feet NGVD.

In Year 2 the observed high tide elevations at ESM-2 ranges from 1.05 to 3.45 feet NGVD; in Year 3 the high tide elevations at ESM-2 ranged from 2.65 to 4.11 feet NGVD; in Year 4 the high tide elevations at ESM-2 ranged from 3.05 to 3.39 feet NGVD; in Year 5 the high tide elevations at ESM-2 ranged from 3.19 to 3.81 feet NGVD.

The Year 2 staff gauge data at ULSG show a decreasing trend from 11.54 feet NGVD to less than 8.87 feet NGVD for the water level elevation in the upper freshwater lagoon during the overall monitoring period. In Year 3 the upper lagoon was dry during both monitoring events and therefore below 8.87 feet NGVD. The trend of decreasing water level elevations is expected since, during the summer, the impounded water evaporates. On July 31, 2007, it was observed that there was no standing water in the upper freshwater lagoon and the sediment accumulations reached the 0.3 foot mark on the staff gauge. This suggests that approximately 0.3 foot of sediment has accumulated since the ULSG staff gauge installation in 2006. Year 4 had more rainfall and the lagoon had water during all of the monitoring events. The surface-water elevations ranged from 9.67 to 11.65 feet NGVD. In Year 5 elevations ranged from 8.79 to 11.17 feet NGVD.

The observed high tide elevations at ESM-1 and ESM-2 fall in the upper range of water level elevations to be expected and are generally in the “Average” category of the table in Section 8.2. It is expected that for 20% of the time, the water level elevation reaches about 3 feet NGVD. It is also expected that during extreme high tides and storm surge events, the water level elevations reaches about 4 feet NGVD. These expectations are consistent with the defined marsh areas; the low salt marsh, the middle salt marsh, and part of the upper salt marsh are below 4 feet NGVD while the transitional salt marsh, coastal scrub, and part of the upper salt marsh are above 4 feet NGVD. The observed inundation levels support the development of the salt marsh and its species below 4 feet NGVD. There is a high likelihood that the species located in the transitional salt marsh will survive. The individual staff gauge readings confirm that the tidal wetland area is inundated during regular high tide events for Year 2 (2007), Year 3 (2008), Year 4 (2009), and Year 5 (2010).

9.0 CONCLUSION

9.1 Vegetation Monitoring

Throughout the fifth annual monitoring period, additional native wetland plant establishment and survival was observed in the tidally influenced restored portions of the HEA. The extent of native salt marsh vegetation, including pickleweed, salt grass, and cordgrass within the low, middle, and upper salt marsh areas, has steadily increased as shown on Figure 4. Monitoring results from 2010 show that a large portion of the restored tidal wetland areas either meet or exceed the 60% native vegetation cover performance criteria. However, some select areas in the low marsh zones surrounding the new channel maintain mud flat characteristics. It is assumed that these low marsh/mud flat areas will slowly re-vegetate after the substrate has stabilized and additional aggradation occurs, as is expected. In addition, a select area of middle salt marsh in the southeastern portion of the HEA remains partially vegetated due to excessively compacted soil conditions; however, additional colonization of salt marsh vegetation and soil tilling and replanting in this area has shown marked improvement throughout 2010.

Overall vegetation coverage in upslope and transitional upland areas along the ESM perimeter adjacent to the upper salt marsh has also shown a steady increase. However, the extent of native vegetation cover in the upland habitat zones varies depending on the specific location. In general, the restored native shrubs are successful within the coastal scrub zone; most of the grassland, particularly in central portions of the northern edge of the HEA and under the restored shrubs, supports a high percentage of natives. Portions of the upland transition, coastal scrub zone and along the levee near the Bay Trail exhibit select areas of plant mortality and presence of non-native weed species (basia, Russian thistle, and pepperweed) and ruderal grass species (ripgut brome, annual ryegrass, rabbits foot grass, and foxtail). These areas will continue to require ongoing maintenance/vegetation management activities, including re-seeding, replanting, herbicide application, and exotic vegetation removal.

Vegetative cover within the newly graded tidal wetland area was initially sparse (approximately 10%) two months after marsh remediation and backfill activities were completed (January 2006), in comparison to a cover of greater than 80% of native wetland vegetation observed in Spring 2004. Excessive herbivory by Canada geese and their young impeded the establishment of *Spartina foliosa* cordgrass plantings in the low marsh areas. In most planting zones, total vegetative cover steadily increased throughout 2006–2010 following initial planting; however, required plant cover criteria were not met in all zones as of August 2010.

Since March 2008, continued vegetation monitoring including the detailed quadrat monitoring (Table 1) indicates that the required plant cover criteria have been met in some areas but not in others. With respect to weed control, Pacific OpenSpace considers the herbicide treatment very effective on the whole for treatment of the main target exotic species (French broom, pampas grass, and fennel), but additional control for non-native grasses and pepperweed is recommended.

Vegetation monitoring has continued in the spring of each year through 2010. CRRMP performance criteria (see Appendix A) are met in most areas but have not been attained in every zone. Because the CRRMP vegetation performance criteria were not met in all areas through August 31, 2010, ongoing vegetation management is recommended for the Site and an additional year of monitoring is warranted. Based on current observed trends it is likely that the site vegetation performance criteria will be met within the near future.

9.2 Marsh Sediment Properties

9.2.1 Sediment Quality

Sediment quality was evaluated to determine whether remediation goals have been met and whether appropriate wetland characteristics to support wetland vegetation are present in ESM. The general nutrients (total nitrogen, nitrogen as nitrate, phosphorous, sulfate) results for the June 29, 2006 marsh sediment samples (SS-1 to SS-20) exhibited values that are lower than would be expected in a highly productive natural marsh; however, it is expected that nutrient levels in marsh sediments will increase over time as revegetation and associated accretion occur in the newly constructed marsh areas.

Similar to organic carbon, observed salinity, total alkalinity, and chloride levels in marsh sediment samples are also consistent with what would be expected in a typical salt marsh environment. Tidal channel sediment samples show elevated levels for these three parameters, as would be expected due to the effect of direct inflows of saline waters from San Francisco Bay.

The pH values measured in the marsh sediment samples (SS-1 to SS-20, which were collected on June 29 and 30, 2006, along with SS-21 and SS-22, which were collected on June 6, 2007) indicate that the majority of residual acidity has been removed from ESM. The grain-size distribution results are generally consistent with what would normally occur within a natural salt marsh environment. Please see Appendix C-1 for further discussion of 2006 sediment sampling results.

Sediment sampling for Year 2 involved sampling at two additional sediment sampling locations, SS-21 and SS-22. The results indicate that the arsenic, cadmium, copper, mercury, lead, zinc, and selenium concentrations for both sample locations are within the expected range for the remediated marsh conditions and below the calculated Site-Specific Target Levels for ESM provided in Appendix C-1. Results for 2007 are included in Appendix C-2. Sediment concentration trend data extrapolated from these results indicate stable or decreasing trends in concentration.

Sediment samples collected in 2010 (Table 4a and Table 4b), were compared to the previous sampling events. Samples were collected in the same locations (SS-1 through SS-22) in order to evaluate the longer-term trends in contaminant concentrations and marsh recovery parameters. In general, results show steady decreases in contaminant levels and with respect to sediment quality the marsh sediments are beginning to exhibit characteristics that more closely resemble reported ranges for natural marsh systems including marked increases in total organic carbon and nutrient composition.

