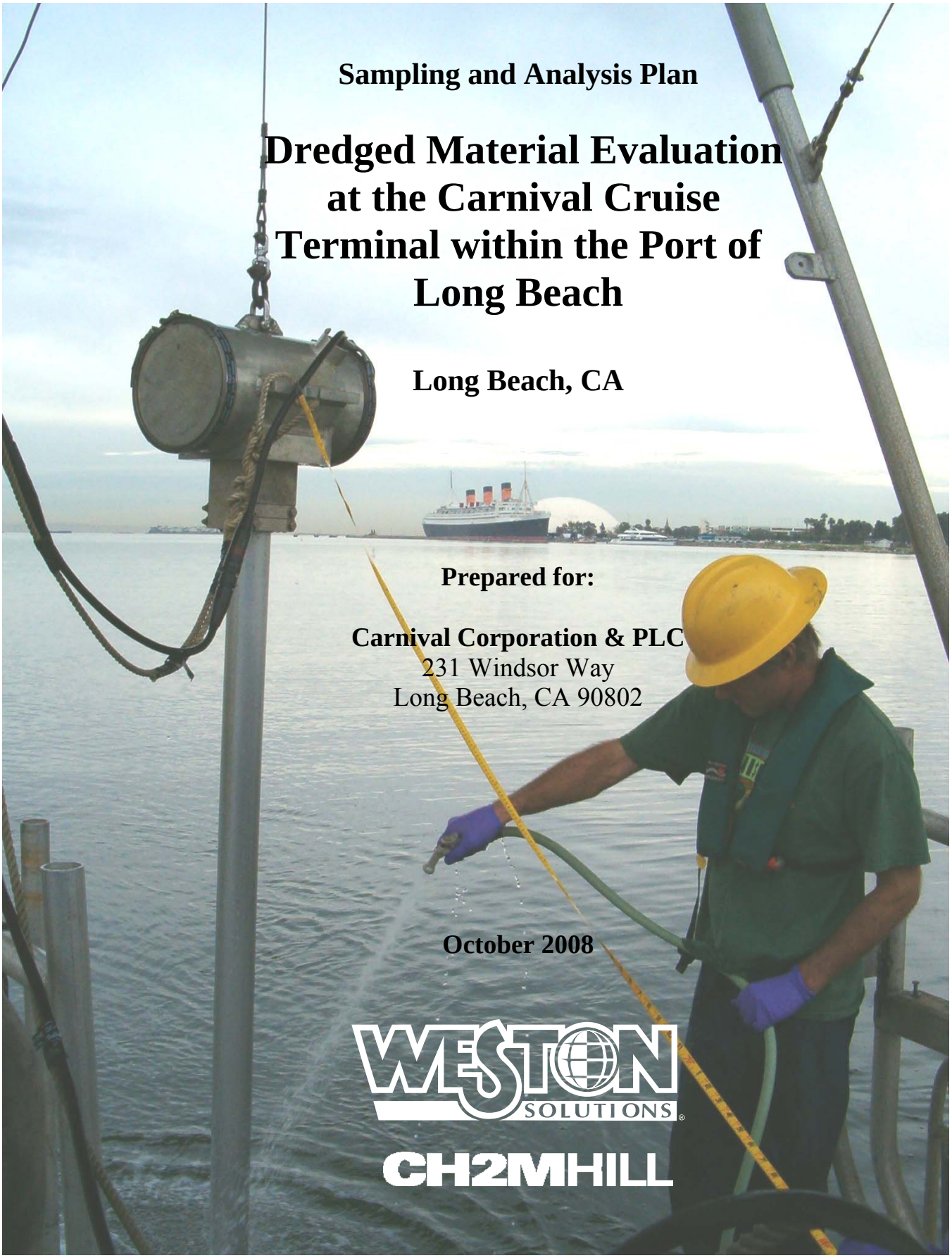

Sampling and Analysis Plan

Dredged Material Evaluation at the Carnival Cruise Terminal within the Port of Long Beach

Long Beach, CA

Prepared for:

Carnival Corporation & PLC
231 Windsor Way
Long Beach, CA 90802

October 2008

WESTON SOLUTIONS

CH2MHILL

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Prepared for:

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October 2008

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
BP	bioaccumulation potential
Carnival	Carnival Corporation & PLC
CCR	California Code of Regulations
CDOH	California Department of Health
CFR	Code of Federal Regulations
COC	chain of custody
CRG	CRG Marine Laboratories
CVAFS	cold vapor atomic fluorescence spectrophotometry
DDT	dichlorodiphenyltrichloroethane
DGPS	Differential Global Positioning System
GPS	global positioning system
DO	dissolved oxygen
EC_{50}	median effective concentration
ER-L	effects range–low
ER-M	effects range–median
GC-MS	gas chromatography – mass spectrometry
ICP-MS	inductively coupled plasma – mass spectrometry
ID	identification
ITM	Inland Testing Manual
LC_{50}	median lethal concentration
LPC	limiting permissible concentration
MEC	MEC Analytical Systems Inc.
MDL	method detection limit
MLLW	mean lower low water
OSWM	Office of Solid Waste Management
OTM	Ocean Testing Manual
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pH	hydrogen ion concentration
POC	point of contact
POLB	Port of Long Beach
QA	quality assurance
QAP	quality assurance plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
SAP	sampling and analysis plan
SIM	selective ion monitoring
SM	Standard Method
SOP	standard operating procedure
SP	solid phase
SPP	suspended particulate phase
STFATE	short-term fate
STLC	soluble threshold limit concentration
SVOC	semi-volatile organic compounds
TCLP	toxicity characteristic leaching procedure
TBT	tributyltin
TEQ	toxic equivalent
TOC	total organic carbon

ACRONYMS AND ABBREVIATIONS CONTINUED

TRPH	total recoverable petroleum hydrocarbon
TTLC	Total threshold limit concentration
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UTM	Upland Testing Manual
WESTON	Weston Solutions, Inc.
WGS 84	World Geodetic System 1984

UNITS OF MEASURE

cm	Centimeter
cy	cubic yard
°C	degrees Celsius
ft	feet or foot
L	Liter
µg/kg	microgram per kilogram
µm	micrometer
mm	millimeter
m	Meter
mg/kg	Milligram per kilogram
mg/L	Milligram per liter
mL	Milliliter
ng/kg	Nanogram per kilogram
ppm	parts per million
%	Percent

1.0 INTRODUCTION

1.1 Background

Carnival Corporation & PLC (Carnival) proposes to conduct maintenance dredging in the area surrounding the Carnival Cruise Terminal within the Port of Long Beach, Long Beach, California, as a result of recent sedimentation that has occurred (Figure 1). Maintenance dredging is required in this area to ensure adequate navigation depth for Carnival ships which utilize this cruise terminal on a regular basis. In particular, dredging will be critical prior to the arrival of the newest and largest cruise ship, Carnival Splendor, scheduled for a maiden call from the Carnival Cruise Terminal on March 29, 2009. The Carnival Cruise Terminal is located on Pier H near the Queen Mary Terminal on the west side of Queensway Bay (Figure 1, Figure 2).

Based on the proposed maintenance dredging plan, a potential of approximately 7,000 cubic yards (cy) of dredged material will need to be managed. Potential management options include upland beneficial use alternatives such as beach replenishment or construction fill, or ocean disposal at the United States Environmental Protection Agency's (USEPA's) designated LA-2 Ocean Disposal Site. To determine the appropriate management option, the material must be evaluated prior to dredging and disposal activities in accordance with the *Inland Testing Manual* (ITM) (USACE and USEPA, 1998), the *Upland Testing Manual* (USACE, 1993), and *Ocean Testing Manual* (OTM) (USEPA and USACE, 1991). Based on the small volume of material to be dredged, the beneficial use of the material may be the most cost effective option available. However, if the material is found not suitable for a beneficial use, an evaluation of the material for ocean or upland disposal alternatives may be required.

