SAMPLING AND ANALYSIS PLAN

DREDGE MATERIAL EVALUATION
DANA POINT HARBOR MAINTENANCE DREDGING

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June, 2006

1.0 INTRODUCTION AND PURPOSE

Operators of Dana Point Harbor (Figure 1) and the Dana Point Harbor Patrol Office have reported navigational hazard conditions due to shoaling that has occurred in the vicinity of storm drain outfalls and along the West and East Breakwaters. The County of Orange proposes to carry out maintenance dredging to remove these shoaled areas and other areas that have silted in. In addition, the County wishes to remove fine-grained material contaminated with coliform bacteria from the inter-tidal shore face at Baby Beach located within the Harbor. All together there are ten units (Figure 2) requiring dredging described as follows:

- West Channel and Turning Basin adjacent to the West Breakwater and Ocean Institute Docks.
- Main Channel adjacent to the West Basin
- West Basin Channel
- East Channel and Anchorage area adjacent to the East Breakwater
- Inter-tidal shore face at Baby Beach
- West Turning Basin between the Pier and Youth and Group Docks
- Pilgrim Moorage
- Boat Launch Ramp Basin
- East Basin adjacent to a 60-inch storm drain outfall
- East Basin Channel

Sediments in the West Channel, Turning Basin, Main Channel and East Channel and Anchorage are anticipated to be predominantly coarse grain material. Total volume of the combined dredge units with anticipated coarse material is 90,000 cubic yards (cy). This volume includes 1 foot paid overdepth and an allowance for ongoing sedimentation and localized slight variations in dredging depths (up to a maximum of 1 additional foot throughout the dredge footprint). The remaining dredge units containing predominantly fine grained sediments encompass a combined total of 54,000 cy also accounting for 1 foot of paid overdepth and an allowance for ongoing sedimentation/localized variations in dredge depths. The proposed depths (before overdepth) of these units vary between -8 and -15 feet from mean lower low water (MLLW) with the exception of Baby Beach. Approximately two feet of material will be dredged from Baby Beach to remove fine-grained sediment. Table 1 identifies the individual dredge units, dredge depths, and estimated quantities of dredge material.

The preferred project intent is to beneficially reuse the 90,000 cy of coarse sand material for beach nourishment. Between 5,700 and 7,500 cy of this material are proposed to replace the fine-grain material removed from Baby Beach. The remaining quantity of coarse sand is proposed to be placed directly on Capistrano Beach County Park or just offshore of the Beach (Figure 3). The other smaller units contain much finer-grained material with preferred disposal at the LA-3 offshore disposal site.

The purpose of the present program is to sample and test sediments from within the proposed maintenance dredging areas to provide sediment quality data for evaluation of dredging and disposal options. This environmental sampling and analysis plan details sampling methods, analytical and biological testing procedures, and reporting procedures.

Recent new guidance on environmental characterization from the USACE (2005/2006) has not yet been tested on small harbor or marina projects involving some variation in dredge depths. There are some concerns regarding the potential for inadvertent removal of material below the 2 feet testing program even though the average depth and total volumes are not exceeded. The quandary is whether characterization below the 2 foot allowance is necessary, and whether this should require testing of additional sediment layers. This subject is discussed in later sections of this report.

1.1 Site Description

The construction of Dana Point Harbor began in the late 1960's and the Harbor was officially dedicated on July 31st, 1971. The Harbor is located in Capistrano Bay on the southern Orange County coastline, approximately half way between Los Angeles and San Diego (Figure 1). Dana Point Harbor is a County Park located within the City of Dana Point, and serves recreational boaters and County residents alike with numerous recreational and leisure activities. It is a vital commercial and community center.

Facilities within the harbor immediately adjacent to the water include the East and West Marinas containing approximately 2,500 slips, a fuel dock, bait barge, boat launch ramps, commercial fishing docks, a boatyard, guest docks, boat rental docks, yacht clubs, the youth and group facility, an interior swim beach (Baby Beach), a fishing pier, and the Ocean Institute docks for tall ships and research vessels.

The beach at the adjacent Capistrano Beach County Park is composed of a sandy intertidal substrate with no rocky intertidal habitats within the proposed boundaries of the disposal area or immediately up or down coast of the project area. The beach experiences an erosion rate of about five feet per year. The beach abuts Doheny State Beach on the west, which extends 1.2 miles up coast of the project site. Doheny State Beach overlaps with Doheny Beach Marine Sanctuary, which extends 600 feet offshore.