9.2.2 Sedimentation Rates

Sediment accretion rates within the affected portions of ESM were monitored at four representative locations for Year 2, Year 3, Year 4, and Year 5; the results show minor sediment accumulation at the four monitoring stations in the marsh plain (0.3 to 3.8 inches). A Mann-Kendall trend analysis shows all four locations are aggrading (see Table 5). This is consistent with what would be expected within a natural marsh plain environment within the greater San Francisco Bay Area.

9.3 Surface-Water Quality

The 2009 surface-water sampling results indicated that the majority of pH values, metal concentrations, VOC concentrations, proprietary pesticide concentrations, and total suspended solid concentrations fall within normal and generally expected ranges. No VOCs or pesticides were detected above laboratory detection limits in any of the samples. Results for total metals showed the presence of arsenic, barium, copper, lead, thallium, and zinc. Other metals were not detected above laboratory detection limits.

2010 surface-water sampling results indicate that that the majority of pH values, metal concentrations, VOC concentrations, proprietary pesticide concentrations, and total suspended solid concentrations fall within normal and generally expected ranges. No VOCs or pesticides were detected above laboratory detection limits in any of the samples. Results for total metals showed the presence of arsenic, barium, copper, molybdenum, nickel, thallium and vanadium. Other metals were not detected above laboratory detection limits (see Tables 3a, 3b, and 3c). Relative to prior sampling events concentrations have decreased in SW-1 for lead. SW-2 exhibits decreased concentrations for arsenic, barium, lead and zinc. SW-3 has also shown decreases with respect to arsenic, barium, and lead levels. Minor increases were observed in SW-1 has for arsenic, barium, copper, thallium and vanadium levels. SW-2 and SW-3 levels increased with respect to copper, thallium and vanadium. Nickel and zinc remained below laboratory detection levels for all three sampling locations with SW-3 also having vanadium below detection limits.

9.4 Hydrologic Monitoring

Tidal study data for ESM-1 and ESM-2 show that channel segments and areas of ESM with marsh surface elevations below approximately 4.4 feet NGVD are inundated and/or saturated by tidal flows during high and high-high tides. In addition, areas above this elevation will be inundated during storm surge events. At low tides, approximately 0.25 foot of water will remain in the channel, and is reflected on the bottom of each tidal curve for ESM-1 and ESM-2 (Figure 3). Although water levels at

ESM-2 (located in the channel east of the inundated portion of the marsh) were recorded as low as 0.6 foot, water levels at ESM-1 (located in the channel within the central portion of the marsh) remain at approximately 1.0 to 1.25 feet during times between tides high enough to reach this area. The approximate tidal dampening observed during the 2006 monitoring period is shown on Figure 3. This is consistent with the intended design and the ESM tidal study conducted in 2000 (Appendix D).

The slow draining of ESM between tidal series that inundate the marsh plain indicates that the sediment in the ponded area of the marsh is of low enough permeability to retain water in the ponded area for one to two hours following high tides. This indicates that the majority of the water that reaches this area is moving over the marsh plain surface, as designed, and not through the sediments found below the marsh surface.

The wetland inundation performance criteria have been met, and the results of the tidal study suggested that inundation of ESM can be expected at least 15% of the growing season.

Based on the five years of hydrologic monitoring, it can be confirmed that the wetland hydrology performance criteria have been met because the newly graded wetland area experiences inundation or soil saturation up to the soil surface during regular high tide events.

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TABLES

Table 1
2010 Quadrat Monitoring Results
East Stege Marsh
Campus Bay, Richmond, California

Quadrat #	Habitat Zone	Transect and Distance	% Total Coverage	% per Species	Plant Height (inches)	Stem Density (stem/quadrat)
1	Coastal Scrub	Transect 1, 195'	60%	50% Grasses*	4	100
				5% *Brassica nigra*	3	10
				3% *Lythrum hyssopifolium*	6	14
				2% *Carduus phycnocephalus*	3	4
2	Transitional	Transect 1, 163'	75%	73% *Salicornia virginica*	5	50
				1% Grasses*	1	3
				1% *Atriplex triangularis*	2	2
3	Upper Marsh	Transect 1, 32'	55%	54% *Salicornia virginica*	9	35
				1% *Atriplex triangularis*	2	4
4	Coastal Scrub	Transect 2, 299'	80%	70% Grasses*	4	180
				7% *Carduus phycnocephalus*	9	10
				3% *Lythrum hyssopifolium*	6	12
5	Transitional	Transect 2, 284'	80%	50% *Lythrum hyssopifolium*	3	50
				23% Grasses*	5	80
				7% *Salicornia virginica*	7	12
6	Middle Marsh	Transect 2, 253'	98%	98% *Salicornia virginica*	10	100
7	Low Marsh	Transect 2, 197'	100%	95% *Salicornia virginica*	18	100
				5% *Jaumea carnosa*	10	12
8	Upper Marsh	Transect 3, 254'	100%	70% *Distichlis spirata*	10	800
				25% *Salicornia virginica*	14	30
				5% Grasses*	8	100
9	Middle Marsh	Transect 3, 201'	97%	50% *Salicornia virginica*	15	60
				47% *Jaumea carnosa*	4	30
10	Willow Scrub	Transect 4, 559'	100%	100% *Salix sp.*	140	1
11	Willow Scrub	Transect 4, 572'	100%	100% *Salix sp.*	160	1
12	Low Marsh	Transect 4, 91'	40%	37% *Jaumea carnosa*	4	30
				3% *Salicornia virginica*	7	15

Notes:
*Grasses include mixture of native and nonnative species:
Hordeum brachyantherum (native)
Elymus glaucus (native)
Bromus carinatus (native)
Bromus diandrus (nonnative)
Lolium multiflorum (nonnative)
Hordeum leporinum (nonnative)
Polypogon monspeliensis (nonnative)

