Ballona Wetland Preserve - Area A
Preliminary Geotechnical Investigation
And Beneficial Use Assessment

Final Report

Prepared For:

Port of Los Angeles
Environmental Division
425 South Palos Verdes Street
San Pedro, CA 90731

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1.0 INTRODUCTION

1.1 Site Background

The Ballona wetland Preserve Area A is a 139 acre portion of the Ballona Wetlands Ecological Reserve, an area currently under evaluation for restoration as part of the Ballona Wetlands Restoration Project (Restoration Project). The Restoration Project is led by the California Coastal Conservancy (CCC) and the current owner, California Department of Fish and Game (CDFG). A feasibility analysis of several restoration alternatives is currently underway. These alternatives include a range of options from enhancement of existing upland habitats to restoration of full tidal flow and establishment of a diverse community of sub-tidal, tidal, and upland habitats. The Port of Los Angeles (POLA) is currently evaluating the potential of Area A as a possible wetland mitigation site, pending the analysis of the full tidal alternative costs and potential credits.

Historical uses of Area A have changed the topography from a tidal wetland to disturbed upland habitat. The construction of railroads in the 1900s placed fill in the southeast corner to elevate the tracks above tidal elevation. Parts of Area A were also filled in the 1920s when gas and oil production began in the area. Platforms to protect the oil and gas facilities from high tides were constructed and connected by a series of access roads, which were also elevated on fill. Area A was altered during the channelization of Ballona Creek in the 1930s and during the excavation of Marina del Rey Harbor in the 1960s when the site received a large volume of dredge material. Appendix A provides historical photographs of the study area showing these changes.

The site is currently fenced off and undeveloped except for a paved parking area along the western boundary. Figure 1-1 presents a current aerial view of Area A. Fiji Ditch, a tidal channel connected to Basin H of Marina del Rey Harbor, starts in the middle of the northern edge of the site and runs east and west. A great blue heron rookery exists on the western edge of the site. Sempra Utilities monitoring wells are located just south of the rookery. Unauthorized use of the site is extensive. Construction of earthen jumps for off-road vehicle use has created many shallow depressions throughout the area, which compacts soil and collects water. It was estimated that 200–300 individuals were encamped within Area A in May 2006.

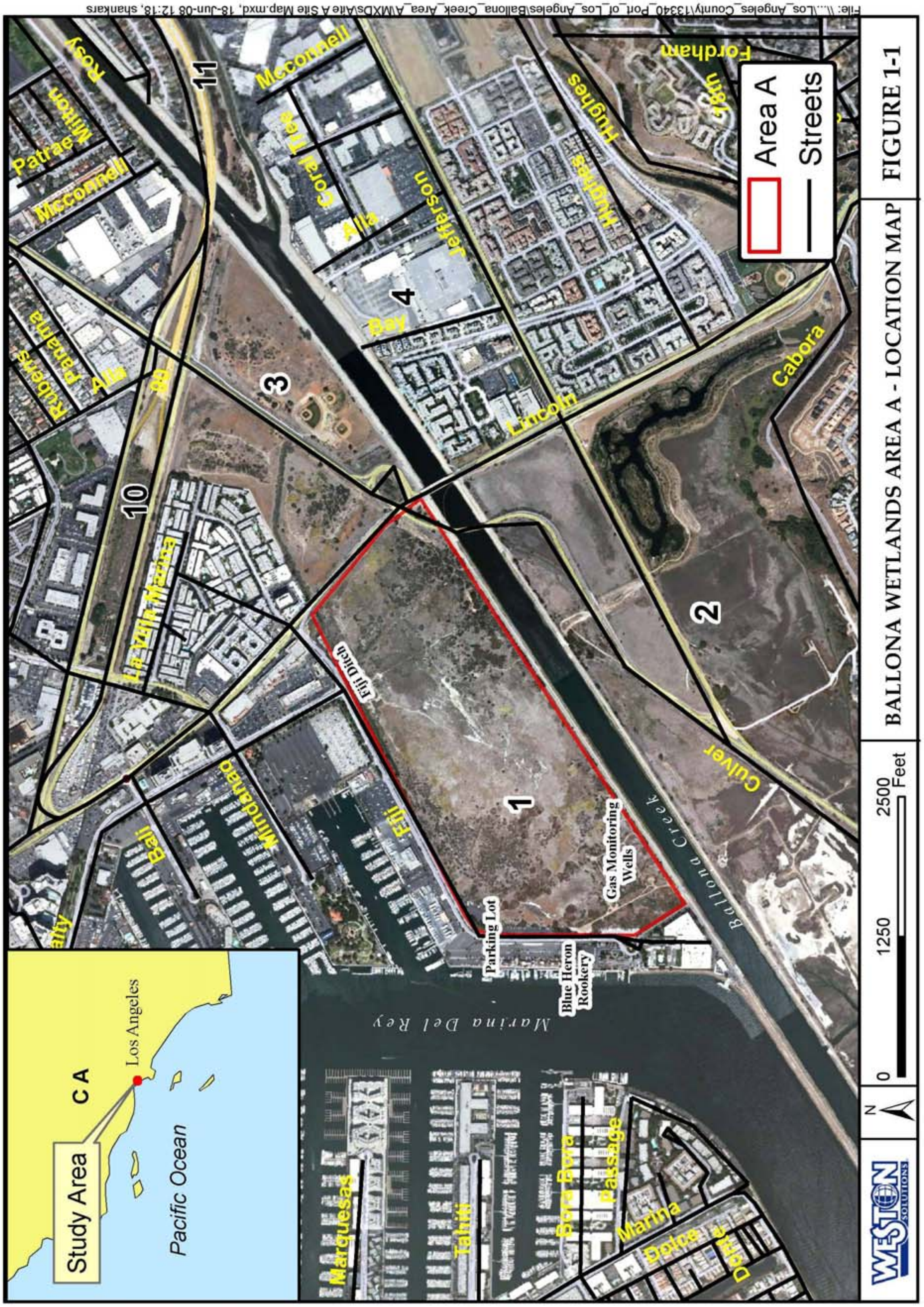

Figure 1-1. Ballona Wetland Preserve – Area A Location Map

In order to evaluate the potential of Area A as a possible wetland mitigation site, several alternatives were being assessed by CDFG and CCC. The United States Fish and Wildlife Service (USFWS) introduced Alternative 4, which was determined by POLA to provide the best opportunity for mitigation credits and a high-end estimate of mitigation costs.

A total of five distinct alternatives were being assessed for the Restoration Project. Each of the five alternatives were developed based on original conceptual designs that considered tidal sources, water quality, and developing sustainable habitats with sufficient transition zones to accommodate soil settlement and sea level rise. It was determined during this process that the open water channels needed to be located on one side of the site in order to establish sufficient transitional zones on the opposite side due to the 20–30 foot elevation differences from the open water to the upland areas. Each of these alternatives includes two inlets in order to provide sufficient tidal flow and circulation within the restored tidal marsh. The conceptual location of the inlet from the main channel of Marina del Rey can be relocated based on the proposed development in this area. Influent water from the main channel is preferred to the back basins and from Ballona Creek due to the water quality issues associated with these water sources.

Figure 1-2 presents Alternative 4, which is being evaluated as part of the Restoration Project. A corresponding cross section describing the depth of excavation and habitat elevation grade is provided on Figure 1-3. In order to begin evaluating the feasibility of using Area A as wetland mitigation site, POLA has contracted Weston Solutions, Inc. (WESTON) to conduct a Preliminary Geotechnical Investigation and Beneficial Use Assessment (Preliminary Area A Study) of the existing dredged material in Area A.

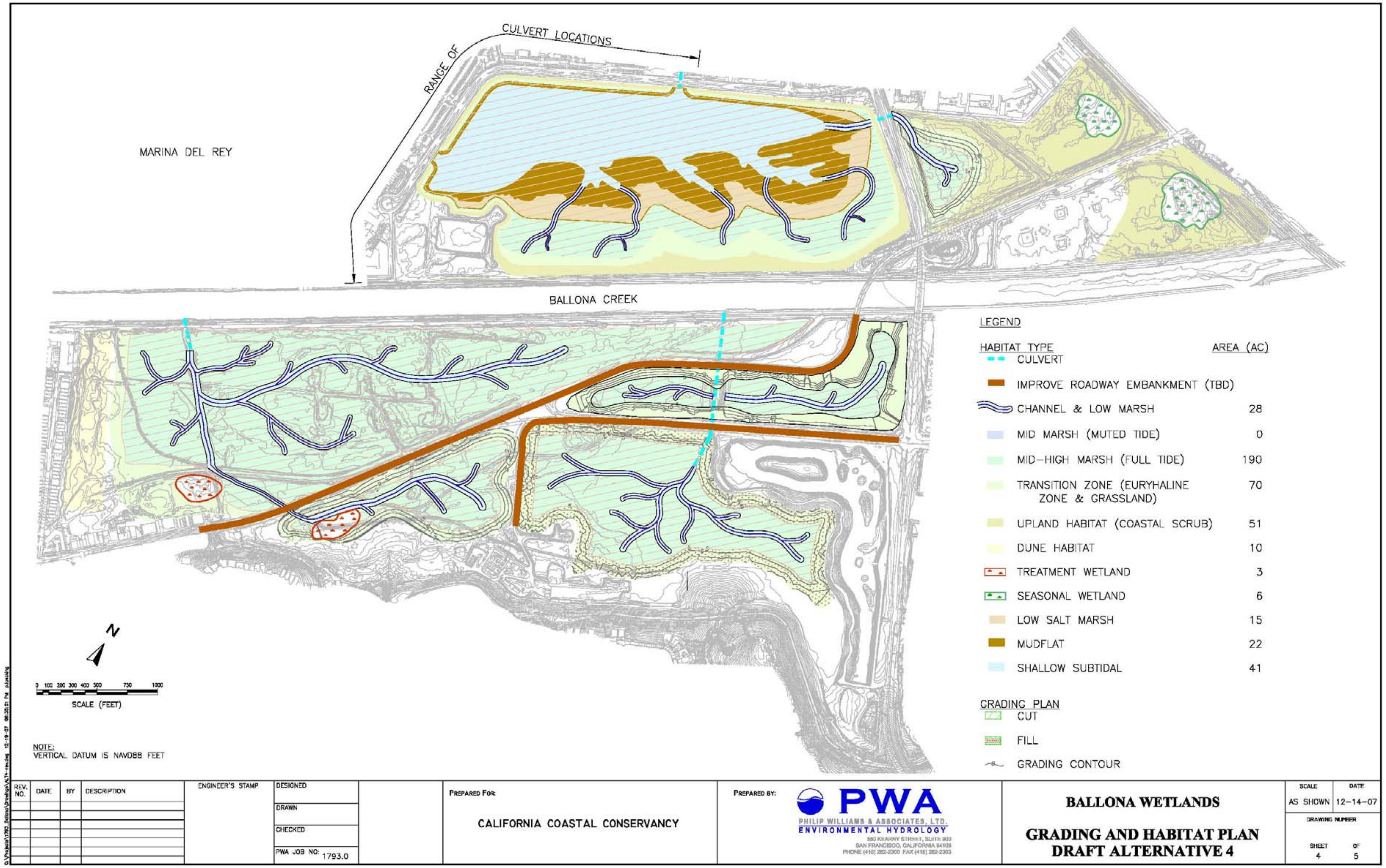

Figure 1-2. Ballona Wetland Restoration Project - Alternative 4

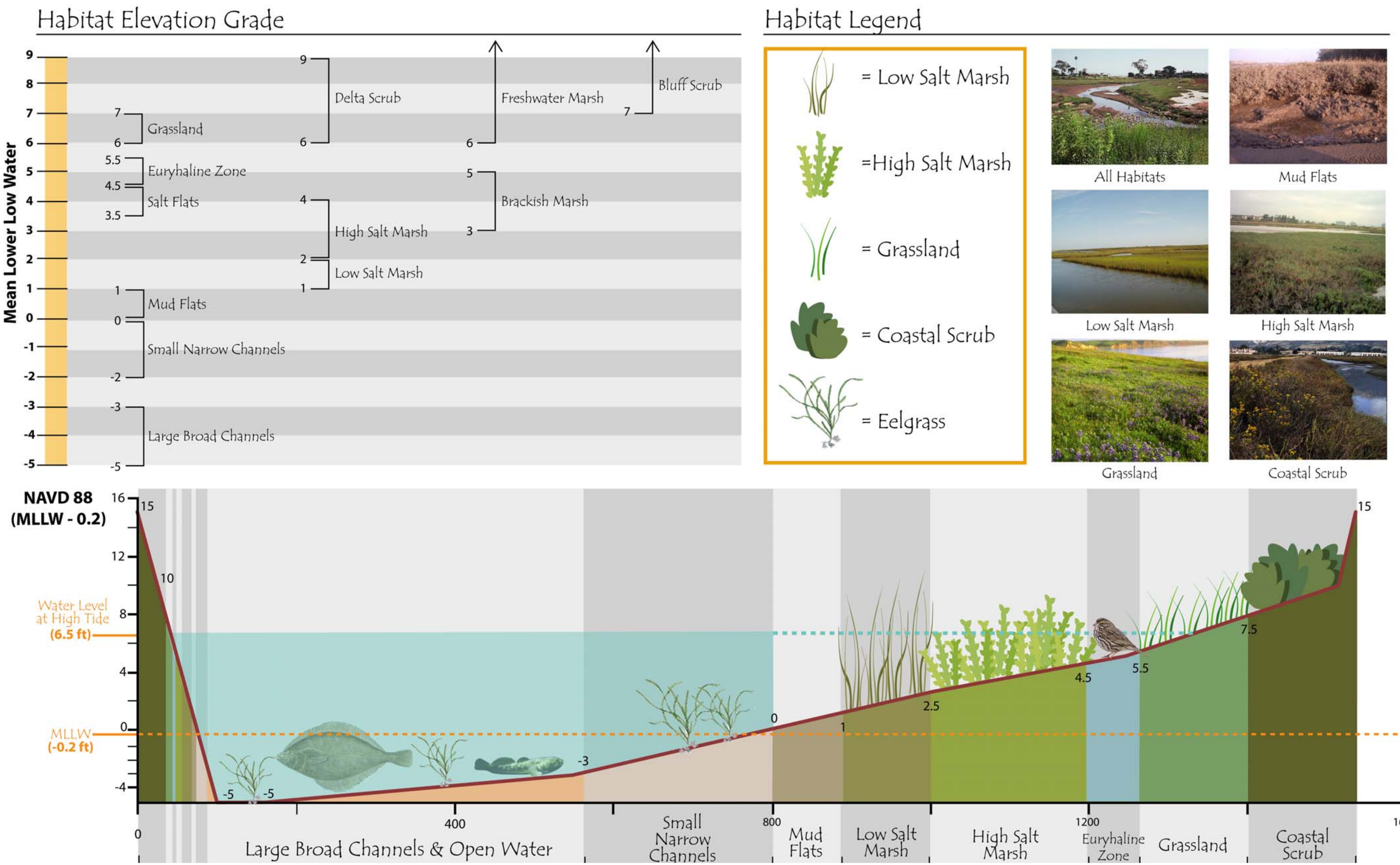

Figure 1-3. Cross Section of the Potential Tidal Restoration – Alternative 4

1.2 Scope of Work

The objectives of the Preliminary Area A Study were to identify the geotechnical, chemical, and physical characteristics of the soil and existing dredged material, determine the potential uses of the dredged material, and assess the cost associated with excavating and transporting the material. This screening level assessment will be used to guide a future, regulatory-compliant beneficial use assessment or dredge material evaluation for ocean disposal. The goal of this project was to answer the following study questions and provide recommendations to POLA.