For the purposes of the dredged material evaluation, one area (Area CT) has been identified within the dredging footprint for sampling and analysis activities (Figure 2, Table 3). This area will be dredged to -30 feet (ft) mean lower low water (MLLW) (-32 ft including a +2 ft overdredge allowance).

1.2 Previous Studies

One previous study was conducted in the area adjacent to the Carnival Cruise Terminal area by Weston Solutions, Inc. (WESTON; as MEC Analytical Systems, Inc. [MEC]) in 2000. In this study, four core samples were collected and physical and chemical analyses conducted to evaluate the material for in-bay fill. Physical analyses indicated that the material was primarily silt (65-76%) and clay (12-21%). Sediment chemistry were compared to sediment quality guidelines (effects-range low [ER-L] and effects range-median [ER-M] values) which are discussed in Section 2.4.2 below. Concentrations of all metals and PAHs in all sediment core samples were in the same range of magnitude or below their respective ER-L values. Concentrations of PCBs and phenols were below reporting limits. The only analyte to exceed an ER-M value was 4,4'-DDT at Stations 1 and 4. Duplicate chemistry results for 4,4'-DDT indicated a lack of sample homogeneity.

Other sediment characterization studies have been conducted in the Los Angeles River Estuary, but not in an area near the Carnival Cruise Terminal. These studies include a Tier III dredged material evaluation study by WESTON (as MEC) in 1998, a capping study by Chambers Group, Inc. (2001), a dredged material evaluation by WESTON (2005) for emergency dredging purposes, and a supplemental Tier III and IV sediment analysis by WESTON (2007).

1.3 Sampling and Testing Objectives

The objective of this investigation is to characterize material proposed for maintenance dredging in the area surrounding the Carnival Cruise Terminal for its environmental suitability for beneficial use or ocean

disposal. A phased approach will be used to evaluate the material for potential beach nourishment, placement at the Port of Long Beach (POLB) West Basin Storage Facility, ocean disposal, or upland placement, as described below in Section 2.1.2. In order to evaluate the material to be dredged, sediment core samples will be collected to -32 ft MLLW (-30 + -2 ft) within the dredge footprint and composited (Figure 2). The composite sample will then be analyzed for chemical and physical properties followed by bioassay and bioaccumulation testing if needed.

Figure 1. Overview of Sampling Area along the Carnival Cruise Terminal

Figure 2. Cruise Terminal Project Area with Sampling Locations

2.0 MATERIALS AND METHODS

2.1 Field Sampling and Testing Approach

2.1.1 Project and Sampling Areas

The dredge footprint to be sampled is located at the Carnival Cruise Terminal on Pier H near the Queen Mary Terminal. One project area has been identified within this dredge footprint for the purposes of sampling and analysis activities (Table 1). This area represents the -30ft MLLW dredge footprint (-32 ft including a +2 ft overdredge allowance). The volume of dredged material, based on the project depth and on the projected bathymetry, is approximately 7,000 cy (Table 1). With an additional 2 ft overdredge allowance (1 ft paid overdredge + 1 ft allowance), the potential dredge material volume will increase.

Table 1. Proposed Depths and Volume of Material to be Removed from the Carnival Cruise Terminal Area at the POLB

Area	Project Depth (ft MLLW)	Volume to be Dredged (to project depth) (cy)
CT	-30	7,000

This dredged material evaluation will include collection of continuous sediment cores at three locations within the area (Figure 2). Sediment core samples will be collected with a vibracore to the project depth plus 2 ft at each of the three sample locations. Sediment sampling will be conducted to a target core depth of -32 ft MLLW (i.e., project depth of -30 ft MLLW plus 2 ft). Existing depths at the designated sampling locations will be confirmed using a lead line or fathometer and compared to bathymetric depth calculations. Field sampling activities are expected to take a total of approximately two days.

2.1.2 Phased Approach for Physical, Chemical and Biological Analyses

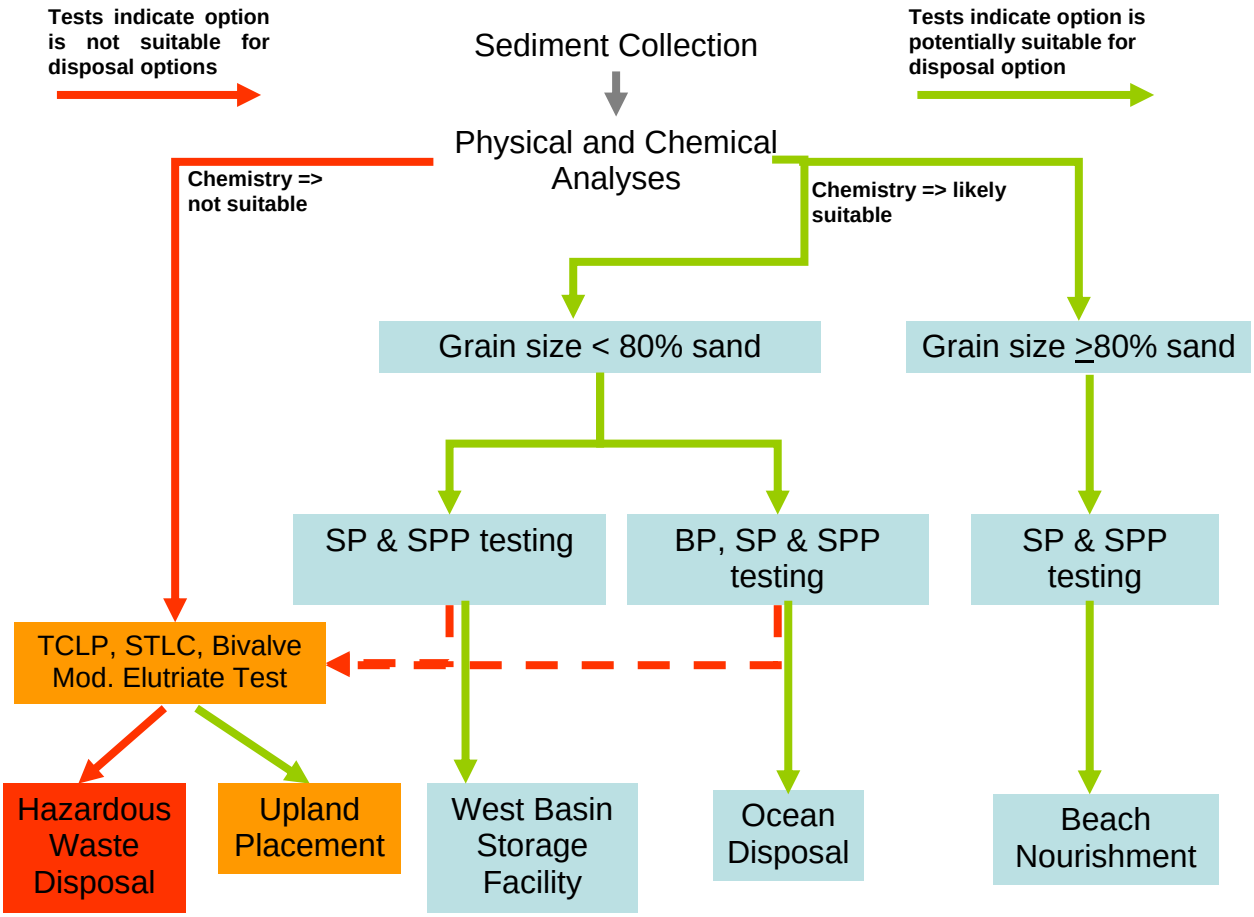
A phased approach will be used to evaluate project material for its suitability for beach nourishment, placement at the POLB West Basin Storage Facility for future construction or beneficial uses, ocean disposal, or upland placement (Figure 3, Table 2). In Phase I, upon collection of project sediment, sediment will be immediately submitted for the physical and chemical analyses as described in detail in Section 2.4. Chemical analysis of the project material will include metals, organotins, organochlorine pesticides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), phenols, and total phthalates. Conventional chemical analyses will include total and water-soluble sulfides, oil and grease, ammonia, total recoverable petroleum hydrocarbon (TRPH), total organic carbon (TOC), and percent solids. Physical analyses will include Atterberg Limits, specific gravity, and grain size. Sediment chemical analyses will be conducted within five business days, and results immediately reviewed upon receipt and presented to Carnival. In Phase II, the following bullets indicate the options for additional testing that may be initiated, based on the results of the initial physical and chemical analyses:

- Sediment chemical analyses indicate that the material is likely not suitable for beach nourishment, placement at the West Basin Storage Facility, or ocean disposal. Testing for upland placement suitability will commence. To determine if material is suitable for upland placement, the following analyses will be conducted: toxicity characteristic leaching procedure (TCLP), soluble

threshold limit concentration (STLC)[1], and a modified elutriate bivalve development toxicity test using *Mytilus galloprovincialis*.