Table 2 Staff Guage Levels

Date	Time	Staff Gauge Location	Water Level Reading from Staff Gauge (feet)	Elevation of Staff Guage	Corresponding Water Level Elevation (feet NGVD)	Station ID 9414863 (feet MLLW)
Year 2 Reporting Period						
3/2/2007	13:28	ESM-1	1.07	0.37	1.44	3.69
3/2/2007	13:50	ESM-2	1.20	0.65	1.85	3.15
3/2/2007	14:04	ULSG	2.97	8.57	11.54	2.80
3/6/2007	10:20	ESM-2	0.40	0.65	1.05	3.07
3/6/2007	11:17	ESM-1	0.96	0.37	1.33	3.98
3/6/2007	12:00	ULSG	2.84	8.57	11.41	4.50
4/25/2007	10:45	ULSG	1.89	8.57	10.46	1.47
6/4/2007	9:20	ULSG	0.80	8.57	9.37	-1.04
6/4/2007	9:40	ESM-1	0.20	0.37	0.57	-0.95
6/4/2007	9:55	ESM-2	0.90	0.65	1.55	-0.86
6/4/2007	16:35	ULSG	0.80	8.57	9.37	4.65
6/4/2007	16:40	ESM-1	1.80	0.37	2.17	4.65
6/4/2007	16:50	ESM-2	2.20	0.65	2.85	4.65
7/31/2007	14:50	ULSG	< 0.30	8.57	< 8.87	5.37
7/31/2007	14:55	ESM-1	2.40	0.37	2.77	5.36
7/31/2007	15:05	ESM-2	2.80	0.65	3.45	5.33
Year 3 Reporting Period						
6/3/2008	14:22	ESM-2	2.20	0.65	2.85	4.64
6/3/2008	14:27	ESM-1	1.85	0.37	2.22	4.60
6/3/2008	14:30	ULSG	< 0.30	8.57	< 8.87	4.55
7/29/2008	12:20	ESM-1	1.40	0.37	1.77	4.60
7/29/2008	12:28	ESM-2	2.00	0.65	2.65	4.64
7/29/2008	12:36	ULSG	< 0.30	8.57	< 8.87	4.55
Year 4 Reproting Period						
11/12/2008	10:06	ESM-1	3.46	0.37	3.83	7.00
11/12/2008	9:58	ESM-2	3.46	0.65	4.11	7.00
11/12/2008	10:10	ULSG	2.14	8.57	10.71	7.00
2/19/2009	8:12	ESM-1	2.70	0.37	3.07	5.38
2/19/2009	8:06	ESM-2	2.74	0.65	3.39	5.38
2/19/2009	8:16	ULSG	3.08	8.57	11.65	5.35
5/26/2009	15:54	ESM-1	3.52	0.37	3.89	5.00
5/26/2009	16:00	ESM-2	2.40	0.65	3.05	5.00
5/26/2009	15:48	ULSG	1.10	8.57	9.67	5.01
Year 5 Reporting Period						
9/24/2009	17:00	ESM-1	3.00	0.37	3.37	5.72
9/24/2009	17:06	ESM-2	3.16	0.65	3.81	5.67
9/24/2009	16:55	ULSG	0.22	8.57	8.79	5.73
3/12/2010	9:53	ESM-1	2.72	0.37	3.09	5.56
3/12/2010	9:49	ESM-2	2.72	0.65	3.37	5.58
3/12/2010	9:58	ULSG	2.60	8.57	11.17	5.54
6/16/2010	17:22	ESM-1	2.64	0.37	3.01	5.22
6/16/2010	17:26	ESM-2	2.54	0.65	3.19	5.22
6/16/2010	17:19	ULSG	2.44	8.57	11.01	5.26

Table 3a
2010 Surface Water Monitoring Results
Volatile Organic Compounds
East Stege Marsh
Campus Bay Site - Richmond, California

Sample Location	Sample ID	Sample Type	Sample Date	Freon 12	Chloromethane	Vinyl Chloride	Bromoethane	Chloroethane	Trichlorofluromethane	Acetone	Freon 113	1,1-Dichloroethene	Methylene Chloride	Carbon Disulfide	MTBE	trans-1,2-Dichloroehene	Vinyl Acetate	1,1-Dichloroethane	2-Butanone	cis-1,2-Dichloroethene	2,2-Dichloropropane	Chloroform	Bromochloromethane	1,1,1-Trichloroethane	1,2-Dichloropropene	Carbon Tetrachloride	1,2-Dichloroethane	Benzene	Trichloroethene	1,2-Dichloropropane	Bromodichloromethane	Dibromomethane	4-Methyl-2Pentanone	cis-1,3-Dichloropropene	toluene
SW-1	SW-1	Primary	6/15/2010	< 1.0	< 1.0	< 0.5	< 1.0	< 1.0	< 1.0	< 10	<5.0	< 0.5	< 5.0	< 0.5	< 0.5	< 0.5	< 10	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
SW-2	SW-2	Primary	6/15/2010	< 1.0	< 1.0	< 0.5	< 1.0	< 1.0	< 1.0	< 10	<5.0	< 0.5	< 5.0	< 0.5	< 0.5	< 0.5	< 10	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
SW-3	SW-3	Primary	6/15/2010	< 1.0	< 1.0	< 0.5	< 1.0	< 1.0	< 1.0	< 10	<5.0	< 0.5	< 5.0	< 0.5	< 0.5	< 0.5	< 10	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

All results in micrograms per liter (µg/L)

Table 3a
2010 Surface Water Monitoring Results
Volatile Organic Compounds
East Stege Marsh
Campus Bay Site - Richmond, California

Sample Location	Sample ID	Sample Type	Sample Date	trans-1,3-Dichloropropene	1,1,2-Trichloroethane	2-Hexanone	1,3-Dichloropropane	Tetrachloroethane	Dibromochloromethane	1,2-Dibromoethane	Chlorobenzene	1,1,1,2-Tetrachloroethane	Ethylbenzene	m,p-Xylenes	o-Xylene	Styrene	Bromoform	Isopropylbenzene	1,1,2,2,-Tetrachloroethane	1,2,3-Trichloropropane	propylbenzene	Bromobenzene	1,3,5-Trimethylbenzene	sec-Butylbenzene	para-Isopropyl Toluene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	n-Butylbenzene	1,2-Dichlorobenzene	1,2-Dipromo-3-Chloropropane	1,2,4-Trichlorobenzene	Hexachlorobutadine	Napthalene	1,2,3-Trichlorobenzene
SW-1	SW-1	Primary	6/15/2010	< 0.5	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 2.0	< 2.0	< 0.5
SW-2	SW-2	Primary	6/15/2010	< 0.5	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 2.0	< 2.0	< 0.5
SW-3	SW-3	Primary	6/15/2010	< 0.5	< 0.5	< 10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.0	< 0.5	< 2.0	< 2.0	< 0.5

All results in micrograms per liter (µg/L)

Table 3b
2010 Surface Water Monitoring Results
Pesticides
East Stege Marsh
Campus Bay Site - Richmond, California

Sample Location	Sample ID	Sample Type	Sample Date	EPTC	Butylate	Venolate	Pebulate	Molinate	Cycloate	Napropamide
SW-1	SW-1	Primary	6/15/2010	< 5.0	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
SW-2	SW-2	Primary	6/15/2010	< 5.0	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5
SW-3	SW-3	Primary	6/15/2010	< 5.0	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5

All results in micrograms per liter (µg/L)

Table 3c
2010 Surface Water Monitoring Results
Title 22 Metals
East Stege Marsh
Campus Bay Site - Richmond, California