Questions:

1. What are the chemical characteristics of the soil in Area A that are important to determine the required handling and use of the dredged material if removed to establish tidal flow?
2. Does the dredge material contain constituents of concern (COCs) at concentrations which require special handling or disposal due to historical gas extraction, or does it contain constituents, such as legacy pesticides, that may have existed in the dredged material prior to placement in Area A?
3. Will leachate from the dredge material contain COCs?
4. Are there chemical constituents in the soil that will remain a potential long-term risk to the ecosystem of the restored wetland?
5. What are the potential beneficial use and disposal options of the dredged material?
6. What are the geotechnical characteristics of the dredge material, including grain size distribution, that are key in determining potential beneficial uses of excavated material and the use of the dredge material for restoration?
7. Can the excavated dredge material be used for upland habitat in Area A?
8. What is the variability of grain size across Area A, with depth across the site, which may require segregation of materials for specific uses?
9. What is the volume of dredge material on site, and what level of assessment is necessary to attain regulatory compliance for beneficial uses?

Due to the unknown characteristics of the existing materials, a phased approach was recommended to address the questions listed above. This Preliminary Area A Study represents an initial assessment of the existing dredged material with regard to handling, placement, and potential beneficial uses. The Preliminary Area A Study consisted of three phases as presented on Figure 1-4.

- **Phase I** - included the analysis of existing geotechnical and groundwater data, review of historical and current topographical maps, completion of a field reconnaissance to identify possible sample location logistical and access issues, and preparation of a Study Work Plan. The Preliminary Area A Study Work Plan was prepared prior to permitting and field activities in order to identify the sampling locations and methods for the field and laboratory activities. The draft Study Work Plan was submitted to POLA for review. Comments from POLA were incorporated, and a draft final Study Work Plan was prepared and sent to CCC and CDFG for comment. Comments from these agencies were then incorporated, and the Final Study Work Plan was completed and submitted to POLA on December 12, 2007. Phase I also included completion of required access permit documents and access requests to the site for the geotechnical borings. WESTON worked with CDFG in the location of boreholes and drill rig access routes to avoid sensitive vegetation/habitat. Permits for site access were granted on October 26, 2007 (Appendix B).

- **Phase II**: included completion of the geotechnical borings and soil sampling within Area A in accordance with the approved Study Work Plan. Field activities began on February 5, 2008 and were completed on February 8, 2008. Phase II also included the site selection, drilling, soil sampling, and laboratory analysis of the soil samples for geotechnical and chemical characterization.

- **Phase III:** included quality assurance/quality control (QA/QC) of the laboratory data, compilation of the geotechnical and chemical results, assessment of the results, and preparation of this report. The report describes the field and laboratory activities performed, results of the sample testing, and findings from these results. Results from this investigation were used to address the study questions developed in the scope of work.

First, this report provides a summary of the methods used for the field and laboratory program (Section 2). Section 3 provides the data interpretation and analysis of the findings with regard to the key project questions. Section 4 presents the updated cost estimate for the proposed Alternative 4 based on the findings of the Preliminary Area A Study. Finally, recommendations for the future regulatory-compliant assessment of the beneficial uses are included in Section 5.

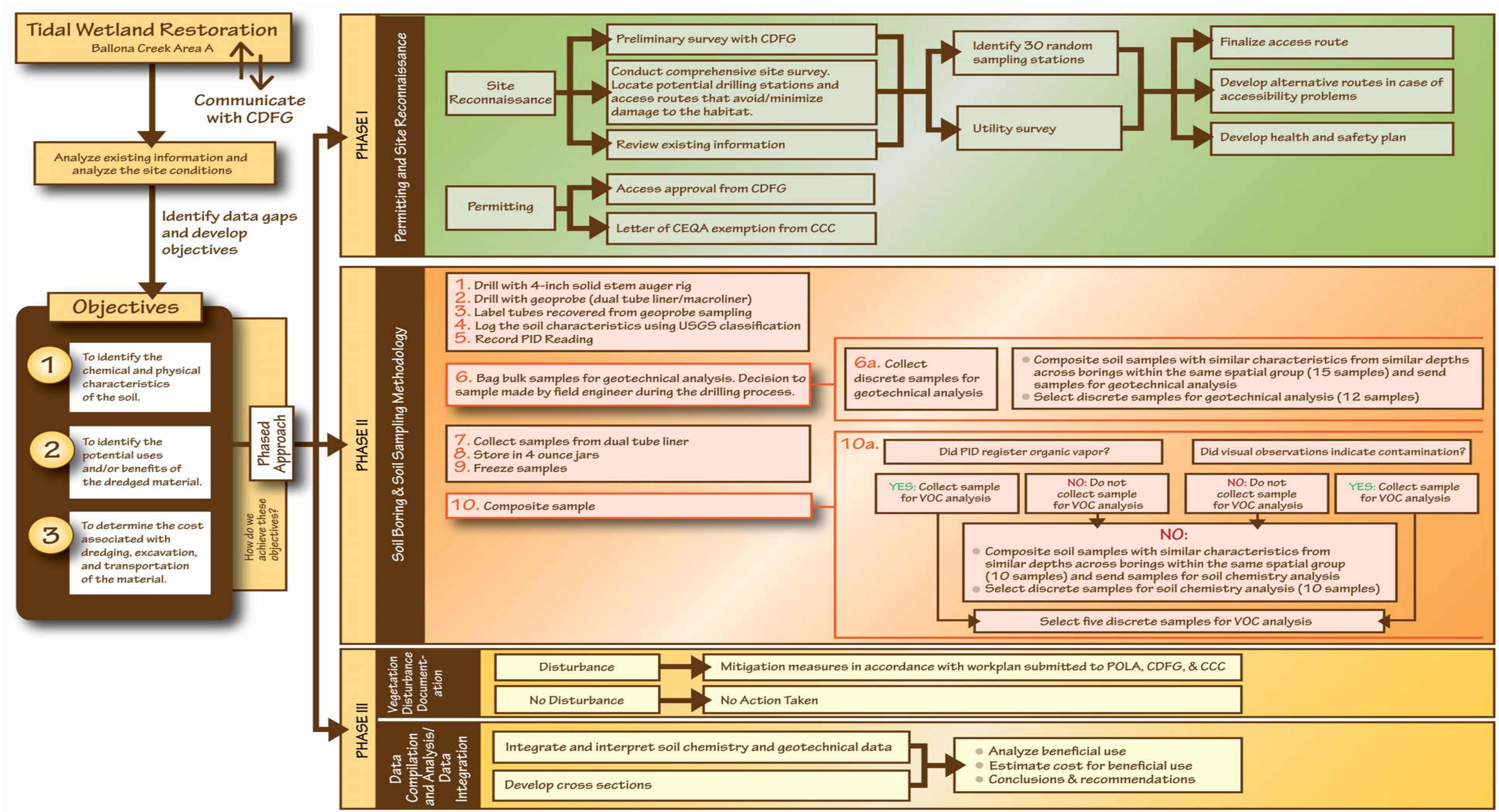

Figure 1-4. Schematic Representation of the Strategic Approach to Conduct Preliminary Geotechnical Investigation

2.0 MATERIALS & METHODS

This section describes the field sampling and laboratory methods and procedure used to complete the Preliminary Area A Study. Sampling and laboratory analysis was conducted in accordance with the approved Study Work Plan (WESTON, 2007). This section summarizes the process for the selection of representative sampling locations, acquisition of access and drilling permits, and completion of the sampling and laboratory programs for the Preliminary Area A Study.

2.1 Sampling Locations

In accordance with the approved Study Work Plan (WESTON, 2007), a total of twenty soil borings were proposed for the Preliminary Area A study. The following process for site selection was completed to ensure equal sample distribution across the study site, accessibility for the drill rig, and minimization of damage to sensitive species.

Step 1 - A random draw of 30 sample locations within the study site was done using Geographic Information Systems (GIS).
Step 2 –The Area A site map was divided into three equal segments. These three segments were then subdivided by transecting the subareas into three groups. It was intended to have two to three sample locations within each group in order to provide quality spatial representation of the sampling locations.
Step 3 - Field reconnaissance was conducted in coordination with POLA, CDFG, and CCC to identify the final 30 locations.
Step 4 – Twenty final sample locations were decided on the day of drilling, incorporating the constraints of drill rig accessibility and habitat considerations.

Table 2-1 includes the final location selections, grouped into segments and groups. Figure 2-1 depicts the initial and final sample locations, overlaid with the section lines and transects.

Table 2-1. Randomized Sampling Locations, Groups, and Segments

Segment	Groups	Stations
Segment 1	Group 1	5 ,6, 7,8,9
	Group 2	4, 10
	Group 3	1, 2, 3
Segment 2	Group 4	12, 13, 14,16, 17, 18
	Group 5	11, 15, 28
	Group 6	27, 29, 30
Segment 3	Group 7	19, 20, 21, 25
	Group 8	22, 23, 24, 26

WESTON staff worked in close coordination with POLA, CDFG, and the CCC to ensure the sampling activities were conducted in a manner that was sensitive to the ecological reserve. Necessary steps were taken to avoid any disturbance to the existing vegetation. Further discussion of the vegetation mapping and modification of the sample site locations and access route is presented below.

WESTON met with representatives of CCC and CDFG to review the selected sample locations and likely access routes to these sampling sites. In addition, the local utilities were contacted to verify that no underground utilities were located near selected boring locations. WESTON met with representatives of Sempra Utilities, which has an operating natural gas well on the southwest corner of the site as well as gasoline product monitoring wells at multiple locations. These wells were verified, marked, and mapped using Global Positioning System (GPS) coordinates. These wells were avoided during soil sampling activities. Figure 2-1 presents the selected 30 potential soil boring locations in green and indicates the final 20 soil boring locations in red. Station 26 was the only location that was relocated eastward to avoid any potential impact from a known abandoned gas line. Relocation of this station did not result in change of spatial distribution of the sampling locations. During the field work, some of the sites were moved marginally to accommodate accessibility issues.

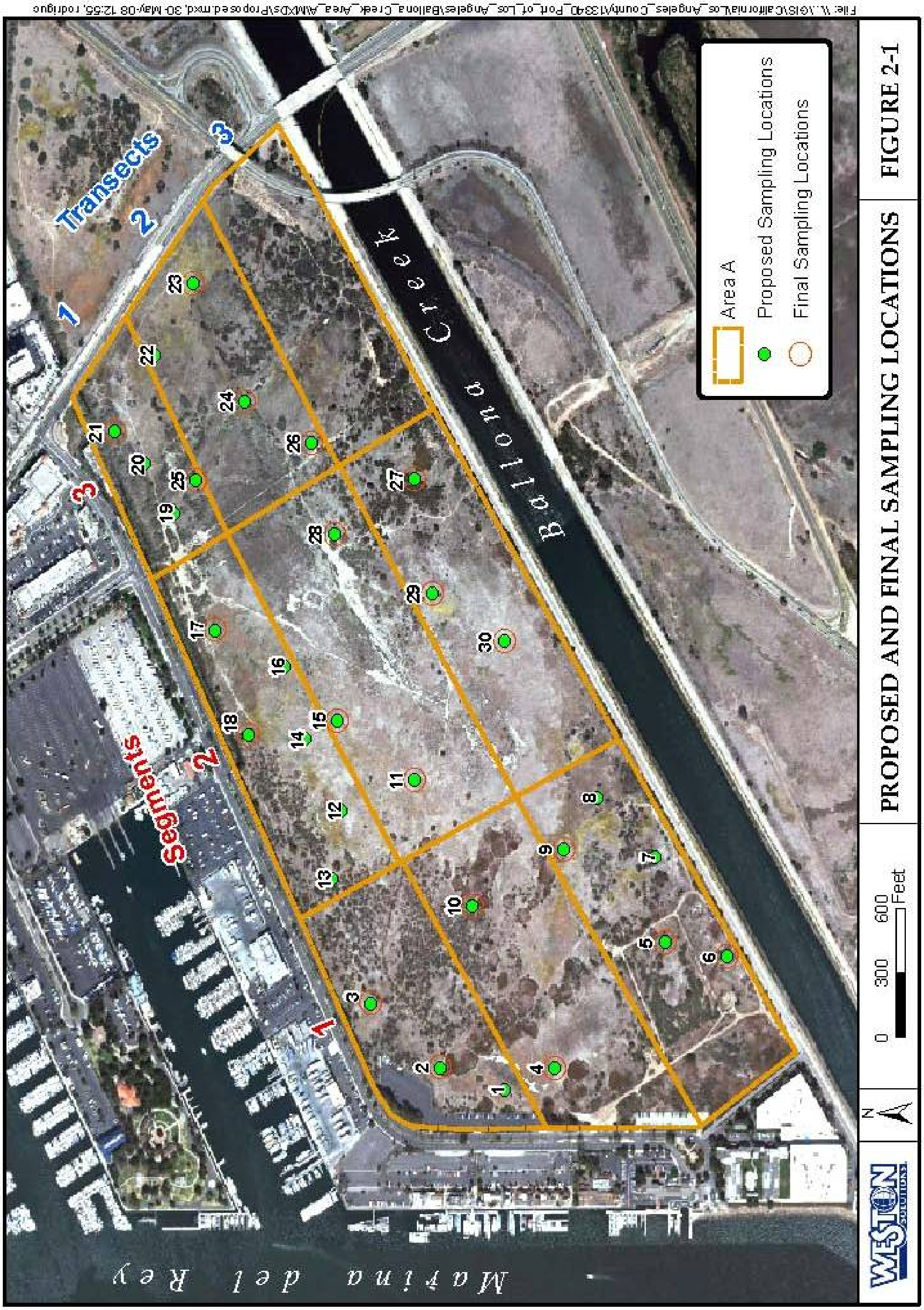

Figure 2-1. Potential and Selected Sampling Locations

2.2 Vegetation Survey and Habitat Protection during Sampling

In accordance with the conditions of CDFG permits (Appendix B) to access the site and conduct the proposed sampling, vegetation surveys were conducted in Area A before and after soil sampling occurred. The survey revealed that the altered elevation contours from the deposition of dredge material developed a variety of plant community types. For the purposes of this report, Area A is broken into six major communities: limited salt pan/mudflats, pickleweed salt marsh, transitional zone with largely exotic species, riparian scrub, *Baccharis* scrub, and coastal scrub (Appendix C). Groupings of plants or individual plants of concern were flagged, and a designated WESTON field biologist was on site during all sampling operations.

Prior to sampling activities, the sampling locations were identified, and routes to and from these sample sites were plotted. Routes were designed to maximize usage of existing access points and pathways and minimize impairment to native habitat. Routes were chosen such that they traversed the exotic transitional zone where iceplant, crown daisy, mustard, and exotic grasses were the dominant species. Potential sample collection sites, which could not be accessed without substantial native plant disturbance, were eliminated and alternative sites were chosen. Stations 15 and 24 were relocated approximately 30 feet from the original location to avoid disturbance of habitat. Relocation of these stations did not result in change of spatial distribution of the sampling locations. Patches of pickleweed, salt marsh, salt pan/mudflats, and coastal scrub along the routes were avoided to the greatest extent possible. The drill rig and the tending Bobcat were instructed to follow one another in a single path to minimize sensitive habitat impacts. Drill equipment operators were made familiar with plant species of concern, and the vehicles were escorted along a pre-scouted route to the station locations by a WESTON field biologist to ensure minimal habitat impact. The proposed access routes and final access routes are as shown on Figure 2-2 and Figure 2-3. The access routes were fairly similar to the proposed routes with only minor changes due to the sensitive habitat and the accessibility constraints of the rig.

Due to limited access at one location, the drill rig and Bobcat had to cross a designated saltpan area. The route selected to access Station 25 and Station 17 was, however, a historic utility dirt road that contained little vegetation due to the highly compacted soils from past and current use.

After sampling activities were completed, the WESTON field team walked the final access route used by equipment. Special attention was given to the salt flat areas. Areas impacted by equipment mobilization were raked and regraded. WESTON revisited the sampling locations and the access route on March 5, 2008, to confirm no sensitive habitat was adversely impacted.

