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PACHECO MARSH RESTORATION PLAN

FINAL REPORT

Prepared for

The Muir Heritage Land Trust
and
Contra Costa County

Prepared by

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with
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1. INTRODUCTION

1.1 BACKGROUND

A Project Team consisting of the Contra Costa County Flood Control District (District), the Muir Heritage Land Trust (MHLT), and the East Bay Regional Park District (EBRPD) propose to restore wetland functions and wildlife habitat at the 126-acre Pacheco Marsh property, located east of Martinez, California (see Figure 1). This report summarizes the existing wetland habitat values at Pacheco Marsh and describes a plan for tidal wetland restoration at the site. Findings from this report will support environmental permitting and development final design documents.

Over the past fifty years, construction of levees along the perimeter of the site has eliminated regular tidal inundation and placement of dredge spoils has substantially raised ground elevations. These changes have significantly diminished tidal wetland functions at Pacheco Marsh. Currently, Hanson Aggregate uses 20 acres at the northern end of the leveed site as a sand yard, and the Central Contra Costa Sanitary District (CCCSD) operates a sewer outfall that crosses the property.

The District acquired the property in 2002, with the assistance of the MHLT and the EBRPD. As stated in the Memorandum of Understanding (MOU) between these agencies, the main goal of the acquisition is to restore wetland and wildlife habitat while accommodating the existing uses at the site and planning for future public recreation projects. To further the goals of the MOU, the MHLT contracted Philip Williams & Associates (PWA) to develop a restoration plan for Pacheco Marsh.

1.2 PURPOSE, SCOPE, AND REPORT ORGANIZATION

The purpose of this study was to develop a feasible restoration plan that met the restoration goals of the project, and to describe the proposed action in sufficient detail to support environmental permitting. This included a delineation of the existing on-site wetland habitats.

PWA and H.T. Harvey & Associates (HTH) developed and evaluated various restoration alternatives at a conceptual level before a preferred alternative was selected, with the assistance of the Technical Advisory Committee (TAC). We refined and evaluated the preferred alternative using a hydrodynamic model of the site, geomorphic principles, and the expected biologic response following tidal restoration.

District staff assisted in the development of the restoration plan by collecting survey data and constructing a topographic model of the project area. Additionally, the District supplied a site characterization report that contained information on soil contamination. No additional soil quality characterization or assessment was carried out by PWA or HTH for the purposes of the present study.

Conclusions and recommendations are summarized in Section 2. Section 3 describes the physical and ecologic setting of the project site. Section 4 summarizes the goals and objectives of the proposed restoration. Opportunities and constraints are listed in Section 5, and were used to develop the restoration alternatives described in Section 6. Section 7 includes a detailed description of the restoration plan for the preferred alternative. Details of the hydrodynamic analysis and delineation of the existing on-site wetland functions are provided in the appendices.

2. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- Existing site topography, multiple land uses, and jurisdictional wetland areas are constraints to tidal marsh restoration. The proposed restoration plan provides for significant ecological enhancement within these project constraints by creating a mosaic of tidal marsh, transitional, and upland habitats throughout the site.

- Marshplain excavation volumes are likely to drive construction costs. Therefore, the proposed plan limits grading to areas easily restored to tidal inundation and does not include any earthwork in areas where existing ground elevations are already suitable for high marsh habitat. The proposed plan will restore 69 acres of high-quality tidal marsh habitat.

- Restoration alternatives with intensive long-term maintenance requirements were rejected in favor of self-sustaining tidal wetland systems. Although managed systems were rejected due to the associated long-term commitment of resources, natural tidal systems are considered biologically superior because of their greater degree of habitat connectivity with the adjacent marshes.

- Costly off-site disposal of excavated material can be avoided by placing sediment in areas not restored to tidal marsh. Assuming a maximum on-site elevation of +13 ft NGVD, the proposed plan includes placement of approximately 330,000 cubic yards (CY) over 42 acres of upland habitat.

- The proposed excavation will impact some potential existing jurisdictional wetlands, but will result in a significant overall increase in wetland acreage and habitat value. The excavation will replace about 7.5 acres of existing jurisdictional wetlands with upland and transitional habitat through on-site placement of material. However, over 44 acres of jurisdictional wetlands will be significantly enhanced over the long-term by restoring regular tidal inundation through levee breaching and marshplain excavation.

- Characterization of the existing soil quality indicates that selenium and mercury concentrations exceed wetland cover standards set by the Regional Water Quality Control Board at some locations. Although the precise impacts to the grading plan are unknown since the soil analysis did not describe the spatial variability or depth of metal concentrations, the quality of on-site soils may affect the proposed extent of marshplain excavation.

- Tide range in the southwestern portion of the site following restoration will be significantly reduced (damped) unless the existing culvert is replaced with an appropriately sized structure and

the upstream reach of the inlet channel is excavated. Numerical modeling indicates that four 48-inch culverts are needed to convey the full tide range under the solid-fill causeway to the west. Even with these elements included in the restoration plan, we expect some tidal muting over the short-term as the downstream reach of the under-sized inlet adjusts to the additional tidal prism.

- Because of the need for the CCCSD to maintain access to the entire length of its buried effluent pipeline, no restoration actions were included in the 130-ft wide easement and the existing barrier to east-west biologically connectivity will remain.

- Public access components have yet to be developed, but the proposed plan accommodates future parking, trail staging, and on-site trail planning. In particular, the perimeter levee along the southwestern boundary of the site is maintained for integration into a looped trail that would connect the existing foot path to the west.

Recommendations:

- Opportunities to reduce the east-west barrier to biological connectively represented by the existing 130-ft wide easement should be explored in the future. Such opportunities may arise during infrastructure upgrades to the CCCSD effluent pipeline and depend on possible mitigation requirements.

- The soil quality should be mapped and the proposed grading plan adjusted accordingly. Of particular interests is the vertical profile of metal concentrations. Potential changes to the grading plan may include over-excavation or limiting the aerial extent of excavation. Contra Costa County should contact the authors of the initial soil quality characterization (Jonas and Associates) to determine if the necessary data already exists and provide assistance in determining the specific location and depth of the elevated selenium and mercury concentrations. This characterization should occur during the next phase of design refinement, in order to address the uncertainties associated with soil quality and modify the proposed grading plan, if necessary. (See Appendix D for a description of unresolved soil quality issues.)

- Public access features should be incorporated into the restoration plan. In particular, levee lowering along the southwestern boundary of the site should be considered in order to increase biologically connectivity to the adjacent salt marsh and the ecological values of Pacheco Marsh.

3. PROJECT SITE CONDITIONS

3.1 HISTORIC CONDITIONS

Pacheco Marsh was historically part of a thin band of coastal brackish marsh along the southwestern portion of Suisun Bay near Carquinez Strait. A network of tidal channels conveyed water, sediment, and nutrients from Suisun Bay onto the marshplain and supported natural tidal marsh functions. Prior to human intervention, Walnut Creek Channel (then Pacheco Slough) was a narrow tidal slough.

Coastal brackish marshes usually occur on the interior edge of coastal bays and estuaries and commonly intergrades with coastal salt marsh towards the ocean (bay). Dominant species of this habitat include alkali bulrush (Scirpus maritimus) and possibly pickleweed in the higher marsh, and, depending upon salinity levels, Olney's bulrush (Scirpus americanus), tule (Scirpus acutus var. occidentalis), broadleaf cattail (Typha latifolia), rush (Juncus spp.), saltgrass, and sedges (Carex spp.). The historic brackish marshes at Pacheco likely supported a high diversity of wildlife species, and provided habitat for special-status species such as the salt-marsh harvest mouse (Reithrodontomys raviventris), California Clapper Rail (Rallus longirostris obsoletus), and California Black Rail (Laterallus jamaicencis coturniculus). Human alterations to the landscape have greatly affected hydrologic conditions at Pacheco Marsh. As shown in Figure 2, levees had eliminated tidal inundation onto the northern portion of the site by the late 1950s, although the natural marshplain and channel network are still visible in the aerial photograph. Additional levees were constructed around the perimeter of the 120-acre site by 1971, and the site received dredge spoils from the flood control project along Walnut Creek Channel.

Other land uses on or near the site over the past few decades include construction of a road and wastewater effluent pipeline, operation of an auto dismantling yard (now dismantled), and operation of a sand yard (PWA 1997).

3.2 EXISTING CONDITIONS

3.2.1 Physical Conditions

Figure 3 shows the boundary of the project site and its existing conditions, including the easement and access road that run the length of the site. Existing topography and drainage patterns are significantly altered from their nature conditions due to past and present land uses.

3.2.1.1 Land Use and Infrastructure

Current on-site land uses include operation of a wastewater effluent pipeline by CCCSD. Secondary treated wastewater flows through the buried 72-inch diameter concrete pipeline, that runs the length of the Pacheco property, before being discharged through a deepwater outfall into Carquinez Strait. Access to

this facility is provided by a 130-foot wide easement generally centered over the pipeline. The ability for CCCSD to continuously operate and access the pipeline is essential. CCCSD is considering constructing a pumping station on-site, near Waterfront Road, to increase the flow through the pipeline.

Hansen Aggregates operates a 20-acre staging area between the northern boundary of the project site and Carquinez Strait. Trucking access is provided by a raised dirt road that extends from Waterfront Road and runs the length of the project site. The access road lies within the 130-foot wide easement on the southern half of the site, but a small sliver of land separates the road and pipeline in the northern half of the site where the road lies outside of the easement.

A raised oil pipeline and access road abut the northwestern perimeter levee. Flow through the tidal channel that feeds the salt marsh to the west of the site is facilitated by an elevated bridge near its mouth and a 48-inch culvert further upland.

Tidal marshes border the Pacheco property to the east along Walnut Creek Channel, and to the west on property managed by the California State Lands Commission. Wickland Oil Company and the City of Martinez own property adjacent to the southwest corner of the Pacheco site.

3.2.1.2 Drainage

Tidal inundation from Carquinez Strait and the Walnut Creek Channel is precluded by perimeter levees, and direct rainfall appears to be the primary source of water. However, off-site drainage to the east occurs via gravity flow through flap-gated culverts when ponded water levels reach depths of 1 to 2 feet (Sycamore 2001). Interior drainage patterns are affected by the raised dirt road that runs from Waterfront Road to the sand yard and hydraulically divides the areas to the east and west. Rainfall collects in low-lying areas, as shown in Figure 4.

3.2.1.3 Topography

Placement of dredge spoils during the Walnut Creek Channel flood program greatly affected ground elevations throughout the site. Much of the material appears to have been placed on the northern half of the site, where ground elevations are highest. The existing topography is plotted in Figure 5 and Figure 6, which show that most of the site is well above elevations suitable for maintaining tidal salt marsh habitat, which is generally between 3.1 and 3.5 ft NGVD (see Figure 7 for a legend to basin numbering). A summary of typical elevations throughout the site and of particular site features is provided in Table 3-1.

Table 3-1. Summary of Typical Elevations

Site Feature	Average Elevation (ft NGVD)
Perimeter Levees	7 to 10
Access Road	6.0/10.5 (south/north)
Southwest Basin (Basin 1)	3.8
Southeast Basin (Basin 2)	5.1
Northeast Basin (Basin 3)	5.4
Northwest Basin (Basin 4)	7.9
Basins 1 – 4 (excluding road & levees)	6.1

Sources & Notes: Elevations based on topographic model provided by the District. Basin numbering is defined in Figure 6.

3.2.1.4 Tides

Suisun Bay is subject to mixed semi-diurnal tides that result in two high tides and two low tides every 25 hours. Oceanic tides are affected by the basin morphology of San Francisco Bay, bottom friction, and the restriction through Carquinez Strait as these tidal prisms travel "up-estuary". Published tidal benchmarks from Suisun Point are representative of conditions at Pacheco Marsh and are summarized in Table 3-2.

Table 3-2. Summary of Tidal Characteristics at Pacheco Marsh

Tide Level	Elevation (ft NGVD)
Estimated 100-year High Tide	6.50
Spring Tide	3.93
Mean Higher High Water (MHHW)	3.08
Mean High Water (MHW)	2.57
Mean Tide Level (MTL)	0.65
Mean Low Water (MLW)	-1.27
Mean Lower Low Water (MLLW)	-2.08

Sources & Notes: NOS/NOAA tidal station, #941-5103. Tidal monitoring period Aug-Oct 1979. Spring tide taken as highest observed (08/06/79) during monitoring period. 100-year tide elevation from Corps (1984).

3.2.2 Biological Conditions

The project site currently contains the following five primary habitat types: diked salt marsh, saline flats, creeping wild-rye grassland, ruderal upland, and developed. The developed habitat on site is discussed in the above section on existing physical conditions. The four remaining biotic habitats are described below.

3.2.2.1 Diked (Non-tidal) Salt Marsh

Diked salt marsh occurs throughout the project site, comprising approximately 37 acres of the site (Sycamore 2000). Dense, monotypic stands of common pickleweed (*Salicornia virginiana*) occupy the topographically lowest areas within this habitat. With a slight increase in elevation, pickleweed intergrades into areas composed of an assortment of hydrophytic species including broad-leaf pepper-grass (*Lepidium latifolium*), saltgrass (*Distichlis spicata*), alkali heath (*Frankenia salina*), spearscale (*Atriplex triangularis*), brassbuttons, and rabbitfoot grass (*Polypogon monspeliensis*). Standing dead pickleweed was observed in the topographically lowest areas within the diked marsh. These areas are presumably either inundated for too long a period or are inundated to a depth greater than that which pickleweed can tolerate.

Some non-native, invasive plant species were observed within diked salt marsh habitat on the project site. These include common reed (*Phragmites australis*), crystalline iceplant (*Mesembryanthemum crystallinum*), and sea fig (*Carpobrotus chilensis*). A single, sapling-size salt cedar (*Tamarix* sp.) was also observed on the project site (Basin 4).

Due to the lack of year-round water, the diked salt marsh habitat on the project site is likely to support a significantly lower diversity and abundance of wildlife species than adjacent tidal salt marsh. The pickleweed on-site may provide habitat for the salt-marsh harvest mouse. Past trapping records (Sycamore 2001) indicate that they are present in the surrounding marshes. However, the on-site pickleweed habitat is not suitable for two other salt and brackish marsh obligates: the California Clapper Rail (*Rallus longirostris obsoletus*) and the California Black Rail. These rail species require tidal marsh channels and more cover than that currently provided on the project site. Additional wildlife likely to occur in the diked salt marsh habitat include California voles (*Microtus californicus*), and foraging Great Egrets (*Ardea alba*) and Great Blue Herons (*Ardea herodias*).

3.2.2.2 Saline Flats

Portions of the project site support saline flats or pannes that are generally dominated by one or two hydrophytic species. They occur in topographic depressions where either diked tidal waters occasionally pool and evaporate, or where the depth to ground water is shallow enough that some of the ground water is drawn to the surface where it then evaporates. Under either scenario, high concentrations of salts remain on the soil surface, thereby creating the appearance of a scalding effect. These areas are mostly dominated by brassbuttons (*Cotula coronopifolia*), but also feature other hydrophytes including spreading alkali-weed (*Cressa truxillensis*), annual hairgrass (*Deschampsia danthoniodes*), western sea-purslane (*Sesuvium verrucosum*), sandspurry (*Spergularia* sp.), and prickle grass (*Crypsis* sp.). Additionally, some algal matting was observed. Vegetation within the saline flats on the project site rarely exceeds 40-50% cover.

Salt panne habitat provides very little cover for wildlife, but some species are well adapted to this unique habitat. Killdeer (*Charadrius vociferus*) likely nest in this habitat at the project site, and are one of the few species likely to use this habitat throughout the year. In winter, when standing water is present, this habitat may support foraging shorebirds, such as the Least Sandpiper (*Calidris minutilla*).

3.2.2.3 Creeping Wild-Rye Grassland

Several areas, primarily within Basin 3, are dominated by dense, monotypic stands of creeping wild-rye (*Leymus triticoides*). This perennial, rhizomatous grass often occurs in moist, saline meadows, but generally does not form monotypic stands like those observed on site. These areas may have been seeded as part of a former restoration/reclamation effort. This homogenous habitat is of little value to wildlife, with the exception of rodents, such as the California vole.