Sample Location	Sample ID	Sample Type	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
SW-1	SW-1	Total	6/15/2010	< 10	22	41	< 2.0	< 5.0	<5.0	<5.0	**26**	<5.0	< 0.20	< 5.0	< 5.0	< 10	< 5.0	17	5.1	< 20
	SW-1	Filtrate	6/15/2010	< 10	12	40	< 2.0	< 5.0	<5.0	<5.0	**26**	<5.0	< 0.20	6.5	5.2	< 10	< 5.0	24	<5.0	< 20
SW-2	SW-2	Total	6/15/2010	<10	21	25	< 2.0	< 5.0	< 5.0	< 5.0	**23**	< 5.0	< 0.20	< 5.0	< 5.0	23	< 5.0	24	5.2	<20
	SW-2	Filtrate	6/15/2010	<10	10	24	< 2.0	< 5.0	< 5.0	< 5.0	**23**	< 5.0	< 0.20	5.4	< 5.0	<10	< 5.0	25	<5.0	<20
SW-3	SW-3	Total	6/15/2010	< 10	14	17	< 2.0	< 5.0	< 5.0	< 5.0	**23**	< 5.0	< 0.20	< 5.0	< 5.0	< 10	< 5.0	18	< 5.0	< 20
	SW-3	Filtrate	6/15/2010	< 10	<5.0	16	< 2.0	< 5.0	< 5.0	< 5.0	**21**	< 5.0	< 0.20	5.9	< 5.0	< 10	< 5.0	24	< 5.0	< 20
National Ambient Water Quality Criteria					**36**			**8.8**	**50**		**3.1**	**8.1**	**0.94**		**8.2**	**71**				**81**

Bold values above NAWQ
NAWQ Criteria for saltwater and chronic exposure
All results in micrograms per liter (µg/L)

Table 4a Sediment Quality

Location	Sample Name	Date	Matrix	Alkalinity, Bicarbonate	Alkalinity, Carbonate	Alkalinity, Hydroxide	Alkalinity, Total as $CaCO_3$	Nitrogen, Nitrate	pH	Salinity	Sulfate	Total Kjeldahl Nitrogen	Total Organic Carbon	Mean Grain Size (Description)	Median Grainsize (mm)
SS-1	SS-1	6/15/2010	Soil	4,200	<50	<50	4,200	0.6	7.7	4.8	4,400	780	0.48	Fine Sand	0.034
SS-2	SS-2	6/15/2010	Soil						7.8						
SS-3	SS-3	6/15/2010	Soil	2,100	<50	<50	2,100	<0.5	7.1	3	670	1100	0.55	Silt	0.023
SS-4	SS-4	6/15/2010	Soil	3,500	720	<50	4,200	<0.5	7.4	3.4	810	760	0.80	Silt	0.013
SS-5	SS-5	6/15/2010	Soil						7.0						
SS-6	SS-6	6/15/2010	Soil	1,800	<50	<50	1,800	<0.5	7.3	2.6	1,100	910	0.32	Silt	0.019
SS-7	SS-7	6/15/2010	Soil						5.0						
SS-8	SS-8	6/15/2010	Soil						7.2						
SS-9	SS-9	6/15/2010	Soil						7.2						
SS-10	SS-10	6/15/2010	Soil						6.4						
SS-11	SS-11	6/15/2010	Soil						6.6						
SS-12	SS-12	6/15/2010	Soil						6.3						
SS-13	SS-13	6/15/2010	Soil						6.2						
SS-14	SS-14	6/15/2010	Soil						6.4						
SS-15	SS-15	6/15/2010	Soil						7.2						
SS-16	SS-16	6/15/2010	Soil						6.2						
SS-17	SS-17	6/15/2010	Soil						6.8						
SS-18	SS-18	6/15/2010	Soil						6.5						
SS-19	SS-19	6/15/2010	Soil						7.2						
SS-20	SS-20	6/15/2010	Soil						7.3						
SS-21	SS-21	6/15/2010	Soil						7.3						
SS-22	SS-22	6/15/2010	Soil						6.3						
Max				4200.0	720.0	0.0	4200.0	0.6	7.8	4.8	4400.0		0.8		0.034
Min				1800.0	720.0	0.0	1800.0	0.6	5.0	2.6	670.0		0.3		0.013
TYPICAL[1] RANGE								$10 - 1.4x10^4$		$1.6x10^4 - 6x10^4$	$2x10^3 - 12.9x10^3$	$4x10^5 - 5.3x10^6$	0.2 – 7.7		

Notes:

[1] Reported data range summaries for North American wetland sediments derived from the following sources: Stolt et al., 2001; Kennedy and Murphy, 2004; Childers et al., 2003; and Dunne et al., 1998 (see list of references In Appendix C-1 for full citations).

Table 4b Metals

Location	Sample Name	Date	Matrix	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Vanadium	Zinc
SS-1	SS-1	6/15/2010	Soil	4.2	54	0.28	<0.25	21	14.0	36	11	4.5	<0.25	28	**3.8**	82	68
SS-3	SS-3	6/15/2010	Soil	6.5	78	0.37	<0.25	25	7.1	17	17	0.23	0.48	28	2.3	29	59
SS-4	SS-4	6/15/2010	Soil	8.0	60	0.29	<0.25	27	6.5	22	17	0.22	0.65	29	2.0	29	66
SS-6	SS-6	6/15/2010	Soil	5.1	87	0.35	<0.25	13	4.3	7	19	0.058	0.91	17	1.6	15	33
SS-2	SS-2	6/15/2010	Soil	9.3	97	0.38	<0.25	30	8.6	22	18	0.19	0.91	34	**3.0**	34	63
SS-5	SS-5	6/15/2010	Soil	8.8	60	0.34	0.30	25	7.4	24	22	0.37	2.30	30	2.0	26	81
SS-7	SS-7	6/15/2010	Soil	21	24	0.26	<0.25	37	6.7	64	32	0.82	3.10	35	**3.2**	33	170
SS-8	SS-8	6/15/2010	Soil	21	26	0.28	0.34	38	6.7	65	32	0.7	2.60	37	**3.2**	33	170
SS-9	SS-9	6/15/2010	Soil	8.7	120	0.40	<0.25	23	7.0	37	28	0.076	0.73	27	**2.4**	24	71
SS-10	SS-10	6/15/2010	Soil	33	24	0.25	0.29	40	5.4	54	28	0.63	3.00	36	<0.5	32	160
SS-11	SS-11	6/15/2010	Soil	24	20	0.27	<0.25	37	4.9	38	33	0.43	1.30	34	**3.0**	33	90
SS-12	SS-12	6/15/2010	Soil	7.1	16	0.23	<0.25	32	4.0	20	20	0.27	1.50	30	1.6	27	65
SS-13	SS-13	6/15/2010	Soil	6.1	14	0.20	<0.25	28	3.5	20	20	0.19	1.30	27	1.3	23	48
SS-14	SS-14	6/15/2010	Soil	25	29	0.31	<0.25	42	7.0	100	45	0.94	1.40	39	<0.5	35	210
SS-15	SS-15	6/15/2010	Soil	26	34	0.29	<0.25	35	7.4	46	32	0.61	1.30	36	**3.7**	29	170
SS-16	SS-16	6/15/2010	Soil	8.6	19	0.25	<0.25	34	4.5	26	25	0.35	1.10	32	2.0	28	70
SS-17	SS-17	6/15/2010	Soil	13	30	0.29	<0.25	41	6.8	47	32	0.61	1.00	39	**2.9**	33	130
SS-18	SS-18	6/15/2010	Soil	8.5	26	0.30	<0.25	45	7.0	32	35	0.5	0.91	45	**2.6**	31	120
SS-19	SS-19	6/15/2010	Soil	15	42	0.29	<0.25	31	5.4	40	20	0.36	0.87	32	<0.5	25	130
SS-20	SS-20	6/15/2010	Soil	21	100	0.39	<0.25	23	7.0	18	12	0.12	0.76	23	2.0	38	60
SS-21	SS-21	6/15/2010	Soil	55	70	0.23	0.88	31	6.2	190	49	0.72	1.60	28	**3.7**	30	320
SS-22	SS-22	6/15/2010	Soil	18	26	0.32	<0.25	42	7.2	62	33	0.58	1.10	39	**2.5**	36	130
Max				55.0	120.0	0.4	0.9	45.0	14.0	190.0	49.0	4.5	3.1	45.0	3.8	82.0	320.0
Min				4.2	14.0	0.2	0.3	13.0	3.5	7.0	11.0	0.1	0.5	17.0	1.3	15.0	33.0
ORIGINAL CONDITIONS[1]		Mean Conc.	mg/kg	16.04			0.45			44.86	26.05	0.61			2.6		117.91
		RME Conc.	mg/kg	261			8			681	160	5.6			14		1995
EXPECTED CONDITIONS[1]		Mean Conc.	mg/kg	49.2			1.2			141	69.2	1.1			1.6		363
		RME Conc.	mg/kg	55			1.4			152	75	1.3			1.8		432
POST-REMEDIATION CONDITIONS[2]		Mean Conc.	mg/kg	36.6			0.9			138	72.7	1.1			1.7		291
		RME Conc.	mg/kg	61.3			1.1			212	112	1.8			2.7		417
SITE SPECIFIC TARGET	Human	Human	mg/kg	110			NC			NC	NC	NC			NC		NC
	Ecological	Marsh Plain	mg/kg	246			2.29			2104	157	7			2.3		3,953
		Channel	mg/kg	246			17.3			2104	157	7			2.3		3,953