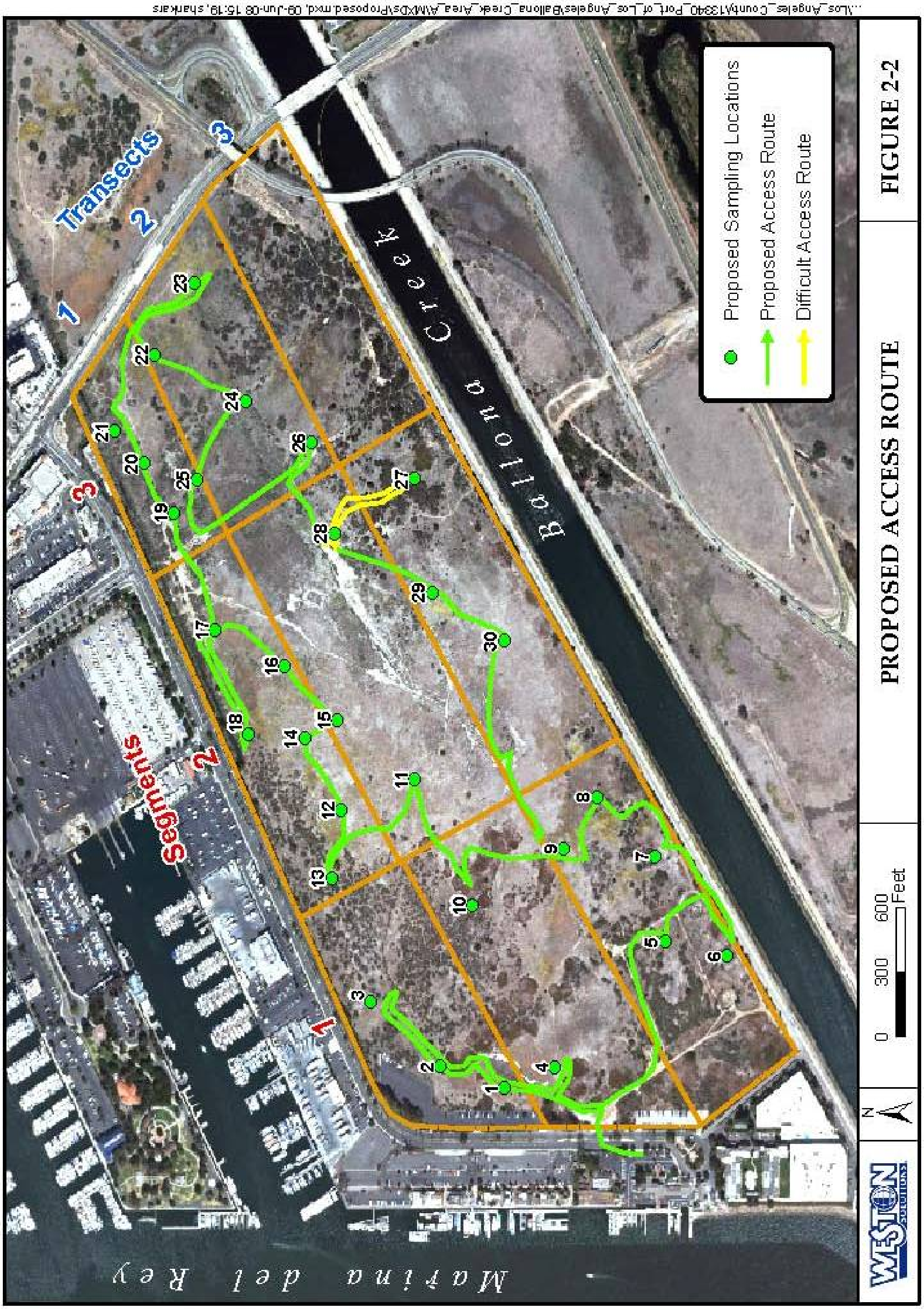

Figure 2-2. Proposed Access Route

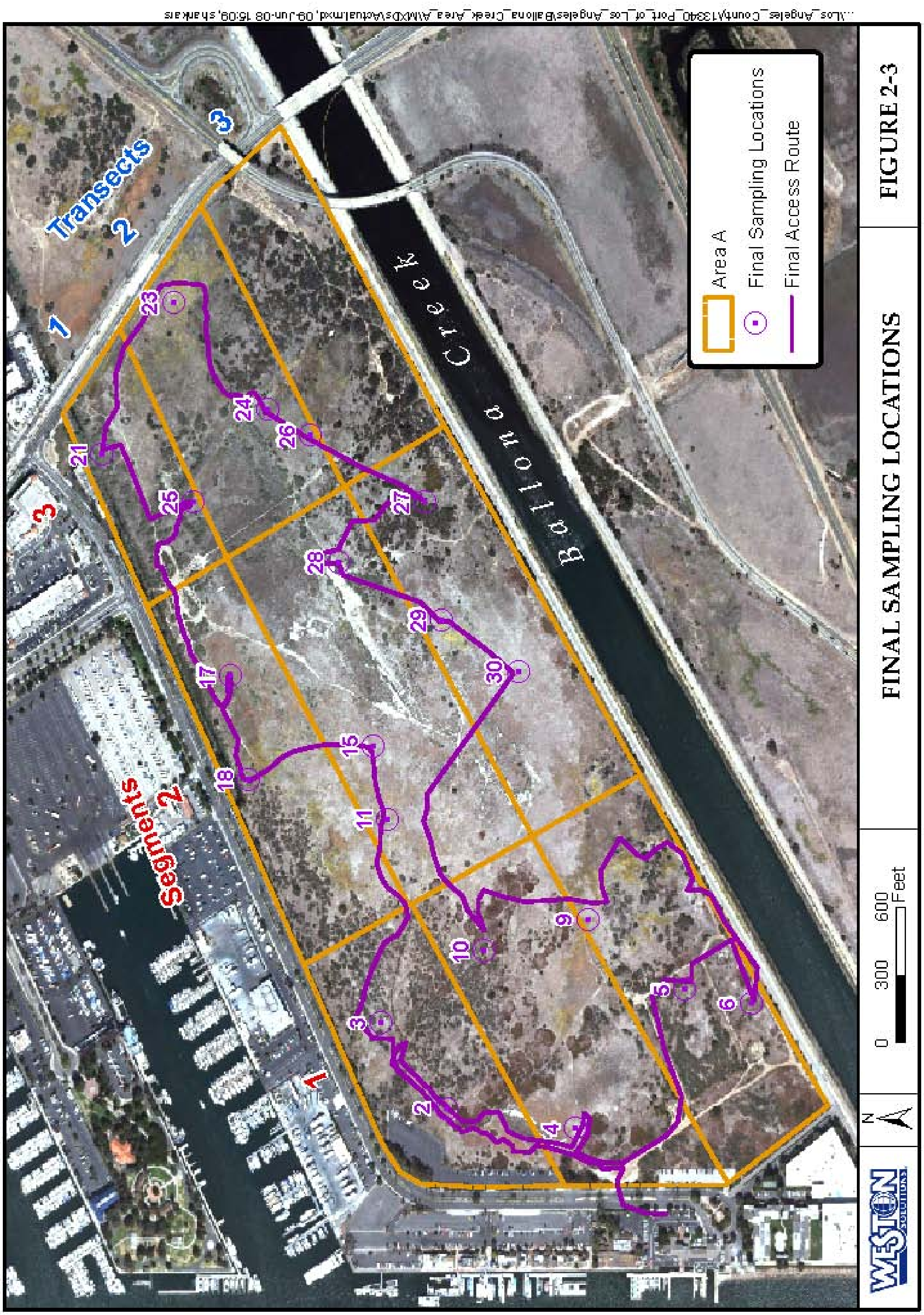

Figure 2-3. Final Access Route

2.3 Access and Permits

WESTON conducted field reconnaissance in accordance with the requirements of the access and sampling permit from CDFG. On October 26, 2007, WESTON obtained an access permit from CDFG to enter Area A in order to survey the site and propose access routes for the selected random sampling points (Appendix B). Field reconnaissance was conducted in the presence of a WESTON field biologist. Existing site conditions and flora was documented. Special vegetation avoidance measures were utilized while identifying the proposed route. Existing access points and pathways were utilized for travel within Area A to the maximum extent possible. Each of the randomized soil sampling locations were located using a portable GPS unit and marked with a painted stake.

After completing the field reconnaissance, WESTON obtained an access permit (dated 12/11/2007) from CDFG to conduct geotechnical and soil sampling in Area A (Appendix B). This permit required sampling to be restricted to the designated areas sample sites using the proposed access points/routes. WESTON also obtained a letter of California Environmental Quality Act (CEQA) exemption (dated 01/14/2008) from the CCC. This letter is included in Appendix B.

2.4 Sampling Methodology

2.4.1 Sample Collection

Soil borings were completed at each of the 20 sampling stations using an ATV-mounted direct push rig and a 4-inch diameter solid stem auger drill rig. This drilling technique was selected because of its smaller footprint and lighter weight which, therefore, minimized the potential impact to sensitive ecosystems present in Area A. Due to the potential presence of natural gas in this area, non-sparking tools were used. WESTON sub-contracted RSI Drilling to complete the soil borings in accordance with the approved Study.

The soil sampling approach for the Preliminary Area A Study is presented on Figure 2-4. The direct push coring technique (DPT) was used in collection of both discrete and composite soil chemistry samples. Discrete chemistry core samples are samples taken from a discrete boring depth interval from a single borehole. Composite chemistry core samples were taken from similar boring depths or similar soil types from different borings. The cores samples were combined and then homogenized into one sample. Soil chemistry core samples were collected by driving a dual-lined, 4-foot long, 1.5-inch diameter DPT soil core into the subsurface using hydraulic pressure. Upon retrieval of the 4 foot long core, visual observations were made by a field engineer. These observations led to the selection of discrete and composite soil samples for chemical analysis. These soil cores were also used to visually define any changes in soil texture, moisture, or evidence of contamination. Soil descriptions noted by the engineer are presented in the field boring logs provided in Appendix D. Drilling equipment was thoroughly decontaminated between each borehole to avoid cross-contamination.

Soil core samples were scanned with a Photo Ionization Detector (PID) to detect the presence of organic vapors potentially from volatile organic compounds (VOC). Soil samples were also visually inspected for evidence of contamination, such as soil staining or sheen on the pore fluid of the soil sample. Five discrete samples identified as potentially impacted based on the PID reading and/or visual evidence were sent to the CRG Marine Laboratories (CRG) for VOC analysis.

Samples for geotechnical analysis (grain size distribution, liquid and plastic limits, and hydrometer analysis) were collected using a 4-inch diameter solid stem auger rig. The solid stem auger was advanced at 5 foot intervals. The solid stem auger technique was used to collect bulk soil grab samples for geotechnical analysis because these analyses required greater sample volume. Both discrete and composite were collected from borehole cuttings for geotechnical analysis in accordance with the approved sampling strategy as outlined on Figure 2-4. Composite bulk geotechnical soil samples were taken from similar stratigraphic layers at different boring depths within a single boring. Composite samples were also taken from soil cuttings of similar soil type from 2-3 borings within the same sub area. The sampling depth interval from which the soil samples were collected was determined based on the measurement of the length of auger that had been advanced into the boring location.

The depth of the borings depended on the distance from the ground surface to native materials (i.e., marsh mat) and the depth of excavation expected during restoration. Auger samples were collected to average depths of 12–13 feet below grade surface (bgs) where groundwater was typically encountered. DPT core samples were collected to the depth of approximately 24 feet bgs. Table 2-2 lists the boring locations, GPS coordinates, surface elevations, final boring depth, and depth to water (dtw). Table 2-3 shows the sample number for each discrete soil chemistry sample and the bore depth at which the sample was collected.

Table 2-2. Surface Elevations and Final Boring Depths

Boring Location	Latitude	Longitude	Drilling			Surface Elevation (ft)	Final Boring Depth		Depth to Ground-water (ft)
			Date	Start Time	End Time		Direct Push Technology (Dual Core Liner) (ft)	Solid Stem Auger Rig (Bulk Samples) (ft)	
Station 2	33.9734	-118.44451	2/5/2008	15:50	16:10	30	24	10	10
Station 3	33.97418694	-118.443475	2/8/2008	16:05	16:45	30	24	8	8
Station 4	33.97184333	-118.4447522	2/5/2008	13:30	13:55	30	24	16	16
Station 5	33.97051444	-118.4430675	2/6/2008	9:45	10:10	30	24	13	13
Station 6	33.96970806	-118.4432386	2/6/2008	7:45	8:10	20	24	13	13
Station 9	33.97168611	-118.4422205	2/6/2008	11:20	12:15	30	24	8	8
Station 10	33.97272	-118.46211	2/6/2008	13:40	14:10	30	24	5	5
Station 11	33.97410972	-118.4410092	2/7/2008	8:10	8:55	30	24	9	9
Station 15	33.97427444	-118.4401275	2/8/2008	15:05	15:35	30	24	4	4
Station 17	33.97600417	-118.4392794	2/8/2008	13:05	13:40	30	24	4.5	4.5
Station 18	33.97579	-118.4405436	2/8/2008	13:55	14:50	30	24	14	14
Station 21	33.97755694	-118.4365917	2/8/2008	9:50	10:50	30	24	18	18
Station 23	33.976865	-118.4345305	2/8/2008	8:35	9:30	30	24	12	12
Station 24	33.97556	-118.43605	2/8/2008	7:20	8:20	20	24	7	7
Station 25	33.97502917	-118.4378281	2/8/2008	11:15	12:50	20	24	6	6
Station 26	33.97504	-118.43637	2/7/2008	15:15	16:05	30	24	10	10
Station 27	33.97364	-118.63718	2/7/2008	14:05	15:05	30	24	12	12
Station 28	33.97469778	-118.4379058	2/7/2008	11:30	12:20	20	24	9	9
Station 29	33.97345389	-118.4386047	2/7/2008	10:30	11:15	30	24	9.5	9.5
Station 30	33.97252472	-118.4392269	2/7/2008	9:30	10:20	20	24	12	12

2.4.2 Sample Processing and Storage

The process for selecting soil samples for geotechnical and chemical analysis is outlined on Figure 2-4. Soil core and cuttings was bagged, labeled, and placed on ice. Once all drilling activities were complete, discrete samples (from a defined depth interval and single boring) were selected from the soil core and cuttings for geotechnical analysis in accordance with the selection process presented on Figure 2-4. Twelve discrete samples—samples from one soil horizon—were taken for geotechnical analysis, and 10 discrete samples were taken for chemical analysis. CRG was tasked to composite core samples from different soil horizons within one borehole or from across similar soil horizons from different boreholes. A total of 10 composite samples were analyzed for soil chemistry parameters. The various soil chemistry parameters that were analyzed have been tabulated in the following subsection. Table 2-3 shows boring locations and the corresponding depths at which the samples were collected for chemical analysis. Table 2-4 shows the individual samples used to create composite samples for chemical analysis. A total of 14 composite samples were combined from soil cuttings for geotechnical analysis. Table 2-5 shows boring locations and corresponding depths at which the samples were collected for geotechnical analysis. Table 2-5 also shows individual samples that were used to create 14 composite samples for geotechnical analysis.

Chain-of-custody procedures were followed in accordance with the approved Study Work Plan. Documentation of sample collection, transport, and list of analytes were recorded in the chain-of-custody. The chain-of-custodies are attached in Appendix E.