3.2.2.4 Ruderal Upland

The majority of the site consists of upland habitat dominated by an assortment of non-native herbaceous, ruderal vegetation. This habitat is widespread throughout the site and includes some plant species that are more commonly observed in more mesic environments. Plant species that are common to the ruderal upland habitat on site include oat grass (*Avena* sp.), Italian ryegrass (*Lolium multiflorum*), ripgut brome (*Bromus diandrus*), white sweetclover (*Melilotus alba*), prickly lettuce (*Lactuca serriola*), black mustard (*Brassica nigra*), bristly ox-tongue (*Picris echioides*), curly dock (*Rumes crispus*), wild radish (*Raphanus sativus*), cheeseweed (*Malva parviflora*), prostrate knotweed (*Polygonum arenastrum*), and coyote brush (*Baccharis pilularis*).

This habitat likely supports a greater diversity of wildlife species, including California vole and other rodents (but no salt-marsh harvest mouse), desert cottontail (*Sylvilagus audubonii*), western fence lizard (*Sceloporus occidentalis*), and garter snakes (*Thamnophis* spp.). Avian species likely to occur in this dry open habitat include Western Meadowlark (*Sturnella neglecta*), House Finch (*Carpodacus mexicanus*), and Mourning Dove (*Zenaida macroura*).

4. PROJECT GOALS, OBJECTIVES, OPPORTUNITIES AND CONSTRAINTS

4.1 PROJECT GOALS AND OBJECTIVES

The following restoration goal was developed by the MHLT, the District, and the EBRPD and used to guide the planning process.

> *Maximize wetland and wildlife habitat while allowing for compatible land uses on the site.*

This goal was translated into specific objectives by the Project Team. These objectives were modified and appended after identifying the opportunities and constraints, and the final list of project objectives consisted of the following:

- Maximize habitat value for diverse wildlife in a cost efficient manner by restoring self-sustaining tidal marsh functions and structure to the maximum extent feasible. In areas where tidal marsh restoration is infeasible due to existing high ground elevations and high excavation costs, consider improving ecologic values by creation of salt panne, managed brackish wetland, or managed freshwater marsh habitat.

- Enhance the quality and quantity of habitat for the following special status species likely or potentially to occur on site:

  Wildlife:
  - Salt-marsh harvest mouse,
  - California Black Rail,
  - California Clapper Rail,
  - Short-eared Owl,
  - Northern Harrier,
  - Saltmarsh Common Yellowthroat,
  - Suisun Song Sparrow,
  - Tricolored Blackbird, and
  - Suisun shrew

  Plants:
  - Delta Tule pea,
  - Mason's lilaeopsis,
  - Soft bird's-beak and
  - Suisun marsh aster.

- Enhance public education and resource interpretation, and allow for a staging area for future projects that may include a trail segment that would connect the Ironhorse and Bay Trails.

- Maximize management flexibility in response to further changes in environmental conditions, sea-level rise, or management goals.

- Minimize the conditions that promote mosquito production by creating the proper hydraulic regime and vegetation.

- Insure maintenance and access to pipelines and adjacent private property within a documented right-of-way.

4.2 OPPORTUNITIES

PWA and HTH identified specific opportunities, given the existing physical setting of the site and ecologic functions of the study area. These opportunities include:

- Restoration of tidal wetland functions by allowing regular inundation through a combination of excavation and levee breaching/removal. Restored areas within Pacheco Marsh would be connected to adjacent salt marsh habitats to the west and east of the site, increasing the rates of vegetation and wildlife colonization. This will also restore key estuarine ecological processes (e.g. sedimentation, nutrient exchange) by increasing connectivity of the marsh and the Bay.

- Creation of tidal panne or seasonal wetland habitat by limited earthwork at higher elevations, where extensive excavation required to achieve elevations suitable for tidal inundation is infeasible.

- Opportunity to rely on natural vegetation recruitment from adjacent sites, such as the narrow band of salt marsh along the Walnut Creek Channel and the tidal marsh on State Land property to the west.

- Use treated effluent from the CCCSD pipeline to create freshwater habitat and minimize the amount of excavation.

- Improve the existing mosquito conditions by reducing the quantity of small pools of standing water with dense vegetation, and hence the conditions that lead to mosquito production.

- Currently, it is unlikely that any of the 6 special-status plant species listed above would occur on site. At best, only marginal habitat may exist. Restoration of tidal wetlands and functions will increase the potential for these species, and other desirable, native tidal wetland species, to re-colonize the site.

4.3 CONSTRAINTS

Constraints arise from the multiple and sometimes competing objectives of the site, namely to provide both tidal marsh habitat and maintain the existing land uses, as well as from the physical setting of the site. The following constraints were identified and used to refine the project objectives:

- Placement of dredged material at Pacheco Marsh has significantly raised ground elevations. Therefore, excavation and removal of a substantial volume of fill material is necessary to lower the entire site to elevations suitable for tidal inundation. The exact volume would depend on the grading plan, but a rough estimate can be established by computing the amount of material above the natural marshplain elevation, about 330 acre-feet. In addition to the costs associated with the mechanical excavation, off-site removal of the material may be constrained by soil contamination and identifying a disposal site. Preliminary analysis of available soil investigations indicates elevated mercury and selenium concentrations.

- The CCCSD effluent pipeline runs the length of the project site and represents a barrier to hydraulically connecting the east and west portions of the property. Continued operation of this facility is essential, and access to the 130-foot wide easement restricts the area that can be inundated by tides in Walnut Creek Channel to a thin strip of land immediately inboard of the western levee.

- The use of the 20-acre aggregate staging area at the north end of the site restricts the degree to which natural drainage patterns can be reestablished. Historical photographs show an entrance channel at this location that served as a direct tidal connection to Carquinez Strait.

- Water quality of the secondary treated wastewater may constrain its use in wetland creation. Regulatory agencies are likely to require long-term monitoring for heavy metals, dissolved ammonia, or ammonium if the effluent contains concentrations high enough to be harmful to aquatic species. In addition, depending on how the wetland is designed, freshwater discharges may impact the existing habitat in adjacent salt marshes by altering the local salinity regime.

- Hydraulic structures required to regulate discharges of treated wastewater from the CCCSD effluent line would significantly increase the long-term maintenance requirements at the site, and proper management of the flow control structures is difficult. Experience at other sites has shown that unintended, unanticipated, and sometimes undesirable effects have often resulted from structural management of marsh hydrology. These constraints also apply to the enhancement of seasonal wetlands.

- The 48-inch culvert along the tidal channel to the west of the site limits the amount of water that can be delivered to the site. Improvements to this structure that will increase its conveyance need to be implemented to use this tidal creek as a source of tidal waters.

- Construction may cause disturbance to or direct take of special-status species. The only special-status wildlife species likely to occur on site are the salt-marsh harvest mouse, and possibly, the California Horned Lark and Suisun Song Sparrow.

- Restoration may inadvertently facilitate invasion of the site by non-native species (e.g., smooth cordgrass [*Spartina alterniflora*]), although not currently common in this part of San Francisco Bay.

- Opening these parcels to tidal action may provide a source of non-native invasive plant species (e.g., common reed [*Phragmites australis*] and perennial peppergrass [*Lepidium latifolium*]) to the surrounding marshes.

- Excavation and grading activities associated with restoration efforts may result in the loss of existing wetland vegetation. However, these wetland areas provide little habitat for special-status plant species. It is anticipated that the restoration of tidal wetlands to the site will ultimately provide significantly better quality habitat for special-status plants and other desirable, native plants.

5. FORMULATION AND EVALUATION OF ALTERNATIVES

PWA and HTH established various restoration and enhancement alternatives for preliminary evaluation and to assist in the selection of a preferred alternative. These restoration alternatives included a mix of habitat types that reflect the project opportunities and constraints. Although tidal marsh is the preferred habitat type due to its diverse ecological values and ability to be self-sustaining over the long-term, other habitat types were also considered when formulating the restoration alternatives to address specific project constraints.

The various habitat types that were included in the alternatives are described in Section 5.1. Specific alternatives were developed, as described in Section 5.2, that emphasize different habitat types and vary in configuration. A technical assessment of the existing wetlands is provided in Appendix A, and mapped in Figure 8.

5.1 HABITAT TYPES

The following habitat types were considered in formulating the alternatives:

- **Tidal Marsh** – Tidal marshes are dominated by emergent vegetation and are subject to tidal inundation, which is conveyed through a network of sinuous tidal channels. Tidal channels within the marsh form a complex drainage network, and serve as important conduits for sediments, nutrients, and tidal waters. Marsh elevations vary from sub-tidal habitats found in the tidal channels to the upper limit of flooding on extreme tides. California cordgrass (Spartina foliosa) is usually the primary colonizer on tidal mudflats in brackish to saline marshes and it occurs in dense stands up to mean high water (MHW). In fresher conditions, tules (Scirpus acutus and S. californicus) are usually observed on the marsh edges at these lower elevations. Middle tidal marsh in brackish conditions, such as those at the project site, is generally dominated by alkali bulrush with areas of pickleweed as the distance from the marsh edge increases. In South San Francisco Bay, the non-native perennial peppergrass (Lepidium latifolium) has invaded large portions of the marshplain in brackish areas. High tidal marsh occurs above the MHW and extends to the maximum extent of the tides. This habitat is dominated by pickleweed with an assortment of peripheral halophytic species including alkali heath (Frankenia salina), salt grass, sea lavender (Limonium californicum), fleshy jaumea (Jaumea carnosa), and Suisun marsh gumweed (Grindelia paludosa).

  Tidal marsh provides habitat for several special-status wildlife species whose populations have declined during the last century, concurrent with the loss of tidal marsh habitat along the California coast. These species include the saltmarsh harvest mouse, the California Black Rail, the California Clapper rail, and the Suisun Song Sparrow (Melospiza melodia maxillaris). Tidal marshes also provide habitat for other avian species, such as nesting Forster's Terns (Sterna

forsteri), and foraging and roosting Willets (Catoptrophorus semipalmatus) and Long-billed Curlews (Numenius americanus). In addition, tidal channels within marshes provide habitat for a number of marine invertebrates and coastal fishes.

- **Tidal Panne** – A distinctive feature of salt marshes are the tidal pools, or pannes, that are infrequently inundated by the tides but retain water even at low tide. Tidal pannes occur either within the vegetated marsh plain between drainage networks, or at the transitional upland boundary of the tidal wetland. In either case, the water surface elevation inside the panne is controlled by a topographic feature such as a small berm or depression. The magnitude and frequency of tidal inputs are determined by the height of this pond containment feature relative to the tides, although tidal inundation is enough to maintain ponded water throughout the year. Evaporation between periods of inundation concentrates salts in the soils and prevents encroachment by emergent vegetation. Most of the tidal pannes in historic Suisun marshes were larger than an acre, less than two feet deep, devoid of vegetation expect for sago pondweed and widgeon grass, and surrounded by low-growing vegetation that permitted a long view of predators (Collins 1997). Evaporation in the late summer and fall may produced hypersaline conditions, especially in very dry years, but retain open-water habitat over most of its area. The water and salt balances are essential to the sustainability and quality of wildlife habitat in tidal pannes.

  Tidal panne habitat is likely to be used in winter months by waterfowl and foraging shorebirds. Waterfowl, including Northern Shoveler (Anas clypeata) and Northern Pintail (Anas acuta), are likely to use ponded habitats in the Suisun Bay area for foraging and resting. During the fall and winter, American White Pelicans (Pelecanus erythrorhynchos) also use various coastal wetland habitats around Suisun Bay for foraging and roosting. From autumn through spring, tidal pannes are likely to be used for foraging and roosting by a variety of shorebirds, including Least Sandpipers, Western Sandpipers (Calidris mauri), Dunlin (Calidris aplina), American Avocets (Recurvirostra americana) and Black-necked Stilts (Himantopus mexicanus). During periods when these areas are not inundated, the value of tidal panne habitat to wildlife is reduced. Killdeer often nest in this habitat during summer, but in the Suisun Bay area few other wildlife species are likely to use tidal pannes.

- **Managed Brackish Wetland** – Managed brackish wetlands are similar to tidal pannes, in that they provide shallow ponded open-water habitat. Unlike tidal pannes, seasonal wetlands have no direct tidal connection and therefore collect water from a contributing watershed or rely upon the management of fresh or tidal water levels for their ponding. The major distinction is that seasonal wetlands do not receive periodic tidal inundation, but rather collect water from direct rainfall and runoff from the contributing watershed. Some seasonal wetland habitat presently exist on-site, but the lack of watershed runoff limits its quantity and quality. Therefore, restoration activity aimed to enhance seasonal wetland uses would include active management of the hydrology.

Emergent vegetation can be suppressed either by excessive ponding or high soil salinities. Most existing seasonal wetland habitat around the margin of San Francisco Bay is an accidental, if beneficial, product of human intervention or is a result of active management of water levels. Long-term sustainability at Pacheco Marsh would depend on manually recharging the site with bay water (i.e., pumping) to maintain appropriate water levels to deter vegetation encroachment, and possibly re-charging the marsh with salt since existing soils would be leached over time. Plant species expected to occur within seasonal wetlands adjacent to the bay predominantly consist of an assortment of annual and perennial emergents. These species are salt-tolerant and able to endure seasonal inundation. Such species would include brassbuttons (Cotula coronopifolia), saltgrass, spreading alkali-weed (Cressa truxillensis), annual hairgrass (Deschampsia danthonioides), sandspurry (Spergularia spp.), spearscale (Atriplex triangularis), and western sea-purslane (Sesuvium verrucosum).

Like tidal panne habitat, seasonal wetlands are likely to be used in winter months by foraging shorebirds and waterfowl. Non-tidal open water habitat is important for these birds as alternate habitat when tidal habitats are unavailable.

- **Managed Freshwater Wetland** – Constructed freshwater wetlands are commonly used to treat sewage effluent prior to discharge into the receiving waters. In the present application, the objective is to minimize the need for excavation by using diversions from the CCCSD outfall to create freshwater habitat at elevations close to existing grade. Nonetheless, environmental permitting would likely require long-term monitoring of water quality, and wetland hydrology needs to be managed to establish the appropriate chemical and biological conditions.

  Initially, managed freshwater wetlands would more closely resemble coastal/brackish marsh than freshwater. Alkali bulrush would likely be one of the dominant perennial emergent species, but other species might include salt rush (Juncus lesueurii), pickleweed, and fleshy jaumea. Over time, as soil salinities decrease due to leaching, a transition to more freshwater emergent vegetation would occur. These species would likely include tule, Olneyi's bulrush, broad-leaved cattail, giant bur-reed (Sparganium eurycarpum), and alkali bulrush (Scirpus robustus).

  Freshwater wetlands provide habitat for a high diversity of wildlife species. Rushes provide nesting habitat for several avian species, including the Marsh Wren (Cistothorus palustris), Red-winged Blackbird (Agelaius phoeniceus), and two special-status species, the Saltmarsh Common Yellowthroat (Geothlypis trichas), and the Tricolored Blackbird (Agelaius tricolor). Freshwater wetlands also support a variety of waterbirds, including Amercian Coots (Fulica americana), Pied-billed Grebes (Podilymbus podiceps), and waterfowl. In addition, various small mammals, reptiles, and amphibians are likely to be found in or near this productive habitat.

5.2 DESCRIPTION OF ALTERNATIVES

Restoration alternatives were developed by exploiting the current opportunities to create tidal marsh habitat relatively easily at lower elevations and emphasizing the various habitat types described above elsewhere. The current rights-of-way and access along the dirt road and easement are preserved in each of the restoration alternatives described below. Due to the constraints imposed by the existing uses of the site, restoration activity is excluded from the small sliver of land between the raised access road and sewer line. Therefore, it is assumed that the existing habitat uses here will be maintained in each of the restoration alternatives considered.

Each alternative includes an area for parking and trail staging at the southeast portion of the site. Trail alignment within the site may be affected by restoration features particular to each alternatives, such as the location and size of levee breaches or removal.