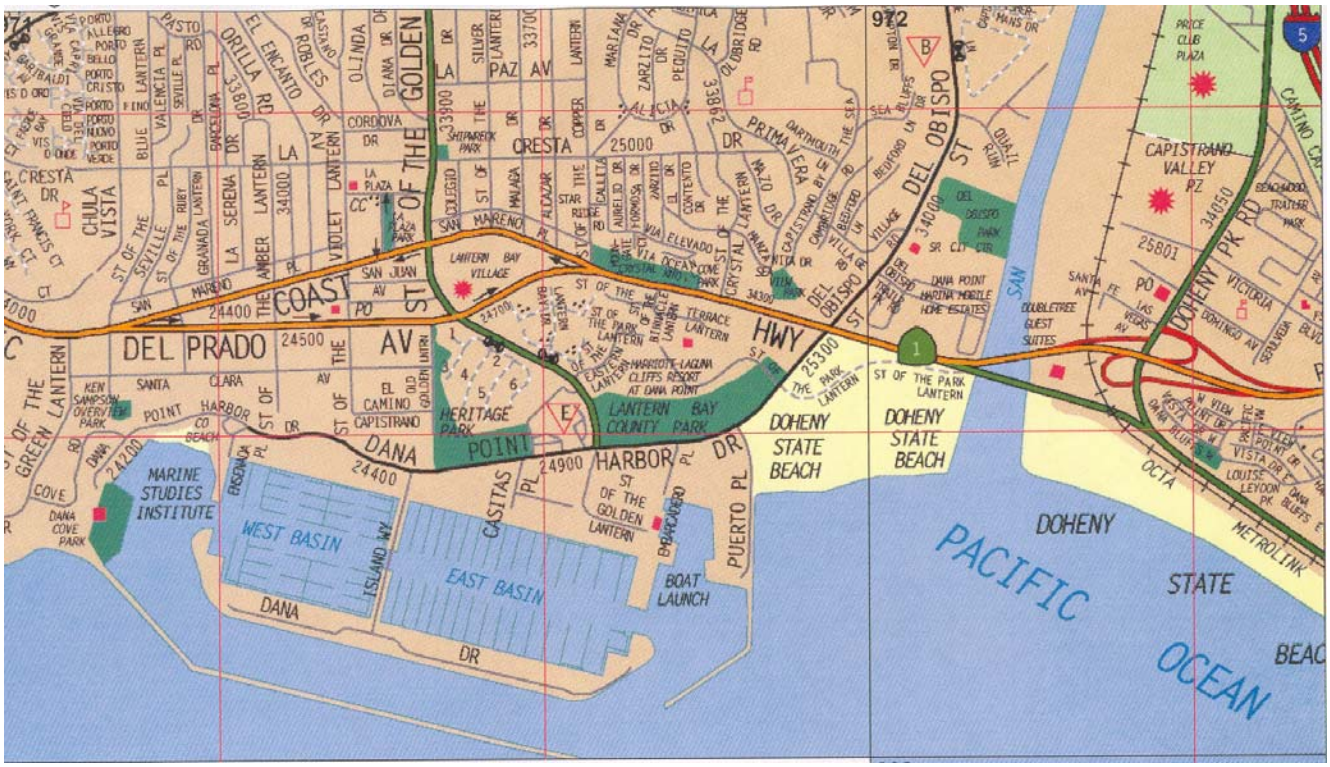

Figure 1. Location of Dana Point Harbor

Figure 2. Dana Point Harbor Limits of Dredging and Proposed Sampling Locations

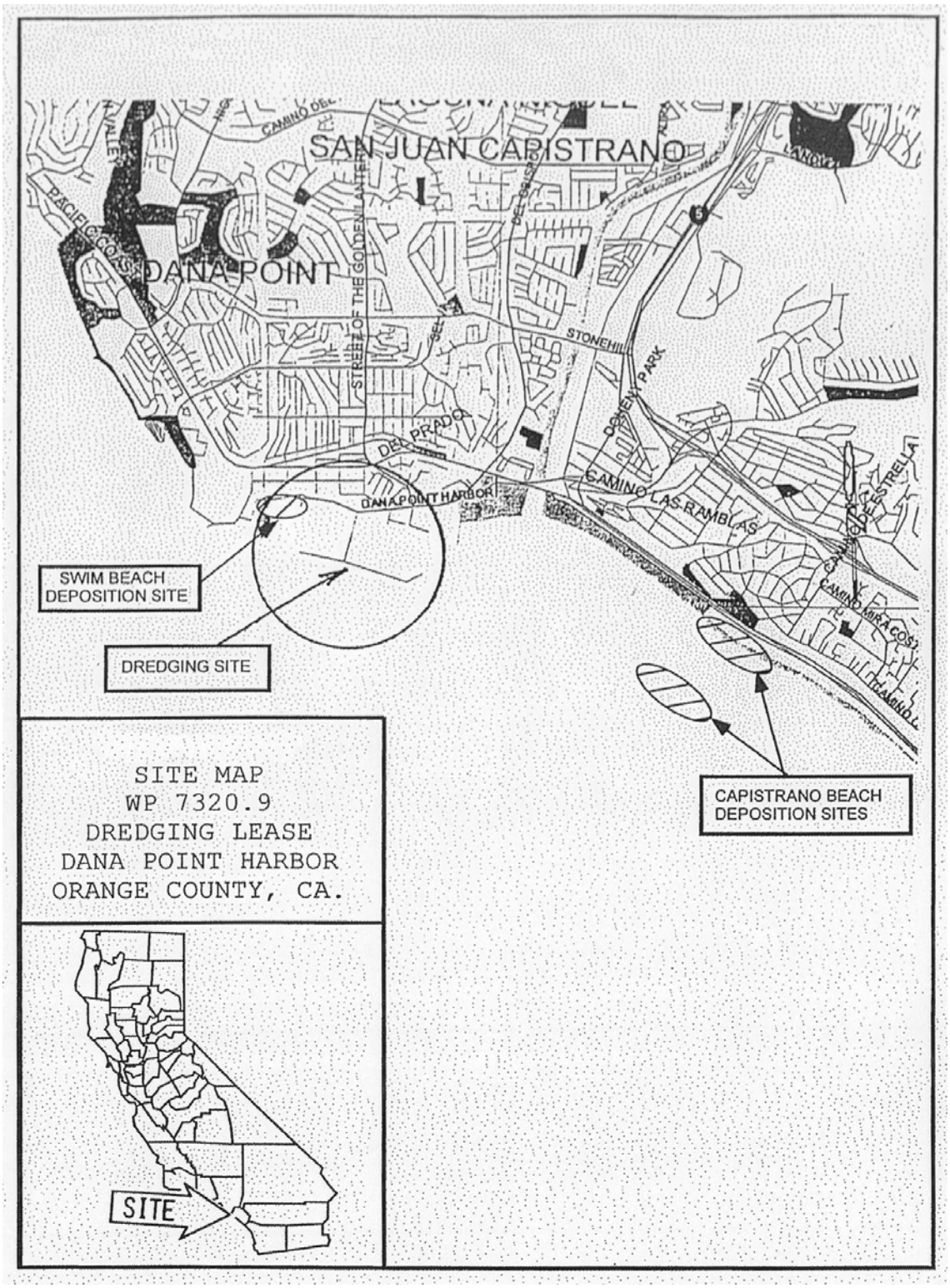

Figure 3. Capistrano Beach County Park Deposition Sites

Table 1. Dredge Depths and Estimated Dredge Quantities of Shoaled Areas within Dana Point Harbor

Dredge Units	Dredge Depth (ft, MLLW)	Estimated Quantity (cy)		
		Without Overdredge	With 1 ft Overdredge	With 30% Contingency
Area A				
West Channel and Turning Basin	-10	12,700	14,500	18,900
Main Channel (West)	-15	32,900	34,500	44,900
East Channel and Anchorage	-15	14,800	22,700	29,500
Total Area A Volumes		60,400	71,700	93,300
Area B				
West Basin Channel	-10	930	4,300	5,600
Pilgrim Moorage	-14	500	800	1,100
West Turning Basin (Youth Docks)	-8	9,200	12,700	16,600
Offshore Baby Beach	Dredge 2 ft	5,700	--	7,500
Total Area B Volumes		16,330	17,800	30,800
Area C				
East Basin (60" Outfall)	-10	1,700	2,600	3,400
East Basin Channel	-10	3,900	8,700	11,400
Boat Launch Ramp Basin	-8	4,800	6,400	8,400
Total Area C Volumes		10,400	17,700	23,300
Total Project Volumes		**87,130**	**107,200**	**147,400**

1.2 Existing Sediment Quality Information

Historically, the County of Orange has carried out maintenance dredging in navigation channels, anchorages, and areas under docks within Dana Point Harbor that have become shoaled due to sediment build up. The previous dredging cycle occurred in 1999/2000 when approximately 50,500 cubic yards of sediment were dredged in accordance with General Waste Discharge Requirements Order No. 96-32. Of this volume, it is estimated that 32,500 cubic yards of clean sand were placed on or nearshore to Capistrano Beach, which is adjacent to the harbor, 3,000 cubic yards of clean sand were placed on the interior swim beach (Baby Beach), and the remaining 15,000 cubic yards of fine silty and clayey material were deposited at the EPA-approved LA-3 offshore disposal site.

Advance Biological Testing, Inc. (1997) performed chemical and bioassay testing on three composite samples and bioaccumulation testing on two composite samples prior to dredging. Test sediments contained between 47% and 97% sand and the concentration of contaminants were similar or less than concentrations found in the LA-3 reference site sediments. Suspended phase bioassays produced LC_{50}s that were greater than 100% in all samples and the Limiting Permissible Concentration (LPC) was not exceeded. *Ampelisca* and *Nephtys* benthic bioassays revealed no significant toxicity over the reference site. However, the *Mysidopsis* benthic bioassay revealed significant toxicity over the LA-3 reference sediment in one of the three composite samples (80% survival), thus the LPC was exceeded. Tissues obtained from test sediment bioaccumulation exposures of both test species contained levels of Cr, Cd, Pb and Zn that were slightly elevated over tissues obtained from the LA-3 reference sediment exposures. There was no significant bioaccumulation of organic compounds. It was determined that the two of the composite areas were suitable for disposal at LA-3 and the third composite area was suitable for disposal at Capistrano County Beach.

2.0 PROJECT ORGANIZATION

2.1 Project Team and Responsibilities

The responsibilities for elements of this program are tabulated below (Table 2). Key contacts for this sediment characterization program are listed as follows:

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2.2 Principal Data Users and Decision Makers

The principal users of the data produced by this project are the following regulating agencies:

1. Los Angeles District, U.S. Army Corps of Engineers (USACE)
2. Santa Ana Regional Water Quality Control Board (RWQCB) – Region 8
3. U.S. Environmental Protection Agency (USEPA) - Region IX;
5. California State Lands Commission (CSLC).

Other users of the data will include the following agencies:

1. California Department of Fish and Game (CDFG);
2. U.S. Fish and Wildlife Service (USFWS); and
3. U.S. National Marine Fisheries Service (USNMFS).

Table 2. Project Team and Responsibilities

Responsibility	Name	Affiliation
Project Planning and Coordination	Vincent Gin	County of Orange
	Tom Townsend	County of Orange
	Russ Boudreau	M&N
	Ken Kronschnabl	KLI
Sampling and Analysis Plan (SAP) Preparation	Patrick Kinney	KLI
	Ray Markel	
	Ken Kronschnabl	
Field Sample Collection and Transport	Spencer Johnson	KLI
	Ken Kronschnabl	
Geotechnical Investigation	Rachel Martinez	LGI
	Matthew Hunter	LGI
Health and Safety Officer and Site Safety Plan	Jon Toal	KLI
Laboratory Physical and Chemical Analyses	Katie Scott	KLI
Laboratory Biological Testing	Dave Lewis	KLI
QA/QC Management	Marty Stevenson	KLI
Technical Review	Pat Kinney	KLI
	Russ Boudreau	M&N
	Vincent Gin	County of Orange
	Tom Townsend	County of Orange
Final Report	Ray Markel	KLI
	Dave Lewis	
	Ken Kronschnabl	
	Patrick Kinney	
Agency Coordination	Patrick Kinney	KLI

M&N = Moffatt & Nichol
KLI = Kinnetic Laboratories, Inc.
LGI = Laguna Geosciences, Inc.

3.0 STUDY DESIGN

3.1 Basic Study Design Approach

The study design attempts to characterize the relatively small amounts of total sediment to be dredged that are distributed at differing areas within the Harbor by an efficient and cost effective sampling and analyses plan suitable to a routine maintenance project within a small harbor. Therefore, classification of sediments according to grain size and previous data has been used to define test units and to optimize compositing to reduce testing costs.

The study design will be based upon sediment sampling for environmental and geotechnical testing utilizing a vibracore sampler working off Kinnetic Laboratories' survey vessel the *DW HOOD*. This sampler will be able to obtain a 4-inch diameter continuous core to dredge depth plus defined overdredge depth. Geotechnical logging will be conducted to identify any layers of sediment within these cores.

The harbor has been divided up into three testing areas based on sediment grain size characteristics and geographic location. Area A, consisting of the West Channel and Turning Basin, the Main Channel, and the East Channel and Anchorage dredge units, contains predominantly coarse grain material. Area A will be tested for beach replenishment according to the Inland Testing manual (ITM), (USEPA/USACE 1998). Only Tier II (chemical) testing will be conducted on the sediments from Area A, and compositing will not be used to reduce the number of samples. Areas B and C consist of the remaining seven dredge units with predominantly fine-grained sediments. Area B consists of the Baby Beach, West Turning Basin, West Basin Channel and Pilgrim Moorage, and Area C consists of the Boat Launch Ramp Basin, East Basin Channel and East Basin Outfall. All sediment collected within each area will be combined into a composite sample and tested for ocean disposal at LA-3 according to the ITM (USEPA/USACE 1998) and the Ocean Disposal Testing Manual (USEPA/USACE 1991). Thus, two composite samples will be formed for ocean disposal testing. Figure 2 defines the limits of dredging for all areas.

According to the ITM, each geographically separated dredge area should be treated as separate dredge areas or project segments. However, it would be economically infeasible to do so when the preferred disposal option is at an open water environment requiring full biological testing. Because of the relatively small amount of dredge material within areas considered for open water disposal, only two composite samples for Tier III testing will be formed. For Tier II testing, each individual core sample within Area B will be subjected to bulk sediment chemical analysis. A high density of core locations and individual core chemistry should reveal any areas with potentially toxic sediments or sediments with high bioaccumulation potential.

The proposed Areas B and C sampling scheme is to collect one core from Pilgrim Moorage, two cores each from Baby Beach, the East Basin Outfall, the East Basin Channel, the West Basin Channel and the Boat Launch Ramp Basin, and three cores from the West Turning Basin. Proposed core locations are depicted on Figure 2.

The basic approach for each core collected for ocean disposal purposes is to form single vertical composite samples from the mudline to project depth plus two feet for overdredge unless more than one distinct vertical strata of greater than two feet is present. This basic approach for overdredge sampling and testing is consistent with the US Army Corps of Engineers' draft guidance document on "overdepth" allowance (USACE, 2005) and with a memorandum from the Director of Civil Works for the USACE to USACE Commanders of Major Subordinate Commands on assuring the adequacy of environmental documentation for the maintenance dredging of federal navigation projects (USACE, 2006). As described further below, it is suggested that an additional one-foot of overdepth sampling be added to the basic approach to accommodate inaccuracies in the dredging process bringing the total sampling and

characterization depth to three feet below design depths and two feet below paid overdredge allowance.