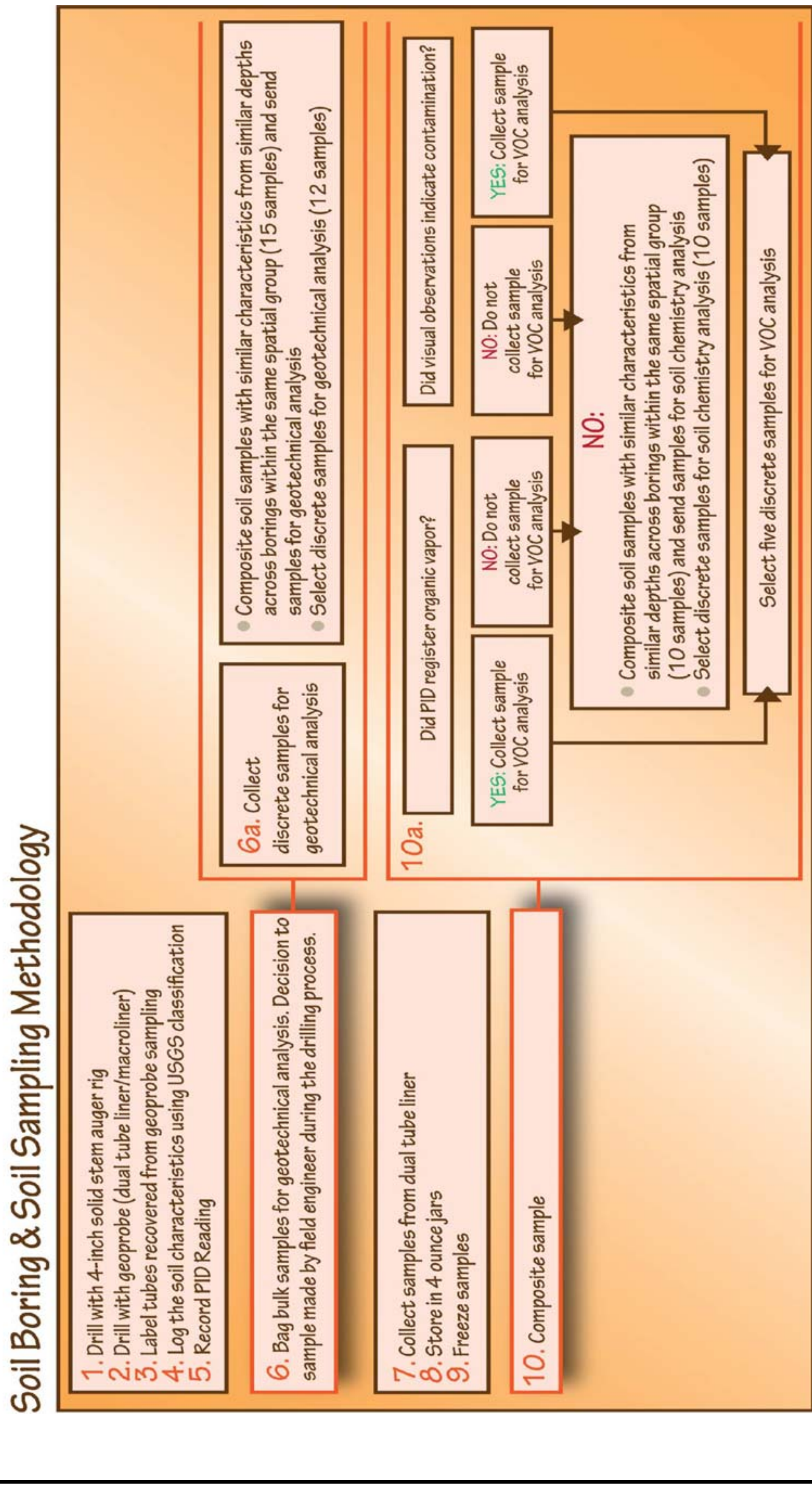

Figure 2-4. Soil Boring and Sampling Strategy

Table 2-3. Sample ID and Sampling Location Depth for Chemistry Analysis

Samples for Soil Chemistry Analysis	Station ID	Sample Depth (ft)
Discrete Samples		
S5-060208-15-16	Station 5	15-16
S9-060208-3-4	Station 9	3-4
S10-060208-6-7	Station 10	6-7
S18-060208-7-8	Station 18	7-8
S17-080208-10-11	Station 17	10-11
S15-080208-15-16	Station 15	15-16
S11-070208-14-15	Station 11	14-15
S29-070208-6-7	Station 29	6-7
S23-080208-12-13	Station 23	12-13
S21-080208-6-7	Station 21	6-7
Discrete Samples for VOC Analysis		
S18-080208-11-12	Station 18	11-12
S15-080208-11-12	Station 15	11-12
S23-080208-15-16	Station 23	15-16
S23-080208-12-13	Station 23	12-13
S21-080208-11-12	Station 21	11-12
Composite* Samples		
S5-S6-15-16	*	*
S5-S6-S9-3-4	*	*
S4-S10-5-7	*	*
S3-11-12-15-16	*	*
S17-S18-10-12	*	*
S15-S28-15-16	*	*
S11-S15-14-20	*	*
S27-S29-S30-6-8	*	*
S23-S24-S26-21-24	*	*
S21-S25-6-8	*	*

*see the Table 2-4 for component of composite samples

Table 2-4. Soil Compositing Information for Chemistry Analysis

Composite Sample ID	Discrete Samples*	Station Id	Sample Depth (ft)
S5-S6-15-16	S5-060208-15-16	Station 5	15-16
	S6-060208-15-16	Station 6	15-16
S5-S6-S9-3-4	S5-060208-3-4	Station 5	3-4
	S6-060208-3-4	Station 6	3-4
	S9-060208-3-4	Station 9	3-4
S4-S10-5-7	S4-050208-5-6	Station 4	5-6
	S10-060208-6-7	Station 10	6-7
S3-11-12-15-16	S3-080208-11-12	Station 3	11-12
	S3-080208-15-16	Station 3	15-16
S17-S18-10-12	S17-080208-10-11	Station 17	10-11
	S18-080208-11-12	Station 18	11-12
S15-S28-15-16	S15-080208-15-16	Station 15	15-16
	S28-070208-15-16	Station 28	15-16
S11-S15-14-20	S15-080208-17-18	Station 15	17-18
	S11-070208-14-15	Station 11	14-15
S27-S29-S30-6-8	S27-070208-7-8	Station 27	7-8
	S29-070208-6-7	Station 29	6-7
	S30-070208-7-8	Station 30	7-8
S23-S24-S26-21-24	S23-080208-23-24	Station 23	23-24
	S24-080208-21-22	Station 24	21-22
	S26-070208-22-23	Station 26	22-23
S21-S25-6-8	S21-080208-6-7	Station 21	6-7
	S25-080208-7-8	Station 25	7-8

* Samples were composited using equal amounts of the discrete samples.

Table 2-5. Sample ID and Sampling Location Depth for Geotechnical analysis

Samples for Soil Chemistry Analysis	Sample ID	Station ID	Sample Depth (ft)
Composite Samples			
G1-0-2	S6-060208-0-2	Station 6	0-2
	S5-060208-0-2	Station 5	0-2
	S9-060208-0-2	Station 9	0-2
G1-3-5	S5-060208-3-5	Station 5	3-5
	S9-060208-3-5	Station 9	3-5
	S6-060208-3-5	Station 6	3-5
G1-10-13	S6-060208-10-13	Station 6	10-13
	S5-060208-10-13	Station 5	10-13
G2-3-5	S4-050208-3-5	Station 4	3-5
	S10-060208-3-5	Station 10	3-5
G3-3-5	S2-080208-3-5	Station 2	3-5
	S3-080208-3-5	Station 3	3-5
G4-3-5	S18-050208-3-5	Station 18	3-5
	S17-080208-3-5	Station 17	3-5
G5-6-9	S11-070208-6-8	Station 11	6-8
	S28-070208-7-9	Station 28	7-9
G6-7-10	S29-070208-7-9	Station 29	7-9
	S27-070208-8-10	Station 27	8-10
	S30-070208-10-11	Station 30	10-11
G7-3-5	S21-080208-3-5	Station 21	3-5
	S25-080208-3-5	Station 25	3-5
G8-3-5	S26-070208-3-5	Station 26	3-5
	S23-080208-3-5	Station 23	3-5
	S24-080208-3-5	Station 24	3-5
G8-7-10	S26-070208-7-9	Station 26	7-9
	S23-080208-8-10	Station 23	8-10
	S24-080208-8-10	Station 24	8-10

Table 2-5. Sample ID and Sampling Location Depth for Geotechnical analysis

Samples for Soil Chemistry Analysis	Sample ID	Station ID	Sample Depth (ft)
Seg1-0-2	S2-050208-0-2	Station 2	0-2
	S3-080208-0-2	Station 3	0-2
	S10-060208-0-2	Station 10	0-2
Seg2-0-2	S15-080208-0-2	Station 15	0-2
	S28-070208-0-2	Station 28	0-2
	S18-080208-0-2	Station 18	0-2
	S11-070208-0-2	Station 11	0-2
	S29-070208-0-2	Station 29	0-2
	S30-070208-0-2	Station 30	0-2
	S17-080208-0-2	Station 17	0-2
	S27-070208-0-2	Station 27	0-2
Seg3-0-2	S21-080208-0-2	Station 21	0-2
	S25-080208-0-2	Station 25	0-2
	S23-080208-0-2	Station 23	0-2
	S24-080208-0-2	Station 24	0-2
Discrete Samples			
S6-060208-8-10		Station 6	8-10
S2-050208-8-10		Station 2	8-10
S21-080208-13-15		Station 21	13-15
S21-080208-8-10		Station 21	8-10
S18-080208-8-10		Station 18	8-10
S2-050108-13-15		Station 2	13-15
S25-080208-5-6		Station 25	5-6
S18-080208-12-14		Station 18	12-14
S30-070208-3-5		Station 30	3-5
S5-060208-8-10		Station 5	8-10
S4-050208-13-15		Station 4	13-15
S4-050208-8-10		Station 4	8-10

2.4.3 Geotechnical and Chemical Analysis

WESTON subcontracted the chemical analysis of the selected samples to CRG. G Force Companies (G Force) was sub-contracted for the geotechnical analysis of the selected soil samples. Geotechnical and geochemical analysis was conducted on 20 discrete and composited soil samples. Geotechnical analysis used American Society for Testing and Materials (ASTM) methods for grain size, liquid and plastic limits, and moisture content. Chemical analysis included general chemistry, metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, semi-volatile organic carbons (s-VOCs) and VOCs. These analyses were performed using the appropriate United States Environmental Protection Agency (USEPA) methods. Table 2-6 shows the chemical analyses for each discrete and composite soil samples. Table 2-7 shows the samples and corresponding analysis for the geotechnical parameters.

Table 2-6. List of Analytes and Samples analyzed for Soil Chemistry

Samples for Soil Chemistry Analysis	Station ID	Depth (ft)	Trace Metals	Trace Mercury	Organotins	Polynuclear Aromatic Hydrocarbons	Phthalates	Acid Extractable Compounds	Organochlorine Pesticides & PCBs	Toxicity Characteristic Leachate Procedure (TCLP)	Dissolved sulfides	Percent solids	pH	Salinity	TOC	Total Sulfides	TPH diesel	TPH gas	Volatile Organic Compounds inc. Acrolein & Acrylonitrile	Ammonia in Sediment Determination	TRPH in Sediment Determination
Method			USEPA 6020(m)	USEPA 245.7(m)	Krone et. Al., 1989	USEPA 8270C(m)	USEPA 8270C(m)	USEPA 8270C(m)	USEPA 8270C(m)		Plumb, 1981/TERL	USEPA 160.3	SM 4500 H+	SM 2510 B	USEPA 9060 A	Plumb, 1981/TERL	USEPA 8015m	USEPA 8015m	USEPA 8260B	USEPA 8270C(m)	USEPA 1664
Discrete Samples																					
S5-060208-15-16	Station 5	15-16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S9-060208-3-4	Station 9	3-4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S10-060208-6-7	Station 10	6-7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S18-060208-7-8	Station 18	7-8	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S17-080208-10-11	Station 17	10-11	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S15-080208-15-16	Station 15	15-16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S11-070208-14-15	Station 11	14-15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S29-070208-6-7	Station 29	6-7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S23-080208-12-13	Station 23	12-13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S21-080208-6-7	Station 21	6-7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Discrete Samples for VOC analysis																					
S18-080208-11-12	Station 18	11-12																	Yes		
S15-080208-11-12	Station 15	11-12																	Yes		
S23-080208-15-16	Station 23	15-16																	Yes		
S23-080208-12-13	Station 23	12-13																	Yes		
S21-080208-11-12	Station 21	11-12																	Yes		
Composite Samples																					
S5-S6-15-16	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S5-S6-S9-3-4	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S4-S10-5-7	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S3-11-12-15-16	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S17-S18-10-12	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S15-S28-15-16	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S11-S15-14-20	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S27-S29-S30-6-8	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S23-S24-S26-21-24	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
S21-S25-6-8	*	*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes

Table 2-7. List of Samples and Geotechnical Analysis

Samples for Soil Chemistry Analysis	Sample ID	Station ID	Depth (ft)	Grain Size Analysis with Hydrometer (ASTM D-422-63)	Atterberg Limits (ASTM D-4318)	Moisture Content (ASTM D-2216)
Composite Samples						
G1-0-2	S6-060208-0-2	Station 6	0-2	Yes		
	S5-060208-0-2	Station 5	0-2			
	S9-060208-0-2	Station 9	0-2			
G1-3-5	S5-060208-3-5	Station 5	3-5	Yes	Yes	
	S9-060208-3-5	Station 9	3-5			
	S6-060208-3-5	Station 6	3-5			
G1-10-13	S6-060208-10-13	Station 6	10-13	Yes	Yes	
	S5-060208-10-13	Station 5	10-13			
G2-3-5	S4-050208-3-5	Station 4	3-5	Yes	Yes	
	S10-060208-3-5	Station 10	3-5			
G3-3-5	S2-080208-3-5	Station 2	3-5	Yes	Yes	
	S3-080208-3-5	Station 3	3-5			
G4-3-5	S18-050208-3-5	Station 18	3-5	Yes	Yes	
	S17-080208-3-5	Station 17	3-5			
G5-6-9	S11-070208-6-8	Station 11	6-8	Yes	Yes	
	S28-070208-7-9	Station 28	7-9			
G6-7-10	S29-070208-7-9	Station 29	7-9	Yes	Yes	
	S27-070208-8-10	Station 27	8-10			
	S30-070208-10-11	Station 30	10-11			
G7-3-5	S21-080208-3-5	Station 21	3-5	Yes		
	S25-080208-3-5	Station 25	3-5			
G8-3-5	S26-070208-3-5	Station 26	3-5	Yes		
	S23-080208-3-5	Station 23	3-5			
	S24-080208-3-5	Station 24	3-5			
G8-7-10	S26-070208-7-9	Station 26	7-9	Yes	Yes	
	S23-080208-8-10	Station 23	8-10			
	S24-080208-8-10	Station 24	8-10			
Seg1-0-2	S2-050208-0-2	Station 2	0-2	Yes		
	S3-080208-0-2	Station 3	0-2			
	S10-060208-0-2	Station 10	0-2			
Seg2-0-2	S15-080208-0-2	Station 15	0-2	YES		
	S28-070208-0-2	Station 28	0-2			
	S18-080208-0-2	Station 18	0-2			
	S11-070208-0-2	Station 11	0-2			
	S29-070208-0-2	Station 29	0-2			

Table 2-7. List of Samples and Geotechnical Analysis

Samples for Soil Chemistry Analysis	Sample ID	Station ID	Depth (ft)	Grain Size Analysis with Hydrometer (ASTM D-422-63)	Atterberg Limits (ASTM D-4318)	Moisture Content (ASTM D-2216)
	S30-070208-0-2	Station 30	0-2	Yes		
	S17-080208-0-2	Station 17	0-2			
	S27-070208-0-2	Station 27	0-2			
Seg3-0-2	S21-080208-0-2	Station 21	0-2	Yes		
	S25-080208-0-2	Station 25	0-2			
	S23-080208-0-2	Station 23	0-2			
	S24-080208-0-2	Station 24	0-2			
Discrete Samples						
S6-060208-8-10	S6-060208-8-10	Station 6	8-10	Yes	Yes	Yes
S2-050208-8-10	S2-050208-8-10	Station 2	8-10	Yes	Yes	Yes
S21-080208-13-15	S21-080208-13-15	Station 21	13-15	Yes	Yes	Yes
S21-080208-8-10	S21-080208-8-10	Station 21	8-10	Yes	Yes	Yes
S18-080208-8-10	S18-080208-8-10	Station 18	8-10	Yes	Yes	Yes
S2-050108-13-15	S2-050108-13-15	Station 2	13-15	Yes	Yes	Yes
S25-080208-5-6	S25-080208-5-6	Station 25	5-6	Yes	Yes	Yes
S18-080208-12-14	S18-080208-12-14	Station 18	12-14	Yes	Yes	Yes
S30-070208-3-5	S30-070208-3-5	Station 30	3-5	Yes	Yes	Yes
S5-060208-8-10	S5-060208-8-10	Station 5	8-10	Yes	Yes	Yes
S4-050208-13-15	S4-050208-13-15	Station 4	13-15	Yes	Yes	Yes
S4-050208-8-10	S4-050208-8-10	Station 4	8-10	Yes	Yes	Yes

3.0 RESULTS AND FINDINGS

3.1 Geotechnical Results

Appendix D provides the soil boring logs for the 20 borings completed for the Preliminary Area A Study. The boring logs were developed from the field boring logs and the results of the geotechnical analysis of selected soil samples. The boring logs indicate that, in general, the dredged materials at the site do not greatly vary with depths or site location. The dredged materials are predominantly low plasticity clays, silty clays, and clayey silts. The exception is a gradual transition to soils with greater gravel and cobble content on the north eastern portion of the site adjacent to Lincoln Boulevard.