5.2.1 Alternative 1: Maximum Tidal Marsh

This alternative is shown in Figure 9 and consists of earthwork to establish conditions appropriate for tidal inundation throughout the entire site. This earthwork is likely to include excavation and off-site removal of fill material, construction of channels across the outboard marshes and within the site to improve circulation patterns and drainage, and removal or breaching of levees to allow for tidal inundation. Hydraulic structures would be upgraded, or possibly replaced if hydrodynamic modeling indicates the need for increased conveyance through the existing infrastructure.

Limited or no grading will be required in Basins 1 and 2. However, a substantial amount of excavation would be necessary to lower ground elevation in Basins 3 and 4 to levels suitable for tidal marsh restoration. The bulk of material would come from Basin 4 due to its large area and high elevation. Since the effective tidal range within in the site could possibly be limited (muted) due to under-sized channels across the outboard fringe marsh along Walnut Creek Channel, construction of channels through the outboard marsh may be considered. Excavation of channels inside the project area may also be considered in order to provide adequate site drainage. Depending on modeling results, the 48-inch culvert along the tidal channel to the west may be upgraded, replaced, or another culvert could be installed further downstream to directly convey tidal water to Basin 4.

5.2.2 Alternative 2: Tidal Panne

Restoration Alternative 2 includes a mix of tidal marsh restoration in areas suitable for tidal inundation, and creation of tidal panne habitat at higher elevations. Figure 10 shows this concept in plan view. The amount of excavation is expected to be somewhat less than under Alternative 1, due to the slightly higher ground elevations and less frequent tidal inundation of tidal pannes.

Since the existing topography and pickleweed habitat in Basins 1 and 2 easily lends these areas to tidal marsh restoration, activities here are identical to Alternative 1 and require relatively little grading. However, excavation would be required to lower ground elevations and construct the desired basin morphology in Basins 3 and 4. Levees along Basins 3 and 4 would be lowered at selected locations to prevent drainage at low water but allow for periodic tidal inundation during higher spring tides. Construction of pilot channels would probably not be considered due to the limited volume and infrequent nature inundation into the tidal panne. However, some improvement to the existing culvert along the tidal channel to the west may be desirable to ensure that high water levels are not muted.

5.2.3 Alternative 3: Managed Brackish Wetland

Restoration Alternative 3 includes a mix of tidal marsh restoration in areas suitable for tidal inundation and active management hydrology for creation of brackish wetlands at higher elevations (see Figure 11). Under this alternative, pumping would be used to manage the salt and water balances required to suppress emergent vegetation and provide the target habitat. Restoration activities in Basins 1 and 2 are identical to Alternative 1.

Levees may need to be improved to accommodate ponding on site. No levee lowering or breaching would take place under this alternative since water levels will be controlled by active pumping, evaporation, seepage, and direct rainfall. Some earthwork may be considered in the interiors of Basins 3 and 4 to create suitable basin morphology. A pump facility would be installed at the northwest section of Basin 4 and periodically draw water from the tidal channel to the west. This facility would probably rely on automatic flow controls to maintain the appropriate water depths and require regular maintenance. Hydraulic structures below the road and buried sewer line could be installed to convey water to Basin 3.

5.2.4 Alternative 4: Managed Freshwater Wetland

As depicted in Figure 12, Alternative 4 includes a mix of freshwater wetland and tidal marsh creation. Treated wastewater from the CCCSD sewer line would be used as a source of water for wetland creation at higher elevations where excavation costs are high (Basins 3 and 4). Basins 1 and 2 are treated as in Alternative 1.

This alternative would require the installation of a flow control structure and distribution line to route the desired amount of effluent from the sewer line and into Basin 4. As in Alternative 3, levee improvements may be necessary, and a hydraulic structure would be used to convey water to Basin 3. Since pressurized flow from the sewer line is used as the primary source of water (direct rainfall is considered secondary) under this alternative, earthwork would be limited to creating the desired basin morphology and channeling flow through Basins 3 and 4. Discharge from these basins into the tidal channel and Walnut Creek Channel would occur through a limited number of small breaches or culverts in the perimeter levee.

5.3 EVALUATION OF ALTERNATIVES AND SELECTION OF A PREFERRED ALTERNATIVE

The four alternatives described above were evaluated at a cursory level to assist the project team, with the assistance of the TAC, in identifying a preferred alternative. Alternatives were ranked by comparing approximate excavation volumes, maintenance requirements, and ecological values. A relative comparison among the conceptual alternatives was made by qualitatively examining the ecological values, ability for self-maintenance, costs, and potential for increasing mosquito production, as shown in Table 5-1. Excavation volumes for tidal marsh and tidal panne habitat were developed assuming the existing grade was lowered to an average elevation of +2.75 ft NGVD and +3.3 ft NGVD, respectively. Estimates of the amount of excavation required varied from approximately 540,000 CY for full tidal marsh or panne restoration to about 120,000 CY for the managed wetland alternatives, as summarized in Table 5-2. Most of the excavated material comes from Basin 4 due to its existing high elevation and relatively large area.

Table 5-1. Qualitative Evaluation of Conceptual Alternatives

Alternative	Ecological Value	Self-Maintaining	Costs	Mosquito Production
Alternative 1: Maximum Tidal Marsh	High	Yes	High initial costs Low long-term costs	Low
Alternative 2: Tidal Panne	Moderate but less certain	Yes	High initial costs Low long-term costs	Moderate
Alternative3: Managed Brackish Wetland	Moderate	No	Low initial costs High long-term costs	High
Alternative 4: Managed Freshwater Wetland	High	No	Low initial costs High long-term costs	Low

Alternatives 1 and 2 are self-maintaining since tidal inundation would control the hydroperiod of tidal marsh and tidal panne habitats. However, both require a significant amount of earthwork to lower the existing grade to appropriate elevations. Alternatives 3 and 4 would require a commitment of management resources and operational costs since the hydrology of both of these rely on active pumping or diversions from the effluent pipeline. Alternative 4 would have the additional burden of complex water quality permitting and long-term monitoring associated with the shallow-water discharge of the treated effluent from the CCCSD pipeline.

Table 5-2. Excavation Volumes for Conceptual Alternatives

Alternative	Excavation Volumes (cubic yards, CY)				
	Basin 1	**Basin 2**	**Basin 3**	**Basin 4**	**Total**
Alternative 1: Maximum Tidal Marsh	45,000	75,000	45,000	375,000	540,000
Alternative 2: Tidal Panne	Same as Alt 1	Same as Alt 1	Similar to Alt 1	Similar to Alt 1	540,000
Alternative3: Managed Brackish Wetland	Same as Alt 1	Same as Alt 1	minimal	minimal	120,00
Alternative 4: Managed Freshwater Wetland	Same as Alt 1	Same as Alt 1	minimal	minimal	120,000

Notes: Volumes based on conceptual-level alternatives and existing topographic data supplied by the District. Channel excavation and levee removal not included.

From a biological perspective, Alternative 1 provides the most valuable habitat for the target special-status species. The freshwater wetland of Alternative 4 would also provide diverse wildlife habitat with appropriate management of hydrology and vegetation. Alternative 2 could provide shorebird and waterfowl habitat during the wet season, although the tidal panne concept is more risky since establishment of an appropriate hydroperiod requires a high degree of precision in grading the sill elevation. Similarly, the actively managed hydrology of Alternative 3 may lead to unintended consequences and would require close monitoring and management to achieve successful habitat creation.

Based on direction received from the TAC, Alternatives 3 and 4 were not pursued further due to the long-term operational and management costs. Instead, the preference among the TAC members was to create a self-maintaining system by refining Alternatives 1 and 2. Specifically, the TAC directed PWA and HTH to consider the following:

- Create a mosaic of tidal and upland habitat to minimize excavation volumes,
- Use Basin 4 for on-site placement of excavated material to the greatest extent feasible,
- Enhance east-west connectivity for plant and wildlife species by minimizing the width of the barrier created by the easement and raised dirt road.

Although is was suggested by some TAC members to enhance east-west connectivity by creating a shallow channel over the CCCSD effluent pipeline and culvert under the raised dirt road, further discussions (pers. comm. with Ba Than and Russ Leavitt) with the sanitation district revealed that access to the buried effluent pipeline would preclude such activity. Therefore, the preferred restoration

alternative focused on minimizing the width of the existing barrier by relocating the dirt road to within the 130-ft wide easement.

6. PREFERRED ALTERNATIVE

6.1 OVERVIEW

PWA and HTH developed the preferred alternative shown in Figure 13 by refining the preliminary tidal marsh restoration concept in response to comments received from the project proponents and the TAC. The design creates self-maintaining and high-value tidal marsh habitat over a majority of the site, while reducing construction costs. The design meets all of the project goals and objectives and provides the best practical opportunity for maximizing the desired ecological functions of the site.

The preferred alternative will create a mix of tidal marsh and upland habitat through marshplain excavation and on-site disposal of material. Other construction activity includes channel excavation, enlargement of the existing inlet channel, installation of new culverts, and limited planting. The restoration plan assumes that soil quality is not a constraint, although further studies are required to confirm whether or not the on-site sediment will meet wetland cover criteria after excavation.

This section describes the preferred alternative in detail, including: the expected habitat evolution (Section 6.2), the conceptual restoration design and its features (Section 6.3), accommodation for future planning of public access features (Section 6.3.8), and the excavation volumes and anticipated construction methods (Section 6.5).

6.2 EXPECTED HABITATS AND SITE EVOLUTION

The proposed restoration is expected to create approximately 69 acres of tidal marsh, 12 acres of transitional habitat, and 42 acres of upland habitat (Table 6-1). Note that approximately 18.3 acres of upland habitat consist of developed area to accommodate the parking/staging area, utility easement, and weigh station. The graded marshplain areas will be unvegetated intertidal mudflats immediately following restoration. Within the first several years, brackish marsh vegetation is expected to colonize the site through natural vegetation recruitment. The marshplain will drain through graded tidal channels. Minimal tidal damping is expected along the enlarged inlet channel, but its initially trapezoidal shape will adjust in response to tidal scour over time. Sedimentation and erosion will continue to shape the site in the future, as the site evolves to more closely resemble the adjacent marshes.

Table 6-1. Summary of Habitat Areas

	Basin 1 (acres)	Basin 2 (acres)	Basin 3 (acres)	Basin 4 (acres)	Total (acres)	Percent of Project Site
Tidal Marsh	24.0	12.9	11.2	22.0	68.9	58%
Transitional	1.7	1.3	0.0	7.4	12.2	8%
Upland	8.2	6.9	2.1	25.3	42.0	34%
All Habitats	33.9	21.1	13.3	54.7	123.1	100 %

The following paragraphs describe the expected habitats in more detail, and their importance to wildlife.

- **Tidal Marsh** – Based upon the vegetation dominating the adjacent tidal marshes, we believe that areas restored to tidal inundation will support mostly brackish tidal marsh vegetation. The flora of brackish marshes is quite diverse, attracting a wide variety of wildlife species, especially migratory waterfowl. Brackish marshes also provide other positive functions such as flood protection through increased capacity for storage and conveyance, and improved water quality through trapping and filtration of sediments, nutrients, and contaminants. Brackish marsh provides habitat for the salt marsh harvest mouse and other special-status species, including the California Clapper Rail, California Black Rail, Short-eared Owl, Northern Harrier, Suisun Song Sparrow, and Suisun Shrew.

  We anticipate that portions of the restored tidal wetlands will support salt marsh vegetation, particularly in Basin 1, as well as throughout the site early in the restoration process since soil salinities are likely elevated. With increased tidal flushing, the interstitial soil salinities will lower over time and vegetation will transition toward brackish marsh vegetation. The marshes to the west of Basin 1 currently support tidal salt marshes dominated by pickleweed. We anticipate the creation of tidal salt marsh habitat in this area, providing high quality habitat for the salt marsh harvest mouse. Restoration at Pacheco Marsh will improve tidal circulation to these marshes, potentially leading to more brackish vegetation.

- **Channels and Subtidal Zone –** Existing and constructed tidal drainage channels will allow marine life access to interior areas of the marsh, such as juvenile fish that rely upon aquatic habitat within marshes for feeding and cover. Channels also provide intertidal habitat for invertebrates and are essential feeding areas for migratory shorebirds. Intertidal channels are an important habitat for the California Clapper Rail, which relies on complex tidal channels for foraging and protective cover. Channels also import and export important nutrients that support the established food web.

  Just below the elevation of the intertidal zone is the subtidal zone, which is not usually exposed at low tide. This zone supports a different assemblage of invertebrates that are important for the water quality functions of aquatic habitats and also provide a food source for fish and diving birds.

  Major adjustments to the constructed and enlarged channels is not expected, however the cross-sectional shape will adjust to deposition and erosion until an equilibrium shape is achieved.

- **Upland/Transitional Zone –** Transitional habitats will be created between marshplain and upland areas. Transitional habitats may contain some of the plant species found in high marsh zones and upland areas, but also contain some representative flora. These “fringe” areas are essential high tide refugia (or escape cover) for salt marsh harvest mice and other wildlife that

must abandon the marsh during the high spring tides and also stay under vegetation cover to avoid predation.

Transitional zones, together with high quality upland habitat, provide buffer areas that are often lacking in coastal restoration. High quality upland habitats adjacent to coastal marshes are not protected by regulation, so are often developed with urban land uses, eliminating essential habitat for many endemic plant and animal species.

6.3 RESTORATION DESIGN FEATURES

The Preferred Alternative includes several physical design features, which are described below. The following sections include design criteria, construction methods, and details of each feature.

6.3.1 Marshplain Excavation

6.3.1.1 Excavation Plan

The restoration plan includes a significant amount of marshplain excavation in order to lower existing site grades to elevations that will support marsh habitat. Intertidal areas within the restoration site will initially be graded to just below natural marsh elevations. This approach allows for approximately 0.5 ft of sedimentation on top of the graded surface, which provides the appropriate substrate for colonization of invertebrates and recruitment of vegetation. Excavated marshplain elevations should vary +/- 0.5 ft for constructability purposes and to allow for some variation in micro topography.

The grading plan shown in Figure 14 was established by an optimization process of minimizing the volume of excavation while maximizing the ecological values of the site, within the constraints of the project. We used the following design criteria in establishing the preliminary grading plan:

- **Minimize Marshplain Excavation –** The volume of marshplain excavation is reduced by excluding areas at the highest elevations from tidal restoration. Furthermore, the restored marshplain elevation is set at +3.0 ft NGVD to minimize the amount of over-excavation. Areas below the spring tide elevation (3.9 ft NGVD) are excluded from excavation since these elevations are already at levels suitable for periodic inundation.

- **On-Site Placement of Material –** Excavated material is placed on-site in order to avoid costly off-site trucking and disposal. This consists of filling un-restored portions of the site to elevations up to about +13 ft NGVD. The upland and tidal areas are connected by a band of transitional habitat, with a 10:1 (horizontal:vertical) side-slope.

- **Improve Biological Connectivity** – The restoration plan includes levee lowering and selective marshplain excavation to improve biological connectivity. Connectivity for wildlife migration

could possibly be improved further by construction of one or more semi-circular arches underneath the raised access road, although this would not provide hydrologic connectivity and would may preferentially favor access for predators and not for the target marsh species.

- **Maintain Access to Existing Land Uses –** In order to maintain access to the sand yard and CCCSD effluent pipeline, restoration activity is excluded from the 130-foot wide utility and access easement that spans the length of the project area. However, the northern half of the access road is re-aligned to within its proper easement. The lack of restoration elements within the easement effectively divides the site into eastern and western halves with no hydrologic connection.

6.3.1.2 Impacts to Existing On-Site Wetlands

Marshplain excavation will affect existing vegetation, which includes an assortment of non-native herbaceous vegetation, creeping wild-rye grassland, hydrophytic vegetation, and diked (non-tidal) salt marsh habitat. As discussed in Section 3.2.2.1, the existing salt marsh supports significantly lower diversity and abundance of wildlife species than adjacent tidal marshes due to the lack of year-round inundation.

Table 6-2 summarizes the impacts to existing jurisdictional wetlands due to the proposed grading plan. About 17.6 acres of jurisdictional wetlands are enhanced by simply restoring tidal inundation. Although 26.5 acres of jurisdictional wetlands are impacted by marshplain excavation, we expect the ecological values to improve significantly over the long-term as natural wetland functions and structure are restored. Only 7.2 acres of the existing jurisdictional wetlands will be filled with excavated material to create transitional or upland habitat.