- Sediment chemistry results indicate that the material is potentially suitable for beach nourishment and physical analyses indicate that the grain size distribution of the project material is greater than or equal to 80% sand[2]. The following additional tests will be conducted: three SPP tests (bivalve larvae, fish, and shrimp), and two SP tests (amphipod and polychaete worm).
- Sediment chemistry results indicate that the material is potentially suitable for placement at West Basin Storage Facility or ocean disposal and physical analyses indicate that the grain size distribution of the project material less than 80% sand.
    - For determination of suitability for placement at West Basin Storage Facility, the following additional tests will be conducted: three SPP tests (bivalve larvae, fish, and shrimp), and two SP tests (amphipod and polychaete worm).
    - For determination of suitability for ocean disposal, the following additional tests will be conducted: three SPP tests, two SP tests, and two BP tests (bivalve and polychaete worm).

Reference material used in all biological tests will be collected from LA-2 EPA designated reference site. In addition, the appropriate laboratory control samples will be run with each of the selected test species.



[1] The STLC test will only need to be conducted if sediment chemistry results indicate values that are 10 times the STLC limit concentrations.
[2] Grain size will be measured at each core location.

Figure 3. Phased Approach Used to Evaluate Sediment for Various Disposal Options

Table 2. Potential Phase II Testing Proposed to Determine Suitability of Project Material for Various Disposal Options

Test Type	Type of Organism	Taxon	Project Sediments	Control	Reference[1] Sediment	Reference[1] Toxicant	Ammonia[1] Reference Toxicant	Disposal Option Evaluated
SPP	Bivalve larvae	*Mytilus galloprovincialis* or *Crassostrea gigas*	X	Elutriate Dilution Water		X	X	BN WBSF OD
	Fish	*Menidia beryllina*	X	Elutriate Dilution Water		X	X	BN WBSF OD
	Mysid shrimp	*Americamysis bahia*	X	Elutriate Dilution Water		X	X	BN WBSF OD
SP	Amphipod	*Ampelisca abdita* or ***Rhepoxynius abronius***	X	Control Sediment	X	X	X	BN WBSF OD
	Polychaete	*Neanthes arenaceodentata*	X	Control Sediment	X	X	X	BN WBSF OD
BP	Bivalve	*Macoma nasuta*	X	Control Sediment	X			OD
	Polychaete	*Nereis virens*	X	Control Sediment	X			OD
TCLP	NA	NA	X	NA				UP
STLC	NA	NA	X	NA				UP
Effluent Elutriate SPP	Bivalve	*Mytilus galloprovincialis*	X	Effluent Elutriate Dilution Water				UP

[1]Shaded areas indicate tests or treatments that are not applicable to the selected tests.
BN = Beach Nourishment
WBSF = placement at the West Basin Storage Facility
OD = Ocean Disposal
UP = Upland Placement

2.2 Field Collection Program for Sediment Core Samples

The sampling design designates three locations for the collection of sediment core samples within the proposed maintenance dredging footprint along Pier H near the Queen Mary Terminal on the west side of Queensway (Figure 2). The locations are positioned within one composite area and will be sampled using a vibracore.

2.2.1 Sampling Locations and Depths

The sediment composite sample created from the three sediment core samples will be evaluated on site for physical characteristics and stratigraphy (described in Section 2.2.3). The composited sample will be analyzed for chemical constituents in accordance with the phased testing approach described above (Section 2.1.2). The number of cores, core identification (ID) numbers, locations, and target lengths are

provided in Table 3. The actual lengths of these cores are based on bathymetric surveys and may differ, contingent on encountered bathymetry.

All sediment cores will be collected to the project depth plus 2 ft unless refusal is encountered. Depending on the amount of sediment retrieved, more than one core per location in a selected area may be required to ensure that there is sufficient material (≈ 90 L) for all required testing and archival (Table 3).

In addition to the project sediments, a reference sediment sample will be collected from the USACE–USEPA-approved reference sediment sampling location at the LA-2 reference site. Reference sediment will be collected with a stainless steel bucket. Control sediment will be provided with the bioassay test organisms or from a USEPA-approved reference location where appropriate (i.e., SPP tests do not use a control sediment). A sample of site water (approximately 40 L) will also be collected from the Los Angeles River Estuary (in an area near the Carnival Cruise Terminal) to be used in preparation of the 100% elutriate concentrations for the SPP tests (Table 4).

Table 3. Core Locations, Target Lengths, Number of Cores, Composite ID, and Proposed Initial Analyses for Samples Collected During Sampling

STATION ID	Water Depth (ft MLLW)	Latitude World Geodetic System 1984) (WGS 84)	Longitude (WSG 84)	Target Sampling Depth (ft MLLW)	Target Core Length (ft)	No. of Cores per Location for Required Sample Volume*	Composite ID	Proposed Composite Analyses**
CT1	28.0	33.751439	-118.186862	32.0	4.0	4	CT	Chemical &Physical
CT2	27.3	33.749339	-118.186911	32.0	4.7	4		
CT3	28.0	33.748451	-118.186921	32.0	4.0	4		

* Projected number of cores is based on the required sample composite volume for proposed Tier III analysis of 90 L.
** Number of composite samples is dependent on physical/chemical results and may change

Table 4. Approximate Coordinates for the Collection of Seawater for Use in SPP Tests

Latitude (WGS 84)	Longitude (WGS 84)
33.751328	- 118.182275

2.2.2 Navigation

Pre-plotted station positions will be located using a Differential Global Positioning System (DGPS), accurate to less than 10 ft (3 m). In the event of differential failure, stations will be located using visual lineups. All final station locations will be recorded in the field using positions from the DGPS or through lineups on the field map.

2.2.3 Core Collection and Handling

Cores will be collected using an electric vibracore (Figure 4), which will be deployed from a 42-ft research vessel. The vibracore will be equipped with a 4-inch (~10 cm) outer diameter aluminum barrel and stainless steel catcher to retain sediment. The standard system is capable of collecting cores up to ~20 ft (~6 m) long and can be equipped to handle greater depths, up to an additional 10 ft (~3 m), which is more than sufficient to cover the target sampling depths identified in this project (Table 3). A new polyethylene liner will be inserted into the tube prior to sampling at each station to eliminate the possibility of cross contamination between stations. Following sampling, the vibracore will be retrieved to the deck of the boat and the liner with sediment core removed from the aluminum tube and placed in a core tray for processing. The liner will then be cut vertically along the length of the sediment core and each core examined by a qualified scientist and photographed. The geologic description of each core will include the texture, odor, color, length, and any evident stratification of the sediment. This description will be documented in a core log (Appendix B). The samples will be labeled (i.e., project name, date, sampler ID and analysis), logged into a field chain-of-custody (COC) form (Appendix C), and placed into a cooler. Cores will remain on ice and in the dark until delivered to the appropriate laboratory for analysis.

All sediment cores will be collected to the appropriate depth unless refusal is encountered. Refusal is defined as less than 2 inches (~5 cm) of penetration per minute. If refusal is encountered, the vessel will be moved and a second core attempted. If refusal is encountered again, additional cores will not be attempted unless operational problems are suspected.