The results of the geotechnical analysis are provided in Appendix F and a summary of the geotechnical results is presented in Table 3-1. The results for the composite samples are shown for the depth interval from which the soil samples were taken. For example, composite sample G5-6-9 was composed of Station 11 discrete sample S11-070208-6-8 and Station 28 discrete sample S28-070208-7-9. The results of the geotechnical analysis for the individual Station 11 and Station 28 samples were then used to characterize the composite sample G5-6-9.

The results of the geotechnical analysis confirm the field observations which indicated the dredged materials within Area A do not vary greatly in grain size and soil classification. In fact, all the composite and discrete samples collected and analyzed for geotechnical properties were classified as low plasticity clays, silty clays, sandy clays or clayey silts (CL) per the Unified Soil Classification System (USCS). The only exception was the soil at Station 25 at a depth of 5-6 feet bgs. At this location, the soil is classified as high plasticity clay (CH). Historically, Area A was formed by filling the area with the dredge material that was excavated from Marina del Rey Harbor and Ballona Creek in the 1960s. These clayey soils are generally poor draining soils as evident by the seasonal ponding of precipitation during high rainfall years and the formation of salt pans and salt-marsh adapted vegetation on low lying areas of Area A. Due to the high clay content, these soils are generally not well suited for structural fill materials, but may be used for grading fill as part of the Restoration Project or other landscaped areas that are not subject to structural loading. Further discussion of potential beneficial uses of the dredged material is presented in Section 4. Beneficial uses will also depend on the chemical constituents present in the soil.

Table 3-1. Summary of Geotechnical Results by Depth and Sampling Locations

Depth	Station ID	Sample ID	Classification by Particle Size	Percent Retained – Gravel – 3"	2"	1.5"	1"	0.75"	0.5"	3/8"	Total Gravel #4	Sand – #10	#20	#40	#60	#100	Total Sand #200	Clay/Silt – Total Silt + Clay <#200	Atterberg Description	Atterberg Limits – Liquid Limit	Plastic Limit	Plasticity	USCS Classification
0-2	Station 6	G1-0-2	Sandy Clay	0	0	0	0	0	0	0	1	3	5	7	9	14	32	68					
0-2	Station 5	G1-0-2	Sandy Clay	0	0	0	0	0	0	0	1	3	5	7	9	14	32	68					
0-2	Station 9	G1-0-2	Sandy Clay	0	0	0	0	0	0	0	1	3	5	7	9	14	32	68					
0-2	Station 2	Seg1-0-2	Clayey Sand	0	0	0	0	1	1	3	6	12	16	21	26	36	62	38					
0-2	Station 3	Seg1-0-2	Clayey Sand	0	0	0	0	1	1	3	6	12	16	21	26	36	62	38					
0-2	Station 10	Seg1-0-2	Clayey Sand	0	0	0	0	1	1	3	6	12	16	21	26	36	62	38					
0-2	Station 15	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 28	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 18	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 11	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 29	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 30	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 17	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 27	Seg2-0-2	Sandy Clay	0	0	0	0	0	0	1	3	8	12	17	21	28	44	56					
0-2	Station 21	Seg3-0-2	Sandy Clay	0	0	0	0	0	0	0	0	1	3	6	9	18	38	62					
0-2	Station 25	Seg3-0-2	Sandy Clay	0	0	0	0	0	0	0	0	1	3	6	9	18	38	62					
0-2	Station 23	Seg3-0-2	Sandy Clay	0	0	0	0	0	0	0	0	1	3	6	9	18	38	62					
0-2	Station 24	Seg3-0-2	Sandy Clay	0	0	0	0	0	0	0	0	1	3	6	9	18	38	62					
3-5	Station 4	G2-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	13	49	51	Lean Clay	29	21	8	CL
3-5	Station 10	G2-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	13	49	51	Lean Clay	29	21	8	CL
3-5	Station 5	G1-3-5	Clayey Sand	0	0	0	0	0	1	3	10	14	18	22	27	35	61	39					
3-5	Station 9	G1-3-5	Clayey Sand	0	0	0	0	0	1	3	10	14	18	22	27	35	61	39					
3-5	Station 6	G1-3-5	Clayey Sand	0	0	0	0	0	1	3	10	14	18	22	27	35	61	39					
3-5	Station 2	G3-3-5	Sandy Clay	0	0	0	0	0	0	1	2	5	7	10	14	24	46	54	Lean Clay	38	18	20	CL
3-5	Station 3	G3-3-5	Sandy Clay	0	0	0	0	0	0	1	2	5	7	10	14	24	46	54	Lean Clay	38	18	20	CL
3-5	Station 18	G4-3-5	Sandy Clay	0	0	0	0	0	0	1	2	7	11	14	17	21	33	67	Lean Clay	38	20	18	CL
3-5	Station 17	G4-3-5	Sandy Clay	0	0	0	0	0	0	1	2	7	11	14	17	21	33	67	Lean Clay	38	20	18	CL
3-5	Station 21	G7-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	2	5	8	18	42	58					
3-5	Station 25	G7-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	2	5	8	18	42	58					
3-5	Station 26	G8-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	10	24	76	Lean Clay	45	17	28	CL
3-5	Station 23	G8-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	10	24	76	Lean Clay	45	17	28	CL
3-5	Station 24	G8-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	10	24	76	Lean Clay	45	17	28	CL
3-5	Station 30	S30-070208-3-5	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	8	17	83	Lean Clay	48	20	28	CL
5-6	Station 25	S25-080208-5-6	Sandy Clay	0	0	0	0	0	0	0	0	0	0	1	2	8	22	78	Fat Clay	51	18	33	CH
6-8	Station 11	G5-6-9	Sandy Clay	0	0	0	0	0	0	0	0	0	1	1	2	10	30	70	Lean Clay	38	17	21	CL
7-9	Station 28	G5-6-9	Sandy Clay	0	0	0	0	0	0	0	0	0	1	1	2	10	30	70	Lean Clay	38	17	21	CL
7-9	Station 29	G6-7-10	Sandy Clay	0	0	0	0	0	0	0	0	0	1	3	7	12	21	79	Lean Clay	40	19	21	CL

Table 3-1. Summary of Geotechnical Results by Depth and Sampling Locations

Depth	Station ID	Sample ID	Classification by Particle Size	Percent Retained: Gravel								Sand						Clay/Silt	Atterberg Description	Atterberg Limits			USCS Classification
				3"	2"	1.5"	1"	0.75"	0.5"	3/8"	Total Gravel #4	#10	#20	#40	#60	#100	Total Sand #200	Total Silt + Clay <#200		Liquid Limit	Plastic Limit	Plasticity	
7-9	Station 26	G8-7-10	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	9	21	79	Lean Clay	44	17	27	CL
8-10	Station 27	G6-7-10	Sandy Clay	0	0	0	0	0	0	0	0	0	1	3	7	12	21	79	Lean Clay	40	19	21	CL
8-10	Station 23	G8-7-10	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	9	21	79	Lean Clay	44	17	27	CL
8-10	Station 24	G8-7-10	Sandy Clay	0	0	0	0	0	0	0	0	0	1	2	4	9	21	79	Lean Clay	44	17	27	CL
8-10	Station 6	S6-060208-8-10	Sandy Clay	0	0	0	0	0	0	0	0	2	4	8	16	25	42	58	Lean Clay	37	16	21	CL
8-10	Station 2	S2-050208-8-10	Clayey Sand	0	0	0	0	0	0	1	3	7	13	23	33	44	60	40	Lean Clay	30	15	15	CL
8-10	Station 21	S21-080208-8-10	Sandy Clay	0	0	0	0	0	0	0	0	1	4	11	15	20	28	72	Lean Clay	46	18	28	CL
8-10	Station 18	S18-080208-8-10	Sandy Clay	0	0	0	0	0	0	1	5	10	16	22	27	32	38	62	Lean Clay	35	17	18	CL
8-10	Station 5	S5-060208-8-10	Clayey Sand	0	0	0	0	1	4	7	14	24	29	38	48	52	62	38	Lean Clay	35	16	19	CL
8-10	Station 4	S4-050208-8-10	Sandy Clay	0	0	0	0	0	0	0	1	3	6	9	13	20	47	53	Lean Clay	31	18	13	CL
10-11	Station 30	G6-7-10	Sandy Clay	0	0	0	0	0	0	0	0	0	1	3	7	12	21	79	Lean Clay	40	19	21	CL
10-13	Station 6	G1-10-13	Sandy Clay	0	0	0	0	0	0	0	1	2	4	6	10	15	30	70	Lean Clay	42	20	22	CL
10-13	Station 5	G1-10-13	Sandy Clay	0	0	0	0	0	0	0	1	2	4	6	10	15	30	70	Lean Clay	42	20	22	CL
12-14	Station 18	S18-080208-12-14	Sandy Clay	0	0	0	0	0	0	0	0	2	6	9	12	14	19	81	Lean Clay	43	19	24	CL
13-15	Station 21	S21-080208-13-15	Sandy Clay	0	0	0	0	0	0	0	0	1	3	8	14	21	29	71	Lean Clay	42	16	26	CL
13-15	Station 2	S2-050108-13-15	Clayey Sand	0	0	0	0	1	2	3	4	10	17	25	34	43	56	44	Lean Clay	33	16	17	CL
13-15	Station 4	S4-050208-13-15	Sandy Clay	0	0	0	0	0	0	0	1	2	5	12	22	28	46	54	Lean Clay	30	15	15	CL

USCS Definition:
CL- Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
CH- Inorganic clays of high plasticity, organic silts

3.2 Chemistry Results

3.2.1 Comparison to Relevant Criteria

Analytical results were compared to relevant soil screening levels, sediment quality guidelines, and hazardous waste criteria to determine suitability of material for specific beneficial uses or placement options. Relevant numeric standards for comparisons include:

- Hazardous Waste Criteria
  - Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC): TTLC and STLC are used to determine the hazardous waste characterization under California State regulations as outlined in Title 22 of the California Code of Regulations (CCR).Concentrations of contaminants in project soil were compared to TTLC and 10 times the STLC. If concentrations exceed 10 times the STLC, a Waste Extraction Test (WET) must be performed to estimate the contaminant leachate. If concentrations of contaminants in soil exceed the TTLC or leachate from the WET exceed the STLC, the material is classified as hazardous waste. If a waste is determined to be a hazardous waste, specific regulations and statutes regarding the management, storage, transportation and disposal must be met.
  - Toxicity Characteristic Leaching Procedure (TCLP): TCLP is the characterization for hazardous waste based on Federal guidelines. TCLP analysis was performed to provide an estimate of the soil contaminant leachate and to determine if this material is classified as hazardous waste or if it is considered suitable for upland placement. Analytes leaching from the soil were compared to USEPA Title 40 Code of Federal Regulations (CFR) Part 261 values (USEPA, 2006).

- Human Health Screening Levels
  - California Human Health Screening Levels (CHHSLs): Concentrations of 54 hazardous chemicals in soil that the California Environmental Protection Agency (Cal/EPA) considers to be below thresholds of concern for risks to human health based on ingestion, inhalation, and dermal absorption. The CHHSLs were developed by the Office of Environmental Health Hazard Assessment (OEHHA) on behalf of Cal/EPA, and are contained in their report entitled "Human-Exposure-Based Screening Numbers are Developed to Aid Estimation of Cleanup Costs for Contaminated Soil". Any exceedances of the CHHSLs do not indicate that the levels are of concern, but suggest that further evaluation of potential human health concerns may be considered. Residential CHHSLs are recommended for use by the California Department of Toxic Substances Control (DTSC) for human health screening evaluation described in the Preliminary Endangerment Assessment (PEA) Guidance Manual.
  - Preliminary Remediation Goals (PRGs): For contaminants that CHHSLs are not developed, the PRGs are used. The PRGs were developed by USEPA Region IX as a risk-based screening tool for evaluating and cleaning up contaminated sites. The Region IX PRGs were developed prior to the CHHSLs and are similar or slightly less stringent. The values are calculated from current human health toxicity values with standard exposure factors to estimate contaminant concentrations in environmental

media (soil, air, and water) that are considered by the Agency to be health protective of human exposures (including sensitive groups), over a lifetime. As with CHHSLs, exceedances do not indicate that the levels present are a human health concern, however, more evaluation may be required.

- Ecologically Relevant Screening Criteria
  - Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse. These sediment screening criteria and testing requirements are for the beneficial reuse of dredged material such as wetlands creation and upland disposal. The criteria were developed by the California Regional Water Quality Control Board.
  - Effects Range-Low (ER-L) and Effects Range-Median (ER-M) Values: Effect range values are used in dredged material evaluations for ocean disposal. These values were developed by Long et al. (1995), and are helpful in assessing the potential significance of elevated sediment-associated COCs, in conjunction with biological analyses. Briefly, these values were developed from a large data set where results of both benthic organism effects (e.g., toxicity tests, benthic community effects) and chemical analysis were available for individual samples. To derive these guidelines, the chemical values for paired data demonstrating benthic impairment were sorted in according to ascending chemical concentration. The ER-L was then calculated as the lower tenth percentile of the observed effects concentrations and the ER-M as the 50^{th} percentile of the observed effects concentrations. While these values are useful for identifying elevated sediment-associated contaminants, they should not be used to infer causality because of the inherent variability and uncertainty of the approach. For dredged material evaluations, the ER-L and ER-M sediment quality values are used in conjunction with bioassay testing and are included for comparative purposes only. For certain pesticide compounds (i.e., chlordane and dieldrin) the ER-L and ER-M levels are so low as to make it largely impractical to detect them in typical harbor sediments using routine analytical procedures. Accordingly, having non-detect results that were greater than the ER-L, ER-M, or method detection limits (MDLs) would not require re-analysis.