Notes:
NC = Not Calculated; mg/kg = milligram/kilogram; Conc. = Concentration;
[1] Derived from data presented to and approved by the RWQCB in May 2003 submittal for Remedial Alternative RA-4a (modified) (LFR 2003)
[2] Reasonable Maximum Exposure concentrations are calculated as the 95% Upper Confidence Limit on the mean as calculated by PRO-UCL (EPA 2002); non-detection were given the value of their detection limit to most closely mimic the values used in the original calculations. Output from PRO-UCL is attached.
[3]Site Specific Target Levels are specific to human health or ecological health; ecological site specific target levels are specific to the habitat type (channels or marsh plain) and are the lower of the values calculated for the Salt Marsh Harvest Mouse and California Clapper Rail considering bioavailability if it was calculated in the Human and Ecological Risk Assessment (LFR 2002).

Do we change this reference because I put in new data or is it talking about the RME?

Italic Values are above SST Human Values
Bold Values are above SST Ecological Marsh Plane Values
Shaded Values are above SST Ecological Channel Values

Table 5 Mann-Kendall Analysis

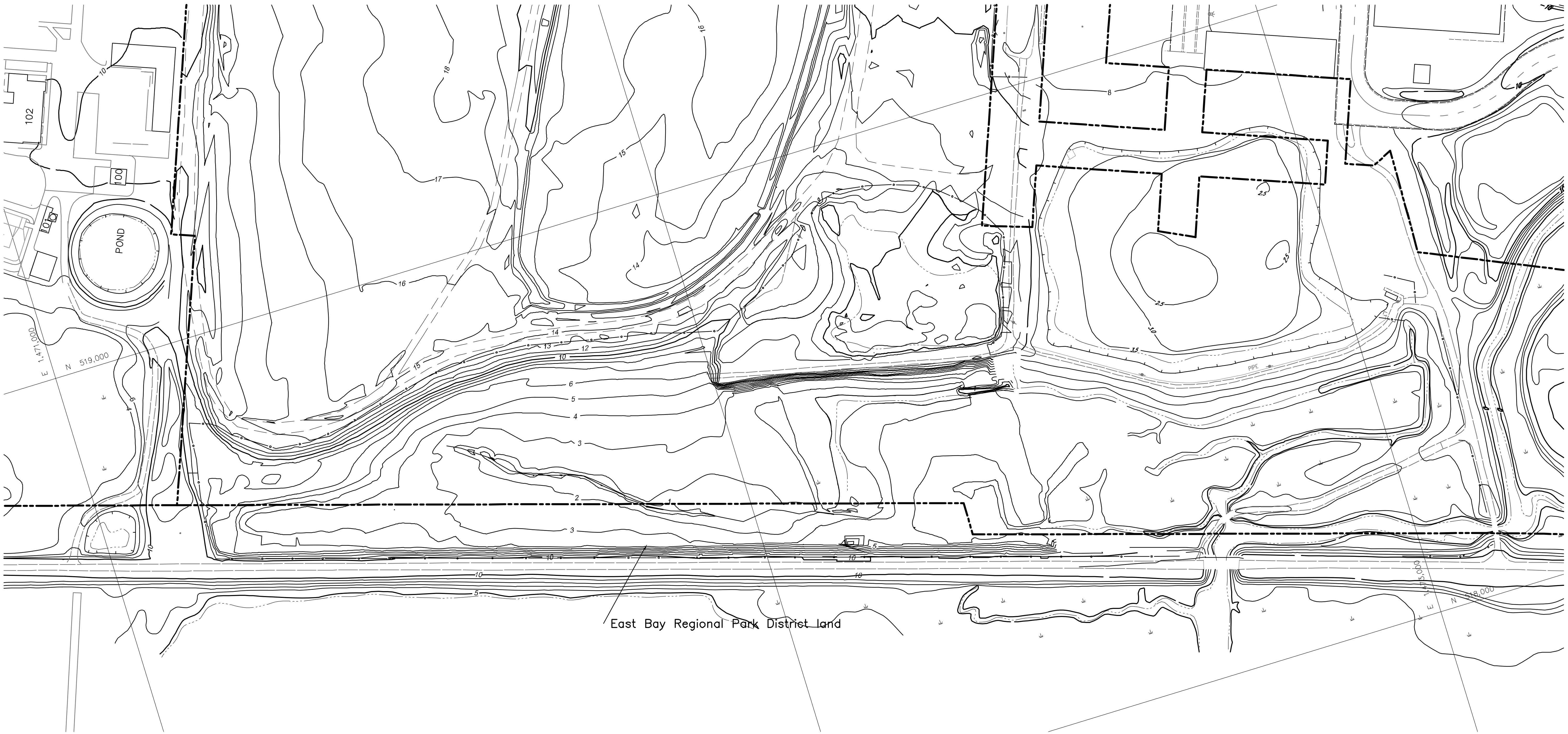
Monitoring Well	Sample Date	Accretion (inches)	Mann-Kendall Test Matrix for SG-1									Number of Positive Signs	Number of Negative Signs	Sum of Signs
SA-1	4/25/2007	32.88												
	6/4/2007	32.50	-0.38	-1.88	-0.24	-2.38	-2.98	-3.58	-4.38	-6.88	-7.38	0	-9	-9
	6/3/2008	31.00		-1.50	0.14	-2.00	-2.60	-3.20	-4.00	-6.50	-7.00	1	-7	-6
	7/29/2008	32.64			1.64	-0.50	-1.10	-1.70	-2.50	-5.00	-5.50	1	-6	-5
	11/12/2008	30.50				-2.14	-2.74	-3.34	-4.14	-6.64	-7.14	0	-6	-6
	2/19/2009	29.90					-0.60	-1.20	-2.00	-4.50	-5.00	0	-5	-5
	5/26/2009	29.30						-0.60	-1.40	-3.90	-4.40	0	-4	-4
	9/24/2009	28.50							-0.80	-3.30	-3.80	0	-3	-3
	3/12/2010	26.00								-2.50	-3.00	0	-2	-2
	6/16/2010	25.50									-0.50	0	-1	-1
	n =9													
													Mann-Kendall Statistic (S)	-41