Assuming only one stratum, the entire vertical segment from each Area B and C core will be homogenized. One liter of each homogenous vertical composite will be sent to the analytical laboratory and analyzed for bulk sediment chemistry and grain size distribution on a quick turn around basis. The remainder of each vertical composite will be archived for future compositing. The results of the individual cores will be compared to sediment quality guidelines to determine if the sediments from the five individual dredge units will have a reasonable chance of qualifying for ocean disposal. If unreasonable contamination exists at any dredge unit, then these units will be excluded from biological (Tier III) testing. Archived vertical composites from all dredge units with a reasonable chance of qualifying for ocean disposal will be proportionally combined into two horizontal composite samples. These composite samples will also be analyzed for bulk sediment chemistry. In addition, a standard elutriate will be prepared from each composite sediment sample and site water and analyzed for the same list of constituents performed on the bulk sediments. These analyses will also be performed on a sample of site water. Biological testing will also be conducted including both benthic and water column bioassays and bioaccumulation exposures. Vertical composite samples from those areas deemed as poor candidates for ocean disposal will be combined into a second horizontal composite for modified elutriate and Waste Extraction Test (WET) analyses to satisfy upland disposal requirements.

The chemical and biological testing requirements and procedures detailed in the ITM and "Green Book" will be used to evaluate the suitability of Areas B and C composite sediments for unconfined aquatic (open water) disposal. Tier III evaluations will include statistical comparisons with the LA-3 offshore reference sediments. As each phase of testing is completed, critical data review will be performed to direct subsequent test phases. If the results of any test phase indicate that the sediment will not qualify for open water disposal, then subsequent testing will be directed toward an alternate disposal option. New guidance (USACE, 2003) is available to clarify the test procedures on sediments slated for an upland disposal facility.

Coarse grain material (Area A) is less likely to be a carrier of contamination. Per ITM guidance, dredged materials proposed for beach nourishment often can be excluded from chemical or biological testing and instead focus on determining physical compatibility with the disposal area as measured by grain size and total organic carbon (TOC). However, since the harbor is not isolated from sources of pollution, both grain size and bulk sediment chemistry testing will be conducted. Therefore, for Area A, the basic approach is to collect ten cores to project depth plus two feet for overdredge. Similar to Areas B and C, it is suggested that the basic approach be modified by adding two additional feet of sampling and testing below project depths bringing the total sampling and characterization depth to four feet below design depth and three feet below paid overdredge allowance. Justifications for modifying the basic approach are discussed further below.

A vertical composite sample of each Area A core will be analyzed for bulk sediment chemistry and grain size to determine suitability for beach replenishment. Laguna Geosciences will analyze additional grain size and TOC samples from discrete layers within each core. If any significant fine grain layering exists in any Area A core, then these layers will be separated from the rest of the core and chemically analyzed separately.

To determine if the Area A sediments are compatible with Capistrano Beach County Park sand, surface samples will be collected from the exposed and subtidal portions of the beach disposal area. Specifically, two perpendicular transects will be sampled from +12 feet MLLW to –30 feet MLLW and sampling locations will be spaced every six feet in elevation along these transects. Thus samples will be collected at +12, +6, 0, -6, -12, -18, -24 and –30 feet MLLW along each transect. Transects and approximate sampling locations are depicted in Figure 3. Stainless-steel utensils will be used to sample exposed

portions of the beach and a grab sampler will be used to sample subtidal portions. Grain size and TOC will be determined from each sample collected. In addition, a portion of each sample collected at and above 0.0 feet MLLW will be composited into a single sample for bulk sediment chemistry in order to assess baseline concentrations of contaminants.

3.2 Modifications to Basic Sampling and Compositing Approach - Issues of Overdredge Allowance

The issue of adequately testing all dredged material that may be moved inadvertently as part of the dredging operations has recently arisen and new guidance has been issued by the U. S. Army Corps of Engineers (USACE 2005 and 2006). These documents are clear that both pay and non-pay dredging must be characterized and dredging to a maximum of two feet below design depth is allowable. The purpose of the USACE guidance is to make sure that everything that might be dredged and disposed of has been characterized along with minimizing the amount of material that is dredged. Thus up to a 2 foot overdredge allowance is permissible (unless justification is given for a larger number) and environmental characterization of this overdredge material is specified.

Dredging contractors are now concerned about inadvertent dredging at spots below this 2-foot allowance and whether testing past this depth must be done to address this possibility, even though the average depth and total volumes will not be exceeded.

Past practice has been to test a 2-foot overdredge allowance by adding this part of the core to the regular bottom sample of the dredge material. Layering within the core has determined how many layers of dredge material must be tested, but the bottom two feet are added in unless a different layer is present. Adding too many feet of additional core to the test sample can of course dilute the sample of dredge material actually to be removed with the material below that on the average will not be removed. Testing an overdredge layer separately significantly increases test costs, particularly for small maintenance projects where relatively small amounts of dredge materials are spread throughout a small harbor.

As a compromise for the present Sampling and Analysis Plan, modifications to the basic overdredge characterization approach have been made to accommodate inherent inaccuracies in the dredging process. The depth of characterization has been increased to four feet below design depth for Area A (coarse grained) and three feet below design depth for Area B (fine grained). As justification of the recommended overdepth sampling, Area A dredging will likely be performed using an large hydraulic dredge; Area B dredging will be performed with more precise equipment such as an barge-mounted excavator. Hence, a greater allowance for potential over-digging in Area A is appropriate. Concern for sample dilution from this greater depth of composited material should be significantly alleviated since this material is fully anticipated to be beach quality material with no reason to believe contaminants may exist at that location. The extra one-foot of over-depth sampling in Area B should not significantly affect the characteristics of the upper material.

Characterization would involve compositing the entire vertical lengths of each core obtained unless layering is encountered. Excursions below the non-pay overdredge allowance are anticipated to be minor and incidental and the final grade is anticipated to be primarily above the allowable non-pay overdredge limit of two feet below design depth. The dredge material volume estimates presented in Table 1 include a maximum volume of up to 2 feet of overdepth dredging. The contract will be established to limit the paid removal to one-foot below design depth as an incentive for the contractor to avoid dredging below that limit. These volumes should therefore represent the maximum amounts that could be removed from the project limits.

3.3 Testing Sequence for Area B

A flowchart for the planned testing approach for the Dana Point Harbor Areas B and C sediments is given in Figure 4.

The first phase of testing for either open water or upland disposal will be bulk sediment chemical analysis of each composite and discrete sample. The determination of whether the sediments are hazardous waste can be made by comparison of chemical analysis results with California Code of Regulations Title 22, Chapter 11 criteria, supplemented if necessary by WET testing for any analytes that exceed 10% of the Total Threshold Limit Concentration (TTLC) criteria. This comparison is limited to constituents included in the program that have Title 22 criteria available. Title 22 compounds not typically found in Southern California dredge material, such as asbestos, are not included in the analytical set.

Analytical results will be further evaluated using the sediment quality guidelines consisting of Effects Range-Low (ER-L) and Effects Range-Medium (ER-M) values developed by Long, *et al*. (1995) and Threshold Effects Levels (TELs) and Probable Effects Levels (PELs) developed by McDonald, *et al*. (1996) for marine sediments. Buchman (1999) provides a summary of these sediment quality guidelines. These screening guidelines correlate concentrations of selected contaminants with likelihood of adverse biological effects. Table 3 lists available ER-L, ER-M, PEL and TEL values; please note that screening guidelines have not been developed for all analytes.

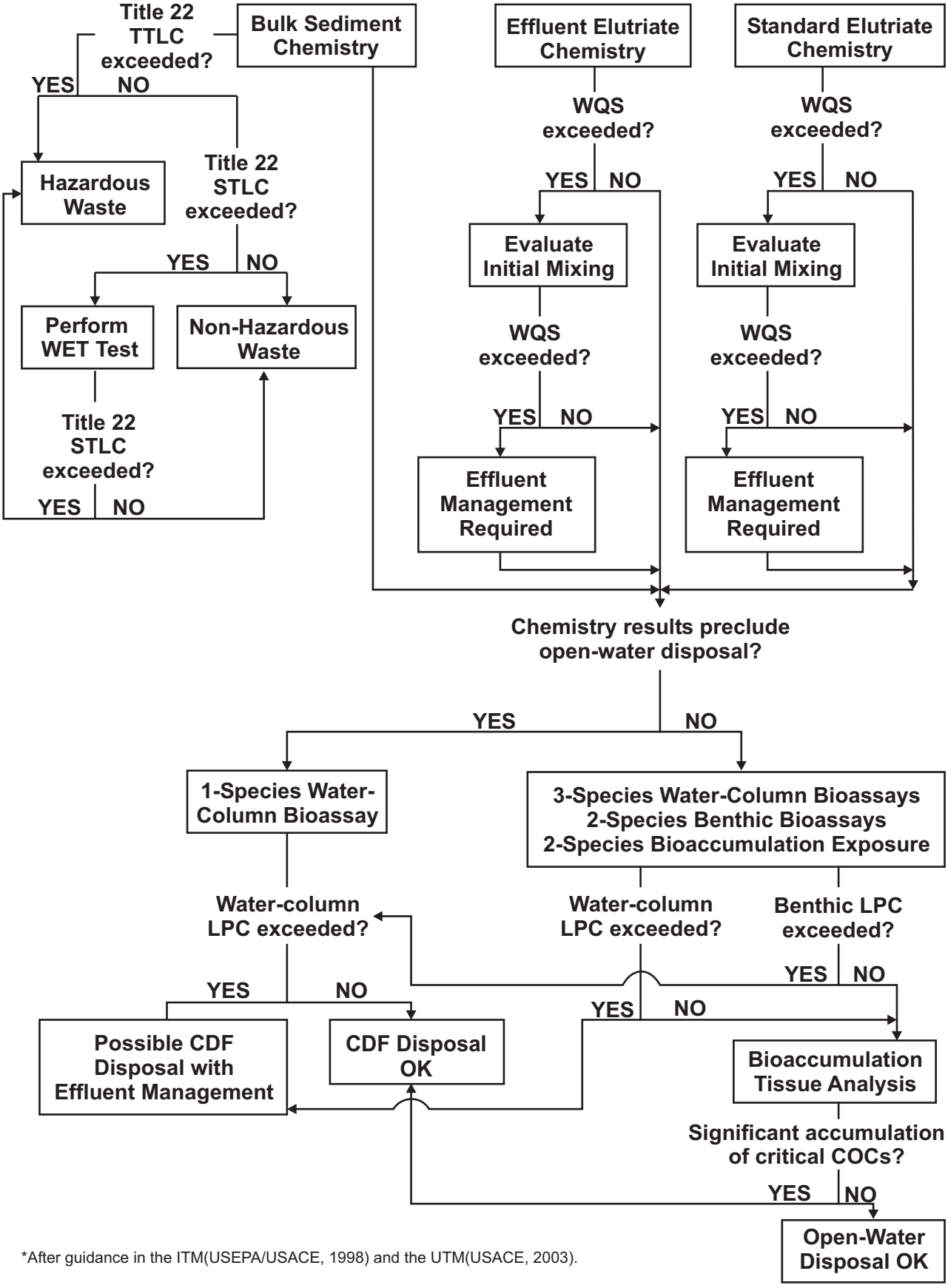
Those samples that show low to moderate levels of contamination and would not be expected to produce unacceptable biological impacts would proceed to the next phase of open water testing. Sediments with contaminant levels that are judged likely to produce toxicity will be further tested following procedures detailed in the Upland Testing Manual (UTM) (USACE 2003).