A summary of the measured chemical constituents and comparison to the most appropriate soil screening levels, sediment quality guidelines, and hazardous waste criteria are provided in the appendices. The complete chemical analysis results from CRG of the selected soil samples are provided in Appendix G1 - G5. A summary of elevated contaminants above soil screening criteria and sediment quality guidelines are discussed below and presented in Table 3-2 and Table 3-3, respectively.

3.2.1.1 Comparison to Hazardous Waste Criteria

No chemicals were detected at concentrations greater than the TTLC or at concentrations greater than 10 times the STLC value (Appendix G1). Results of TCLP analyses indicated no analytes above the toxicity characteristic standards USEPA 40 CFR Part 261 values (USEPA, 2006) (Appendix G2). Therefore, the material is not classified as a hazardous waste and is suitable for upland placement options.

3.2.1.2 Comparison to Human Health Criteria

The analyzed organic chemicals of concern were PAHs, PCBs and organochlorine pesticides. With the exception of one soil sample, none of the Area A samples contained concentrations of PAHs, PCBs, or pesticides above the CHHSLs and PRGs soil criteria (Appendix G3). The concentration of benzo [a] pyrene at Station 27 was 39.7 µg/kg dry weight and this exceeded the human health screening level (set at 38 µg/kg dry weight) for potential use at residential land use.

While most of the chemical screening values for are below levels of concern for human health, arsenic and iron have ambient concentrations greater than residential CHHSLs and PRGs (Appendix G3). These exceedances suggest the material could be an issue if the sediments are used where humans will have continual contact (e.g. residential property or recreational property). The concentrations of arsenic and iron found are consistent with natural concentrations in marine sediments. A summary of soil samples that exceeded soil criteria is shown in Table 3-2.

During the boring and sampling operations, PID readings were taken to identify potential "hot" zones which might contain elevated VOC concentrations. Soil samples from five stations showed elevated PID readings in the field and were subsequently selected for s-VOC and VOC analysis. The results of the laboratory analysis showed that none of the five samples exceeded CHHSLs or PRGs criteria for residential and commercial land use. Appendix G3 shows the results of all the s-VOC and VOC analysis from the discrete and composite station samples.

Due to the historic and current presence of gasoline production and transportation at Area A, the 20 soil stations were analyzed for total petroleum hydrocarbons (TPHg and TPHd) and benzene, ethylbenzene, toluene, and xylenes (BETX). None of the soil samples had concentrations of TPHg, TPHd or BETX above the CHHSLs and PRGs (Appendix G3). However, during drilling operations at Station 25 and 26, the field engineer noted evidence of soil staining throughout the soil core. These two stations are closest to the abandoned gasoline transportation line that runs north-to-south through Area A. Additional soil sampling may be necessary prior to any large-scale excavation of site.

3.2.1.3 Comparison to Ecologic Criteria

The results of the chemical analysis were also compared to soil clean-up standards which may be applied to the Area A soils since the dredged material has been dewatered. In addition, the soil below the water table may be considered sediment and may be subject to proposed sediment quality criteria if used for the Restoration Project. The Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation and Upland Beneficial Reuse, as established by the California Regional Water Quality Control Board, were used to determine if the Area A soil was suitable for wetland application (Appendix G4). The results of chemical analysis showed that all the analyzed chemical constituents were below the Interim Sediment Screening Criteria.

Concentrations of metals were also compared to ER-L and ER-M values (Appendix G5). Several metals slightly exceeded the corresponding ER-L values, including arsenic, cadmium, copper, lead, mercury, nickel, and silver (Table 3-3). No metals exceeded the corresponding ER-M values, indicating relatively low concentrations.

Concentrations of organics were also compared to ER-L and ER-M values (Appendix G5). The only organic to exceed the corresponding ER-L value was 4,4'-DDE in the composite sample from Stations 21 and 25 (Table 3-3). No organics exceeded the corresponding ER-M values, indicating relatively low concentrations.

CRG was not able to extract enough pore water from the soil samples for salinity and conductivity analysis. However, two soil samples were analyzed for salinity at the WESTON laboratory by using a refractometer. The dissolved salts were extracted from the soil samples by adding small quantities of deionized (DI) water and agitating the soil samples. The results indicate that the salt concentration of the soil is greater that 5 ppt. The soil at Area A is from marine sources such as Marina del Rey Harbor and Ballona creek. Currently there is existence of pickle weed which grows in soils with high salt content. Hence, it is inferred that the soil has a high salt content relative to that from a freshwater source. In addition, the soil pH indicates that it is basic in nature across Area A.

Table 3-2. Summary of Soil Samples with Analytes that Exceed California Human Health Screening Levels or Preliminary Remediation Goals

Group	Analyte	Units	RL	Residential Land Use		Commercial/Industrial Land Use Only		S10-060208-6-7	S11-070208-14-15	S11-S15-S28-14-20	S15-080208-15-16	S15-S28-15-16	S17-080208-10-11	S17-S18-10-12	S18-080208-7-8	S21-080208-6-7	S21-S25-6-8
				CHHSLs	PRG	CHHSLs	PRG	Discrete	Discrete	Composite	Discrete	Composite	Discrete	Composite	Discrete	Discrete	Composite
Metals	Arsenic (As)	µg/dry g	0.05	0.07	0.39	0.24	1.60	5.129	4.086	4.557	12.61	7.145	3.59	3.816	3.561	9.254	9.218
	Iron (Fe)	µg/dry g	5		23000		100000	15890	37840	41390	38250	32840	28970	37170	37940	30390	32920
PAHs	Benzo[a]pyrene	ng/dry g	5	38	15	130	210	<5	<5	<5	<5	<5	<5	<5	<5	7.3	6.8

Group	Analyte	Units	RL	Residential Land Use		Commercial/Industrial Land Use Only		S23-080208-12-13	S23-S24-S26-21-24	S27-S29-S30-6-8	S29-070208-6-7	S3-11-12-15-16	S4-S10-5-7	S5-060208-15-16	S5-S6-15-16	S5-S6-S9-3-4	S9-060208-3-4
				CHHSLs	PRG	CHHSLs	PRG	Discrete	Composite	Composite	Discrete	Composite	Composite	Discrete	Composite	Composite	Discrete
Metals	Arsenic (As)	µg/dry g	0.05	0.07	0.39	0.24	1.60	13.73	4.814	8.977	3.848	7.636	4.666	7.393	3.038	5.73	5.802
	Iron (Fe)	µg/dry g	5		23000		100000	27480	36000	31170	26180	34330	18770	35380	26340	20140	14270
PAHs	Benzo[a]pyrene	ng/dry g	5	38	15	130	210	3.4 J	<5	39.7	<5	6.1	<5	<5	<5	<5	<5

Notes:
J – Below the Reporting Limit (RL) but above the Method Detection Limit (MDL)
Yellow - Concentration exceeds respective soil screening criteria.

Table 3-3. Summary of Soil Samples with Analytes that Exceed Effects Range-Low or Effects Range-Median Values

Group	Analyte	Units	RL	Disposal Option Sediment Screening Criteria		S10-060208-6-7	S11-070208-14-15	S11-S15-S28-14-20	S15-080208-15-16	S15-S28-15-16	S17-080208-10-11	S17-S18-10-12	S18-080208-7-8	S21-080208-6-7	S21-S25-6-8
				ER-L	ER-M	Discrete	Discrete	Composite	Discrete	Composite	Discrete	Composite	Discrete	Discrete	Composite
Metals	Arsenic (As)	µg/dry g	0.05	8.2	70	5.129	4.086	4.557	12.61	7.145	3.59	3.816	3.561	9.254	9.218
	Cadmium (Cd)	µg/dry g	0.05	1.2	9.6	0.262	0.201	1.243	0.836	0.684	0.089	0.595	0.307	0.614	0.57
	Copper (Cu)	µg/dry g	0.05	34	270	11.15	33.62	22.17	39.25	28.84	18.03	28.89	28.99	31.63	35.6
	Lead (Pb)	µg/dry g	0.05	46.7	218	4.742	7.802	4.583	7.924	6.104	3.783	5.758	6.194	24.94	50.72
	Mercury (Hg)	µg/dry g	0.02	0.15	0.71	0.043	0.053	0.055	0.068	0.052	0.041	0.049	0.06	0.303	0.215
	Nickel (Ni)	µg/dry g	0.05	20.9	51.6	14.69	27.15	21.2	25.37	21.42	17.05	24.09	23.61	22.55	23.94
	Silver (Ag)	µg/dry g	0.05	1	3.7	0.04 J	0.035 J	0.072	0.038 J	0.113	0.042 J	0.173	0.052	1.079	1.027
Pesticides	4,4'-DDE	ng/dry g	5	2.2	27	<5	<5	<5	<5	<5	<5	<5	<5	<5	11.6

Group	Analyte	Units	RL	Disposal Option Sediment Screening Criteria		S23-080208-12-13	S23-S24-S26-21-24	S27-S29-S30-6-8	S29-070208-6-7	S3-11-12-15-16	S4-S10-5-7	S5-060208-15-16	S5-S6-15-16	S5-S6-S9-3-4	S9-060208-3-4
				ER-L	ER-M	Discrete	Composite	Composite	Discrete	Composite	Composite	Discrete	Composite	Composite	Discrete
Metals	Arsenic (As)	µg/dry g	0.05	8.2	70	13.73	4.814	8.977	3.848	7.636	4.666	7.393	3.038	5.73	5.802
	Cadmium (Cd)	µg/dry g	0.05	1.2	9.6	0.67	0.482	0.63	0.257	0.499	0.199	0.175	0.147	0.255	0.208
	Copper (Cu)	µg/dry g	0.05	34	270	25.64	30.61	37.79	20.12	28.08	14.52	27.21	21.25	12.81	9.257
	Lead (Pb)	µg/dry g	0.05	46.7	218	5.361	7.187	31.96	8.573	19.58	4.625	4.742	3.514	6.364	3.383
	Mercury (Hg)	µg/dry g	0.02	0.15	0.71	0.028	0.083	0.189	0.077	0.089	0.065	0.067	0.058	0.046	0.053
	Nickel (Ni)	µg/dry g	0.05	20.9	51.6	26.33	25.27	25.6	19.71	26.05	15.74	20.98	16.44	15.2	13.25
	Silver (Ag)	µg/dry g	0.05	1	3.7	0.105	0.221	0.224	0.129	0.174	0.096	<0.05	0.258	0.138	0.04 J
Pesticides	4,4'-DDE	ng/dry g	5	2.2	27	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Notes:
J – Below the Reporting Limit (RL) but above the Method Detection Limit (MDL)
Yellow - Concentration exceeds respective sediment screening criteria.

3.3 Soil Cross Sections

Soil cross sections were developed from boring logs (Appendix D) and geotechnical laboratory results. Figure 3-1 shows the location of the cross sections in the study site. Figure 3-2 shows the cross section A-A' and Figure 3-3 shows the cross section B-B'. For the purpose of development of cross sections, it was assumed that the area is topographically flat in elevation. The cross sections indicate that soil within the site could be characterized as having limited stratification and is spatially similar in nature. The cross sections show that the water table is tidally influenced. The water table indicated is representative of the water table at the specific time the water table was recorded or the sampling was conducted (Refer to Appendix D for borelogs and sampling times)