Monitoring Well	Sample Date	Accretion (inches)	Mann-Kendall Test Matrix for SG-2									Number of Positive Signs	Number of Negative Signs	Sum of Signs
SA-2	4/25/2007	41.75												
	6/4/2007	41.75	0.00	-1.15	0.25	-1.25	-2.05	-1.75	-2.75	-4.75	-3.75	2	-7	-5
	6/3/2008	40.60		-1.15	0.25	-1.25	-2.05	-1.75	-2.75	-4.75	-3.75	1	-7	-6
	7/29/2008	42.00			1.40	-0.10	-0.90	-0.60	-1.60	-3.60	-2.60	1	-6	-5
	11/12/2008	40.50				-1.50	-2.30	-2.00	-3.00	-5.00	-4.00	0	-6	-6
	2/19/2009	39.70					-0.80	-0.50	-1.50	-3.50	-2.50	0	-5	-5
	5/26/2009	40.00						0.30	-0.70	-2.70	-1.70	1	-4	-3
	9/24/2009	39.00							-1.00	-3.00	-2.00	0	-3	-3
	3/12/2010	37.00								-2.00	-1.00	0	-2	-2
	6/16/2010	38.00									1.00	1	0	1
	n =9													
													Mann-Kendall Statistic (S)	-34

Monitoring Well	Sample Date	Accretion (inches)	Mann-Kendall Test Matrix for SG-3									Number of Positive Signs	Number of Negative Signs	Sum of Signs
	4/25/2007													
SA-3	6/4/2007	39.00												
	6/3/2008	37.40		-1.60	-1.20	-2.00	-1.60	-2.00	-2.00	-2.00	-2.00	0	-8	-8
	7/29/2008	37.80			0.40	-0.40	0.00	-0.40	-0.40	-0.40	-0.40	1	-5	-4
	11/12/2008	37.00				-0.80	-0.40	-0.80	-0.80	-0.80	-0.80	0	-6	-6
	2/19/2009	37.40					0.40	0.00	0.00	0.00	0.00	1	0	1
	5/26/2009	37.00						-0.40	-0.40	-0.40	-0.40	0	-4	-4
	9/24/2009	37.00							0.00	0.00	0.00		0	0
	3/12/2010	37.00								0.00	0.00		0	0
	6/16/2010	37.00									0.00		0	0
	n =8													
													Mann-Kendall Statistic (S)	-21

Monitoring Well	Sample Date	Accretion (inches)	Mann-Kendall Test Matrix for SG-4									Number of Positive Signs	Number of Negative Signs	Sum of Signs
SA-4	4/25/2007	37.81												
	6/4/2007	38.00	0.19	-0.31	-0.01	-0.31	-0.31	-0.51	-0.81	-0.81	-0.81	1	-6	-5
	6/3/2008	37.50		-0.50	-0.20	-0.50	-0.50	-0.70	-1.00	-1.00	-1.00	0	-6	-6
	7/29/2008	37.80			0.30	0.00	0.00	-0.20	-0.50	-0.50	-0.50	1	-4	-3
	11/12/2008	37.50				-0.30	-0.30	-0.50	-0.80	-0.80	-0.80	0	-6	-6
	2/19/2009	37.50					0.00	-0.20	-0.50	-0.50	-0.50	1	-4	-3
	5/26/2009	37.30						-0.20	-0.50	-0.50	-0.50	0	-4	-4
	9/24/2009	37.00							-0.30	-0.30	-0.30	0	-3	-3
	3/12/2010	37.00								0.00	0.00		0	0
	6/16/2010	37.00									0.00			0
														0
	n =9													
													Mann-Kendall Statistic (S)	-30

FIGURES



EXPLANATION:

- Site topography
- Project boundary
- HEA boundary
- Property boundary
- Planting area

0 160'

Scale: 1" = 160 Feet

CAMPUS BAY, RICHMOND, CALIFORNIA

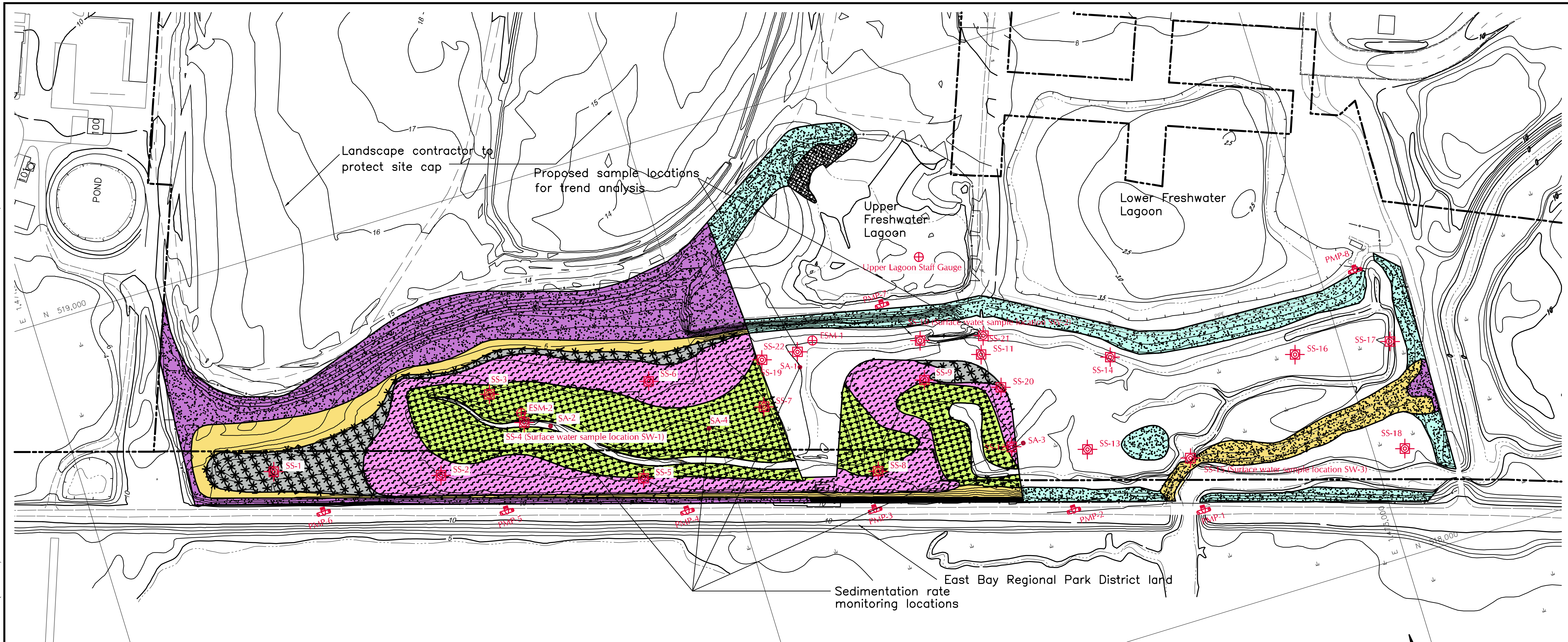
AS-BUILT SITE TOPOGRAPHY

ARCADIS

FIGURE

1

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
I:\Design\001\09359\28\Grading plan As Built-rev.dwg LAYOUT: 1 SAVED: 8/18/2010 9:03 AM ACADVER: 17.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: STANDARD.CTB PLOTTED: 8/18/2010 10:32 AM BY: BEARDSLEY, DANIEL
XREFS: IMAGES: PROJECTNAME: 07545
Site update 12-20-06 a-marsh-aerial for BA.TIF