Figure 4. Electric Vibracore Sampler in Long Beach, California

2.2.4 Sample Processing and Storage

The sediment cores will be stored at 4°C until processed. Each core sample will be homogenized to a uniform consistency. One composite sample will be prepared from the three cores, based on the stratigraphy, and other sediment characteristics of the cores from each area (i.e., relative grain size distribution, texture, color, etc.). Composite samples will be generated by homogenizing sediment to a uniform consistency at the laboratory using a stainless steel mixing apparatus, and will then be placed into certified clean glass jars with Teflon-lined lids for chemical and physical analysis. Samples intended for potential bioassay and bioaccumulation analysis will be stored at WESTON's laboratory until results of the chemical analysis are evaluated. A sub-sample from each core, as well as the composite used in testing, will be archived frozen in the event that further delineation of chemical contamination is required.

2.2.5 Decontamination of Field and Laboratory Equipment

All field equipment will be cleaned prior to sampling as well as between sampling locations to avoid cross contamination. Before homogenizing each core and creation of composite samples, all stainless steel utensils (e.g., stainless steel bowls, spoons, spatulas, mixers) will be cleaned with soapy water, rinsed with tap water, and then rinsed three times with deionized water.

2.2.6 Shipping

Prior to shipping, sample containers will be placed in sealable plastic bags and securely packed inside the cooler with ice. COC forms will be filled out (Section 2.2.7), and the original signed COC forms will be placed in a sealed plastic bag and taped to the inside of the cooler lid. All cooler lids will be securely taped shut. After processing, samples will be delivered to the analytical laboratories listed in Table 5.

Table 5. Analytical Laboratories, Points of Contact, and Shipping Information

Laboratory	Volume	Analyses Performed	Point of Contact	Shipping Information
Weston Solutions, Inc. Carlsbad, CA	90 L sediment, 40 L water	Grain size, specific gravity, total solids, SPP, and SP testing	Dr. Shelly Anghera and Ms. Amy Margolis (760) 795-6900	Weston Solutions, Inc. 2433 Impala Dr. Carlsbad, CA 92010
NewFields *Northwest*, LLC	40 L sediment	BP testing	Dr. Jack Word (360) 297-6068	Northfields Northwest, LLC 4729 NE View Drive Port Gamble, WA 98364
CRG Marine Laboratories	500 mL sediment and 50 g tissue	Sediment and bioaccumulation tissue chemistry, TOC and Atterberg analysis	Mr. Rich Gossett (310) 533-5190	CRG Marine Laboratories 2020 Del Amo Blvd., Suite 200 Torrance, CA 90501

2.2.7 Documentation of Chain of Custody

This section describes the program requirements for sample handling and COC procedures. Samples are considered to be in custody if they are: (1) in the custodian's possession or view, (2) retained in a secured place (under lock) with restricted access, or (3) placed in a secured container. The principal documents used to identify samples and to document possession are COC records, field log books, and field tracking forms. COC procedures will be used for all samples throughout the collection, transport, and analytical process as well as for all data and data documentation, whether in hard copy or electronic format.

COC procedures will be initiated during sample collection. A COC record will be provided with each sample or sample group (sample COC form provided in Appendix C). Each person who has custody of the samples will sign the form and ensure that the samples are not left unattended unless properly secured. Minimum documentation of sample handling and custody will include the following:

- Sample ID.
- Sample collection date and time.
- Any special notations on sample characteristics.
- Initials of the person collecting the sample.
- Date the sample was sent to the laboratory.
- Shipping company and waybill information.

The completed COC form will be placed in a sealable plastic envelope that will travel inside the ice chest containing the listed samples. The COC form will be signed by the person transferring custody of the samples. The condition of the samples will be recorded by the receiver. COC records will be included in the final analytical report prepared by the laboratory and will be considered an integral part of that report.

2.3 Bioassay Test Methods

2.3.1 Suspended-Particulate Phase Testing

SPP bioassay tests will be performed to estimate the potential impact of ocean disposal of dredged material to organisms that live in the water column. The elutriate used in the SPP test will be prepared by mixing project sediment from each composite with dredging-area site seawater in a 1:4 ratio by volume, vigorously agitating for 30 minutes, and then allowing to settle for approximately 1 hour at room temperature (16 to 18°C). Following settling, the supernatant will be gently decanted. This supernatant represents the 100% test concentration and is used in dilutions with clean seawater (Scripps Institute of Oceanography, filtered to 0.2 microns for the bivalve larvae test or 3 microns for the mysid shrimp and fish test) to create subsequent test concentrations for the SPP tests. Three species will be tested: the larvae of a bivalve (i.e., *M. galloprovincialis* or *Crassostrea gigas*), mysid shrimp (*A. bahia*), and inland silverside fish (*M. beryllina*).

The bivalve larvae test will be performed on the project sediment elutriates at 100, 50, 10, and 1% dilutions, a site water control, and a seawater control. This test will be conducted in accordance with procedures outlined in the OTM (USEPA and USACE, 1991), ITM (USEPA and USACE, 1998), and ASTM E724-98 (ASTM, 2008b). The test will be run for 48 hours, or longer if necessary, to ensure development of the bivalve larvae to the D-hinge stage in the control. At the termination of the study, survival will be compared between the control and test groups to determine if significant mortality exists. If bivalve larvae are not available (due to seasonal issues) an echinoderm development test will be run using either sea urchin *Strongylocentrotus purpuratus* or sand dollar *D. excentricus*. Test conditions for the bivalve SPP test are presented in Table 6.

Table 6. Test Conditions for the 48-Hour SPP Bioassay Using *Mytilus galloprovincialis*

Test Conditions **48-Hour SPP Bioassay**	
Sample ID	CT
Test species	***Mytilus galloprovincialis***
Test procedures	ITM (USEPA and USACE, 1998); OTM (USEPA/USACE, 1991); ASTM E724-98 (ASTM, 2008b)
Test type/duration	Bivalve Larvae – SPP / 48 hours
Control water	Scripps Pier seawater; 0.2 µm filtered, UV sterilized
Test temperature	Recommended: 16 ± 1°C
Test salinity	Recommended: 18–32 ± 1 ppt
Test dissolved oxygen (DO)	Recommended: > 60% saturation (equivalent to 5.3 mg/L*)
Test hydrogen ion concentration (pH)	Monitor for pH drift
Test total ammonia	No recommended concentration
Test un-ionized ammonia	No recommended concentration
Test photoperiod	16 hour light:8 hour dark
Test chamber	20-mL glass shell vials
Replicates/SPP concentration/treatment	5
SPP concentrations	100%, 50%, 10%, 1%
Organisms/replicate	Recommended: 15–30/mL
Exposure volume	10 mL
Feeding	None
Water renewal	None

***** Test salinity affects the conversion of DO. Since this test may be performed at a range of salinities, the most conservative value was used.

The shrimp and fish test will be performed on the project sediment elutriates at 100, 50, and 10% dilutions, a site water control, and a seawater control. These tests will be conducted in accordance with procedures outlined in the OTM (USEPA and USACE, 1991), and ITM (USEPA and USACE, 1998).The shrimp test will also be conducted in accordance with procedures outlined in ASTM E1463-92 (ASTM, 2008c). Ten animals will be used per replicate with five replicates per elutriate concentration. The test will be run for 96 hours under static conditions. If mortality in the control exceeds 10%, the test will be repeated. Test conditions for the shrimp and fish SPP tests are presented in Table 7 and Table 8, respectively.

Table 7. Test Conditions for the 96-Hour SPP Bioassay Using *Americamysis bahia*

Test Conditions **96-Hour SPP Bioassay**		
Sample ID		CT
Test species		***Americamysis bahia***
Test procedures		ITM (USEPA/USACE, 1998); OTM (USEPA/USACE, 1991); ASTM 1463-92 (ASTM, 2008c)
Test type/duration		Static - Acute SPP/96 Hours
Sample storage conditions		4°C, dark, minimal head space
Control water source		Scripps Pier seawater, 3 µm filtered, UV sterilized
Recommended Water Quality Parameters	Temperature	20 ± 1°C
	Salinity	25 - 30 ppt ± 10%
	DO	> 40% saturation (equivalent to 3.1 mg/L*)
	pH	Monitor for pH drift
	Total ammonia	No recommended concentration
	Un-ionized ammonia	No recommended concentration
Photoperiod		16 hours light: 8 hours dark
Test chamber		500 mL plastic beakers
Replicates/SPP concentration/sample		5
SPP concentrations		100%, 50%, 10%
No. of organisms/replicate		10
Exposure volume		250 mL
Feeding		~1,000 freshly hatched *Artemia* nauplii per replicate, twice daily
Water renewal		None

***** Test salinity affects the conversion of DO. Since this test may be performed at a range of salinities, the most conservative value was used.