Table 6-2. Impacts to Existing Jurisdictional Wetlands

	Basin 1 (acres)	Basin 2 (acres)	Basin 3 (acres)	Basin 4 (acres)	Total (acres)	Percent of Project Site
Enhanced to Tidal Marsh without excavation	13.4	4.0	0.1	0.1	17.6	14 %
Enhanced to Tidal Marsh with excavation	8.5	6.2	5.4	6.5	26.5	22%
Replaced with Transitional	0.5	0.1	0.0	1.8	1.9	2%
Replaced with Upland	0.4	0.0	0.0	4.5	5.6	4%
Totals	22.8	10.3	5.5	12.9	51.6	42%

6.3.2 Interior Channel Excavation

A properly designed channel network is essential to restoring natural wetland functions. PWA used hydraulic geometry relationships developed for the San Francisco Bay (PWA 1995, Williams et. al. 2002) as the basis for the channel design at Pacheco Marsh. These relationships are practical geomorphically-based tools with broad application in wetland design. Hydraulic geometry data collected at Peyton Slough for the design of the recently restored salt marsh at the Martinez Shoreline Park has confirmed the applicability of the relationships developed for San Francisco Bay to the study area (PWA 1998).

The proposed planform configuration of the interior channel network shown in Figure 13 is based on the shape of the restored marshplain, breach locations, and design guidelines (PWA 1995) and consists of about 11,500 linear feet of excavation. Hydraulic geometry relationships shown in Figure 15, along with constructability considerations, were used to establish design criteria such as top width and depth. Channel dimensions will vary gradually from breach dimensions for the largest channels to a minimum size based on constructability for the smallest first-order channels.

Typically, construction considerations require a minimum bottom width of 2 feet for all for third order channels and 1 foot for second and first-order channels. We recommend a trapezoidal shape with 3:1 side-slopes for all excavated channels. Intermediate channel sizes can be determined by a more refined analysis in final design based on the hydraulic geometry relationship. We expect the cross sectional shape of the channels will adjust after construction due to scour and deposition of sediment, but the initial geometry should be sufficient to convey tidal waters to the restored marsh.

6.3.3 Breach Cross Sections

Breaches were sized according to the following criteria:

- **Full Tidal Exchange** – Breach dimensions were chosen to provide full drainage between the outboard tidal slough and the restored marsh (i.e. minimize tidal muting across the breach). This is important for site evolution since restricted drainage has the potential to limit material delivery and vegetation establishment. Material delivery during flood tides is critical to supplying the restored site with the sediment, nutrients, and seed required to reestablish natural wetland functions.

- **Uninhibited Channel Formation** – Breach dimensions were selected to provide reasonable assurance of achieving uninhibited long-term channel formation. Sizing the constructed breaches to equilibrium dimensions will prevent compacted levee material or other potential erosion resistant material from inhibiting long-term channel development.

The breach depths summarized in Table 6-3 were established from the hydraulic geometry relationships shown in Figure 15. Top widths were calculated based on a side-slope of 3:1 (horizontal:vertical) and a

minimum bottom width of 5 ft. These top widths are slightly larger than the equilibrium dimensions predicted by hydraulic geometry. The dimensions of the single breach to the Walnut Creek Channel were based on the combined marsh area of Basins 1 and 2.

Table 6-3. Expected Long-Term Breach Dimensions

Basin	Marsh Area (acres)	Top Width (ft)	Depth (ft)
2 & 3	24.1	45	6.7
1	24.8	46	6.8
4	22.0	45	6.6

6.3.4 Inlet Channel Excavation

Excavation to enlarge the upstream and downstream reaches of the inlet channel is included in the restoration plan in order to expedite marshplain establishment and reduce the risk to adjacent infrastructure. The channel is currently undersized to convey the restored tidal prism (see Appendix B) and would naturally widen through in response to tidal scour if not enlarged through mechanical excavation prior to levee breaching.

Based on aerial photography collected in May 2000, the center of the downstream reach lies between 110 – 40 ft from the toe of the solid-fill causeway that supports the oil and gas pipelines. We expect this channel to widen to approximately 60 – 80 ft following tidal restoration, significantly reducing the distance between the channel and toe of the adjacent solid-fill causeway. Excavation along this reach of the inlet channel should occur west of the present channel alignment (away from the causeway), and the dimensions of the constructed channel should approximate the expected equilibrium geometry in order to minimize further widening. We recommend constructing a trapezoidal channel with a side slope of 3:1, depth below MHHW of 8 ft, and bottom and top widths of 10 ft and 60 ft, respectively. As an alternative to enlarging the inlet channel to its equilibrium dimensions, the volume of excavation could be reduced by constructing a slightly undersized channel far enough away from the causeway so that future widening would not threaten the causeway. This option can be examined more closely as part of the design refinement.

Construction activity and initial impacts to the existing tidal marsh could be reduced by monitoring channel development and only excavating the inlet channel as needed, and could be considered as an alternative after consultations with U.S. Fish and Wildlife Service.

6.3.5 Levee Lowering

The grading plan depicted in Figure 14 includes lowering of the levee along the eastern side of the site. The lowered levee sections will support tidal marsh vegetation and increase biological connectivity with the existing fringe marsh along the Walnut Creek Channel. The existing levee crest is 8 to 10 ft NGVD and supports primarily non-native upland vegetation. Additionally, these levees create a barrier to wildlife migration.

The preferred alternative presently includes maintaining the southwestern levees along Basins 1 and 4 for inclusion into a public trail, although details of the public access component are yet to be defined. We recommend more extensive levee lowering if feasible, once trail locations are known.

6.3.6 Improvements to Existing Water Control Structures

PWA carried out limited numerical modeling to investigate hydraulic conveyance of the existing inlet channel and culverts (see Appendix B). Results from this effort indicate that the existing culvert is significantly undersized to provide full tidal exchange to the restored marsh. Therefore, we proposed installation of adequately sized flow control structures (i.e., culverts) so tidal restoration will not be substantially affected by poor drainage. Based on modeling results, a set of control structures with a minimum flow area of 100 ft^2 are needed to significantly increase tidal exchange and to convey an adequate amount of the tidal prism under restored conditions.

6.3.7 Road Re-alignment

The current alignment of the northern half of the access road (between Basins 3 and 4) is currently outside of its easement, increasing the width of the barrier to east-west biological connectivity. As shown in Figure 14, the proposed plan includes moving this portion of the access road such that it is entirely within the 130-foot wide easement that spans the length of the site. The re-alignment also allows for the direct connection between Basins 1 and 4, forming a contiguous tidal marsh along the western half of the site.

Detailed design of the road re-alignment will include a geotechnical analysis to confirm that this change would not impact the buried CCCSD effluent pipeline. In order to minimize the possibility of road activity damaging the pipeline, the re-aligned road should run along the western edge of the easement and have the same offset to the effluent pipeline as presently exists along the southern section of the pipeline/road easement.

6.3.8 Accommodation for Public Use and Other Land Uses

Public access features will be designed by the EBRPD and are expected to include a parking/staging area and trails. The restoration plan includes preliminary-level public access, described below, and consistent with discussions with the City of Martinez and EBRPD (see Appendix E).

- **Improvements to the CCCSD Outfall –** The CCCSD is considering a pumping plant to increase the flow through the buried effluent pipeline either on the project site or in the nearby area. Future planning of this facility should coordinate with the restoration plan of Pacheco Marsh to ensure that the pump station may be accommodated within the upland area near Waterfront Road in Basin 2.

- **Parking and Trail Staging –** The restoration footprint includes an approximately 200-ft by 200-ft square area for parking and trail staging at the southern end of the site, near Waterfront Road. In order to minimize disturbance to wildlife, this parking area is located within a larger patch of upland habitat.

- **Accommodation for Trail Planning –** As mentioned in Section 6.3.5, we have assumed that the levee along the southwestern perimeter of Basins 1 and 4 will be maintained to allow for a public access trail. Span bridges, similar to those constructed at the restored wetland at the Martinez Shoreline Park, can be designed to allow access across the levee breaches in Basins 1 and 4 (detailed design criteria have yet to be specified by the EBRPD).

  At the suggestion of the TAC, the southwestern perimeter levee was chosen as the preferred trail alignment since this portion could be integrated into the existing public access trail along the levee between Wickland Oil and State Lands properties. If the public access plan developed by the EBRPD does not include a trail along this route, levee lowering along Basins 1 and 4 could be incorporated into the restoration plan to increase the ecological values of the restored tidal marsh.

  Over the long-term, CDFG will manage the site consistently with the Point Eden Wildlife Area, and future planning of trails at Pacheco Marsh should consider safety issues related with waterfowl hunting.

6.4 PLANTING PLAN AND VEGETATION COLONIZATION

Active planting in many habitats will be essential, whereas in others, natural colonization will suffice. The low and middle marsh areas (the intertidal and marsh areas) should not require active planting, as there is ample adjacent seed source and natural recruitment should readily occur. High marsh areas and transitional zones would benefit from active planting of species such as pickleweed, alkali heath, salt grass, fat hen and marsh gumplant, as seed would have less opportunity to reach these infrequently flooded areas and there are several invasive species such as peppergrass that could limit habitat development.

In upland areas, active planting is essential if quality habitat is to develop. Planting should include hydroseeding appropriate native grasses, forbs, and upland shrubs. Invasive species such as fennel

(Foeniculum vulgare) will thrive if steps are not taken to limit its competitive advantage. This should include amending the soils to ensure native species are competitive with the non-native invasive species.

6.5 EXCAVATION VOLUMES AND ANTICIPATED CONSTRUCTION METHODS

6.5.1 Excavation Volumes

Preliminary excavation volumes associated with the proposed plan are summarized in Table 6-4, which shows that marshplain excavation in Basin 4 accounts for half of the 333,500 CY of cut. Under this plan, excavated material is spread on-site, raising the average upland elevation to about +13 ft NGVD. Alternatively, lower upland elevations could be achieved by reducing the footprint of tidal marsh restoration or disposing a portion of the excavated material off-site.

Poor soil quality can reduce the development and even the long-term quality of a restoration site. Creating suitable soil quality can require the site be over-excavated and backfilled with appropriate material in order to meet the requirements for wetland surface soils provided by the Regional Water Quality Control Board (RWQCB). For the purposes of this planning effort, we have assumed that soil contaminants will not restrict the excavation plan. However, a more through analysis needs to be performed to confirm this, and future findings may affect the grading plan and excavation volumes reported in this document.

Table 6-4. Summary of Excavation and Fill

Volumes (CY)	Basin 1	Basin 2	Basin 3	Basin 4	Total
Marshplain Excavation	12,000	24,000	38,000	164,000	238,000
Interior Channel Excavation	8,500	6,000	6,000	11,000	31,500
Inlet Channel Excavation	-	-	-	-	64,000
Total Cut	20,500	30,000	44,000	175,000	333,500
Fill	12,000	24,000	-	295,500	333,500

6.5.2 Construction Methods

6.5.2.1 Implementation

Most of the site is upland and is accessible through existing roads and/or levees. Therefore it is assumed that earthwork activities would be performed using land-based equipment. Construction equipment may likely include track-mounted excavators for excavation, dump trucks for on-site and off-site transport, and bulldozers and other heavy equipment for on-site fill placement.

As an alternative, large-capacity scrapers may be used for mass grading (i.e. marshplain excavation and onsite fill placement). In the right setting, scrapers are efficient for moving large soil volumes; however, their effectiveness may be limited at the Pacheco Marsh site because saturated soils may not support the weight of equipment.

Breaching and excavation/enlargement of the exterior channels will likely be performed with excavators.

6.5.2.2 Construction Sequence and Approach

Design elements will likely be constructed in the following order:

- Marshplain and interior channels excavation
- Onsite fill placement
- Road grading and surfacing
- Dredging of exterior channels
- Culvert installation
- Breaches and levee lowering

We assume that the marshplain and interior channels will be excavated concurrently, working progressively from the outer limits of the marsh toward inland areas. Once excavated to the design elevation, the marshplain will no longer be accessible because of saturated soils. The existing levee and/or high area will remain along the site perimeter for equipment access.

Prior to breaching, the upstream and downstream reaches of the inlet channel would be enlarged and excavated. Silt curtains and/or other sediment control measures should be in-place during dredging. In addition, if permitted by resource agencies, the existing culvert may be blocked while dredging the upstream channel.

Levee breaching would be performed during low tide and each breach would be completed within one tide cycle. Prior to breaching and tidal inundation of the site, the perimeter levee may be partially lowered (e.g. 6 feet NGVD). This would allow breaching and final levee lowering to be completed more quickly during low tide cycles. Final levee lowering will likely be performed starting at breach locations and working toward upland areas.

7. SITE MAINTENANCE

The restoration of Pacheco Marsh has been designed to minimize the necessity of long-term maintenance. However, some site maintenance will be required for infrastructure protection, to ensure successful restoration of tidal natural wetland structure and function, and possibly adaptive management actions.

Successful restoration at Pacheco Marsh will require adequate conveyance of tidal waters through the culverts, or other structures, that separate the "downstream" and "upstream" reaches of the inlet channel. These structures will require routine visual inspections to confirm proper function and check for debris blockage.

Infrastructure, such as the raised access road, bridges that span levee breaches, and pedestrian paths should be inspected on a regular basis to ensure that the structural integrity of these elements is maintained. Also, the protective levee along the eastern border of the 130-ft wide easement should be inspected to ensure that tidal inundation is not threatening access to the buried effluent pipeline.

The restored tidal marsh is expected to significantly reduce the mosquito production that presently occurs on-site by minimizing the areas of shallow ponded water and disturbing breeding with regular wetting and drying over the tidal marsh. In addition, the proposed grading plan allows for access to tidal marsh areas in the event that chemical treatments are required.

Although the existing peppergrass seed source on the site has the potential to invade the developing brackish marsh after restoration, native brackish species (alkali bulrush) have a competitive advantage due to the slight over-excavation of the marshplain which will allow natural sedimentation to raise the marshplain to the appropriate elevations for vegetation establishment. However, in the event that peppergrass is able to become established, spot treatments with chemical herbicides should be implemented for the first two or three years. Mechanical removal methods are unlikely to control peppergrass, as the species is able to regenerate quickly from rootstock remaining in the soil. Any chemical treatment should be by a Certified Pest Control Advisor with an herbicide approved by the EPA for use in aquatic settings.

8. ACKNOWLEDGMENTS

The Pacheco Marsh Restoration Plan was developed under the day-to-day direction of Kevin Emigh of the Contra Costa County Flood Control District. The Project Management Team – consisting of staff from the District, MHLT, and EBRPD – provided broader direction.

Comments and advice received from the TAC were integrated into the restoration plan. TAC participants included:

Larry Appleton	Hanson Aggregate
Tina Batt	MHLT
Greg Connaughton	CCC Flood Control
Jim Cutler	MHLT
Kevin Emigh	CCC Flood Control
Eric Gillies	State Lands
John Krause	CDFG
Russ Leavitt	CCCSD
Karl Malamud-Roam	CCMVCD
Tina Low	RWQCB
Beth Pardiech	MHLT
Cece Sellgren	CCC Public Works

This report was prepared by the following PWA staff:

Don Danmeier, Ph.D., Project Manager
Michelle Orr, P.E., Project Director
Dennis Ruttenberg, Engineering Design

With contributions from the following HTH staff:

John Bourgeois, M.S., Project Manager and Restoration Ecologist
David Thomson, M.S., Restoration Ecologist
Daniel Stephens, B.S., Principal
Scott Terrill, Ph.D., Senior Wildlife Biologist
Patrick Boursier, Ph.D., Senior Plant Ecologist
Kurt Flaig, M.S., Botanist
Laird Henkel, M.S., Wildlife Biologist

9. REFERENCES

Jonas & Associates Inc., 2002. Site Characterization Report: Praxis Property Martinez, California. Prepared for the Contra Costa County Public Works Department. January 22,2002.

Philip Williams & Associates, (PWA), 1991. Alternatives, Opportunities, and Constraints for Wetland Creation. Pacheco Creek at Martinez. Prepared for the California Coastal Conservancy.