EXPLANATION:

ESM-2	Staff gauge
PMP-7	Photo monitoring point
SS-14	Sediment quality monitoring location
SA-2	Sedimentation rate monitoring location

PLANTED AREA (ACRES)	HABITAT ZONE
(2.2)	Low salt marsh
(2.0)	Middle salt marsh
(0.7)	Upper salt marsh
(1.2)	Transitional salt marsh
(2.2)	Coastal scrub
(3.8)	Herbaceous ground cover seeding area
(0.1)	Willow scrub
(1.5)	Exotic vegetation removal

Site topography prior to HEA remediation
Project boundary
HEA boundary
Property boundary

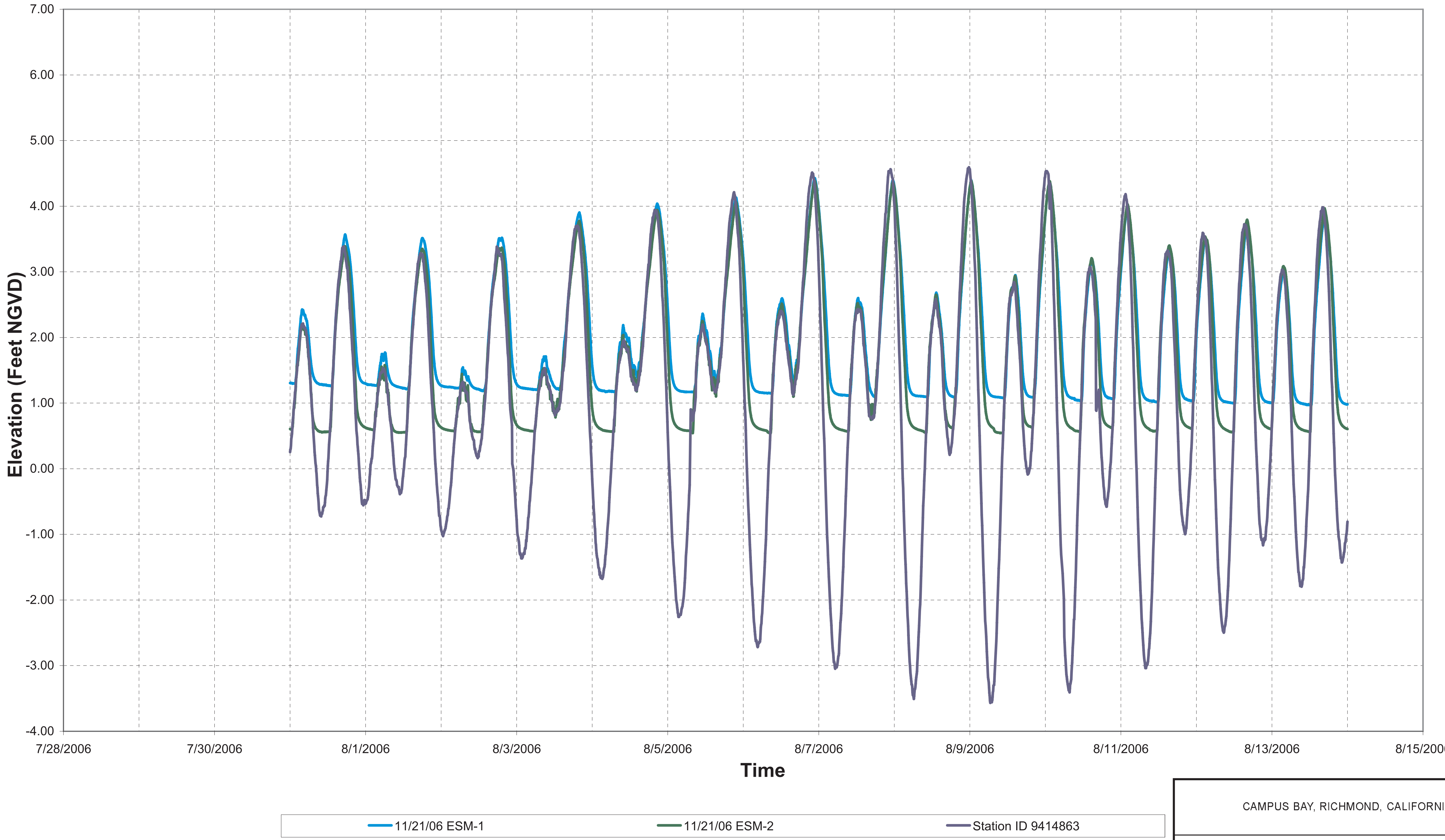
0 160'
Scale: 1" = 160 Feet

CAMPUS BAY, RICHMOND, CALIFORNIA

MONITORING LOCATIONS AND PLANTED HABITAT ZONES

ARCADIS

FIGURE
2



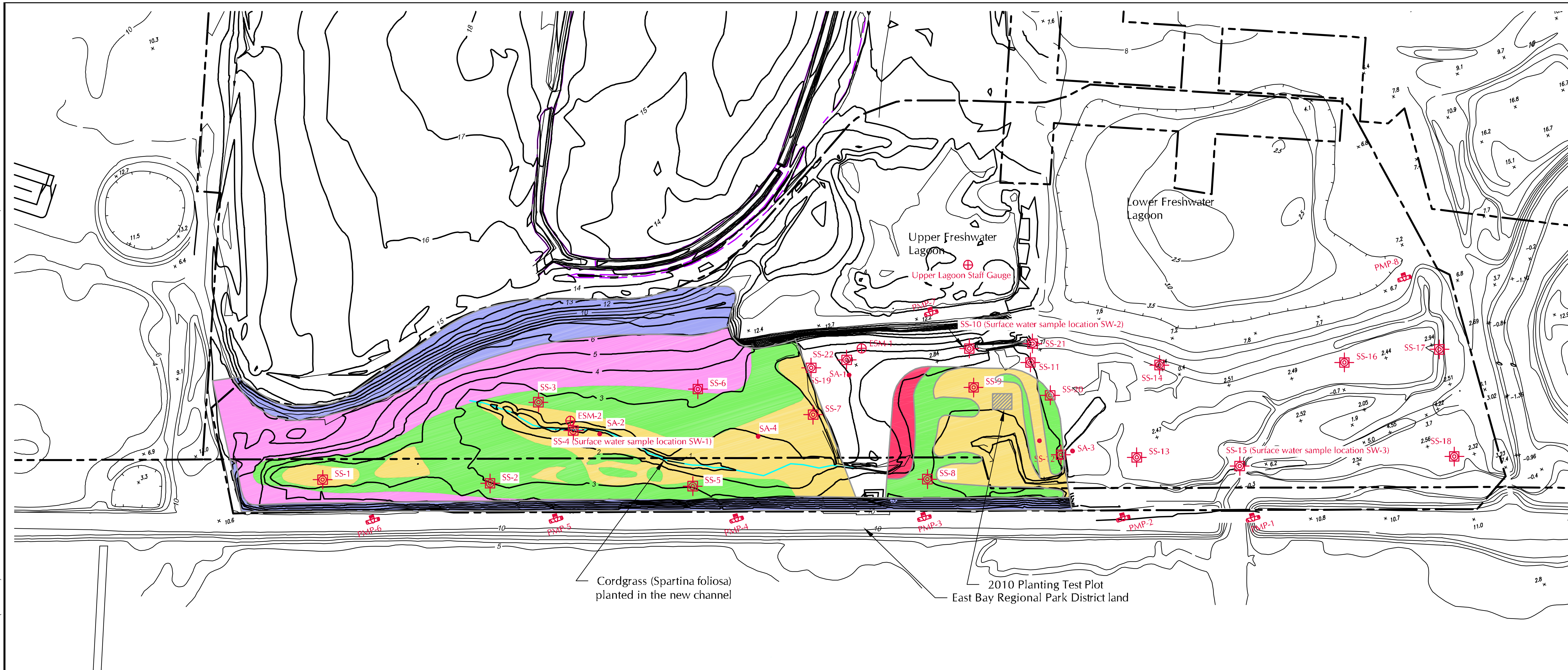
DESIGN\001\001\09359\28\Monitored Tidal Fluctuation July August 2006.cdr

CAMPUS BAY, RICHMOND, CALIFORNIA

MONITORING TIDAL/FLUCTUATION AT EAST STEGE MARSH JULY 31 THROUGH AUGUST 13, 2006

ARCADIS

FIGURE