Testing will also include elutriate analyses. Both open water and upland disposal requires chemical analysis of sediment elutriate prepared with water from the dredge site. For open water disposal, the ITM describes methods for preparation of a "standard elutriate", while the UTM requires analysis of an "effluent or modified elutriate", prepared by slightly different methods for upland disposal where effluent created by the disposal of sediments or runoff from disposed sediments are an issue. Elutriate chemistry results are evaluated by comparing them with water quality standards (USEPA, 2000 and SWRCB, 2001) to assure that, after appropriate dilution and mixing have occurred, water quality criteria will not be exceeded.

The second phase of testing for upland disposal is an elutriate bioassay with a single, sensitive water column species. The effluent or modified elutriate is used for this purpose. Elutriate toxicity is evaluated to assure that the Limiting Permissible Concentration (LPC) would not be exceeded by effluent water returning to the disposal environment from the disposal site. Testing prescribed by the ITM for open water disposal consists of elutriate bioassays with three water column species using the standard elutriate, benthic bioassays with two infaunal species, and evaluation of bioaccumulation potential using two sediment-dwelling organisms. After bioassays are complete, results will be evaluated to determine if sediment toxicity is severe enough to preclude open water disposal.

Following ITM guidelines, results of the test sediments will be compared to LA-3 reference sediments in the vicinity of the open water disposal site. Thus, reference sediments in the vicinity of the LA-3 ocean disposal site will be tested.

Figure 4. Phased Testing Approach for the Dana Point Harbor Maintenance Dredging.*



*After guidance in the ITM(USEPA/USACE, 1998) and the UTM(USACE, 2003).

Table 3. Sediment Screening Values for Selected Analytes.

Analyte	Units	TEL[1]	ER-L[2]	PEL[3]	ER-M[4]
Silver (Ag)	mg/kg	0.73	1.0	1.77	3.7
Arsenic (As)	mg/kg	7.2	8.2	41.6	70
Cadmium (Cd)	mg/kg	0.67	1.2	4.21	9.6
Chromium (Cr)	mg/kg	52.3	81	160.4	370
Copper (Cu)	mg/kg	18.7	34	108.2	270
Mercury (Hg)	mg/kg	0.130	0.15	0.696	0.71
Nickel (Ni)	mg/kg	15.9	20.9	42.8	51.6
Lead (Pb)	mg/kg	30.2	46.7	112.2	218
Selenium (Se)	mg/kg	--	--	--	--
Zinc (Zn)	mg/kg	124	150	271	410
DDT Total	µg/kg	3.89	1.58	51.7	46.1
DDE	µg/kg	2.07	2.2	374	27
Dieldrin	µg/kg	0.71	0.02	4.3	8.0
Chlordane	µg/kg	2.26	0.5	4.79	6.0
Lindane	µg/kg	0.32	--	0.99	--
PCBs Total	µg/kg	21.55	22.7	188.8	180
PAHs Total[5]	µg/kg	1684	4022	16,770	44,792
LMW PAHs	µg/kg	312	552	1442	3160
HMW PAHs	µg/kg	655	1700	6676	9600
Phenanthrene	µg/kg	86.7	240	43	1500
Pyrene	µg/kg	153	665	1398	2600
Benzo(a)anthracene	µg/kg	74.8	261	692	1600
Chrysene	µg/kg	108	384	846	2800
Benzo(a)pyrene	µg/kg	88.8	430	763	1600
Dibenzo(a,h)anthracene	µg/kg	6.22	63.4	135	260
Fluoranthene	µg/kg	113	660	1493	5100
Anthracene	µg/kg	46.8	85.3	245	1100
Acenaphthene	µg/kg	6.71	16	88.9	500
Acenaphthylene	µg/kg	5.87	44	128	640
Naphthalene	µg/kg	34.6	160	391	2100
Fluorene	µg/kg	21.2	19	144	540
Methylnaphthalene, 2-	µg/kg	20.2	70	201	670
Di[2-Ethylhexyl] phthalate	µg/kg	182.2	--	2,646	--

1. Based on toxic effects and no effects data sets, contaminant concentrations below TELs rarely cause adverse biological effects (Buchman, 1999).
2. Concentration below ER-L, biological effects are rarely observed. ER-L values from Long, et al. (1995).
3. Based on toxic effects and no effects data sets, contaminant concentrations above PELs frequently cause adverse biological effects (Buchman, 1999).
4. Concentrations above ER-L and below ER-M occasionally exhibited biological effects. Concentrations above ER-M most often exhibited biological effects. ER-L and ER-M values from Long, et. al. (1995).
5. The definition of total PAHs in the scientific literature is highly variable so comparing different studies can be misleading. Previous studies most often included the sum of 13 to 18 individual compounds.

If the composite sediment is considered a good candidate for open-water disposal, suspended particulate-phase (water column) bioassays will be performed using mysids, fish and larvae of mussels or oysters. A standard elutriate will be prepared with water collected from the Dana Point Harbor, and dilution water will be clean open-coast seawater from Kinnetic Laboratories' bioassay laboratory in Santa Cruz, CA. Control bioassays will be performed on laboratory dilution water. Results of elutriate bioassays will be statistically compared with control (dilution water) bioassays. Those elutriates which produce significantly greater toxicity than control water will be identified; and if mortality and/or development effects are sufficiently high to produce LC_{50} and/or EC_{50} values, initial mixing calculations will be performed to determine the Limiting Permissible Concentration (LPC) of the elutriate. Sediments that will not exceed their LPCs may be placed at an open-water disposal site.

Solid phase (benthic) bioassays will also be conducted on sediments considered for open water disposal using worms and amphipods. Test sediments will undergo bioassay testing concurrently with reference sediments collected from the vicinity of the LA-3 offshore disposal sites, and with control sediments collected from the organisms' home environment. Results of benthic bioassays will be statistically compared with reference sediment bioassay results. Those test sediments which produce statistically greater mortality than reference sediments and in which test mortality exceeds reference mortality by greater than an allowable percentage, are considered to exceed their LPC and may not be permitted for open water disposal.

Twenty-eight day bioaccumulation exposures will be performed on sediments considered for open water disposal using worms and clams. Test sediments will be exposed concurrently with reference and control sediments, and tissues will be analyzed for a suite of constituents of concern. If sediments are so toxic as to prevent open water disposal, bioaccumulation tissues will not be analyzed and sediment testing will be completed using UTM procedures.

If sediments are not severely toxic to benthic species, the final phase of testing for open water disposal will be accomplished by analyzing the tissues of organisms that have completed 28-day exposure to test sediments along with control and reference sediments. Concentrations of metal and organic contaminants in tissues of organisms exposed to reference sediments will be compared with concentrations in organisms exposed to test sediments. Constituents that show statistically significantly elevated concentration in test tissues are considered to be potentially bioaccumulative, and are then evaluated to determine if these levels are biologically important.

3.4 Evaluation Criteria

As mentioned above, to aid in the evaluation of sediment test data, chemical concentrations of contaminants found within the sediments will be compared to sediment quality guidelines (Long et. al., 1995 and McDonald et. al. 1996) summarized by NOAA (Buchman, 1999). These guidelines (Table 3) can be used to screen sediments for contaminant concentrations that might cause biological effects and to identify sediments for further toxicity testing. For any given contaminant, the Effects Range Low (ER-L) guideline represents the 10^{th} percentile concentration value in the NOAA database that might be expected to cause adverse biological effects and the Effects Range Medium (ER-M) reflects the 50^{th} percentile value in the database. TELs and PELs are based on similar data compilations, but use different calculations. TELs are calculated as the geometric mean of the 15^{th} percentile concentration of the toxics effects data set and the median of the no-effect data set. PELs are the geometric mean of the 50% of impacted or toxic samples and the 85% of the non-impacted samples. Note that ERLs, ERMs, TELs and PELs will only be used as a screening tool. They will not be used to determine suitability for ocean disposal.

Standard elutriate chemistry results will be compared to water quality objectives established in the Water Quality Control Plan for Ocean Waters of California (California Ocean Plan; SWRCB, 2001) and to ambient water concentrations. The modified (effluent) elutriate chemistry results will be Ocean Plan criteria as well as water quality criteria for enclosed bays and estuaries for priority toxic pollutants in the State of California (California Toxics Rule), (USEPA, 2000). The final site selected for upland disposal purposes will dictate which set of criteria applies to the modified elutriate.

WET chemistry results will be compared with Title 22 STLC criteria to determine if sediments must be classified as hazardous waste as defined by the State of California.

4.0 SAMPLING METHODS

4.1 Sediment Sampling

Vibracore sampling will be conducted from Kinnetic Laboratories' research vessel *DW HOOD.* This vessel is equipped with an A-frame and winch suitable for handling the coring equipment. Figure 2 shows the approximate core locations to be sampled, and Table 4 lists the estimated core lengths, number of cores required at each sampling location, and target positions of the approximate core locations. Positioning at the coring locations will be accomplished using a Garmin 215D series differential GPS navigation system or equivalent, referenced to a local geodetic benchmark, resulting in positioning accuracies of 1 to 3 meters. Water depths will be measured with a graduated lead line and corrected to mean lower low water. Tidal stage will be determined using *Tide Tool 2.1a* software calibrated to a local tide gage.