Philip Williams & Associates, (PWA), 1997. Tidal and Freshwater Marsh Creation at Pacheco Marsh, Martinez. Opportunities and Constraints and a Comprehensive Scope of Work. Prepared for the California Coastal Conservancy, the San Francisco Bay Joint Venture, and the Martinez Regional Land Trust. Project #1154-21. November , 1997.

Philip Williams & Associates, (PWA), 1995. Design Guidelines for Tidal Channels in Coastal Wetlands. Prepared for the U.S. Army Corps of Engineers, Waterways Experiment Station. Project #934. January 1995.

Philip Williams & Associates, (PWA), 1998. Martinez Shoreline Salt Marsh Enhancement: Conceptual Plan Elements. Prepared for the City of Martinez. Project #1246. November 20, 1998.

Sycamore Environmental Consultants (Sycamore), 2001. Evaluation of Special-Status Plant and Wildlife Species on the Praxis Property. Prepared for Jonas & Associates, Inc. December 20,2001.

Williams, P.B., M. Orr, and N. Garrity, 2002. "Hydraulic Geometry: A Geomorphic Design Tool for Tidal Marsh Channel Evolution in Wetland Restoration Projects", Restoration Ecology, September 2002, 10:3, pp. 577-590.

10. FIGURES

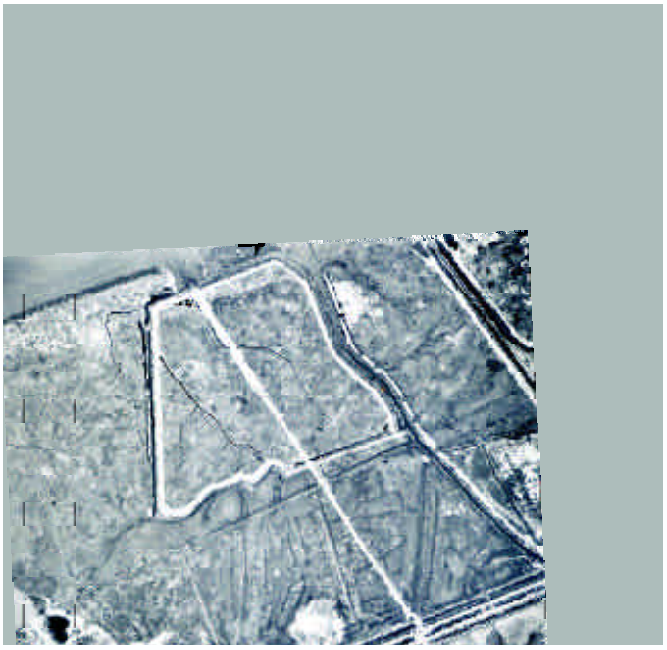
figure 1

Pacheco Marsh Restoration Plan

Project Site Location Map

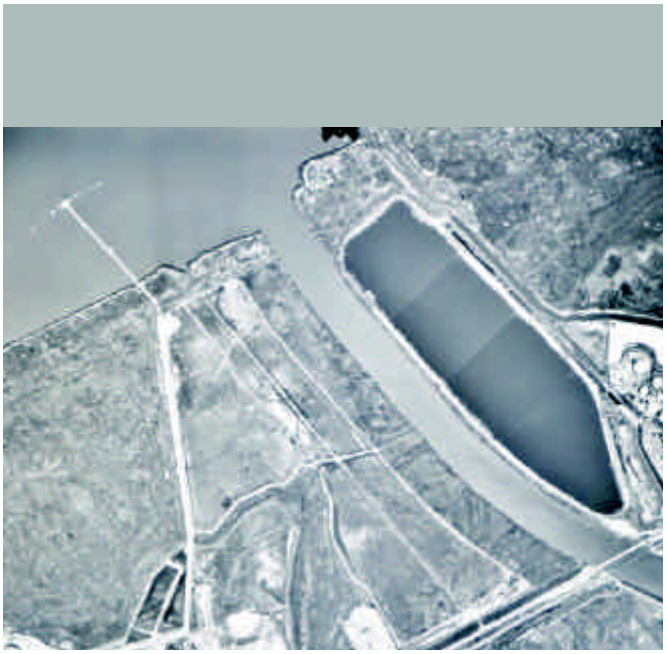
1672/ task 11/ figures/LocMap.cdr

PWA



1959

1971



1982

1996

figure 2

Pacheco Marsh from 1959-1996

#1672/Task11/figures/HistoricPacheco.cdr

PWA

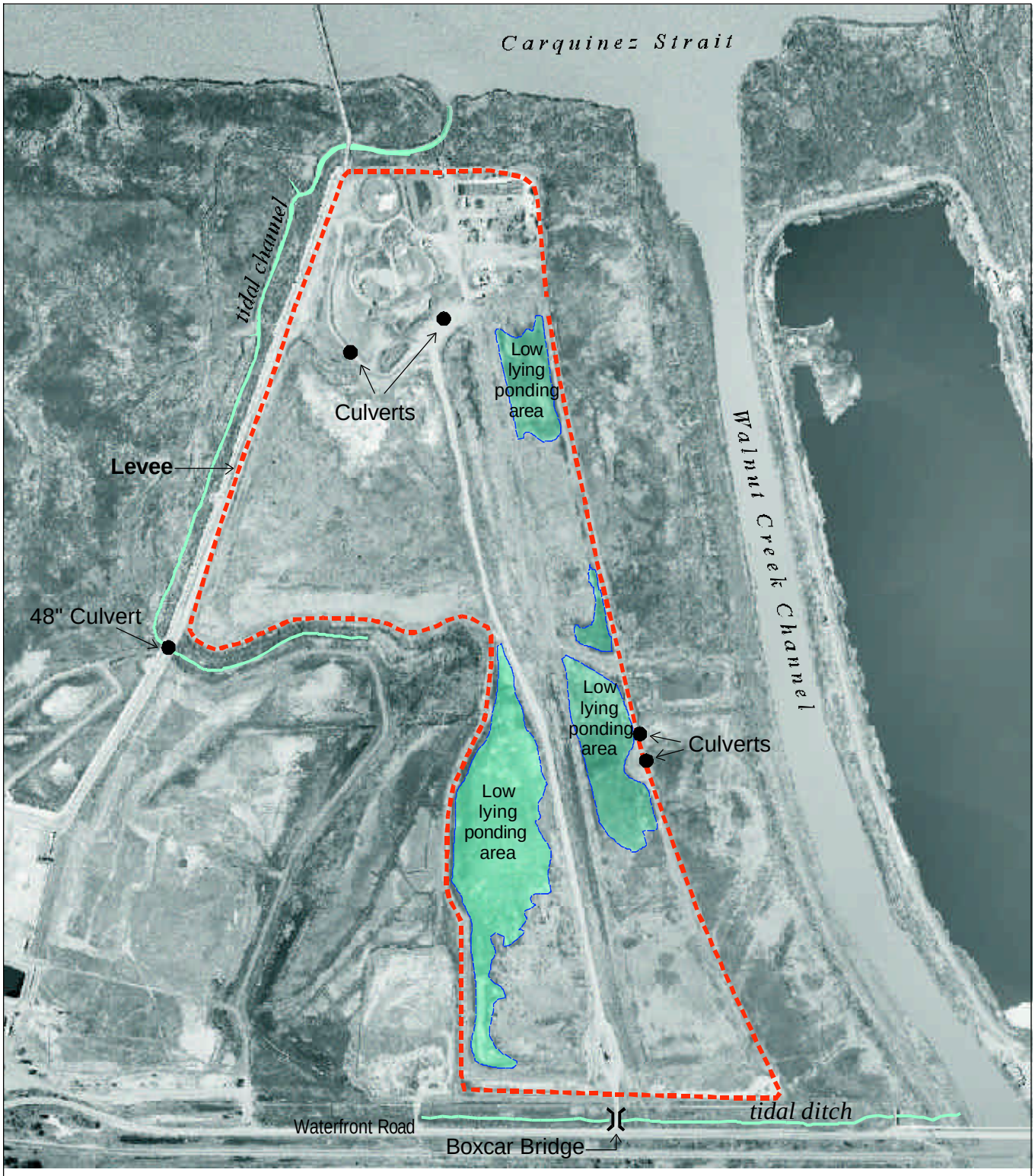
figure 3

PachecoMarsh RestorationPlan

Existing Conditions

1672/task 11/figures/Ex_Con.cdr

PWA



N

0 600 1,200

feet

figure 4

Pacheco Marsh Restoration Plan

Site Drainage

1672/task 11/figures/Site_Drainage.cdr

PWA

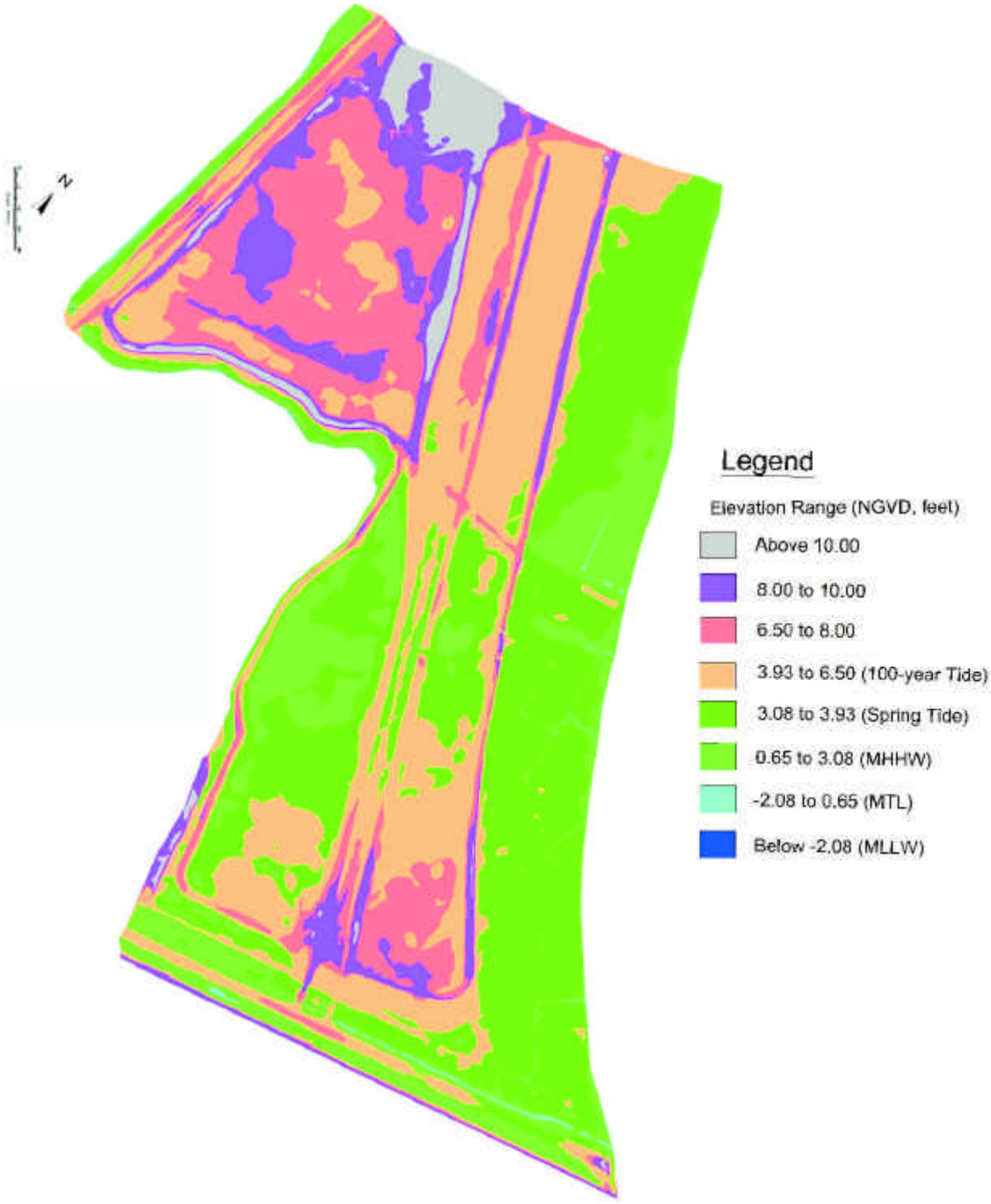


figure 5

Pacheco Marsh RestorationPlan

Existing Topography

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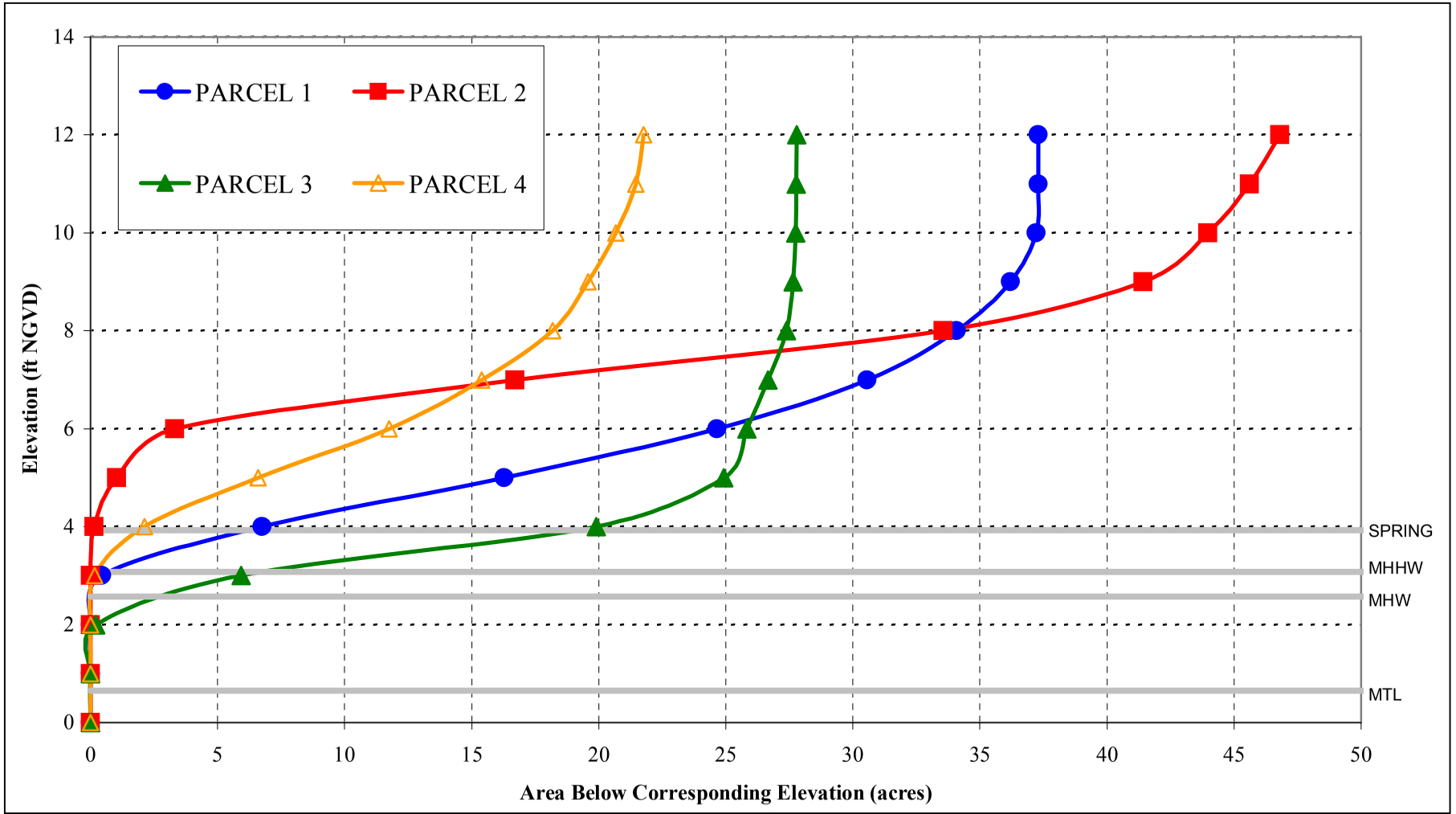