Table 8. Test Conditions for the 96-Hour SPP Bioassay Using *Menidia beryllina*

Test Conditions 96-Hour SPP Bioassay		
Sample ID		CT
Test species		***Menidia beryllina***
Test procedures		ITM (USEPA/USACE, 1998); OTM (USEPA/USACE, 1991)
Test type/duration		Static - Acute SPP/96 Hours
Sample storage conditions		4°C, dark, minimal head space
Control water source		Scripps Pier seawater, 3 µm filtered, UV sterilized
Recommended water quality parameters	Temperature	20 ± 1°C
	Salinity	5–32 ppt ± 10%
	DO	> 40% saturation (equivalent to 3.5 mg/L*)
	pH	Monitor for pH drift
	Total ammonia	No recommended concentration
	Un-ionized ammonia	No recommended concentration
Photoperiod		16 hours light: 8 hours dark
Test chamber		1,000 mL plastic beakers
Replicates/SPP concentration/sample		5
SPP concentrations		100%, 50%, 10%
No. of organisms/replicate		10
Exposure volume		500 mL
Feeding		1,000 freshly hatched *Artemia* nauplii per replicate on Day 2
Water renewal		None

***** Test salinity affects the conversion of DO. Since this test may be performed at a range of salinities, the most conservative value was used.

If the calculated median lethal concentration (LC_{50}) estimate in any of the SPP tests is less than 100%, a 0.01 correction factor will be applied to the LC_{50} estimate and the short-term fate (STFATE) mixing zone model will be used to predict whether the concentration of dredged material in the water column would comply with the limiting permissible concentration (LPC) requirements described in the OTM (USEPA and USACE, 1991). The LPC is the concentration of dredged material elutriate that is equivalent to 1% of the median LC_{50} or median effective concentration (EC_{50}), 4 hours after disposal of the dredged material, either outside or within the disposal site. Compliance with LPC requirements indicates that there is no water column toxicity associated with dredged material disposal and therefore the material would be suitable for ocean disposal.

Daily water quality monitoring of test chambers will include pH, DO, salinity, and temperature. Ammonia will be analyzed at the start and end of the test in the 100% concentration. Measurements in other concentrations will only be performed if total ammonia in the 100% concentration is greater than 4 ppm. To evaluate the relative sensitivity of the organisms, reference toxicity tests will be performed using standard reference toxicants (Lee, 1980). An ammonia reference toxicant test will also be conducted to evaluate the potential effect of ammonia on the test organisms.

2.3.2 Solid Phase Testing

SP bioassays will be performed to estimate the potential impact of ocean disposal of dredged material on benthic organisms that attempt to re-colonize the area. Project sediment will be tested in 10-day SP tests using two species: an amphipod species (*Ampelisca abdita or Rhepoxynius abronius*, dependent on grain size) and a polychaete (*Neanthes arenaceodentata*). The most appropriate amphipod species cannot be selected until grain size and ammonia concentrations are known. Specifically, if the sediment is primarily fine-grained, then *Ampelisca abdita* will be chosen as the test species because it is more tolerant to fine-grained material. However, if the sediment is primarily coarse-grained, then *Rhepoxynius abronius* will be chosen as the test species because it is more tolerant to a wide range of sediment grain size characteristics. Amphipod tests will be conducted in accordance with procedures described in Appendix E of the ITM (USEPA and USACE, 1998), and ASTM Standard E1367-99 (ASTM, 2003). Tests with the polychaete will be conducted in accordance with procedures outlined in the ITM (USEPA and USACE, 1998). Toxicity test experimental design and water quality measures are provided in Table 9 for the amphipod test and Table 10 for the polychaete test. Sediment will be sieved for all test, reference and control materials prior to solid phase testing. Each sediment type (i.e., test, references, and control) will be performed with five replicates containing 20 organisms per test chamber for the amphipod test, and 10 organisms per test chamber for the polychaete test. Control sediment will be provided by the supplier.

Table 9. Test Conditions for the 10-Day Solid Phase Bioassay with *Ampelisca abdita*

Test Conditions **10-Day SP Bioassay**		
	Sample ID	CT, Reference
	Test species	***Ampelisca abdita (or Rhepoxynius abronius)***
	Test procedures	ITM (USEPA/USACE, 1998); OTM (USEPA/USACE, 1991); USEPA (1994); ASTM E1367-03 (ASTM, 2008a)
	Test type/duration	Static - Acute SP/10 days
	Sample storage conditions	4°C, dark, minimal head space
	Control water source	Scripps Pier seawater, 3 µm filtered, UV sterilized
Recommended water quality parameters	Temperature	20 ± 2°C
	Salinity	28 ± 2 ppt
	DO	> 60% saturation (equivalent to 4.6 mg/L)
	pH	Monitor for pH drift
	Overlying total ammonia	No recommended concentration
	Overlying un-ionized ammonia	No recommended concentration
	Interstitial total ammonia	< 30 mg/L
	Interstitial un-ionized ammonia	< 0.4 mg/L
	Photoperiod	Continuous light
	Test chamber	1 L glass jars
	Replicates/sample	5
	No. of organisms/replicate	20
	Exposure volume	2 cm sediment, 800 mL water
	Feeding	None
	Water renewal	None

Table 10. Toxicity Test Conditions for the 10-Day Solid Phase Test Using *Neanthes arenaceodentata*

Test Conditions		
10-Day SP Bioassay		
Sample ID		CT, Reference
Test species		***Neanthes arenaceodentata***
Test procedures		ITM (USEPA/USACE, 1998); OTM (USEPA/USACE, 1991); ASTM E1611-00 (ASTM, 2008d)
Test type/duration		Static - Acute SP/10 days
Sample storage conditions		4°C, dark, minimal head space
Control water source		Scripps Pier seawater, 3 µm filtered, UV sterilized
Recommended water quality parameters	Temperature	20 ± 1°C
	Salinity	28 ± 2 ppt
	DO	> 60% saturation (equivalent to 4.6 mg/L)
	pH	Monitor for pH drift
	Overlying total ammonia	No recommended concentration
	Overlying un-ionized ammonia	No recommended concentration
	Interstitial total ammonia	No recommended concentration
	Interstitial un-ionized ammonia	No recommended concentration
Photoperiod		12 hours light: 12 hours dark
Test chamber		1 L glass jars
Replicates/sample		5
No. of Organisms/replicate		10
Exposure volume		2.0 cm sediment, 800 mL water
Feeding		None
Water renewal		None

Test organisms will be exposed to the sediment for ten days in 1-L glass test chambers with 2 cm of sediment and 750 mL of overlying seawater from Scripps Institution of Oceanography, La Jolla, California. Tests will be run as static non-renewal if ammonia concentrations are below species specific criteria. If ammonia concentrations are above criteria, tests will be run as static renewal with no more than two water changes per day; these tests will be initiated once the ammonia concentrations are brought down to levels appropriate for each test species. Pore water ammonia, temperature, pH, and salinity will be measured at test initiation and termination. Daily water quality measurements will be collected from one replicate for each treatment for pore water and overlying ammonia, salinity, temperature, DO, pH, and flow rate. Daily observations of obvious mortality, sublethal effects and abnormal behavior will be recorded. To evaluate the relative sensitivity of the organisms, reference toxicity tests will be performed using standard reference toxicants (Lee, 1980). An ammonia reference toxicant test will also be conducted in parallel with the test dredged materials to evaluate the potential effect of ammonia on the test organisms. A final determination of survival will be determined at test termination. If the mean control survival is below 90% in any test, the test will be repeated.