3



EXPLANATION:

0-20% Vegetative cover; pickleweed (Salicornia virginica), cordgrass (Spartina foliosa) and salt grass (Distichlis spicata)

30-60% Vegetative cover; predominently pickleweed (Salicornia virginica) and salt grass (Distichlis spicata)

60-80% Vegetative cover; pickleweed (Salicornia virginica) and herbaceous transition ground cover species

60-85% Vegetative cover; coastal scrub and grass species

70-90% Vegetative cover; predominantly cordgrass (Spartina foliosa)

ESM-2 Staff gauge

PMP-7 Photo monitoring point

SS-14 Sediment quality monitoring location

SA-2 Sedimentation rate monitoring location

HEA boundary

Property boundary

0 160'

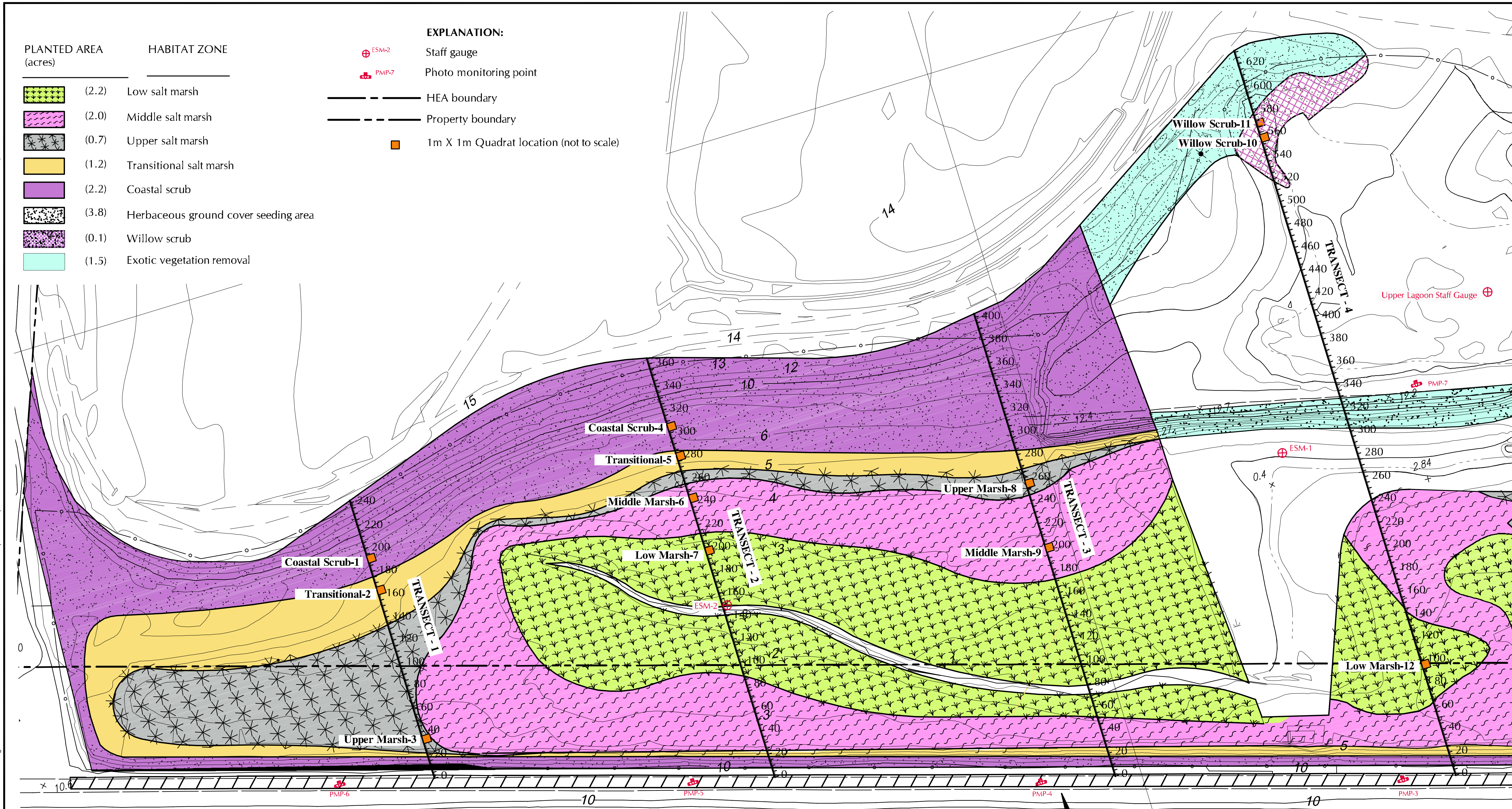
Scale: 1" = 160 Feet

CAMPUS BAY, RICHMOND, CALIFORNIA

VEGETATIVE COVER MAP

ARCADIS

FIGURE 4



CAMPUS BAY, RICHMOND, CALIFORNIA

QUADRAT LOCATIONS AND ASSOCIATED HABITAT ZONES

ARCADIS

FIGURE 5