figure 6

Pacheco Marsh Restoration Plan

Hypsometric Curves of Existing Conditions

PWA REF 1672

PWA

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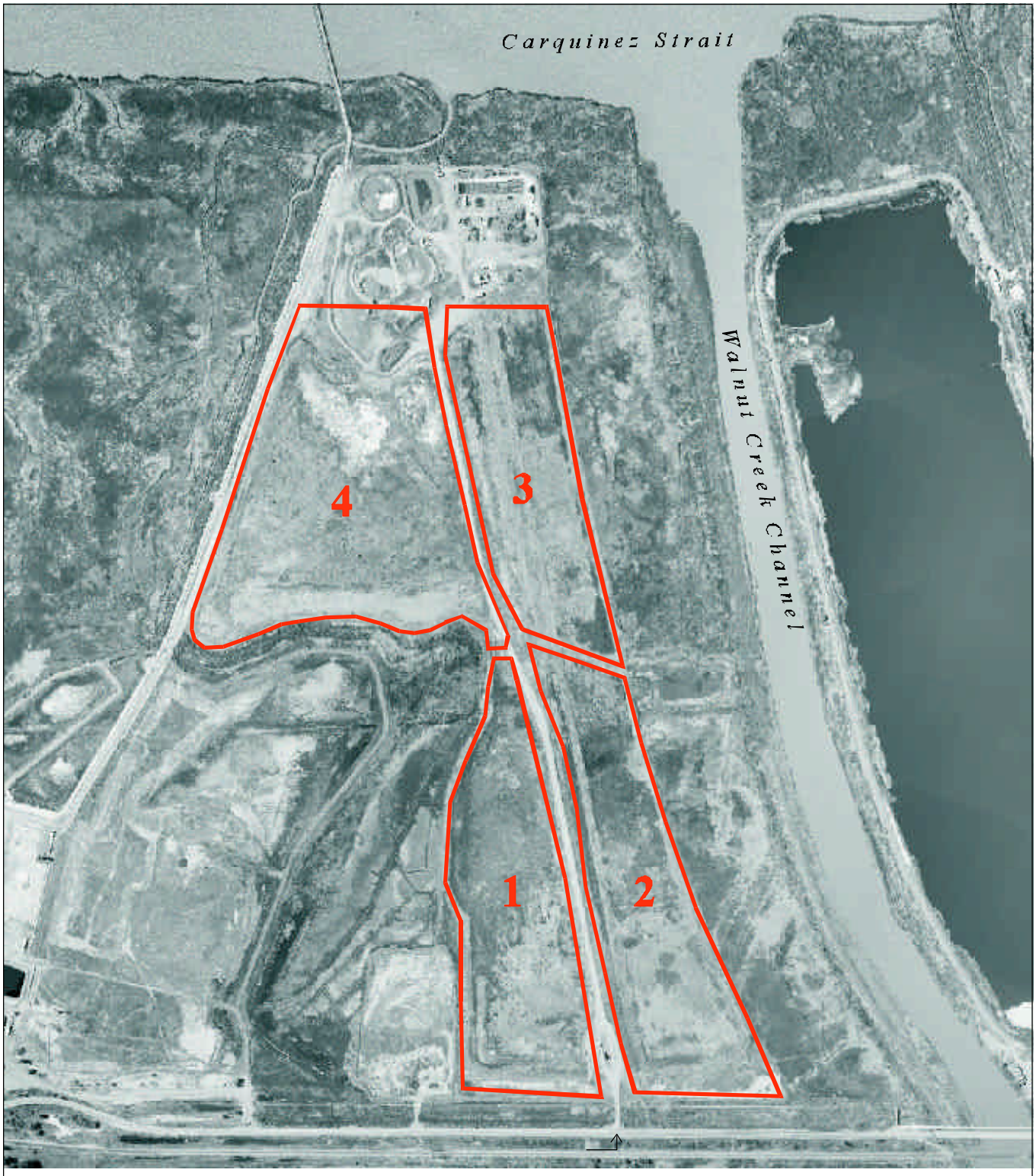

N

0 600 1,200

feet

figure 7

PachecoMarsh RestorationPlan

Basin Numbering

1672/task 11/figures/numbering.cdr

PWA

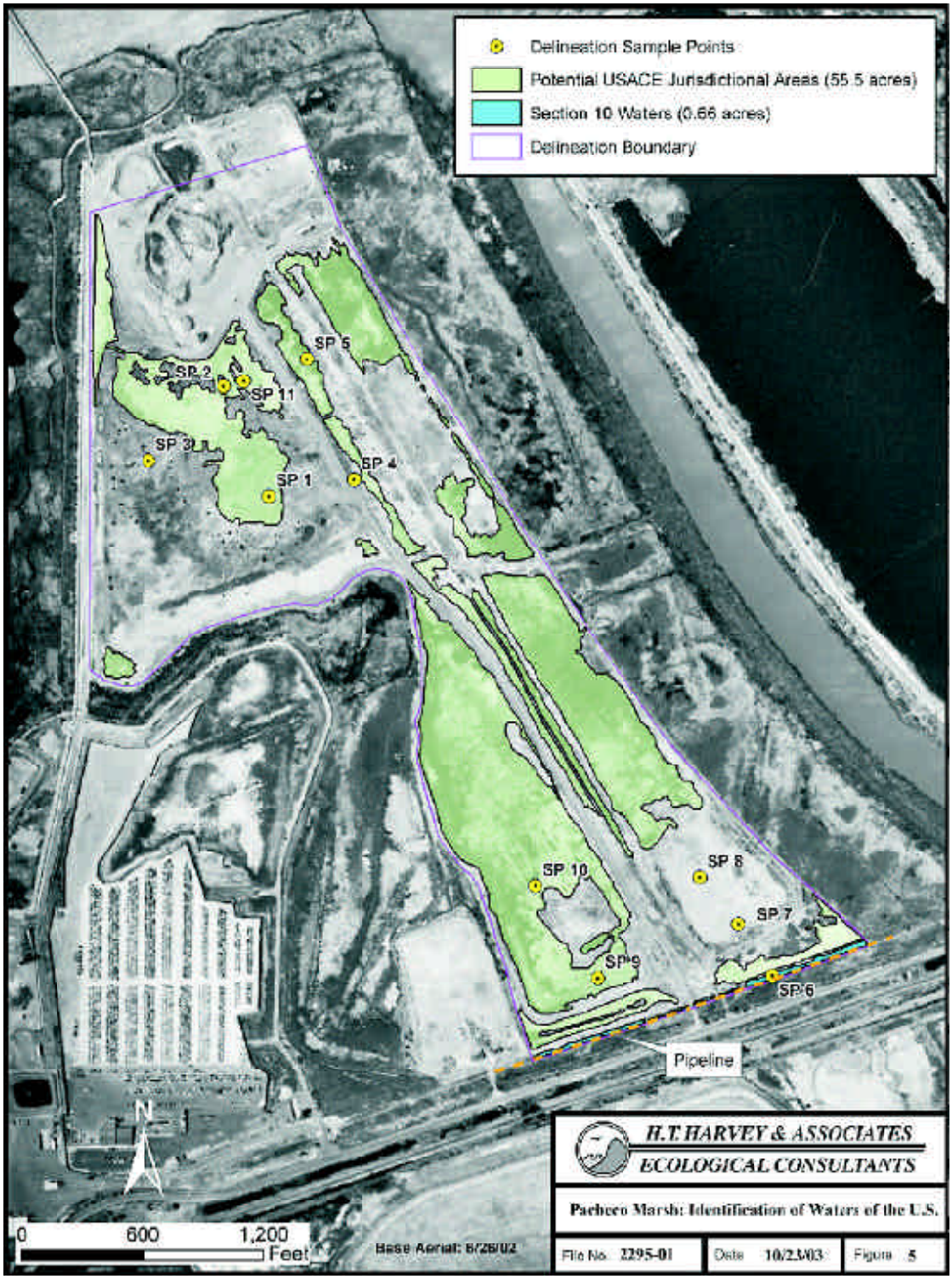

figure 8

PachecoMarsh RestorationPlan

Existing On-Site Wetland Habitat

#1672/task11/figures/ExistingOn-Ste_WetlndHab.cdr

PWA

Pilot/StarterChannel

New/Improved Culvert

Tidal salt marsh (nograding)

Tidal salt marsh (grading)

Remove levee or breach

figure 9

Pacheco Marsh Restoration Plan

Alternative 1
Maximum Tidal Marsh Restoration

1672/task 11/figures/Alt1-Marsh_RestBE.cdr

PWA

Pilot Channel

Tidal salt marsh (nograding)

Tidal salt marsh (grading)

Remove levee or breach

Lower levee

figure 10

Pacheco Marsh Restoration Plan

Alternative 2
Tidal Panne Creation

#1672/task11/figures/Alt2-Tidal_PanneBE.cdr PWA

Pilot Channel

Tidal salt marsh (nograding)

Tidal salt marsh (grading)

Remove levee or breach

Lower levee

figure 11

Pacheco Marsh Restoration Plan

Alternative 3
Managed Brackish Wetland

#1672/task11/figures/Alt3-Seasonal_WetlandBE.cdr

PWA

Pilot Channel

Outlet

Tidal salt marsh (nograding)

Tidal salt marsh (grading)

Remove levee or breach

Lower levee

figure 12

Pacheco Marsh Restoration Plan

Alternative 4
Managed Freshwater Wetland

#1672/task11/figures/Freshwater_WetlandBE.cdr

PWA

figure 13

Pacheco Marsh
Plan View of Preferred Alternative

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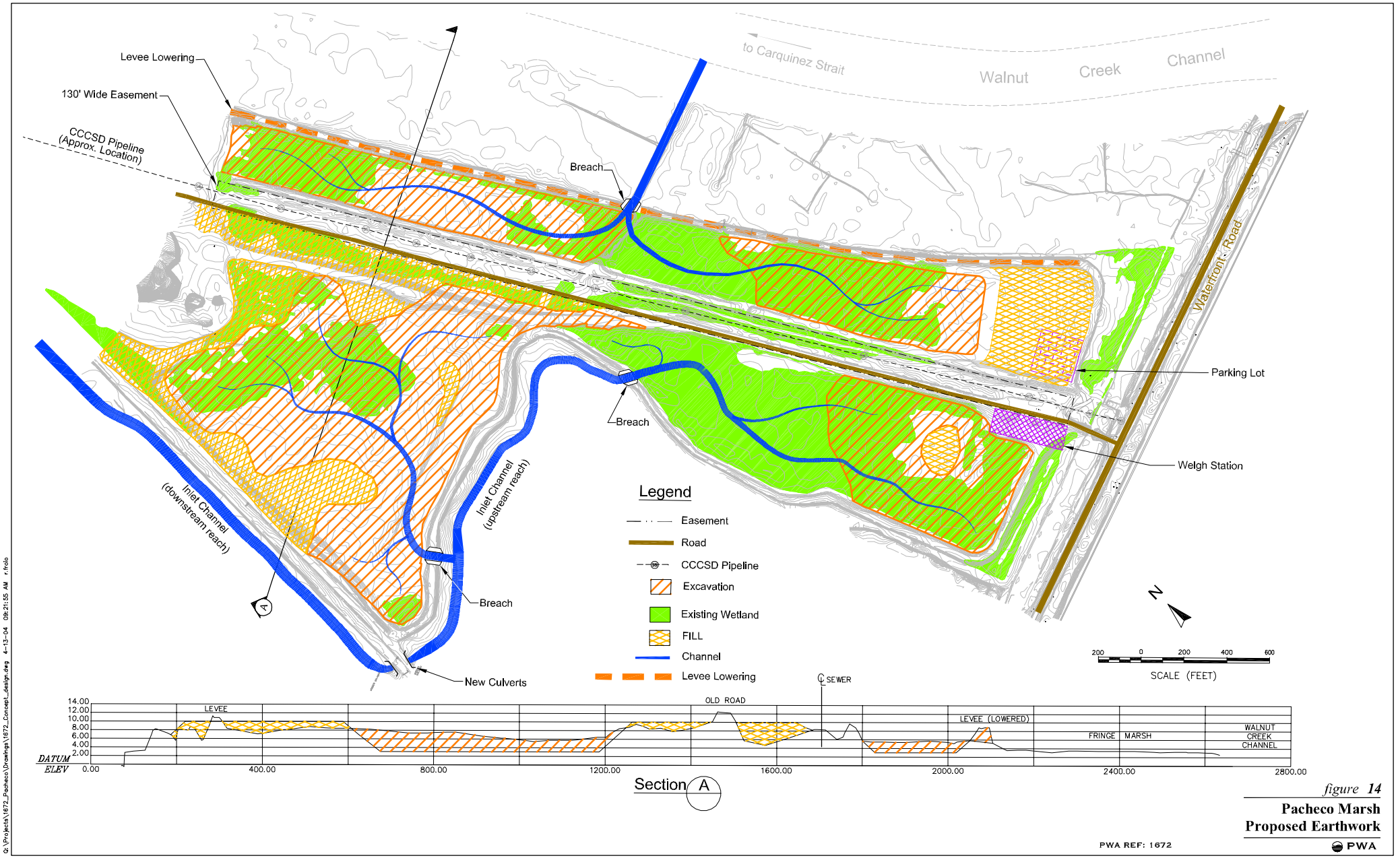

figure **14**

Pacheco Marsh
Proposed Earthwork

PWA REF: 1672

PWA

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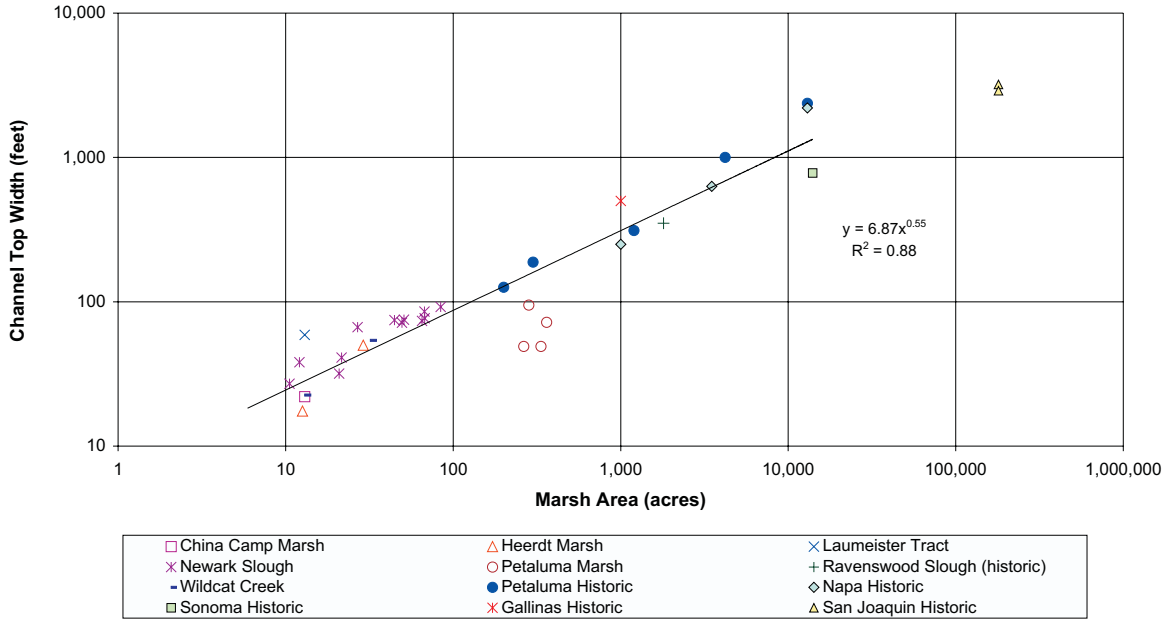
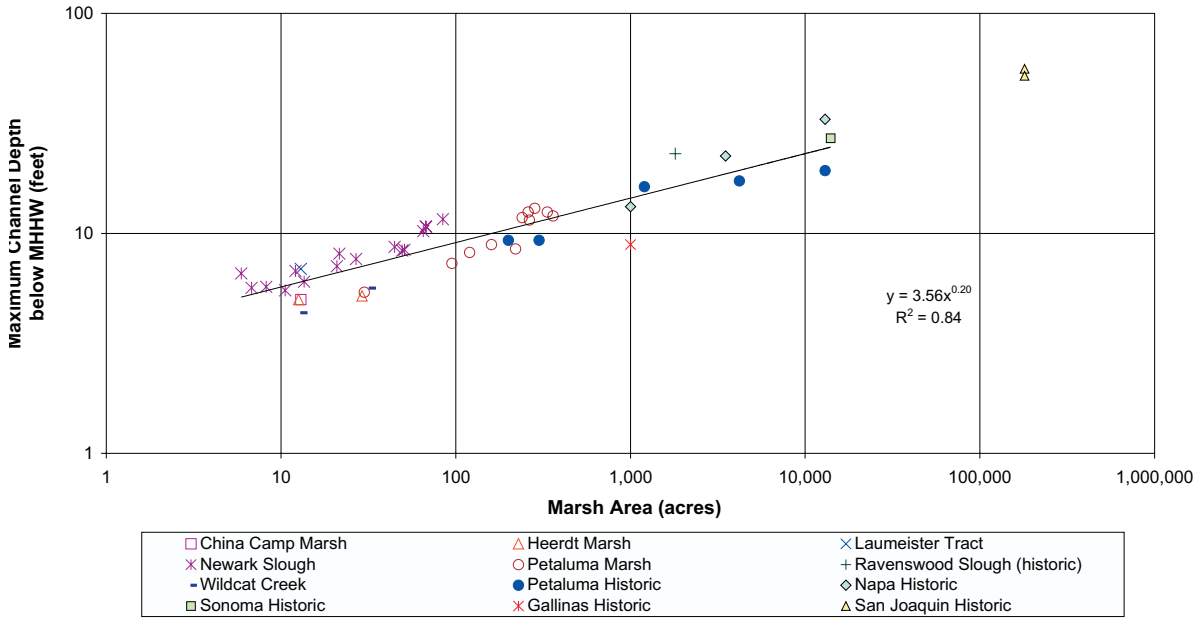