Kinnetic Laboratories' vibracore consists of a 4-inch diameter aluminum coring tube, a stainless steel cutting tip, and a stainless-steel core catcher. Inserted into the core tubes will be food-grade clean polyethylene liners. The vibrating unit has two counter-rotating motors encased in a waterproof aluminum housing. A three-phase, 240-volt generator powers the motors. The vibracore head and tube are lowered overboard via the A-frame and winch. The core tube is allowed to penetrate the surficial materials below the mudline as far as possible under the static weight of the vibracore unit. The unit is then vibrated until it reaches project depth plus two foot for overdredge or until the vibracore is rejected from further penetration. If refusal is encountered, then a second attempt will be made at a nearby location and the reason for moving the core location will be noted on the field log. If refusal is encountered again, any material obtained will be used for testing and the reason for refusal will be noted on the field log.

When penetration of the vibracore is complete, power is shut off to the vibra-head, and the vibracore is brought aboard the vessel. A check valve located on top of the core tube reduces or prevents sediment loss during pull-out. The length of sediment recovered is noted by measuring down the interior of the core tube to the top of the sediment. The core tube is then detached from the vibra-head, and the core cutter and catcher are removed. Afterwards, the core liners are removed and sealed on both ends, iced, and transported to a shore-side processing facility. Two cores will be collected at all Area B and C sampling sites to ensure sufficient material for all analytical and biological testing.

All sample contact surfaces are stainless steel, polyethylene, Halar®, or Teflon® coated. Compositing tools are stainless steel or Halar®-coated stainless steel. Except for the liners, all contact surfaces of the sampling devices and the coring tubes are cleaned for each sampling area. The cleaning protocol consists of a site water rinse, a Micro-90® soap wash, steam cleaning, and then finished with deionized water rinses. The polyethylene core liners used are new and are of food grade quality.

A total of 24 locations will be sampled within the Dana Point Harbor (Figure 2, Table 4), ten in Area A, six in Areas B, and eight in Area C. The seven cores collected in Area A that are proposed for beneficial reuse as beach replenishment material will be analyzed individually for grain size distribution and bulk sediment chemistry.

Sediment samples collected from Areas B and C will be combined into two composite samples in order to minimize Tier III testing costs. The composite samples will be tested following the sequence outlined in Section 3.2 and graphically summarized in Figure 3. Each of the cores comprising the two composites will also be tested for grain size and bulk sediment chemistry.

Table 4. Approximate Target Locations, Core Lengths, and Number of Cores for Each Composite Area.

Dredge Areas and Core Numbers	State Plane Zone 6 Coordinates (feet)		Approximate Core Length (ft) (Includes 3 or 4 ft Overdredge*)	Number of Cores Required for Sufficient Material
	Easting	Northing		
West Channel and Turning Basin				
A-1	644466	1864620	7.4	1
A-2	644365	1864636	8.1	1
A-3	644302	1864697	12.0	1
A-4	644421	1864775	5.1	1
Main Channel				
A-5	644240	1864757	19.0	1
A-6	644207	1864811	18.3	1
East Channel and Anchorage				
A-7	644096	1865978	4.6	1
A-8	644198	1866106	7.5	1
A-9	644133	1866079	11.8	1
Baby Beach				
B-1	644669	1864683	4.0	2
B-2	644638	1864744	4.0	2
West Turning Basin				
B-3	644625	1864641	TBD	2
B-4	644603	1864730	4.8	2
B-5	644599	1864808	5.8	2
Pilgrim Moorage				
B-6	644587	1864652	4.2	2
West Basin Channel				
B-7	644522	1864876	3.8	2
B-8	644487	1864933	3.2	2
East Basin Outfall				
C-1	644392	1865725	TBD	2
C-2	644380	1865768	TBD	2
East Basin Channel				
C-3	644300	1865579	3.8	2
C-4	644268	1865686	3.8	2
Boat Launch Ramp Basin				
C-5	644460	1865988	TBD	2
C-6	644472	1866036	TBD	2

TBD = to be determined in the field

* Cores from Area A will be advanced to four feet below design depths and cores from Area B will be advanced to three feet below design depths.

4.2 Water Sampling

Water will be collected in the vicinity of the bridge separating the East and West Basins for use in preparing elutriates for chemical analyses and bioassays. A sample of background water will also be collected to assess ambient aquatic chemistry. Water will be collected from a depth of 1 ft below the water surface by submerging protocol-cleaned 10 liter borosilicate glass bottles. Water samples will be iced and shipped to the analytical laboratory, where they will be held at 4EC until used.

4.3 Core Processing

After placement in a clean PVC core rack, the core liners will be split lengthwise to expose the recovered sediment. Once exposed, sediment that came in contact with the core liner will be removed by scraping with a pre-cleaned stainless steel spoon. Each core will be photographed, measured, and lithologically logged in accordance with the Unified Soil Classification System (USCS) as outlined in ASTM Standards G-2488 (ASTM, 2004). Additional sediment characteristics including likely sediment origin and other observations will also be recorded. A geologist from Laguna Geosciences, Inc. will do the lithologic logging along with collection of sample splits for physical testing.

Following logging and the collection of discrete samples, a vertical composite will be formed from each core or core stratum by combining and homogenizing the entire remaining portion of each core or core stratum in a pre-cleaned stainless steel or Halar®-coated tray. A one-liter portion of each vertical composite will be placed in a pre-cleaned and certified glass jar with a Teflon®-lined lid for bulk sediment chemistry and archived material. For Area B sediments only, the remaining portion of each vertical composite will be placed in pre-cleaned 3.5 gallon buckets with food grade HDPE liners. The remaining sediment from Area A will be discarded unless the sediments are classified as fine-grained material.

A horizontal composite will be formed from the Area B vertical composites only. The intent is to combine all remaining sediment from each vertical composite unless the individual sediment chemistry results preclude ocean disposal. A portion the horizontal composite sample formed for ocean disposal testing will then be transferred to certified pre-cleaned sample containers consisting of a one-liter glass jar with a Teflon®-lined lid for the bulk of the analyses and a 250 ml HDPE jar for dissolved sulfide analyses. Sediment for bioaccumulation and bioassay assessments will be placed in additional pre-cleaned 3.5 gallon buckets with food grade HDPE liners.

Except for sediment to be used for dissolved sulfides analyses, all sediment samples will be placed on ice immediately following sampling and maintained at 2 to 4°C until analyzed. The dissolved sulfide samples will be placed on dry ice and kept frozen until analyzed. All samples will be handled under Chain of Custody protocols beginning at the time of collection. Redundant sampling data will also be recorded on field log sheets.

Sample volumes, containers, and preservation required for these samples are included in Table 5.

4.4 Reference and Control Sediments

4.4.1 LA-3

Samples of reference sediments will be collected for biological and chemical testing. Samples will be collected from a designated reference site in the vicinity of the LA-3 open water disposal sites. This reference site is located at **33˚ 31' 42" N; 117˚ 51' 18" W** (Figure 5).

The reference site sample will be obtained using a chain-rigged, stainless steel pipe dredge from the *DW Hood*. Navigation, sample compositing, recording, and preservation procedures will follow those described for vibracore sampling.

4.4.2 Control Sediment

Samples of control sediment will be collected for biological testing. Control sediment for amphipod bioassays will be the "home sediment" from the area where amphipods were collected. Control sediment for *Nephtys* bioassays will be "home sediment" from the area where polychaetes were collected (Tomales Bay). Tomales Bay sediment will also serve as the control sediment for bioaccumulation exposures.

Table 5. Sample Volumes and Storage Requirements.

Parameter	Holding Time	Sample Size[a]	Container[b]	Temperature[c]	Archive[d]
Total Solids	7 days	50g	1-Liter Glass (Combined)	4E "2E C	Yes
Total Organic Carbon (TOC)	28 days	50g			
Grain Size	6 months	100g			
Metals	6 months, Hg 28 d	200g			
Butyltins	14 days pre-extraction 40 days post-extraction	200g			
Pesticides/ PCBs		200g			
PAHs		200g			
Sulfides	7 days	50g	250 mL HDPE	-18E C	No
Water Column Toxicity (SPP)	8 weeks	2 L	13 - Liter HDPE (LDPE liner)	4E "2E C	
Benthic Toxicity (SP)	8 weeks	4 L			
Bioaccumulation	8 weeks	45 L			

[a] Required sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.
[b] Containers will be completely filled with no head space.
[c] During transport to the laboratory, samples will be stored on ice.
[d] For each sampling station, a 500 mL container will be filled, and kept at 4° C as needed for any of the analyses indicated. For biological testing, sufficient sample will be collected for re-testing, as needed.