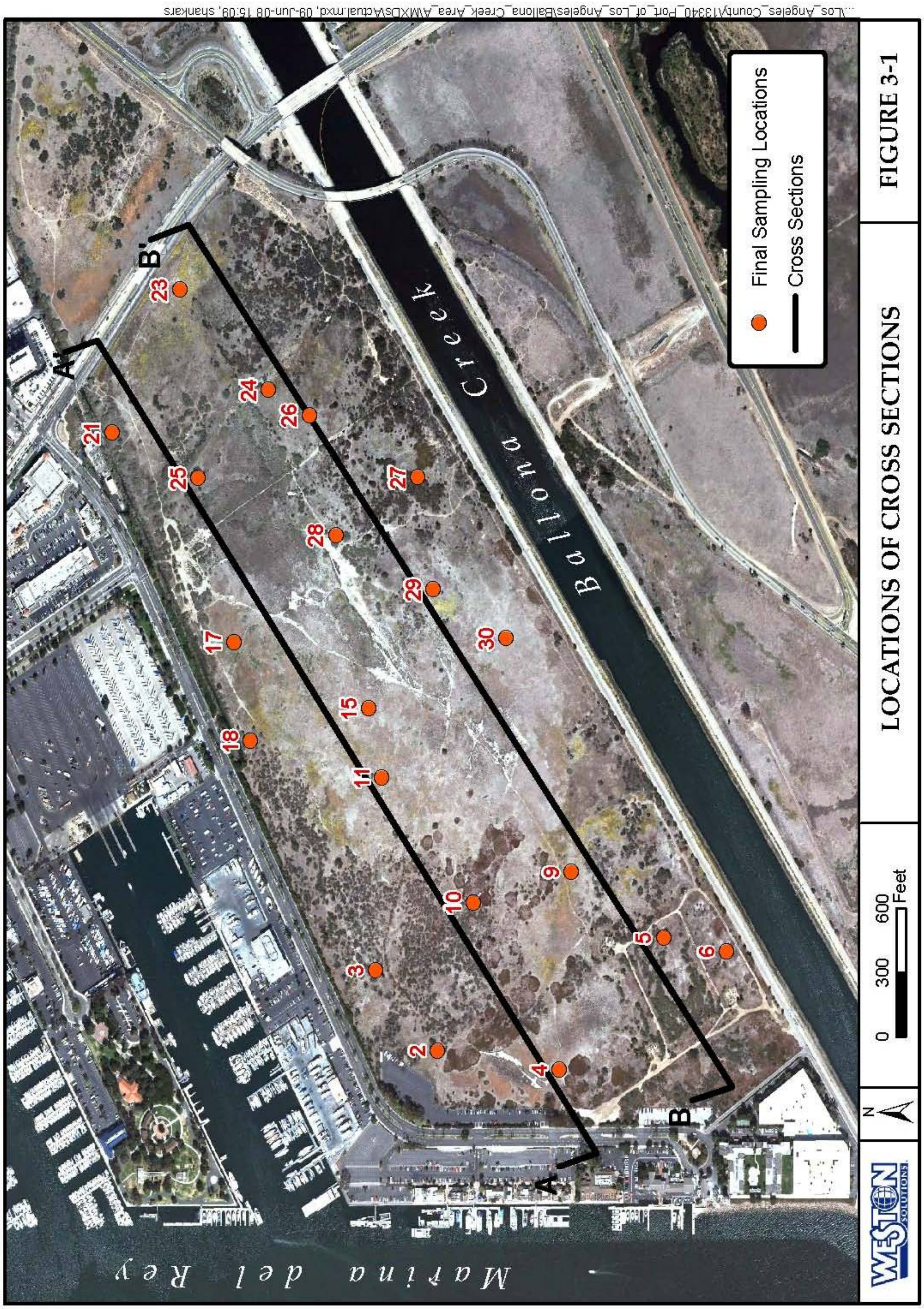

Figure 3-1. Location of Cross Sections

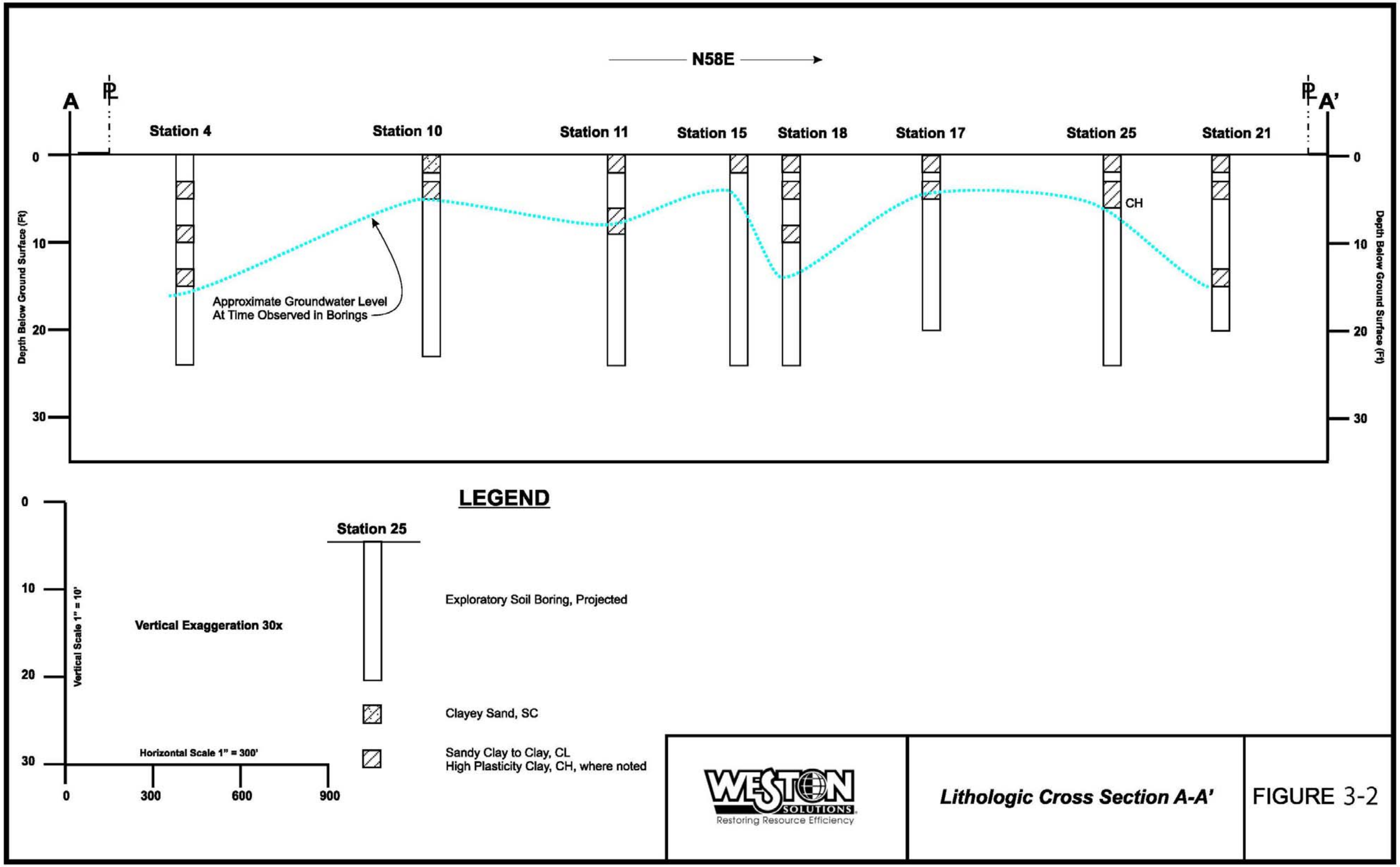

Figure 3-2. Cross Section A-A'

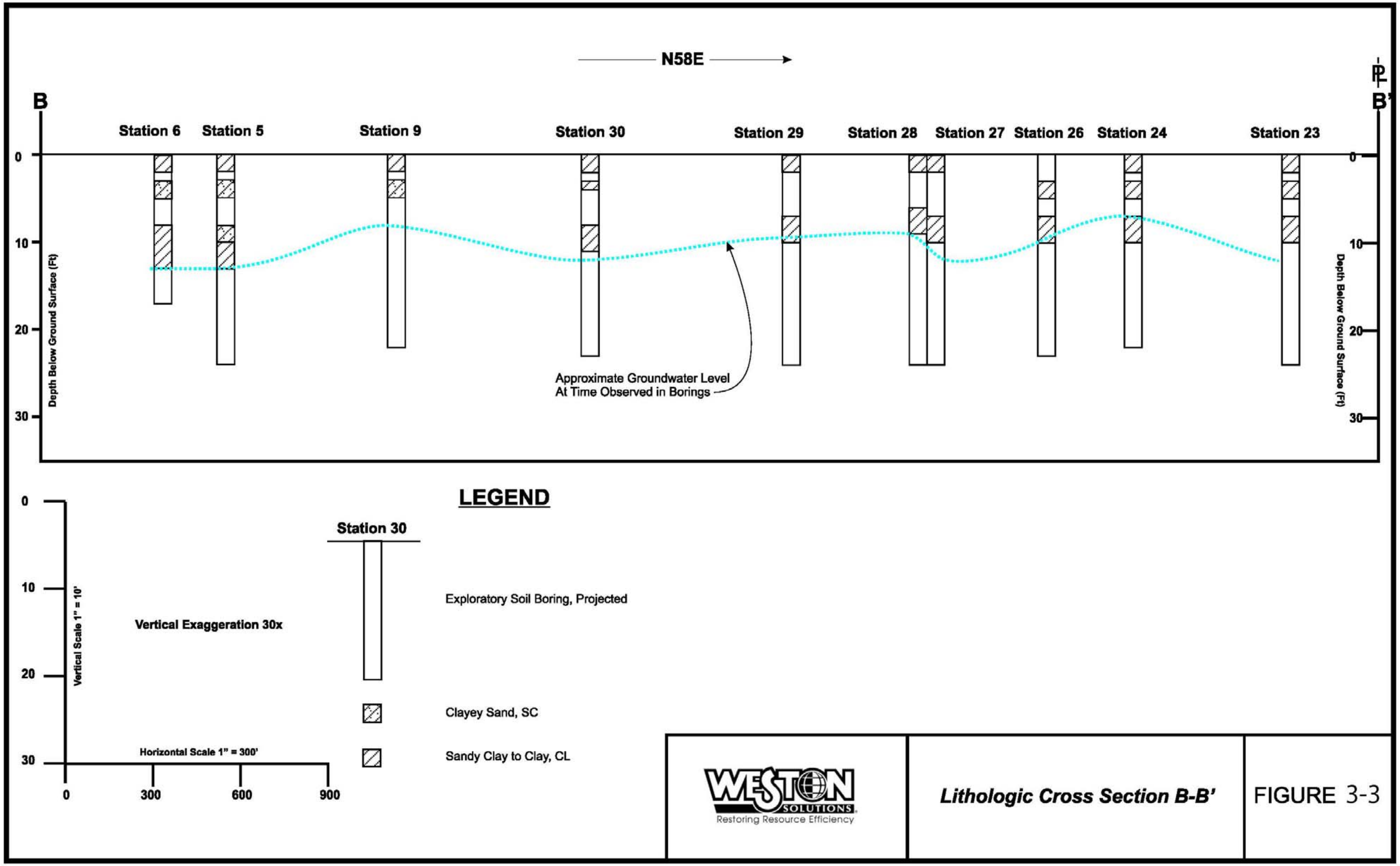

Figure 3-3. Cross Section B-B'

4.0 DISPOSAL OPTIONS

There are a number of environmental, economic and aesthetic beneficial uses for the soil at Area A. Five relevant general categories include: habitat restoration/enhancement, landscaping, beach nourishment, landfill development, and construction activities (i.e., road works/fill). The general criteria used to determine the feasibility of these beneficial uses is summarized in Table 4-1. The primary focus of this section was on potential beneficial uses; however, open water ocean disposal is also presented.

4.1 Habitat Restoration/Enhancement

Dredged material may be used beneficially as substrate for the restoration and enhancement of various wildlife habitats. Habitat restoration is defined as the return of a habitat to a close approximation of its condition prior to disturbance and habitat enhancement is the modification of specific structural features to increase one or more functions based on management objectives (USEPA, 2005). There are four general habitats suitable for the beneficial use of dredged material: wetland, upland, aquatic, and island habitats. The contamination levels compared to the California Regional Water Quality sediment screening criteria and the geotechnical characteristics of the material found in Area A would probably best be utilized for beneficial uses related to habitat development. The most cost effective solution would be to apply as much of the dewatered sediment onsite. The marine dredged material is completely dewatered; therefore, recommendations for material are most likely suitable for wetland and upland placement in coastal zones to support salt tolerant species. However, the saturated zones may be used for upland placement. These saturated soils may also be compared against the sediment criteria developed wetland restoration for San Francisco Bay region by the State of California.

The process steps for wetland restoration or upland habitat creation utilizing dewatered dredged material are as follows:

- Study and design (reconnaissance, feasibility study, design, permitting, easements);
- Perform tiered biological/chemical investigations regarding the effects of the material on plants and animals;
- Excavation of dewatered material from a confined disposal facility (CDF);
- Load, transport, and offload material from truck;
- Natural revegetation of the site or management of site to attract desired wildlife communities;
- Placement of temporary or permanent containment (plants or protective structure);
- Development of success criteria; and
- Ongoing monitoring.

Table 4-1. General Beneficial Use Evaluation Criteria

Beneficial Use	Type of Use	Soil Evaluation Criteria (USCS classification)	pH	Organics	Other Criteria	Area A Soil	Is this a potential Beneficial Use option ?	Comments
Habitat Restoration/ Enhancement	Upland	Upland: plant preferences	6-7.5	> 1.5%	Few pollutants; Salts < 500 ppm	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays and Fat clay (CL/CH) Very small pockets of Clayey sand Liquid limit ranges from 20 to 48 Plastic limit ranges from 15 to 20 Plasticity index ranges from 13 to 33 Low permeability. Low concentrations of pollutants (meets soil quality criteria in accordance with California code of regulations) Soil is non hazardous pH ranges from 8.5 to 9.5 Low to medium organic content	Yes	Salts may prevent beneficial use in the sediments below 5.5 mean lower low water (MLLW), where salt water intrusion may be occurring.
	Wetlands	Wetlands: fine grained; Upland: plant preferences	6-7.5	> 1.5%	Few pollutants; Salts < 500 ppm		Yes	Salts may prevent beneficial use in the sediments below 5.5 MLLW, where salt water intrusion may be occurring.
Landscape/ Vegetative Cover		sandy loam; silt loam	6-7.5	> 1.5%	Few pollutants, Low fines; Salts < 500 ppm; Possible to combine sands with loams (LL<50)		No	High salt content for typical landscape
Beach Nourishment		sands (typed to beach)	-	-	Little/No pollutants (compare against background levels)		No	Grain size: Area A sediments are too fine
Solid Waste Management: Landfill	Cap	CL, CH	-	Medium/ Low	Low permeability		Yes	
	Cover	sandy clay, clayey sand (ideal: 5-10% sand, 5% fines)	-	Medium/ Low	Few pollutants; Low permeability		Yes	
	Liner/Barrier	CL, CH	-	Medium/ Low	Few pollutants; Low permeability		Yes	
	Base	gravels (G-)	-	Low	PI < 1 (where PI=LL-PL)		Yes	
Solid Waste Management: Confined Aquatic Disposal Cap	Cap	CL, CH	-	Medium/ Low	Low permeability		Yes	
Construction Activities	Road fill subbase	gravels (G-)	-	Low	PI < 1 (where PI=LL-PL); if CL or CH, treat with lime/install enhancement fabric		No	Roadwork and other construction applications would likely require the excavated material to be gravels or coarse grained sand with low organic concentrations (to reduce swelling). As such, it is unlikely that the Area A material could be utilized in this manner.
	Road fill subgrade	-	-	-	PI < 12 (where PI=LL-PL)		No	
	General - Fill		-	Low	Little/No Pollutants		Yes	
	Pier A west - Backfill		6-9	Low	Little/No Pollutants Low to medium plasticity Salts < 500 ppm; Possible to combine sands with loams		Yes	

PI = Plasticity Index No
LL = Liquid Limit
PL = Plastic Limit

4.1.1 Wetland Habitat Restoration/Enhancement

Dredged material may be beneficially used to restore or enhance wetland habitats. A wetland habitat is a low-lying area characterized by vegetation that is subject to periodic inundations. Wetland restoration may be used to enhance or reclaim wetlands that have been lost to open water as the result of erosion, subsidence, sea-level rise, and other factors. Wetland enhancement entails the manipulation of the physical, chemical, or biological characteristics of a wetland site, often by modifying the site elevation or hydrology in order to improve a specific function, such as water quality or wildlife habitat. These improvements may provide protected areas free from human, feral, or non-indigenous species impacts, and enhance colonization by desirable organisms including threatened and endangered species. In addition, wetlands provide natural protection from coastal erosion, flooding and storm surge.

Wetland restoration and enhancement is a viable beneficial use option for consolidated clay and silt/soft clay as surface material, with the possibility for using coarser or contaminated sediment as foundational material. Restoration and enhancement is accomplished by either applying thin layers of dredged material to bring a degraded wetland up to an intertidal elevation, or by creating erosion barriers using dewatered dredge material to allow the natural revegetation of a degraded or impacted wetland. Restoration/enhancement of existing wetlands is generally more successful than the creation of a new wetland where none previously existed.

Advantages of wetland restoration and enhancement include:

- High public appeal;
- Enhancement of desirable biological communities, including threatened or endangered species;
- Barrier creation for protection from coastal erosion and storm-related flooding;
- Sequestration of certain contaminants in less bioavailable forms or locations; and
- Typically a lower-cost beneficial use option especially if proximate to dredging location.

Area A contains clayey soils and material is suitable as surface material. The soil chemistry was compared to CHHSLs and PRGs to assess the risk to human health and it was found that the soil is free of chemicals of concern except for increased concentrations for arsenic, iron and benzo[a]pyrene (at one station). The soil chemistry at Area A was also compared to the Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation sediment screening criteria. The data showed that the concentrations of chemical constituents are lower than the prescribed standards and the soil at Area A is probably suitable for wetland habitat restoration/enhancement.

4.1.2 Upland Habitat Creation

An upland habitat is one in which the vegetation is not normally subjected to inundations. Upland habitats provide refuge for a broad category of terrestrial communities and range from bare ground to mature forest. Dredged material may be used to create upland habitat either through relocation of dewatered material to the proposed upland site. Upland habitat creation is a viable beneficial use option for virtually all sediments: rock, gravel and sand, consolidated clay, silt/soft clay, and sediment mixtures. Soil amendments, such as lime and organic matter, may be required to provide a suitable medium for the growth of upland plant species. The relatively high salt concentrations may only allow for salt tolerant upland species (halophytes, e.g., mulefat, saltgrass, statice, sea-blite)

Advantages of upland habitat creation include:

- High public appeal;
- Minimal site management;
- Creation of desirable biological communities; and
- Typically a lower-cost beneficial use option especially if proximate to dredging location

Area A contains predominantly clayey soils. The soil chemistry at Area A was compared to the Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation sediment screening criteria and it was found that the concentration of chemical constituents are lower than the prescribed standards and the soil at Area A is probably suitable for upland habitat creation. The saturated sediments from this region are also potentially viable for upland placement for habitat creation. The saturated sediment may be considered for placement in the upland region within the tidal restoration work at Area A.

4.2 Landscape/Vegetative Cover for Parks

Landscaping refers to the beneficial application of soil for landscaping, agriculture, residential and commercial horticulture, sod farming, and even livestock pastures. Depending on the contaminant levels of the excavated material, it could be applied directly or mixed with rich soils to create an amended mixture. The salt content in Area A limits the suitability of the sediments for typical landscaping.

4.3 Beach Nourishment

Beach nourishment refers to the strategic placement of large quantities of beach quality sand on an existing beach to provide a source of nourishment for littoral movement or restoration of a recreational beach. Generally, beach nourishment projects are carried out along a beach where a moderate and persistent erosion trend exists. Sediment with physical characteristics similar to the native beach material used is used. Material at Area A is predominantly fine-grained; therefore, it is not suitable for beach nourishment on adjacent beaches.