Source: Williams et. al, 2002.

figure 15

Pacheco Marsh Restoration Plan

Hydraulic Geometry Relationships for San Francisco Bay

1672/ task 11/ figures/HydGeo.cdr

PWA

APPENDIX A

Wetland Technical Assessment

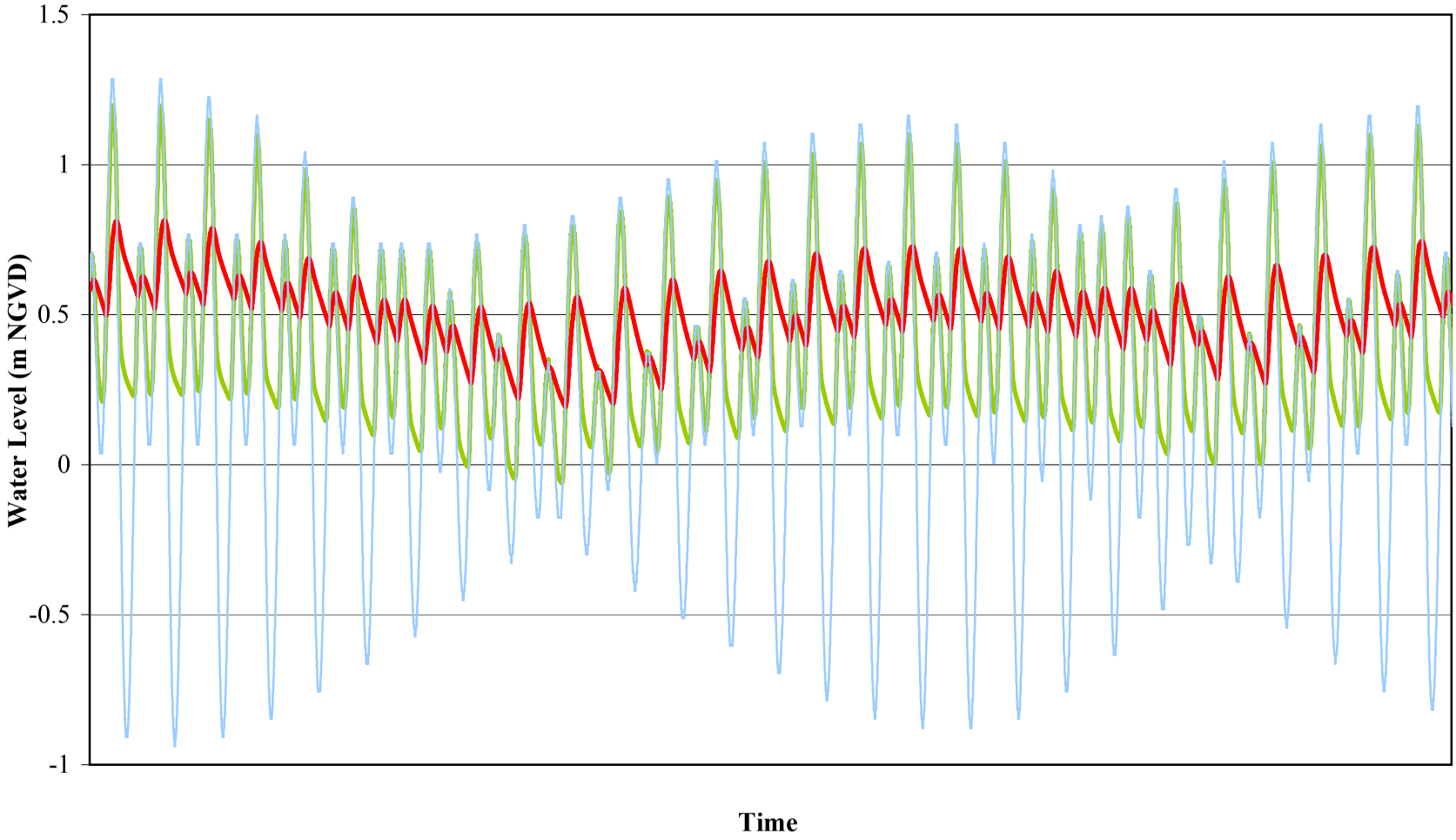
(H.T. Harvey Report – available in PDF format only, with Figure 5 [oversized] graphic printed)

APPENDIX B
Numerical Modeling

PWA carried out numerical modeling to assess the hydraulic conveyance of the existing inlet channel and culverts. Time series of water level and currents were simulated using the MIKE11 model developed by the Danish Hydraulic Institute, and cross sections surveyed by the County. Since no hydrologic data were collected as part of this project, predicted tides were used drive the model and no calibration was carried out. Therefore, the model was only used to examine the tidal conveyance at a screening-level, and empirical data collected form other marshes in San Francisco Bay (Williams et. al. 2002) was used to confirm conclusions drawn from model findings.

Figure B-1 shows simulated water levels along the downstream and upstream reaches of the inlet channel, as well as the predicted tides in Suisun Bay. The simulated tidal damping is generated by the undersized inlet, since no culvert or other hydraulic structure was included in this simulation. Damping is most acute at the downstream reach due to the extremely small cross sections along this section of the inlet channel.

Figure B-2 shows water levels simulated over the same time period, but assumes the long-term equilibrium geometry to the inlet channel and four 48-inch culverts. In this case, some damping is evident from the culvert, but the inlet channel does not impede the conveyance of tidal waters.



Downstream
Upstream
Boundary

figure B-1

Pacheco Marsh Restoration Plan

Simulated Water Levels - No Culvert, Existing Channel Geometry

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PWA

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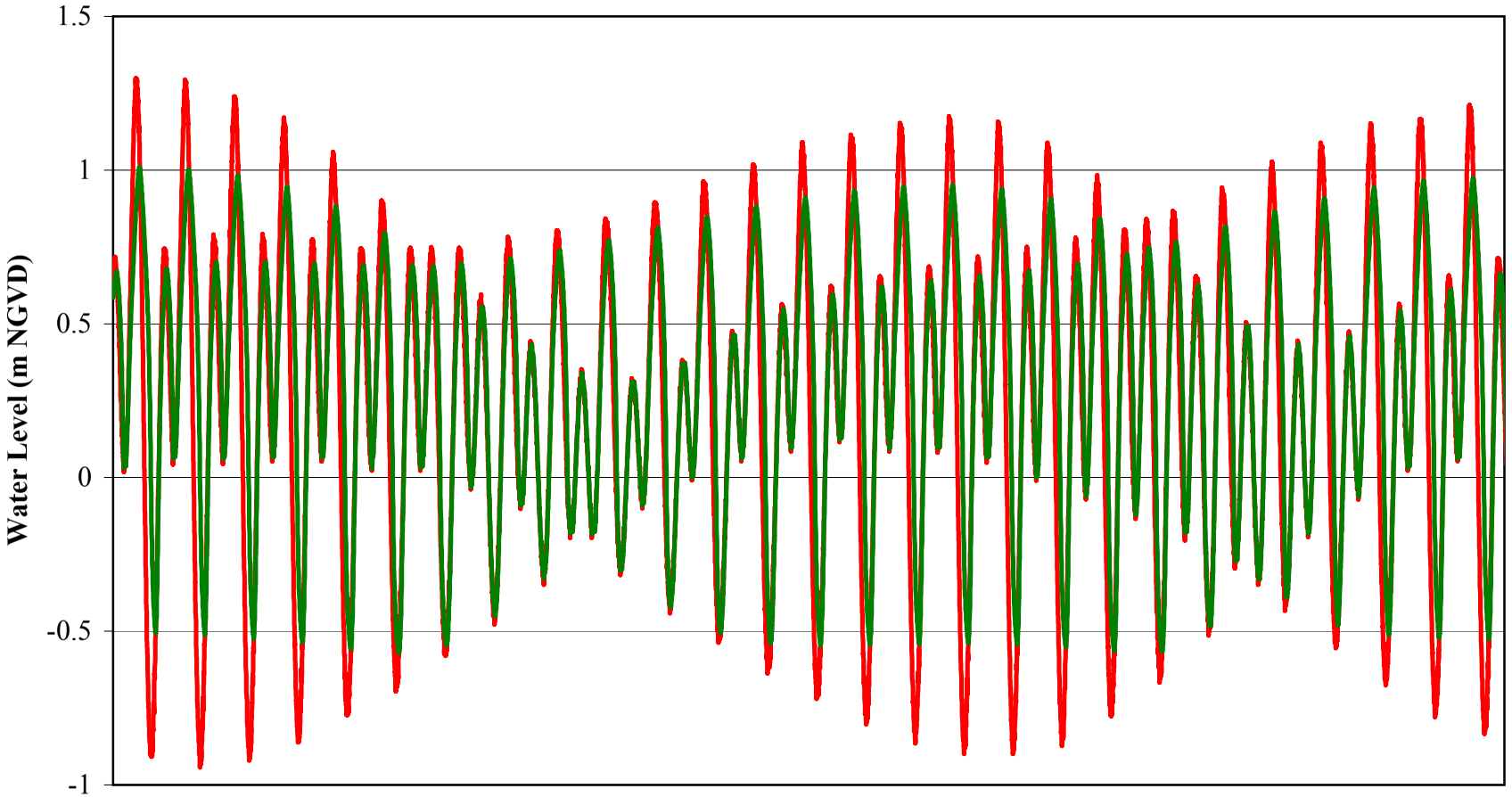

Notes: Assume 4 48-inch culverts and enlarged channel geometry.

4 Culverts (Downstream)

4 Culverts (Upstream)

figure B-2

Pacheco Marsh Restoration Plan

Simulated Water Levels - 4 Culverts, Enlarged Channel Geometry

PWA REF 1672

PWA

P:\1672_Pacheco\Task11-DraftReport\figures\AppB.xls WSE-culvertdamping

APPENDIX C
Estimate of Implementation Costs

PWA and HTH staff generated preliminary cost estimates of expected implementation activities, which include the following:

- Preliminary and final design activities,
- Preparation of construction documents,
- Permitting support, and
- Construction and planting costs.

Although we contacted contractors to discuss likely construction methods and participated in a site visit with District Staff, several details of the restoration plan describe remain unresolved. In order to acknowledge these uncertainties, we have developed a low-high range of expected implement costs for each element and design activates. Tables C-1 and C-2 list these itemized costs, respectively, for the expected costs of design and construction.

Where possible, implementation costs in Table C-2 have been listed by item and basin to assist the MHLT and District in future discussions regarding costs sharing.

Table C-1. Itemized Expected Construction Costs

	All Basins		Basin							
			1		2		3		4	
	low	high	low	high	low	high	low	high	low	high
Revegetation										
Seed Imprinting	$100,000	$250,000	$20,000	$50,000	$20,000	$50,000	$0	$0	$60,000	$150,000
Control of Invasives	$174,400	$436,000	$34,900	$87,200	$34,900	$87,200	$0	$0	$104,600	$261,600
Soil Amendments	$88,000	$154,000	$17,600	$30,800	$17,600	$30,800	$0	$0	$52,800	$92,400
subtotals	**$362,400**	**$840,000**	**$72,500**	**$168,000**	**$72,500**	**$168,000**	**$0**	**$0**	**$217,400**	**$504,000**
Hydroseed + planting	$444,520	$800,640	$88,900	$160,100	$88,900	$160,100	$0	$0	$266,700	$480,400
Control of Invasives	$174,400	$436,000	$34,900	$87,200	$34,900	$87,200	$0	$0	$104,600	$261,600
Soil Amendments	$88,000	$154,000	$17,600	$30,800	$17,600	$30,800	$0	$0	$52,800	$92,400
Revegetation subtotals	**$706,920**	**$1,390,640**	**$141,400**	**$278,100**	**$141,400**	**$278,100**	**$0**	**$0**	**$424,100**	**$834,400**
Construction	**$2,766,000**	**$5,080,500**	**$190,000**	**$371,500**	**$276,000**	**$526,000**	**$284,000**	**$538,000**	**$2,016,000**	**$3,645,000**
Public Access										
Pedestrain Bridge	$224,000	$288,000	$112,000	$144,000	$0	$0	$0	$0	$112,000	$144,000
Trail	$140,000	$280,000	$35,000	$70,000	$35,000	$70,000	$35,000	$70,000	$35,000	$70,000
Parking Area	$40,000	$80,000	$0	$0	$40,000	$80,000	$0	$0	$0	$0
Public Access subtotals	**$404,000**	**$648,000**	**$147,000**	**$214,000**	**$75,000**	**$150,000**	**$35,000**	**$70,000**	**$147,000**	**$214,000**
Subotals										
Revegetation + construction + public access	$3,876,900	$7,119,100	$478,400	$863,600	$492,400	$954,100	$319,000	$608,000	$2,587,100	$4,693,400
Mobilzation	$271,400	$498,400	$33,500	$60,500	$34,500	$66,800	$22,300	$42,600	$181,100	$328,500
Contigencies	$829,700	$1,523,500	$102,400	$184,800	$105,400	$204,200	$68,300	$130,100	$553,600	$1,004,400
TOTALS	**$4,978,000**	**$9,141,000**	**$614,300**	**$1,108,900**	**$632,300**	**$1,225,100**	**$409,600**	**$780,700**	**$3,321,800**	**$6,026,300**

Table C-2. Itemized Expected Design Costs

		low	high
Task 1	Prepare Preliminary Design	$ 30,000	$ 40,000
Task 2	Permitting Assistance	$ 30,000	$ 60,000
Task 3	Stakeholder Meetings & Coordination	$ 15,000	$ 35,000
Task 4	Geotechnical Investigation	$ 15,000	$ 25,000
Task 5	Ground Su	$ 5,000	$ 15,000
Task 6	Grading - Construction Documents	$ 100,000	$ 180,000
Task 7	Pedestrian Bridge - Construction Documents	$ 60,000	$ 90,000
Task 8	Revegetation - Construction Documents	$ 30,000	$ 60,000
Task 9	Cost Estimates	$ 5,000	$ 10,000
Task 10	Bidding & Construction Support	$ 25,000	$ 50,000
Task 11	Expenses	$ 5,000	$ 10,000
	Total	**$ 320,000**	**$ 575,000**

APPENDIX D
Comments on Soil Quality Assessment

1 of 5

H.T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

TRANSMITTAL MEMORANDUM

FAXED 3/1/04

TO: Don Danmeier
Philip Williams & Associates
720 California St., 6th Floor
San Francisco, CA 94108

DATE: March 1, 2004

PROJECT NUMBER: 2295-01

FAX: (415) 262-2303

PROJECT NAME: Pacheco Marsh Restoration

FROM: John Bourgeois

WE ARE TRANSMITTING:

☒ Herewith	☐ Via Mail	☒ Via Fax	#of pages: 5, including cover
☐ Under Separate Cover	☐ To Be Picked Up	☐ Fed Ex	

THE FOLLOWING:

☐ As Requested	☐ For Payment	☐ For Review And Comments
☐ For Signature/Return	☐ For Approval	☐ Returned For Corrections
☐ For Your Use/Information	☐ For Your Records	☐ CONFIDENTIAL!