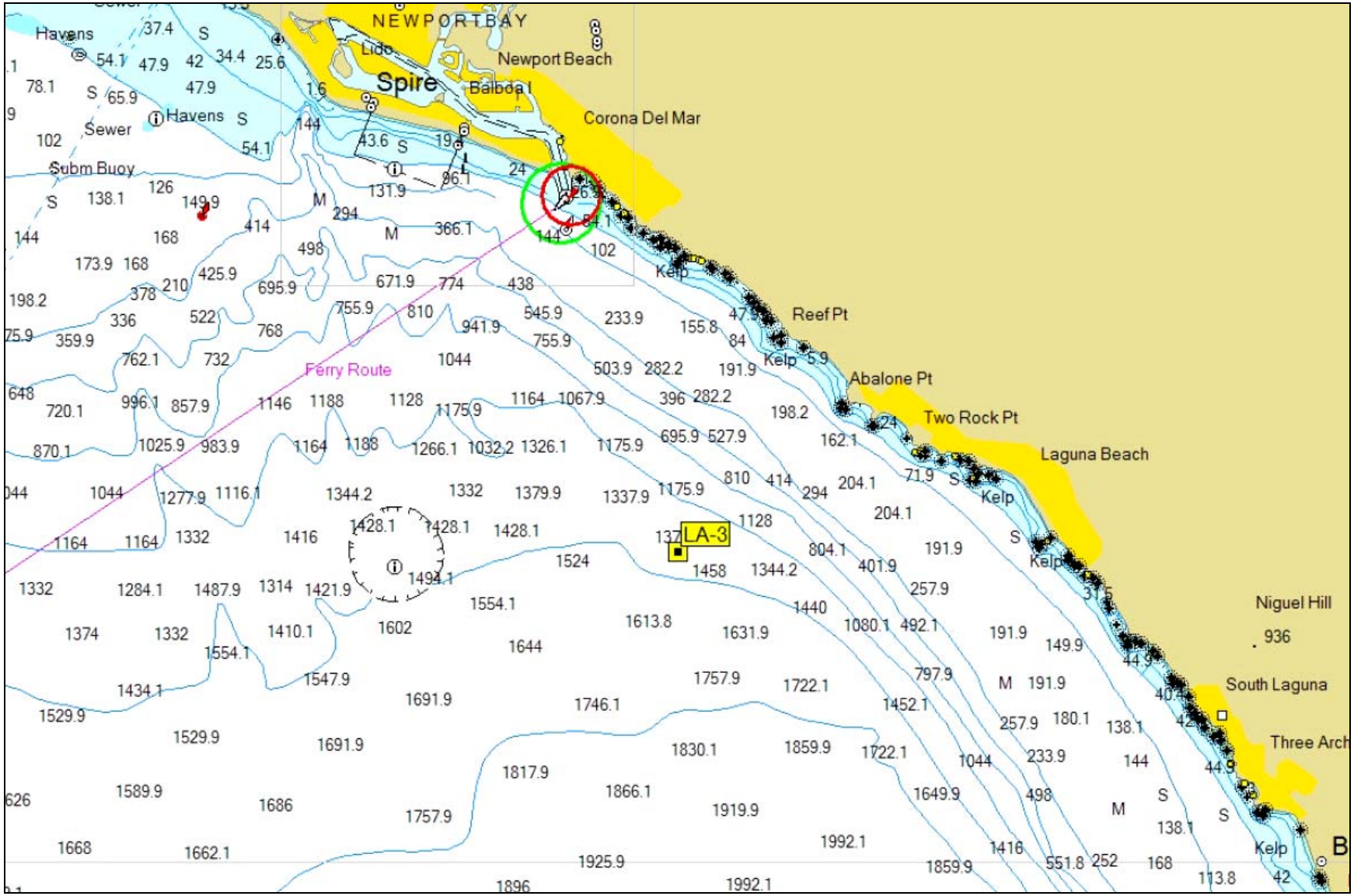


Figure 5. Location of the LA-3 Reference Site

4.4.3 Capistrano Beach

Samples for grain size TOC and bulk sediment chemistry will be collected at the Capistrano Beach County Park beach nourishment area from 0.0 feet to +12 feet MLLW using pre-cleaned stainless-steel sampling utensils. In addition, TOC and grain size samples will be collected in the subtidal area (-6 feet to -30 feet MLLW) in front of the beach. A Ponar Grab or a modified Smith McIntyre Grab will be used to collect the samples. Navigation, sample compositing, recording, and preservation procedures will follow those described for vibracore sampling. Elevations will be determined with a laser level finder and stadia rod.

4.5 Documentation

All samples will be handled under Chain of Custody documentation. Samples will be marked with pre-printed, waterproof labels listing unique alphanumeric identifications. Duplicate information will be recorded on the chain of custody form, which also includes sampling information such matrix, analysis, method, and detection limit.

The following information will be recorded on unique core logs for each boring: station identification, date and time, climatic and rainfall data, sea state observations, total coring time, boring coordinates, core number, depth of penetration, core length recovery, core length requirement, sample type and intervals, stratigraphic observations, presence of contamination, geologic stratum, tidal stage and water depth.

A daily activity report will be maintained in addition to individual boring logs. The activity report includes data on general weather and tidal conditions and hourly and cumulative progress logs. Completed core logs and activity logs will be included in the final report appendices.

5.0 LABORATORY TESTING METHODS

Most chemical analyses will be initiated within two weeks after the collection of samples. Biological analyses and additional chemical analyses will be initiated after receipt of the composite sediment chemistry results but within eight weeks after sample collection. Chemical, physical, and biological samples for analysis will be submitted to ToxScan, Inc. (Cal-ELAP No. 1515), CRG Marine (Cal-ELAP No. 2261) and Soil Control, Inc., (Cal-ELAP No. 1494) State certified testing laboratories using USEPA and USACE approved methodologies.

5.1 Bulk Sediment Analysis

Bulk sediment analytical parameters, methods, and proposed detection limits are presented in Tables 6 and 7. Sediment samples will be analyzed in a manner consistent with guidelines for dredge material testing methods in the USEPA/USACE Inland Testing manual. Samples will be extracted and analyzed within specified EPA holding times, and all analyses will be accomplished with appropriate quality control measures.

5.2 Elutriate Preparation Methods and Analysis

Standard elutriates will be prepared according to ITM methods. Sediment will be mixed with dredge site water in a 4:1 volumetric ratio. Vigorous mixing will proceed for 30 minutes, and the mixture will be allowed to settle undisturbed for one hour. The supernatant is then siphoned off without disturbing the settled material, and centrifuged to remove particulates prior to chemical analysis (approximately 2,000

rpm for 30 min, until visually clear). For bioassay testing, it is only necessary to centrifuge the supernatant to prevent optical interference.

Effluent (or modified) elutriates, if required to address upland disposal issues, will be prepared following the methods described in the UTM, (Appendix B-3.3). A slurry of sediment and dredge site water will be prepared at a concentration of 150 g/L (dry weight basis). The slurry will be mixed for five minutes to a uniform consistency with a laboratory mixer, and then vigorously aerated for one hour. The aerated slurry will then be allowed to settle for 24 hours, and the supernatant will be siphoned off and centrifuged.

Analytes, test methods, and reporting limits for elutriate analyses are presented in Tables 6 and 8. In the case of the standard elutriates, metal analyses will be performed on unfiltered samples to allow comparison to Ocean Plan water quality criteria. For the effluent elutriate, metals will be analyzed in both unfiltered and filtered subsamples of elutriate (0.45µ). This will allow comparison to either Ocean Plan or CTR criteria dependent upon the location of the selected upland disposal site. Organic analyses will utilize unfiltered elutriate to determine total concentrations.

Table 6. Analytical Methods for Sediment, Water, and Tissue Samples.

Analyte	Sediments & Tissues	Water, Leachate & Elutriates
Arsenic	EPA 7061	EPA 206.3
Cadmium	EPA 6020	EPA 200.8
Chromium	EPA 6020	EPA 200.8
Copper	EPA 6020	EPA 200.8
Lead	EPA 6020	EPA 200.8
Mercury	EPA 7471M	EPA 245.7
Nickel	EPA 6020	EPA 200.8
Selenium	EPA 7741	EPA 270.3
Silver	EPA 6020	EPA 200.8
Zinc	EPA 6020	EPA 200.8
Pesticides	EPA 8081A GC-ECD	EPA 8081A GC-ECD
PCBs	EPA 8082 GC-ECD	EPA 8082 CG-ECD
PAHS, Phenols, Phthalates	EPA 8270c GC-MS	EPA 8270c GC-MS
Speciated Butyltins	Uhler & Durell, 1989[1]	Uhler & Durell, 1989[1]
Oil & Grease	EPA 1664 HEM	EPA 1664 HEM
Total Petroleum Hydrocarbons	EPA 1664 HEM/SGT	EPA 1664 HEM/SGT
Sulfides	EPA 9030	EPA 376.1
Total Ammonia	EPA 350.2/SM 4500G	EPA 350.2/SM 4500G
Total Organic Carbon	EPA 9060	--
Total Volatile Solids	EPA 160.4	--
Percent Lipids (tissue only)	EPA 1664 HEM	--
Particle Size Distribution	Plumb, 1981[2]	--
Percent Moisture	EPA 160.3	--

1 Allen D. Uhler, Gregory S. Durell; *Measurement of Butyltin Species in Sediments by n-Pentyl Derivatization with Gas Chromatography/Flame Photometric Detection (GC/FPD) and Optional Confirmation by Gas Chromatography/Mass Spectrometry (GC/MS)*, February 1989.

2 Russell H. Plumb, Jr.; *Procedures for Handling and Chemical Analysis of Sediment and Water Samples*, Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, 1981.

Table 7. Target Analytes and Reporting Limits for Sediment and Tissues.

Analyte	Sediment Dry Wt (mg/kg)	Tissue Wet Wt (mg/kg)
Arsenic	0.1	0.1
Cadmium	0.1	0.1
Chromium	0.1	0.1
Copper	0.1	0.1
Lead	0.1	0.1
Mercury	0.02	0.02
Nickel	0.1	0.1
Selenium	0.1	0.1
Silver	0.1	0.1
Zinc	1.0	1.0
Speciated Butyltins	0.001	--
Aldrin	0.002	0.002
Chlordane, alpha & gamma	0.002	0.002
Dieldrin	0.002	0.002
DDT & derivatives	0.002	0.002
Endrin & derivatives	0.002	0.002
Heptachlor	0.002	0.002
Hexachlorocyclohexane isomers	0.002	0.002
Toxaphene	0.02	0.02
Methoxychlor	0.004	0.004
Endosulfan I	0.002	0.002
Endosulfan II	0.002	0.002
Endosulfan sulphate	0.002	0.002
Arochlor 1016	0.01	0.01
Arochlor 1221	0.01	0.01
Arochlor 1232	0.01	0.01
Arochlor 1242	0.01	0.01
Arochlor 1248	0.01	0.01
Arochlor 1254	0.01	0.01
Arochlor 1260	0.01	0.01
Total PCBs	0.01	0.01
Total Phenols	0.02-0.05	0.02-0.05
Acenaphthene	0.01	0.01
Acenaphthylene	0.01	0.01
Anthracene	0.01	0.01
Benzo(a)anthracene	0.01	0.01
Benzo(a)pyrene	0.01	0.01
Benzo(ghi)perylene	0.01	0.01
Benzo(k)fluoranthene	0.01	0.01
Benzo(b)fluoranthene	0.01	0.01
Fluoranthene	0.01	0.01
Dibenzo(a,h)anthracene	0.02	0.02
Naphthalene	0.01	0.01
Indeno(1,2,3-c,d)pyrene	0.02	0.02
Fluorene	0.01	0.01
Chrysene	0.01	0.01
Phenanthrene	0.01	0.01
Pyrene	0.01	0.01
Benzo(e)pyrene	0.01	0.01
Perylene	0.01	0.01
Total Phthalates	0.01	0.01
Particle Size Distribution	--	--
Total Organic Carbon	0.1%	--
Total Petroleum Hydrocarbons	100	--
Oil & Grease	100	--
Total sulfides	1.0	--
Water soluble sulfides	1.0	--
Total Ammonia	0.5	--
Total Volatile Solids	0.1%	--
Percent Moisture	0.1%	0.1%
Percent Lipids	0.1%	0.1%

Table 8. Target Analytes and Reporting Limits for Waters and Elutriates.