2.3.3 Bioaccumulation Potential Testing

Assessment of BP will be carried out using the polychaete worm *Nereis virens* and the bivalve *Macoma nasuta* over a 28-day test period. BP tests will be conducted in accordance with those procedures outlined in *Guidance Manual: Bedded Sediment Bioaccumulation Tests* (USEPA, 1993), Appendix E of the ITM (USEPA and USACE, 1998), and ASTM method E1688-00 (ASTM, 2006). Additional *Nereis virens* (n=25) and *Macoma nasuta* (n=30) will be used in BP tests such that there is sufficient material for tissue chemical analyses, in the event of low survival. In addition to the preparation of sediment described here, organisms used in BP tests will be fed for several days prior to testing to ensure that organisms are in good health before test initiation.

Toxicity test conditions are provided in Table 11. For each species, five replicates with 20 individuals are required for the test and reference sediment and three replicates with 20 individuals are required for the control sediment. The test chambers will be maintained under flow-through conditions with clean seawater from North Hood Canal, Washington. Daily water quality measurements will be collected from one chamber for salinity, temperature, DO, pH, and flow rate. Daily observations of obvious mortality, sublethal effects and abnormal behavior will be recorded. To evaluate the relative sensitivity of the organisms, reference toxicity tests will be performed using standard reference toxicants (Lee, 1980). At test initiation, three pre-test tissue samples will be collected to determine initial tissue concentrations. On Day 28, the sediment will be sieved to remove the worms and clams, surviving animals. Prior to tissue analysis for time zero and all test treatments all organisms will be placed in clean flow-through aquaria to purge their gut contents for 24 hours and tissues will be frozen. Tissues will then be sent to the chemistry laboratory for tissue analysis. If mortality exceeds 10% in control sediment, then the QC factors listed in the RGM will be addressed to assist regulators in their determination of whether it is necessary to rerun this test. Specifically, it will be determined whether there are adequate replicates to obtain sufficient power to detect differences among treatments, if there is adequate tissue for chemical analyses, whether the organisms were stressed during the test, if there was contamination in the flow-through system or control sediment during the test, and if there were any other QC issues during the test.

Table 11. Test Conditions for the 28-Day Flow-Through Bioassay Using *N. virens* and *M. nasuta*

Test Conditions	
Sample ID	CT, Reference
Age class	adult
Test procedures	ITM (USEPA/USACE, 1998), ASTM (2006), USEPA (1993)
Test location	WESTON Port Gamble, WA
Test type/duration	Flow through / 28 days
Control water	North Hood Canal
Test temperature	*N. virens* 20° ± 2°C; *M. nasuta* 12-14°C
Test salinity	30 ± 2 ppt
Test DO	>60% saturation
Test pH	7.8 ± 0.5
Test photoperiod	16 hours light: 8 hours dark
Test chamber	37 L
Replicates/treatment	5 reference, 5 test, and 3 control
Organisms/replicate	≥20
Exposure volume	≥ 5 cm depth of sediment; up to 11 cm of sediment/tank for high silt content.
Feeding	None
Water renewal	Flow-through (Total of 6 volume exchanges per day)
Test acceptability criteria	≥90% survival in controls, if below 90% discussion with regulators is required to determine if a rerun is necessary.

2.3.4 Effluent Elutriate SPP Test (*Mytilus galloprovincialis)*

An effluent elutriate (i.e., modified elutriate) SPP test will be conducted with *M. galloprovincialis* to evaluate the toxicity of the water discharged as effluent from a confined disposal facility. Effluent elutriates will be prepared from project sediment composites in accordance with procedures outlined in Appendix B.3 of the Upland Testing Manual (UTM; USACE, 2003). Specifically, effluent elutriates will be prepared from a slurry of sediment and dredging site water at a concentration of 150 g/L (dry weight basis). The mixture will be blended thoroughly for five minutes to a homogenous consistency, aerated vigorously for one hour, and then allowed to settle for up to 24 hours. The supernatant will be siphoned off and used as the test medium in a bivalve development SPP test with *M. galloprovincialis*. This supernatant represents the 100% test concentration and is used in dilutions with clean seawater (Scripps Institute of Oceanography, filtered to 0.2 microns for the bivalve larvae test or 3 microns for the mysid shrimp and fish test) to create subsequent test concentrations for the SPP tests. The bivalve development test will be performed on the project sediment elutriates at 100, 50, 10, and 1% dilutions, a site water control, and a seawater control. This test will be conducted in accordance with procedures outlined in the OTM (USEPA and USACE, 1991), ITM (USEPA and USACE, 1998), and ASTM E724-98 (ASTM, 2008b). Test conditions for the effluent elutriate SPP test are the same as those used for the SPP test described above (which uses a standard elutriate as the test medium), and are presented in Table 6.

2.3.5 Seawater for Bioassay Testing

Seawater used in this study, including the flow-through studies, will come from either Scripps Institution of Oceanography at La Jolla, California, or from the North Hood Canal, Washington. These seawater sources have been used successfully on similar bioassay testing programs by the contracting team. Extensive testing on a variety of test species has shown that there is no significant potential for toxicity or bioaccumulation from these water supplies. High survival of organisms in control sediment has been achieved consistently in previous dredged material testing conducted by participating team laboratories.

2.3.6 Quality Assurance / Quality Control

The QA objectives for toxicity testing conducted by participating team laboratories are those detailed in the OTM (USEPA and USACE, 1991), team laboratories' quality assurance plans (QAPs), and Moore et al. (1994). These objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Water and sediment sampling and handling.
- Source and condition of test organisms.
- Condition of equipment.
- Test conditions.
- Instrument calibration.
- Use of reference toxicants.
- Record keeping.
- Data evaluation.

Each test organism will be evaluated in reference toxicant tests during the test period to establish the sensitivity of the test organisms. The reference toxicant LC_{50} or EC_{50} should fall within two standard deviations of the historical laboratory mean. Water quality measurements will be monitored to ensure that they fall within prescribed limits and corrective actions (USEPA-recommended) will be taken if necessary. All limits established for this program meet or exceed those recommended by USEPA.

The methods employed in every phase of the toxicity testing program are detailed in WESTON's Standard Operating Procedures (SOPs). These SOPs have been audited and approved by an independent, USEPA-recommended laboratory and placed in the QA files and the laboratory files. All WESTON staff members receive regular, documented training in all SOPs and test methods.

Finally, all data collected and produced as a result of these analyses will be recorded on approved data sheets, which will become part of the permanent data record of the program. If any aspect of a test deviates from protocol, the test will be evaluated to determine whether it is valid according to the regulatory agencies responsible for approval of the proposed permitting action.

2.4 Physical and Chemical Analysis

Physical and chemical measurements of sediment in this testing program were selected to provide data on regional contaminants of potential concern in the project samples. All analytical methods used to obtain contaminant concentrations will follow USEPA or Standard Methods (SMs). The specific sediment analyses and target detection limits are specified in Table 12.

2.4.1 Physical Analyses

To characterize the physical properties of the sediment, tests will be performed to predict the behavior of sediment after disposal and to compare reference and project sediment. Physical analyses of the sediment will include grain size, specific gravity, and total solids. Grain size is analyzed to determine the general size classes that make up the sediment (e.g., gravel, sand, silt, and clay). The frequency distribution of the size ranges (reported in mm) of the sediment will be reported in the final data report. Grain size will be conducted using the gravimetric procedure described in Plumb (1981). Specific gravity will be measured using SM 2710F (APHA, 1998). Total solids will also be measured to convert concentrations of the chemical parameters from a wet-weight to a dry-weight basis. Percent solids will be determined by SM 2540G (APHA, 1998). Atterberg Limits will be determined by ASTM D4318 (ASTM, 2005).