REMARKS:

A memo detailing the results of tests for contaminants in the property soils and the next steps needed to proceed with a restoration plan.

Please call me if you have any questions; I can be reached at (408) 448-9450 x 403.

Thank you.

COPIES TO:

San Jose Office
3150 Almaden Expressway • Suite 145
San Jose, CA 95118 • 408-448-9450 • Fax: 408-448-9454

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

MEMORANDUM

TO: Don Danmeier (Phillip Williams and Associates)

FROM: John Bourgeois (H. T. Harvey & Associates)

CC: Dan Stephens, David Thomson (H. T. Harvey & Associates)

DATE: 1 March 2004

RE: Pacheco Slough Soil Contaminants Evaluation (Project no. 2295-01)

Dan,

Contra Costa County Flood Control District (District), the Muir Heritage Land Trust (MHLT), and the East Bay Regional Park District (EBRPD) propose to restore wetland functions and wildlife habitat at the 126-acre Pacheco Marsh property, located east of Martinez, California. The District acquired the property in 2002, with the assistance of the MHLT and the EBRPD. As stated in the Memorandum of Understanding (MOU) between these agencies, the main goal of the acquisition is to restore wetland and wildlife habitat while accommodating the existing uses at the site and planning for future public recreation projects.

Over the past fifty years, levees constructed along the perimeter of the site eliminated regular tidal inundation and the internal placement of dredge spoils has substantially raised ground elevations. We base the following summary of soil contamination issues on a soil sampling report by Mark Jonas (Jonas & Associates Inc. 2002) and the San Francisco Bay Regional Water Quality Control Board's sediment screening criteria for wetlands (RWQCB 2000). For planning purposes the project area was subdivided into four Sub-basins. Sub-basin 1 sits to the southwest, Sub-basin 2 to the southeast; Sub-basins 3 and 4 occupy the northeast and northwest, respectively.

The Jonas and Associates report compares the detected metals to background concentration ranges for the western U.S. (Bowen 1979, Shacklette and Boerngen 1984) and California (Kearney 1996). We have added the San Francisco Bay Ambient Sediment Concentrations from the RWQCB document, as it is the basis of their guidelines for sediment in created wetlands under their jurisdiction. Based upon these data, elevated mercury and selenium concentrations will need to be addressed by the restoration project.

The Jonas and Associates *Site Characterization Report* concludes: "Borderline elevated concentrations of arsenic and selenium may exist." However, when compared to the San Francisco Bay RWQCB "Recommended Sediment Chemistry Screening Guidelines" for wetland

surface material (defined as the upper 3 feet), it appears that all sample arsenic levels are actually slightly below the maximum concentration allowed, while many selenium samples and one mercury sample exceeded their respective criteria (Table 1). The one sample contaminated with mercury (SB23 – northwestern boarder of Sub-basin 4) above RWQCB guidelines (0.73 mg/Kg; criterion is 0.70 mg/Kg) lies in an area that will remain upland according to the current restoration design. Therefore, only selenium will be discussed further.

Table 1. Comparison of sampled concentrations to different guidelines

Detected metal	Concentration range from Jonas and Associates (mg/Kg)	W. U.S. background range (mg/Kg)	CA background range (mg/Kg)	SF Bay ambient range (mg/Kg)	SF Bay RWQCB sediment screening guidelines for wetland surface material (mg/Kg)
Arsenic	ND to 11	<0.01 to 97	0.6 to 11.0	13.5-15.3	15.3
Mercury	ND to 0.72	<0.01 to 4.6	0.05 to0.90	0.25-0.43	0.43
Selenium	ND to 3.1	<0.10 to 4.3	0.015 to 0.43	0.59-0.64	0.64

Jonas and Associates collected discrete soil samples by two different methods. In samples 1-14, they collected samples from 1 and 4 feet below ground surface (bgs), whereas in samples 15-27 they collected samples from depths of 1, 3, 5, and 10 feet. Unfortunately, the report states that the discrete samples were combined into one "composite sample" by STL ChromaLab prior to analysis, so there is no way to get depth specific information from this analysis. Depth information would have allowed us to perform a coarse estimation of the acreage contaminated within the wetland footprint. Depth information would also have allowed for comparing the selenium contamination depths to the design grades so that we would know where it would be more than 3 feet bgs, as the RWQCB's has no criterion (*i.e.* no limit) for selenium in their wetland foundation material category.

However, we noted from our analysis of the boring data that the majority of the selenium contaminated borings were from those that reached a depth of 10 feet (8 of 12 or 66%); the shallow borings did not contain a large fraction of contaminated samples (2 of 14 or 15%). From this we can hypothesize that the vast majority of the selenium contamination may occur at a depth greater than 4 feet bgs.

Beginning in Sub-basin I, 2 of the 7 borings in this Sub-basin contained selenium contamination, and one of these is outside of the restoration area (SB 16). Only SB 3, a shallow sample site (*i.e.* 1-4 feet), contains elevated selenium. The area around SB 3 is not slated for grading, although it is near the pilot channel creation footprint. If the selenium contamination is within 3 feet of grade in this vicinity, over-excavation may have to occur in order to meet the RWQCB's criteria for wetland surface material. In those areas where over-excavation is required, we believe that there may be suitable clean material that can be transferred from other areas on-site that are being graded, or from existing wetland channels that will be widened as part of the restoration.

In Sub-basin II, 1 of 6 borings contained selenium contamination. SB 27, a deep sample site (*i.e.* 1-10 feet), is within the restoration area and within an area slated for grading by the current

restoration design. With more detailed depth information, it may be possible to utilize some of the graded material as wetland surface material at the design grade, if necessary.

In Sub-basin III, 3 of the 5 borings were contaminated with selenium. The three contaminated borings (SB 24, 25, and 26) were all deep samples whereas the clean samples (SB 9 and 10) were both shallow samples. If the hypothesis posed above is correct, then this entire Sub-basin may be contaminated with selenium below 4 feet. Depending upon the final design grade, some of this contamination may require over-excavation and backfilling with suitable wetland surface material so that the selenium contamination is at least 3 feet bgs.

In Sub-basin IV, 4 of 9 borings are contaminated with selenium. Three are deep borings (SB 19, 20, and 23) and one was shallow (SB 5). This is a mixture of deep and shallow, likely indicating there is more complexity in the depths of selenium contamination. SB 5 is within the wetland grading area and also near pilot slough channels. SB 19 and 20 are also likely in this same area. Only SB 23 is obviously outside of the wetland footprint and should not be considered further.

Our first recommendation would be to check with the lab or Jonas and Associates to see if there is sufficient (if any) suitable material remaining at specific depths in order to retest for selenium stratification. If not, depth-specific sampling and testing for selenium may be required. It is possible that the majority of the selenium contamination may lie beneath 4 feet bgs. As stated above, the RWQCB has not issued a maximum selenium concentration for wetland foundation material (greater than 3 feet bgs); therefore, it is possible to over-excavate any area where the selenium exists near the finish grade of the predicted wetland to at least 3 feet bgs and then backfill with clean and suitable wetland surface material. Some or all of this material may be available on site. It would also be useful to investigate whether or not the excavated selenium-contaminated material can be safely stockpiled on site or if it needs to be disposed of, and in what class of landfill. Off-haul and disposal would be a significant increase in expense to the project.

If you have any questions please call me at 408-448-9450 ext. 403.

Literature Cited

Bowen, HJM, 1979. Chapter 3. The elemental geochemistry of rocks. Chapter 4. The elemental geochemistry of soils. P. 31-62. In: Environmental Chemistry of the Elements. London: Academic Press.

Jonas, Mark, 2002. Site Characterization Report, Praxis Property. Martinez, California. Prepared for Contra Costa County Public Works Department by Jonas & Associates Inc. (Job CCC-214) January 22, 2002. 10pp. plus appendices.

Kearney Foundation, 1996. Background concentrations of trace and major elements in California soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Press.

RWQCB (SF Bay), 2000. Draft Staff Report on the Beneficial Use of Dredged Materials: Sediment Screening and Testing Guidelines. Contacts: Fred Hetzel and Glynnis Collins. 31pp.

Shacklette, HT and JG Boerngen, 1984. Elemental concentrations in soils and other surficial materials of the conterminous United States. US Geological Survey

APPENDIX E
Minutes from Meeting on Public Access Features

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MEMORANDUM

To: Pacheco Marsh TAC
From: Jim Cutler JWC
Muir Heritage Land Trust
Subject: Public Access Features
Date: December 9, 2003

As a result of the last TAC meeting's discussion on the Pacheco Marsh Restoration Plan, a meeting was held with recreation agencies. In attendance were: Jim Cutler for Muir Heritage Trust, Steve Fiala (EBRPD), Kevin Emigh (CCC FCD), and Richard Pearson and Joe Enke (City of Martinez). The purpose was to discuss potential recreation facilities on site. The committee came to a consensus on these items:

- Staging Areas

  BCDC is requiring the City of Martinez to build a small staging area for 15+ cars on its property immediately to the west of the Pacheco Marsh site. It is on the remedied auto dismantler site owned by the City. The Draft Pacheco Marsh Restoration Plan shows a small staging area for 20+ cars on it.

  There was consensus that it didn't make sense to have two adjacent small staging areas being built. Since Martinez is mandated to move ahead with their facility, it would be more logical to have a consolidated facility built on the City property. The Pacheco Marsh site would become an alternative site if for some reason the Martinez facility doesn't proceed.

- Pacheco Marsh-Martinez Compatibility

  Martinez has obligations to BCDC to place a conservation easement over their property and to protect the whole site as open space in perpetuity. The Martinez property contains wetland on its western half and the eastern half is a rehabilitated upland area. The eastern half will have a loop trail around the upland area with barriers to keep people out of the wetland

areas. It is possible that in the future the upland area will be considered for more active compatible recreation uses.

There appears to be potential to functionally integrate the Pacheco Marsh and Martinez property into a cohesive unit with the adjacent State Lands Commission owned property. This will result in a larger more functional recreational and wetland system.

- Tie to the EBRPD Trail System

The EBRPD has a trail that will parallel the Walnut Creek channel on its western bank with its northern terminus at Waterfront Road. The EBRPD Master Plan anticipates a new District trail extending east-to-west along Waterfront Road from the Walnut Creek channel eastward to connect with the Martinez Regional Shoreline.

It is desirable to design interior trails on Pacheco Marsh and on the Martinez property to allow for convenient connection with this future Waterfront Road Trail. The staging area provided on the Martinez property, or on the alternate Pacheco Marsh property, will be designed with the prospect of connection with this regional trail system.

- Local Trail System

Two loop trails appear desirable to serve this area. A major trail loop will be created by using the access road easement and go north to the Tidewater/Hansen holding. The trail would meander across the uplands to the west to connect to the levee along the western edge of the Pacheco Marsh. The vistas from this wetland of the Carquinez Strait would be exciting. The trail would then jog south along the levee until it joins the Martinez property and merges with the trail at the Martinez staging area. It will parallel Waterfront Road to connect back to the access easement to the east. (See Map 1.)

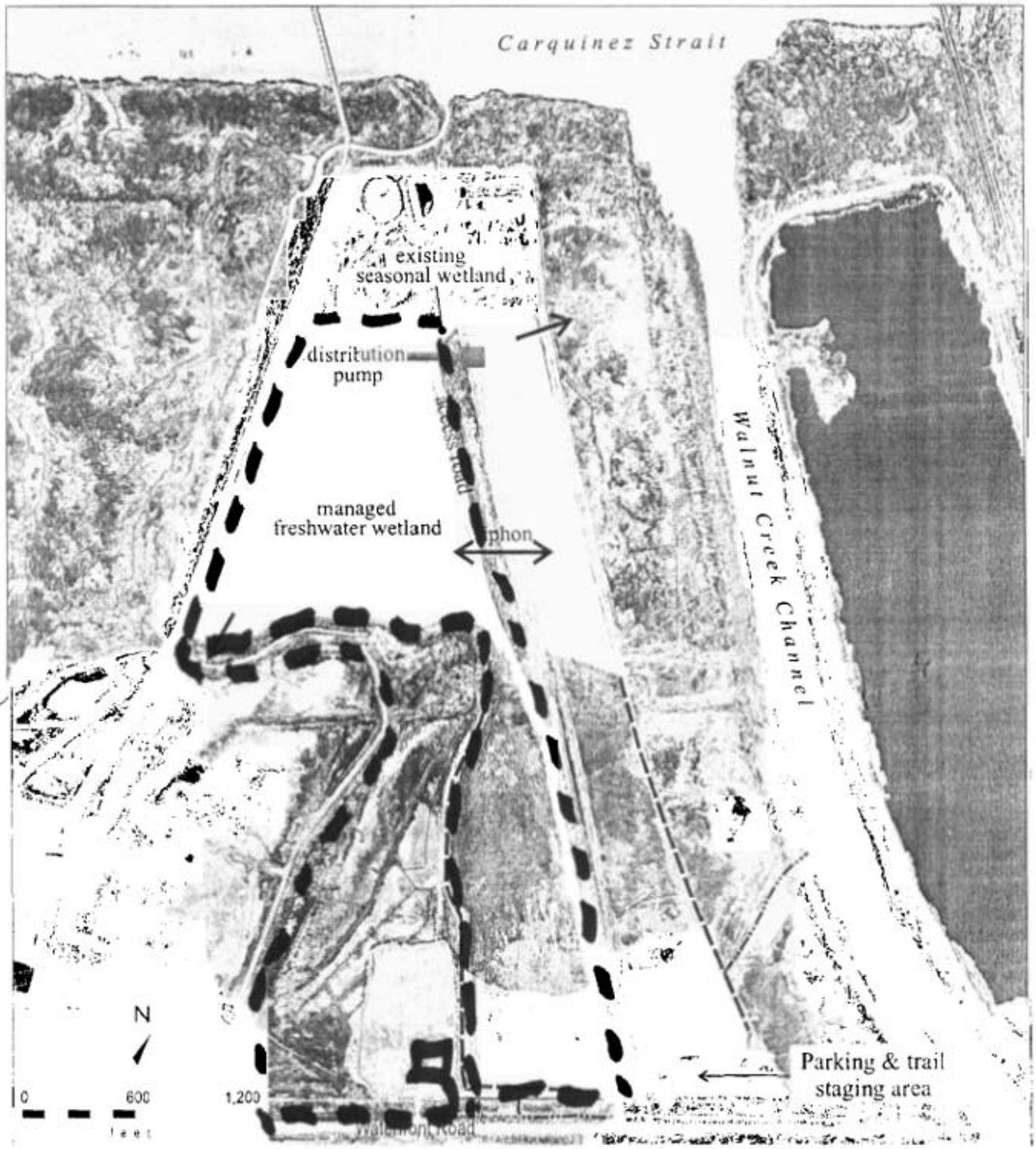
A second smaller loop would be created by connecting the Martinez Staging area with a trail west along Waterfront Road to the existing BCDC mandated trail along the existing levee up to the most westerly edge of the Pacheco Marsh property. Here it will connect to the larger loop trail. It will provide a shorter loop option for trail users.

These trails would be dirt or gravel except for the access easement that may have a more permanent surface material.

- Informational Sign Boards

Information panels could be placed along one or both trails that will help in interpretation and information about the Marsh environment, its residents and how the site was reclaimed.

MAP 1



--- loop trails
Parking Staging Area