Analyte	Water & Elutriate (µg/L)
Arsenic (total recoverable and dissolved)	1.0
Cadmium (total recoverable and dissolved)	0.5
Chromium (total recoverable and dissolved)	2.0
Copper (total recoverable and dissolved)	0.5
Lead (total recoverable and dissolved)	1.0
Mercury (total recoverable)	0.01
Nickel (total recoverable and dissolved)	2.0
Selenium (total recoverable)	1.0
Silver (total recoverable and dissolved)	0.2
Zinc (total recoverable and dissolved)	5.0
Speciated Butyltins	0.002
Aldrin	0.02
Chlordane, alpha & gamma	0.02
Dieldrin	0.02
DDT & derivatives	0.02
Endrin & derivatives	0.02
Heptachlor	0.02
Hexachlorocyclohexane isomers	0.02
Toxaphene	0.5
Methoxychlor	0.05
Endosulfan I	0.02
Endosulfan II	0.02
Endosulfan sulphate	0.02
Arochlor 1016	0.5
Arochlor 1221	0.5
Arochlor 1232	0.5
Arochlor 1242	0.5
Arochlor 1248	0.5
Arochlor 1254	0.2-0.5
Arochlor 1260	0.1
Total PCBs	0.1
Total Phenols	--
Acenaphthene	0.1
Acenaphthylene	0.1
Anthracene	0.1
Benzo(a)anthracene	0.1
Benzo(a)pyrene	0.1
Benzo(ghi)perylene	0.2
Benzo(k)fluoranthene	0.1
Benzo(b)fluoranthene	0.1
Fluoranthene	0.1
Dibenzo(a,h)anthracene	0.2
Naphthalene	0.1
Indeno(1,2,3-c,d)pyrene	0.2
Fluorene	0.1
Chrysene	0.1
Phenanthrene	0.1
Pyrene	0.1
Benzo(e)pyrene	0.1
Perylene	0.1
Total Phthalates	--
Oil & Grease	500
Water soluble sulfides	50
Total Ammonia	50

5.3 WET Analyses

Leaching characteristics are evaluated by use of a State of California, Title 22 Waste Extraction Test (WET). This method uses sodium citrate as an extractant. The test involves extracting 50 grams of sediment for 24 hours at a ratio of one part sediment to ten parts 0.2 M sodium citrate at a pH of 5.0. After extraction, the solution is filtered through a 0.45 micron filter prior to analysis. Analytical results are reported as micrograms of each constituent per liter of extractant. WET analyses may be required for any analytes that exceed 10% of the Title 22, Chapter 11 TTLC criteria. Potential WET analytes and their target reporting limits are listed in Table 9 and their analytical methods are listed in Table 6.

Table 9. Potential Analytes and Target Reporting Limits for the California Title 22 WET.

Dissolved Analytes	Simulated Leachate (WET) (µg/L)	STLC Criteria
Arsenic	50	5,000
Cadmium	10	1,000
Chromium	50	5,000
Copper	50	25,000
Lead	50	5,000
Mercury	2	200
Nickel	50	20,000
Selenium	10	1,000
Silver	50	5,000
Zinc	50	24,000
Aldrin	2	140
Chlordane	2	250
Dieldrin	2	800
DDT & derivatives	2	100
Endrin & derivatives	2	20
Heptachlor	2	470
Heptachlor epoxide	2	470
Mirex	2	2,100
Toxaphene	2	500
Methoxychlor	2	10,000
Kepone	2	2,100
Lindane	2	400

5.4 Bioassay Analyses

For Tier III testing for open water disposal, the composite sediments along with reference-area and control sediments will be tested for toxicity and for bioaccumulation potential. Bioassay protocols will follow the ITM (USEPA/USACE, 1998) and "Green Book" (USEPA/USACE, 1991) for both Suspended Particulate-Phase and Solid Phase bioassays. Testing for CDF disposal will require only a single Suspended Particulate-Phase bioassay.

All species proposed for use in this testing program comply with ITM and Green Book recommendations and guidelines for bioassay and bioaccumulation tests.

For Suspended Particulate-Phase bioassays:

- *Americamysis bahia* (mysid)
- *Menidia beryllina* (fish)
- larvae of *Mytilus galloprovincialis* (mussel)

For Suspended Particulate-Phase bioassays (Upland disposal):

- larvae of *Mytilus galloprovincialis* (mussel)

For Solid Phase Bioassays:

- *Nephtys caecoides* (worm)
- *Ampelisca abdita* (amphipod)

The methods and endpoints to be used for the bioassays are listed in Table 10.

5. Bioaccumulation Assessment

The ITM requires a 28-day exposure period of two benthic species to test, reference, and control sediments prior to tissue analysis. Our proposed species, which conform to ITM recommendations, are as follows:

Nephtys caecoides or *Nereis virens* (worms)
Macoma nasuta (clam)

Following exposure of the organisms to the test sediment, they will be placed in a clean, non-stressful environment to purge their systems of test sediment. The purge time will be long enough to purge sediment, but not long enough to allow them to depurate accumulated toxicants. Generally, 24 hours are sufficient, but a few organisms will be sacrificed to ensure completion of the purge.

Table 10. Species, Methods, and End-Points for Biological Testing.

Test Type	Species	Method	End Points
BIOASSAYS:			
Suspended Particulate Phase:			
Bivalve Larvae	*Mytilus galloprovincialis*	ASTM, 1998 E 724 98	48 hr. survival and normal development
Fish Larvae	*Menidia beryllina*	USACE/USEPA 1998	4 day survival
Mysid Shrimp	*Mysidopsis bahia*	USACE/USEPA 1998	4 day survival
Solid Phase:			
Amphipod	*Ampelisca abdita*	ASTM, 1999a E 1367 92; USEPA 1994	10 day survival
Polychaete worm	*Nephtys caecoides*	ASTM, 1999b E 1611 94	10 day survival
BIOACCUMULATION EXPOSURES:			
Clam	*Macoma nasuta*	USACE/USEPA 1998	28 day benthic exposure
Worm	*Nephtys caecoides or Nereis virens*	USACE/USEPA 1998	28 day benthic exposure

Tissue samples will be thoroughly homogenized with a stainless steel Tekmar Tissuemizer. The entire blade and barrel assembly will be pre-cleaned with hot DI water and Micro 90® detergent and then rinsed thoroughly with DI water. The blade will be rinsed again with DI water just prior to use. The Tissuemizer will be triple rinsed between samples to minimize sample cross contamination. Samples will be triple-wrapped and frozen when not in use. All tissue handling and processing will be conducted at a laminar flow bench in a trace-metal clean laboratory.

Bioaccumulation tissue samples for sediment composites that have passed the chemical screening and the bioassay testing, and qualify as viable candidates for open water disposal will be analyzed for the metals and semivolatile compounds in Table 7. Methods and proposed analytical detection limits for these constituents are listed in Tables 6 and 7.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Kinnetic Laboratories/ToxScan conducts its activities in accordance with formal QA/QC procedures. The objectives of the QA/QC Program are to fully document the field and laboratory data collected, to maintain data integrity from the time of field collection through storage and archiving, and to produce the highest quality data possible. Quality assurance involves all of the planned and systematic actions necessary to provide confidence that work performed by KLI/ToxScan conforms to contract requirements, laboratory methodologies, state and federal regulation requirements, and corporate Standard Operating Procedures (SOPs). The program is designed to allow the data to be assessed by the following parameters: Precision, Accuracy, Comparability, Representativeness, and Completeness. These parameters are controlled by adhering to documented methods and procedures (SOPs), and by the analysis of quality control (QC) samples on a routine basis.

6.1 Chemical Analysis

For the proposed dredge sediment sampling and testing program, please refer to the following tables for specific QC procedures to be employed. Table 11 summarizes minimum laboratory QC for the chemistry analyses, and Tables 12 and 13 summarize Quality Assurance/Quality Control Objectives.

Field Quality Control includes adherence to SOPs, formal sample documentation and tracking, and the use of field quality control samples (field/bottle blanks; equipment rinsate blanks; field replicates).

Analytical chemistry Quality Control is formalized by EPA and State Certification agencies and involves internal quality control checks including method blanks, matrix spike/spike duplicates, duplicates, surrogates, and calibration standards. Standard Reference Materials (SRMs) are also run along with calibration standards for each batch of samples.

All analytical data collected for this sediment testing program will undergo QA/QC evaluation according to EPA National Functional Guidelines for inorganic and organic data review (USEPA, 1999; 2001; 2002). A summary of QA/QC findings will be included in the final report.

6.2 Biological Testing

Quality assurance measures applied to aquatic toxicity testing are explicitly stated in the referenced protocols. Each protocol provides a list of test acceptability criteria, including minimum control performance standards and required monitoring of environmental parameters. Test conditions must remain within the tolerance range of the test organisms throughout the test, and environmental factors are

monitored and recorded daily. Any variation from specifications is documented and corrective action adjustments are reported with the test data. Key monitoring factors for the bioassay tests are summarized in Table 14. Protocols also provide guidance on test organisms procurement, care and acclimation. ToxScan maintains laboratory logbooks documenting these factors.