2.4.2 Chemical Analyses

2.4.2.1 Bulk Sediment

Project and reference sediments will be analyzed for the chemicals indicated in Table 12 with the target detection limits (sediment – dry weight). In order to meet the minimum detection limit specified in the ITM (USEPA and USACE, 1998), all analytical methods used to obtain contaminant concentrations follow USEPA or SM and are the same or equivalent to the methods recommended in the ITM.

To minimize salt interference, the following analyses will be performed as recommended by the OTM (USEPA and USACE, 1991). The analysis for priority pollutant metals (except mercury) will be conducted using an inductively coupled plasma emissions spectrometer equipped with a mass detector (ICP-MS), in accordance with USEPA 6020m. Mercury analysis will be conducted using cold vapor atomic fluorescence spectrophotometry (CVAFS) in accordance with USEPA 245.7m. The analysis for total and dissolved sulfides will follow procedures described in Plumb (1981). The analysis for dissolved ammonia will follow SM 4500-NH3F. Oil and grease and TRPH will be measured using USEPA 1664A[3].

TOC, made up of volatile and nonvolatile organic compounds, will be determined using the Lloyd Kahn method (USEPA Region II, 1988). This procedure involves dissolving inorganic carbon (carbonates and

[3] This recommended method includes a silica gel clean up procedure and is being used in lieu of SM 5520E.

bicarbonates) with hydrochloric acid or sulfuric acid prior to TOC analysis using USEPA 9060A.Total volatile solids will be analyzed using SM 2540E. Acid extractable compounds and semi-volatile organic compounds (SVOCs) including PAHs, phthalates, and phenols, chlorinated pesticides, and PCBs, will be analyzed using gas chromatography-mass spectrometry (GC-MS) with selective ion monitoring (SIM) according to USEPA Method 8270m. This method will follow serial extraction with methylene chloride and alumina and gel permeation column cleanup procedures. PCBs will be identified as Aroclors and individual congeners, separately. Tributyltin (TBT) and its derivatives will be analyzed by GC-MS according to Krone et al. (1989), following a cleanup procedure involving methylene chloride extraction and Grignard derivatization.

2.4.2.2 Comparison of Results to Sediment Quality Guidelines and Regulatory Levels

Results of chemical analyses of project material will be compared to effects range-low (ER-L) and effects range-median (ER-M) values developed by Long et al. (1995). The effects range values are helpful in assessing the potential significance of elevated sediment-associated contaminants of concern, 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 assessments) and chemical concentrations 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 10^{th} percentile of this rank order distribution was identified as the ER-L and the 50^{th} percentile as the ER-M. 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 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 are greater than the ER-L, ER-M, or method detection limits (MDLs) would not require re-analysis.

Results of chemical analyses of project material will be compared to the corresponding total threshold limit concentration (TTLC). The TTLC for each analyte indicates the level above which material must be managed as hazardous waste upon removal, in accordance with the Title 40 CFR part 261 and Title 22 of the California Code of Regulations (CCR).

2.4.2.3 TCLP

As outlined in the tiered approach above (Section 2.1.1), TCLP testing will be performed on sediment samples that do not meet acceptability criteria for ocean disposal. TCLP testing will be performed using USEPA Method 1311. This test provides an estimate of the sediment contaminant leachate, to determine if this material is suitable for upland placement under the Federal Resource Conservation and Recovery Act (RCRA). Analytes leaching from the sediment will be compared to the State of California Department of Health (CDOH) Office of Solid Waste Management (OSWM) toxicity characteristic standards (§11-261-24) and USEPA Title 40 Code of Federal Regulations (CFR) Part 261 values (USEPA, 2006). Analytes, analytical methods, and MDLs are presented in Table 13.

2.4.2.4 STLC

STLC will be conducted on archived samples only if sediment chemistry results are 10 or more times greater than the STLC limits outlined in Title 26 of the CCR. In this waste extraction test, a sediment sample is tumbled in 10 times its weight of a 0.2M sodium citrate buffer for 48 hours. The resulting leachate is then analyzed to determine the soluble concentrations.

2.4.3 Bioaccumulation Tissue Chemistry

Tissue analysis will be performed to determine the availability of sediment contaminants taken up by the test organisms. Tissue analysis (including pre-exposure samples) will be carried out for those constituents listed in Table 12 and will include the determination of lipids by gravimetric analysis using the Bligh and Dwyer method (Bligh and Dwyer, 1959). Tissue composites from each replicate will be analyzed separately.

2.4.4 Quality Assurance / Quality Control

The QA objectives for chemical analysis conducted by the participating analytical laboratories are detailed in their Laboratory QA Manual(s). These objectives for accuracy and precision involve all aspects of the testing process, including the following:

- Methods and SOPs.
- Calibration methods and frequency.
- Data analysis, validation, and reporting.
- Internal QC.
- Preventive maintenance.
- Procedures to ensure data accuracy and completeness.

Results of all laboratory QC analyses will be reported with the final data. Any QC samples that fail to meet the specified QC criteria in the methodology or QAP will be identified, and the corresponding data will be appropriately qualified in the final report.

All QA/QC records for the various testing programs will be kept on file for review by regulatory agency personnel.

Table 12. Chemical and Physical Parameters, Analytical Methods, and Target Detection Limits

Parameter	Method	Procedure	Sediment Target Detection Limit (dry weight)	Tissue Target Detection Limit (wet weight)
Physical / Conventional Tests				
Grain size	Plumb (1981)	Sieve/Pipette	1.0%	n/a
Specific gravity	SM 2710F	Gravimetric	0.001 g/cc	n/a
Atterberg limits	ASTM D4318	Wet Preparation	1%	n/a
TOC	EPA 9060A	Combustion IR	0.01%	n/a
Percent solids	SM 2540G	Gravimetric	0.1%	n/a
Percent volatile solids	SM 2540E	Gravimetric	0.1%	n/a
Ammonia	SM 4500-NH3F	ICP-MS	0.01 mg/L	n/a
Total sulfides	Plumb (1981)	Titrametric	0.05 mg/L	n/a
Dissolved sulfides	Plumb (1981)	Titrametric	0.01 mg/L	n/a
Oil and grease	EPA 1664A	Gravimetric	2%	n/a
TRPH	EPA 1664A	IR Spectroscopy	0.1%	n/a
Lipids	Gravimetric	Gravimetric	n/a	0.01%
Metals				
Arsenic (As)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Cadmium (Cd)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Chromium (Cr)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Copper (Cu)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Lead (Pb)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Mercury (Hg)	USEPA 245.7m	CVAFS	0.01 mg/kg	0.01 mg/kg
Silver (Ag)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Selenium (Se)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Nickel (Ni)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Zinc (Zn)	USEPA 6020m	ICP-MS	0.025 mg/kg	0.025 mg/kg
Pesticides				
2,4′ DDD	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
2,4′-DDE	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
2,4′-DDT	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
4,4′ DDD	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
4,4′-DDE	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
4,4′-DDT	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Aldrin	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
α-BHC	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
β-BHC	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Chlordane and derivatives	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
δ-BHC	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Dieldrin	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Endosulfan I	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Endosulfan II	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Endosulfan sulfate	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Endrin	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Endrin aldehyde	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Heptachlor	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Endrin ketone	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Heptachlor epoxide	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
γ-BHC	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Methoxychlor	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Toxaphene	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
PCBs				
Aroclor 1016	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
Aroclor 1221	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
Aroclor 1232	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
Aroclor 1242	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
Aroclor 1248	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
Aroclor 1254	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
Aroclor 1260	USEPA 8270Cm	GC/MS SIM	10 µg/kg	10 µg/kg
PCB congeners	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Semivolatile Organics				
2,4-dimethylphenol	USEPA 8270Cm	GC/MS SIM	100 µg/kg	10 µg/kg
2,4,6-trichlorophenol	USEPA 8270Cm	GC/MS SIM	50 µg/kg	10 µg/kg