4.4 Solid Waste Management: Landfill Cover and Capping

Solid waste in sanitary landfills is covered everyday with a minimum quantity of site soil to prevent infiltration, control vectors, improve aesthetics, and prevent fires. Liners and barriers are used to prevent the lateral and vertical migration of pollutants. Once landfills reach capacity, a relatively impermeable cap in needed to close the system. Caps are usually covered with sandy and vegetated layers and include vents/drains to allow gases to dissipate into the atmosphere (United States Army Corps of Engineers [USACE], 1987; Great Lakes Commission, 2004).

Dewatered dredged material may be used beneficially at landfills as daily or final cover and as capping material for abandoned contaminated industrial sites known as "brownfields." Solid waste landfills require a minimum of 6 inches cover daily to prevent unsightly appearance, pest control, odor control, and to prevent surface water infiltration. In addition, the closure of a landfill or brownfield requires a cap of clean material to isolate the solid waste from the surrounding environment. Landfill cover is a viable beneficial use for consolidated clay and silt/clay. Final cover and capping is applicable for virtually all sediment types, although amendments to the material may be required to achieve the required physical properties for the intended end use.

The process steps for landside solid waste management utilizing dewatered dredged material are as follows:

- Study and Design (Reconnaissance, Feasibility Study, Design, Permitting);
- Excavation of dewatered material from CDF;
- Load, transport and offload material from trucks and stockpile at construction site;
- Blend dredged material with amendments in pug mill (due to the unconsolidated nature of the material);
- Place and spread material with bulldozers; and
- Monitoring.

A confined aquatic disposal (CAD) facility is a location where dredged material is disposed at the bottom of a body of water, usually within a depression constructed specifically for the disposal, or within a depression created during sand mining. Often, material placed in a CAD has elevated contaminants or physical characteristics that are not suitable for standard ocean disposal. Material contained in a CAD is confined to the designated area to prevent lateral or vertical movement. If material is elevated in contaminants, a clean layer of suitable clean sediment is required to minimize exposure to marine organisms.

The process steps for utilizing dewatered dredged material for cover at a CAD facility are as follows:

- Study and design (reconnaissance, feasibility study, design, permitting, easements);
- Perform tiered biological/chemical investigations regarding the effects of the material on plants and animals;
- Excavation of dewatered material from CDF;
- Load and transport by truck to barge loading site, then offload;
- Placement of cap; and
- Operation, maintenance, and monitoring of cap.

Advantages of using dewatered dredged material as daily of final landfill cover or for capping include:

- Accommodates relatively large quantities of dredged material compared to other beneficial uses;
- Dredged material typically possesses important cover material characteristics such as workability, moderate cohesion, and low permeability;
- Dredged material provides a cover that retards the infiltration of water and the diffusion of air to the waste, thus reducing infiltration of leachate into surface water and groundwater;

- Provides foundation for post-closure redevelopment such as parks, golf courses, parking lots, or light industrial use; and
- Material originated from the marine environment, therefore it is consistent with physical properties that are advantageous to placement back into the marine environment

Disadvantages of using dredged material as landfill cover include:

- Lack of availability of appropriate sites within reasonable distance of source

Area A contains fine grained clayey soils. The soil chemistry was compared to CHHSLs and PRGs to assess the risk to human health and it was found that the soil quality is acceptable for use as a landfill cover. The soil chemistry at Area A was also compared to the Interim Sediment Screening Criteria and Testing Requirements for Wetland Creation sediment screening criteria and it was found that the concentrations of chemicals of concern are lower than the prescribed standards. Thus, the soil at Area A is suitable for landfill cover and confined aquatic disposal. However, once the specific facility is identified, the soil quality needs to comply with the soil screening criteria set forth for the specific landfill/CAD.

4.5 Construction Activities: Roads and Fill

The use of dewatered dredged material as construction fill for roads, construction projects, dikes, levees or CDF expansion is a practical beneficial use. The use of dewatered dredged material for material transfer is a viable beneficial use for sands/gravel, consolidated clay, and silt/clay, although fine-grained dredged material may require amendment to provide the physical properties required for light load engineering uses. Road work includes the beneficial use of material for fill layers (base or subbase) for roads, foundations or small structures and grading. The beneficial application of soil for road construction in California is regulated by Caltrans while its application for other constructions is regulated by the California Building Code and local building regulations. The material must have a strong bearing strength and therefore, must consist of gravel with few organics or fines (Caltrans 2006; Port of Long Beach, 2000).

Material may be amended by the addition of crushed glass, lime, cement, and fly ash. The type, combination, and amount of amendment material depends on the moisture content, the amount of fines (clays and silts), and organic content of the dredged material. Greater amounts of amendments are typically required if the dredged material has a high clay and/or organic content. The amount and type of amendment will also be dictated by the required physical properties of the finished product. Such amendments can also be used to stabilize contaminants, making this a potential use for contaminated dredged material. Proven methods have been developed for land improvement by filling the site with sand or fine sediments, such as consolidated clay and silt/clay.

Advantages of utilizing dewatered dredged material for the beneficial use of material transfer for fill include the following:

- Provides a recycled material source to replace standard construction fill materials beneficial from both a cost and resource management perspective;
- Some large public projects require large quantities of fill material and could accommodate large quantities of dredged material;

- Use in CDF expansion creates additional capacity for future maintenance dredging needs;
- Favorable to the public and local officials due to economic benefits to the public and commercial communities that industrial development in port areas can create; and
- Use of dewatered dredge material from a nearby storage facility can offset the increased transportation costs associated with hauling material from a conventional source.

The disadvantages of utilizing dewatered dredged material for the beneficial use of material transfer for fill include the following:

- Availability of this beneficial use option depends upon need and timing of development projects with dredged material;
- Bearing capacity of unamended dredged material will not meet requirements of the proposed development and amendment of dredged material adds to project costs; and
- Rehandling and movement of dredged material over long distances could make use of dredged material impractical for some projects.

Area A has inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays and fat clay with very small pockets of clayey sand. The soil is characterized by low permeability. The soil chemistry was compared to CHHSLs and PRGs to assess the risk to human health and it was found that the soil quality is acceptable for use at both residential land uses and industrial/commercial land uses. The material at Area A is suitable for construction activities. Determination of final acceptance for a construction project will depend on the specific criteria for the specific construction activity.

4.6 Open Water Disposal

Open water disposal refers to the discharge of dredged material in oceans, rivers, lakes, or estuaries by means of a pipeline or release from a hopper dredge or barge. For the purpose of this project, dredged material would be discharged from a barge into the ocean at the USEPA designated LA-3 Ocean Disposal Site. This site is located approximately 31 nautical miles from the project site. Prior to disposal, dredged material from Area A must be evaluated for suitability in accordance with *Evaluation of Dredged Material Proposed for Ocean Disposal* (USEPA/USACE, 1991). This evaluation includes solid phase (SP), suspended particulate phase (SPP), and bioaccumulation potential (BP) tests. SP tests are performed to estimate the potential impact on of dredged material on benthic organisms that attempt to re-colonize the area. SPP tests are performed to estimate the potential impact of dredged material on organisms that live in the water column. BP tests are performed to estimate the potential uptake of dredged material contaminants by organisms.

Open-water placement must comply with applicable state and federal regulations. Such regulations include, but are not limited to the Marine Protection, Research, and Sanctuaries Act (MPRSA); Clean Water Act (CWA), Section 404 (in-harbor placement) and the National Environmental Policy Act (NEPA). In all instances, applicable state and federal regulations must be followed and appropriate permits must be obtained.

Advantages of ocean disposal include the following:

- Accommodates large quantities of dredged material compared to beneficial uses;

- More economical than most beneficial uses;
- Logistically easier than most beneficial uses.

Ocean disposal is more economical than most beneficial uses due to rehandling costs. Rehandling is the process of loading, transporting, and offloading dredged material. Rehandling is often the most important factor in determining the economic feasibility of a dredging project since costs increase with the number of times dredged material is re-handled. For disposal at the LA-3 Ocean Disposal Site, dredged material would be transported by barge. For beneficial use alternatives, material would be transported by truck. Truck haul begins to lose economic efficiency as the transport distance and/or dredged material volume increases.

Based on this screening level assessment, concentrations of contaminants in Area A are relatively low (< ER-M values), indicating the dredged material is potentially suitable for ocean disposal pending a full dredged material evaluation.

4.7 Cost Estimation

The cost estimate for beneficial use of excavated material was developed based on the tidal restoration Alternative 4, proposed by USFWS, that was included in alternatives being analyzed by CDFG and CCC. The purpose of this alternative was to establish tidal and sub-tidal habitat consistent with the tidal habitat that existed in this area before it was filled with dredge material from Marina del Rey Harbor and Ballona Creek. Alternative 4, which is currently under consideration, is shown in Figure 1-2. This concept design was used to estimate the excavation volume which in turn was used to estimate screening level costs. The calculation excavation volume for Alternative 4 is 2,379,000 cubic yards. Figure 1-3 shows the expected cross section after the proposed wetland restoration is completed.

The estimated costs to beneficially use excavated material as landfill cover and/or capping material at a brownfield are provided in Appendix H. The total cost including permitting, design, site preparation and development, excavation, transport, and placement is approximately $59 per cubic yard. This cost estimate is a screening level estimate only and assumes 6% to 8 % escalation of costs per year. If the dredged/excavated material is used for landfill, it is assumed to be transported and used as daily cover for sites within 125 mile radius of the Ballona wetlands.

5.0 CONCLUSIONS

The Ballona Wetlands Area A was a former wetland that was used in the early to mid 1900s as a depository for dredge material removed during construction activities in the Marina del Ray Harbor and Ballona Creek. Approximately 4.5 million cubic yards (mcy) of dredge material was placed on the wetlands and the material is now being considered for removal in support of wetland restoration activities. Before the dredge material can be transported for potential beneficial use or ocean disposal, a geotechnical and chemical study was needed to identify any special handling or disposal restrictions that may be required. The Ballona Wetlands Area A preliminary geotechnical investigation and beneficial use/ocean disposal analyses was performed to characterized the dredge material in terms of general USCS classification, chemical constituents, potential health and environment hazards associated with the dredge material, and potential beneficial uses or disposal options for the material after excavation from the former wetlands.

The geotechnical characteristics of the dredge material that are key to determining potential beneficial uses of the excavated soil and the use of the soil for restoration are 1) grain size distribution, 2) plastic limit, 3) liquid limit and 4) moisture content. The lithology of Area A is similar across the site and is classified as mixtures of clay. According to USCS classification, the soil is classified as inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays and lean clays. The northwest portion of the study site close to Lincoln Boulevard has cobbles and coarse gravel in the top few feet of soil. This subarea might need segregation and separate stockpiling during excavation since its beneficial use is different from the rest of the site.

Soil samples from 20 site locations were analyzed for a suite of organic constituents and metals to determine the potential human health risks associated with exposure to excavated dredge material. In addition, a leaching study was performed to determine potential environmental exposure to toxic metals. The key metrics for screening the Area A soils for beneficial use or ocean disposal was the ability to demonstrate that the soils did not contain chemicals of concern at concentrations exceeding TTCL, STLC, CHHSL, PRGs, Interim Sediment Screening Criteria, and ER-L and ER-M values. The leaching study performed on the soil samples successfully demonstrated that the soil was non hazardous and does not pose an environmental risk due to toxic levels of leachable metals. In addition the soil is suitable for a variety of beneficial uses due to concentrations of PAHs, PCBs, pesticide, s-VOCs, or VOCs that are below the regulated human exposure limits or interim sediment quality criteria. Several soil samples did exceed PRGs (residential use) for arsenic and lead and one sample exceeded the PRG (residential use) for benzo (a) pyrene. Soil samples that contained exceedances in arsenic were found in the eastern third of the site and in the general location where field engineers had noted discoloration and streaking of the soil during core sampling. This area is also the location of an abandoned underground fuel transportation line. Several metals and one organic exceeded the corresponding ER-L values; however, no analytes exceeded the corresponding ER-M values. This indicates relatively low concentrations of contaminants. The dredged material may potentially be suitable for ocean disposal pending a full dredged material evaluation.

The preliminary beneficial use analysis identified the following potential options:

a. Habitat Restoration/ Enhancement

b. Landscape/ Vegetative Cover
c. Beach Nourishment
d. Solid Waste Management: Landfill
e. Solid Waste Management: Confined Aquatic Disposal Cap
f. Construction Activities

The geotechnical characterization of the Area A soil showed that it is a mixture of fine-grained materials. Because the soil is predominately low plasticity clays, silty clays, sandy clays or clayey silts (CL), the dredged material is most suitable for landfill activities and habitat restoration activities. Soil amendments, such as lime and organic matter, may be required to provide a suitable medium for the growth of upland plant species. The salinity of the soil may only allow for salt tolerant upland species (halophytes such as mulefat, saltgrass, statice and sea-blite). In addition, the soil could be used for general fill if the top 3 or 4 feet of fill material consisted of soil with a higher organic content.

The volume of excavated material that would be generated under the Alternative 4 Restoration Project is estimated to be approximately 2.5 to 3 million cubic yards. The estimation is based on the concept design introduced by USFWS that is being evaluated by CDFG and CCC. A summary of the approximate volume potentially suitable for each beneficial use and placement alternative is presented in Table 5-1.

Table 5-1. Summary of Beneficial Use and Disposal Options and Approximate Volume Potentially Suitable for Each Alternative

Beneficial Use or Disposal Option	Type of Use	Approximate Volume Suitable	Comments
Habitat Restoration/ Enhancement	Upland	800,000 cy plus, dependent on salt content and end use.	Salts may prevent beneficial use in the sediments below 5.5 MLLW, where salt water intrusion may be occurring.
	Wetlands	800,000 cy plus, dependent on salt content and end use.	Salts may prevent beneficial use in the sediments below 5.5 MLLW, where salt water intrusion may be occurring.
Solid Waste Management: Landfill	Cap	2.4 mcy	
	Cover	2.4 mcy	
	Liner/Barrier	2.4 mcy	
	Base	2.4 mcy	
Solid Waste Management: Confined Aquatic Disposal Cap	Cap	2.4 mcy	Dependent on compatibility of material with area surrounding the Confined Aquatic Disposal facility.
Construction Activities	General - Fill	2.4 mcy	
	Pier A west - Backfill	2.4 mcy	
Ocean Disposal	N/A	1.5 mcy	Pending a full dredged material evaluation.

Although the preliminary chemical assessment demonstrated that the majority of the Area A soil is within regulatory limits for use as landfill material and restoration activities, the screening criteria cannot be applied without consideration of site specific factors. This is a screening level assessment and more analysis would be required before a disposal option is selected and/or implemented.

6.0 REFERENCES

Caltrans, 2006. California Highway Design Manual. Chapters 610 Pavement Engineering Considerations, Topic 614 – Soil Characteristics. Caltrans, Sacramento, California.

Caltrans, 2006. California Highway Design Manual. Chapters 660 Base and Subbase, Topic 614 – Soil Characteristics. Caltrans, Sacramento, California.

Great Lakes Commission, 2004. Testing and Evaluating Dredged Material for Upland Beneficial Uses: A Regional Framework for the Great Lakes. Great Lakes Commission, Ann Arbor, Michigan.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management*, 19:81-97.

Port of Long Beach, 2000. The Beneficial Reuse of Dredged Material for Upland Disposal.

US Army Corps of Engineers, 1987. Beneficial Uses of Dredged Material, Engineering Manual.

US Army Corps of Engineers and United States Environmental Protection Agency, 2004. Environmental Effects Residue Database (ERED).

US Environmental Protection Agency, 2006. CFR Title 40: Protection of Environment. Available Online at: http://www.epa.gov/epahome/cfr40.htm.

US Environmental Protection Agency and US Army Corps of Engineers, 1991. Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual (Ocean Testing Manual). EPA 503/8-91/001. EPA Office of Water, Washington, DC. February.

Weston Solutions Inc., 2007, Work plan for Area A geotechnical investigation.