Two other important bioassay QA measures are the inclusion of an experimental control, where organisms are simultaneously exposed to laboratory test conditions in the absence of a toxicant stress, and the inclusion of reference toxicant bioassays, in which the organisms are exposed to standard toxicants. Reference toxicant bioassays are run concurrently with and under the same conditions as the bioassays of the test material. The exception to this rule is that reference toxicant tests with solid phase species are performed as sediment-free 96-hour acute tests. Control charts are maintained in the laboratory for each species/toxicant combination. A minimum of five bioassays is required for a valid control chart, and upper and lower limits are developed which are two standard deviations on either side of the mean. Precision is quantified in the control charts by calculation of the coefficient of variation (CV). The application of a maximum acceptable value for the CV or the minimum significant difference (MSD) increases data reliability, and many newer protocols specify such maximum acceptable values.

Table 11. Quality Control Summary for Water, Bulk Sediment, and Tissue Chemistry.

Analyte	Blanks	Duplicates	MS/MSDs	LCS	Surrogates	SRMs
Water Matrices						
Ammonia	✓	✓	—	—	—	✓
Water Soluble Sulfides	✓	✓	—	—	—	—
Total and Dissolved Metals	✓	✓	—	✓[1]	—	—
Speciated butyltins	✓	—	✓	✓	✓	—
Semivolatile Organic Compounds	✓	—	—	✓	✓	—
Organochlorine Pesticides	✓	—	—	✓	✓	—
PCBs	✓	—	—	✓	✓	—
Sediment Matrices						
Total sulfides	✓	✓	—	✓	—	—
Water soluble sulfides	✓	✓	—	✓	—	—
% Solids	—	✓	—	—	—	—
TOC	✓	✓	—	✓	—	—
Grain Size	—	—	—	—	—	—
Total Metals	✓	✓	✓	—	—	✓
Speciated butyltins	✓	—	✓	✓	✓	—
Semivolatile Organic Compounds	✓	—	✓	✓	✓	—
Organochlorine Pesticides	✓	—	✓	✓	✓	—
PCBs	✓	—	✓	✓	✓	—
Tissue Matrices						
Total Metals	✓	✓	✓	—	—	✓
Speciated butyltins	✓	—	✓	✓	✓	—
Semivolatile Organic Compounds	✓	—	✓	✓	✓	—
Organochlorine Pesticides	✓	—	✓	✓	✓	—
PCBs	✓	—	✓	✓	✓	—
Percent Lipids		✓				

1. For metals in seawater, both an LCS and LCS duplicate will be analyzed.

Table 12. Sediment and Tissue Matrices: Quality Assurance/Quality Control Objectives.

Analyte	Accuracy		Precision	
	Spike Recovery	LCS/SRM Recovery	Matrix Spike RPDs	Laboratory Duplicate RPDs
CONVENTIONALS				
Percent Solids	-	-	-	30
Oil and Grease	-	-	-	30
Total Organic Carbon	-	60-110	-	30
Dissolved Sulfides	-	-	-	30
Total Sulfides	-	-	-	30
Percent Moisture	-	-	-	20
Percent Lipids (tissue only)	-	-	-	20
SPECIATED BUTYLTINS	40-140[1]	60-140[1]	30[1]	-
METALS				
Arsenic	70-130	75-125	30	20
Cadmium	70-130	75-125	30	20
Chromium	70-130	75-125	30	20
Copper	70-130	75-125	30	20
Lead	70-130	75-125	30	20
Mercury	76-120	80-120	30	20
Nickel	70-130	75-125	30	20
Selenium	70-130	75-125	30	20
Silver	70-130	75-125	30	20
Zinc	70-130	75-125	30	20
ORGANICS				
Chlorinated Pesticides/PCBs				
gamma-BHC	46-127	-	50	-
Heptachlor	35-130	-	31	-
Aldrin	34-132	-	43	-
Dieldrin	31-134	-	38	-
Endrin	42-139	-	45	-
4,4'-DDT	23-134	-	50	-
PAHs				
Acenaphthene	31-137	-	50	-
Pyrene	35-142	-	36	-

1. QA/QC objectives for butyltins are based upon tributyltin for which the method is optimized. Lower recoveries and higher RPDs are typically experienced for dibutyltin and monobutyltin.

Table 13. Water and Elutriate Matrices: Quality Assurance/Quality Control Objectives.

Analyte	Accuracy		Precision	
	Spike Recovery	LCS/SRM Recovery	Matrix Spike RPDs	Laboratory Duplicate RPDs
CONVENTIONALS				
Ammonia as Nitrogen	-	75-125	-	20
Water Soluble Sulfides	-	-	-	20
Oil and Grease	-	-	-	20
Total Organic Carbon	-	80-120	-	20
SPECIATED BUTYLTINS	50-140[1]	60-140[1]	30[1]	-
TOTAL AND DISSOLVED METALS				
Arsenic		71-114		0-30
Cadmium		69-120		0-30
Chromium		85-133		0-30
Copper		72-128		0-30
Lead		56-116		0-30
Mercury		68-117		0-30
Nickel		68-118		0-30
Selenium		55-110		0-30
Silver		66-125		0-30
Zinc		62-108		0-30
ORGANICS				
Chlorinated Pesticides/PCBs				
gamma-BHC	59-110	-	0-30	-
Heptachlor	43-122	-	0-30	-
Aldrin	43-128	-	0-30	-
Dieldrin	46-125	-	0-30	-
Endrin	32-141	-	0-30	-
4,4'-DDT	69-116	-	0-30	-
PAHs				
Acenaphthene	60-120	-	0-30	-
Pyrene	70-130	-	0-30	-

1. QA/QC objectives for butyltins are based upon tributyltin for which the method is optimized. Lower recoveries and higher RPDs are typically experienced for dibutyltin and monobutyltin.

Table 14. Sediment interstitial and overlying water analyses, water quality control, and control for confounding factors in water column or benthic exposures for acute toxicity and bioaccumulation testing.

	Water Column	Benthic		Bioaccumulation	
Parameter	All Species	Amphipod	Worm	Clam	Worm
Ammonia	A	I, O	I	--	--
Dissolved Sulfides	--	I	I	--	--
DO	O	O	O	O	O
Temperature	O	O	O	O	O
Salinity	O	I, O	I, O	I, O	I, O
pH	O	I, O	I, O	I, O	I, O

I = Interstitial Water O = Overlying Water A = Archive

7.0 DATA REVIEW, MANAGEMENT AND ANALYSIS

All data will be reviewed by laboratory team leaders and by the laboratory director. The project QA officer will be responsible for final data review and qualification. The laboratory will supply data in both electronic and hard copy formats, and results will be retained in the project files at both ToxScan and at Kinnetic Laboratories. Data analysis will consist of tabulation and comparison with regulatory guidelines including ER-L, ER-M, PEL, and TEL criteria as appropriate. Elutriate data will be compared with water quality criteria, and applicable dilution models will be applied to determine if water quality goals will be met during dredge disposal.

8.0 DATA REDUCTION ANALYSIS AND INTERPRETATION

Statistical analysis of experimental data will be performed for each of the bioassay and bioaccumulation experiments. Tests of fundamental assumptions (e.g., variance homogeneity) are followed by the appropriate parametric or non-parametric analyses.

In cases where a contaminant is detected in tissues of organisms exposed to test sediment but is not detected (ND) in reference tissues, a value will be assigned to the ND sample which equals 50% of the analytical detection limit (DL) for that contaminant. This is consistent with interim recommendations published in the Inland Testing Manual (USEPA/USACE, 1998). If new recommendations currently under review by the USEPA/USACE for handling ND values are promulgated prior to issuing a final report, handling of ND data will be reevaluated.

Variance homogeneity is one of the underlying assumptions of most parametric statistics. Bartlett's or Cochran's test is therefore applied to the data from the bioassays and the tissue chemistry of the bioaccumulation experiments. Significant results for this and all subsequent

parametric tests are determined by the critical value (alpha = 0.05) of the appropriate distributions.

Once homogeneity has been established, the ANOVA and Dunnett's test will be employed to analyze differences between treatment responses (e.g., test sediment tanks). Survival responses in the control tanks serve primarily for procedural quality assurance.

When sample variances do not exhibit homogeneity, as determined by Cochran's test, the Testing Manual recommends a data transformation. Arcsine Check is applied to proportional data of bioassays and log(x + 1) is applied to bioaccumulation data which are not homogenous. When the data transformation is unable to compensate the deviation, non-parametric tests are employed.

Non-parametric procedures use ranked values for calculating test statistics and the corresponding hypotheses use rank sums for comparison. Kruskal-Wallace and Wilcoxson-Wilcox tests are used to identify differences between treatment responses.

Inland Testing Manual guidelines for interpretation of suspended particulate-phase bioassays require that initial mixing calculations be performed to determine the concentration of suspended particulate material remaining at the disposal site within four hours after dumping (Csp) for any sample producing toxicity sufficient to generate an LC50. If the Csp does not exceed 1% of the LC50, the sediment is judged to comply with water column toxicity criteria.

Guidelines for interpretation of benthic bioassay results are published in the Inland Testing Manual. If survival responses in test sediment are statistically significantly lower than those in reference sediment *and* if the difference in mean survival between groups is greater than 10% (20% for amphipods), then the test sediment is considered to have the potential to significantly degrade the marine environment.

Guidelines for evaluation of bioaccumulation are described in the ITM and final interpretation is made by the District Engineer and the Regional Administrator. Therefore, statistical testing of bioaccumulation test phase results is complete when an appropriate comparison (Dunnett's or Wilcoxson-Wilcox) describes significant or non-significant tissue burden from exposure to dredged material.

9.0 REPORTING

The findings from the testing program will be summarized in a report that will compare the results to sediment disposal guidelines for the disposal/reuse options. The report will detail all sampling and testing methods and will present summarized results in concise tables. The report will be formatted in traditional scientific style: Introduction, Methods, Results, Discussion and Conclusions. The report will include a Cover Sheet, Table of Contents, List of Tables, List of Figures, and narrative text.

The narrative text will include project description, analytical method descriptions, and discussion of results and implications. Individual sampling locations will be tabulated by date and time of collection, precise position, mudline depth, and core length. Analytical chemistry values for all analytes will be presented by composite sample in a summary table.

Detailed laboratory reports of analytical chemistry data will be presented as appendices. The appendices will also include detailed analytical chemistry QC elements. Copies of completed field logs and chain-of-custody documentation will be included in the appendices.

The project location and detailed sample locations will be presented in digitized maps.

The report and all supporting data will also be supplied in electronic format on a CD.

10.0 REFERENCES CITED

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