Parameter	Method	Procedure	Sediment Target Detection Limit (dry weight)	Tissue Target Detection Limit (wet weight)
2-chlorophenol	USEPA 8270Cm	GC/MS SIM	50 µg/kg	10 µg/kg
2,4-dichlorophenol	USEPA 8270Cm	GC/MS SIM	50 µg/kg	10 µg/kg
2-nitrophenol	USEPA 8270Cm	GC/MS SIM	100 µg/kg	10 µg/kg
4-nitrophenol	USEPA 8270Cm	GC/MS SIM	100 µg/kg	10 µg/kg
4-methylphenol	USEPA 8270Cm	GC/MS SIM	100 µg/kg	10 µg/kg
4,6-dinitro-2-methylphenol	USEPA 8270Cm	GC/MS SIM	100 µg/kg	10 µg/kg
2,4-dinitrophenol	USEPA 8270Cm	GC/MS SIM	100 µg/kg	10 µg/kg
Pentachlorophenol	USEPA 8270Cm	GC/MS SIM	50 µg/kg	10 µg/kg
Naphthalene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	10 µg/kg
Total phthalates	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Bis (2-ethylhexyl) phthalate (66)	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Butyl benzyl phthalate (67)	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Di-n-butylbenzyl phthalate (67)	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Diethyl phthalate (70)	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Dimethyl phthalate (71)	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Di-n-octyl phthalate(69)	USEPA 8270Cm	GC/MS SIM	0.01 mg/kg	0.01 mg/kg
Acenaphthylene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Acenaphthene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Fluorene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Phenanthrene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Anthracene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Fluoranthene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Pyrene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Chrysene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Benzo(a)anthracene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Benzo(b)fluoranthene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Benzo(a)pyrene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Indeno(1,2,3-cd)pyrene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Dibenzo(a,h)anthracene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Benzo(g,h,i)perylene	USEPA 8270Cm	GC/MS SIM	1 µg/kg	1 µg/kg
Organotins				
Monobutyltin	Krone et al. (1989)	GC/MS	1 µg/kg	1 µg/kg
Dibutyltin	Krone et al. (1989)	GC/MS	1 µg/kg	1 µg/kg
TBT	Krone et al. (1989)	GC/MS	1 µg/kg	1 µg/kg
Tetrabutyltin	Krone et al. (1989)	GC/MS	0.001 mg/kg	0.001 mg/kg

* Detection limit may vary significantly based on sample; therefore, reporting limits are presented in this table.
% percent
ng/kg nanogram per kilogram
µg/kg microgram per kilogram
mg/L milligram per liter
g/cc gram per cubic centimeter
n/a not applicable
DDT dichlorodiphenyltrichloroethane
SIM selected ion monitoring
TEQ toxic equivalent

Table 13. Chemical Analytes, Analytical Methods, and Target Detection Limits for Toxicity Characteristic Leaching Procedure

Analyte	Method	Procedure	Leachate Target Detection Limit (wet weight)
TCLP Metals			
Arsenic (As)	USEPA 200.8(m)	ICP-MS	0.2 µg/L
Cadmium (Cd)	USEPA 200.8(m)	ICP-MS	0.2 µg/L
Chromium (Cr)	USEPA 200.8(m)	ICP-MS	0.1 µg/L
Lead (Pb)	USEPA 200.8(m)	ICP-MS	0.05 µg/L
Nickel (Ni)	USEPA 200.8(m)	ICP-MS	0.2 µg/L
Mercury (Hg)	USEPA 245.7m	CVAFS	0.01 µg/L
TCLP Semivolatile Organics			
2,4,6-trichlorophenol	USEPA625(m)	GC/MS SIM	0.05 µg/L
2,4-dichlorophenol	USEPA625(m)	GC/MS SIM	0.05 µg/L
Pentachlorophenol	USEPA625(m)	GC/MS SIM	0.05 µg/L
TCLP Pesticides			
Aldrin	USEPA625(m)	GC/MS SIM	0.001 µg/L
γ-BHC	USEPA625(m)	GC/MS SIM	0.001 µg/L
Chlordane (Total)	USEPA625(m)	GC/MS SIM	0.001 µg/L
Dieldrin	USEPA625(m)	GC/MS SIM	0.001 µg/L
Endrin	USEPA625(m)	GC/MS SIM	0.001 µg/L
Heptachlor	USEPA625(m)	GC/MS SIM	0.001 µg/L
Heptachlor epoxide	USEPA625(m)	GC/MS SIM	0.001 µg/L
Methoxychlor	USEPA625(m)	GC/MS SIM	0.001 µg/L
Toxaphene	USEPA625(m)	GC/MS SIM	0.010 µg/L
Total detectable DDTs	USEPA625(m)	GC/MS SIM	0.001 µg/L
TCLP PCBs			
Total detectable PCBs	USEPA625(m)	GC/MS SIM	0.001 µg/L

2.5 Data Review, Management, and Analysis

2.5.1 Data Review

All data will be reviewed and verified by participating team laboratories to determine whether all data quality objectives have been met, and that appropriate corrective actions have been taken, when necessary. WESTON's QA Officer (Lin Craft) will be responsible for the final review of all data generated.

2.5.2 Data Management

All laboratories will supply analytical results in both hard copy and electronic formats. Laboratories will have the responsibility of ensuring that both forms are accurate. After completion of the sediment data review by participating team laboratories, hard copy results will be placed in the project file at WESTON and the results in electronic format will be imported into WESTON's database system.

2.5.3 Data Analysis

Data analysis will consist of tabulation and comparison with regulatory guidelines. Chemistry data for sediment will be compared to the LA-2 approved reference site. Biological results will be compared to appropriate laboratory controls and reference (LA-2 approved reference site) results where applicable as designated in the OTM (USEPA and USACE, 1991).

2.6 Reporting

2.6.1 Draft and Final Reports

After all results are received, statistical analyses completed, and all evaluations made, WESTON will prepare draft and final reports. These will include summaries of all activities associated with collecting, compositing, transporting, and chemically and biologically analyzing sediment samples. The chemical and biological data reports will be included as appendices. As a minimum, the following will be included in the final report:

- Summary of all field activities, including a description of any deviations from the approved sampling and analysis plan (SAP) and QAP.
- Descriptions of each sample and all original core logs.
- Locations of sediment sampling stations, reported in latitude and longitude (DD MM.MMMM) WGS 84.
- Plan view of the project showing the actual sampling locations.
- Final QA/QC report, as described in Section 2.6.2.
- Data Results—In addition to hard copies of field data, laboratory analysis results, and associated QA/QC data, electronic copies for all data will be stored at WESTON.
- Evaluation of all potential disposal options

2.6.2 Quality Assurance / Quality Control and Laboratory Data Report

Analytical laboratories will provide a QA/QC narrative that describes the results of the standard QA/QC protocols that accompany analysis of field samples. WESTON's QAP details these protocols. All hard copies of results will be maintained in the project file at WESTON in Carlsbad and included in the final report. In addition, back-up copies of results generated by each laboratory will be maintained at their respective facilities. At a minimum, the laboratory reports will contain results of the laboratory analysis, QA/QC results, all protocols and any deviations from the project SAP and QAP, and a case narrative of COC details.

2.7 Project Management and Team Responsibilities

2.7.1 Project Management

Mr. Remco Buis will serve as the point of contact for Carnival for this project. Dr. Shelly Anghera and Dr. Wendy Hovel will be the Project Managers for WESTON and Mr. Milind Desai will be the Project Manager for CH2M Hill. They will provide oversight for project planning and implementation as well as coordination with Carnival. They will also provide technical consulting and coordination with USEPA or USACE and ensure that project goals, budgets, and schedules are met. Mr. Brian Riley of WESTON will serve as the Field Operation Project Manager. He will coordinate team efforts and will provide oversight for all field activities. Ms. Lin Craft of WESTON will serve as the Quality Assurance (QA) / Quality Control (QC) Officer and will be responsible for adherence to QA/QC requirements specified for collection, handling, and analyses. Ms. Sheila Holt of WESTON will provide QA/QC review of all chemical data and will interact with the analytical laboratories. Additional POC information for Carnival and participating team member laboratories is provided in Appendix A.

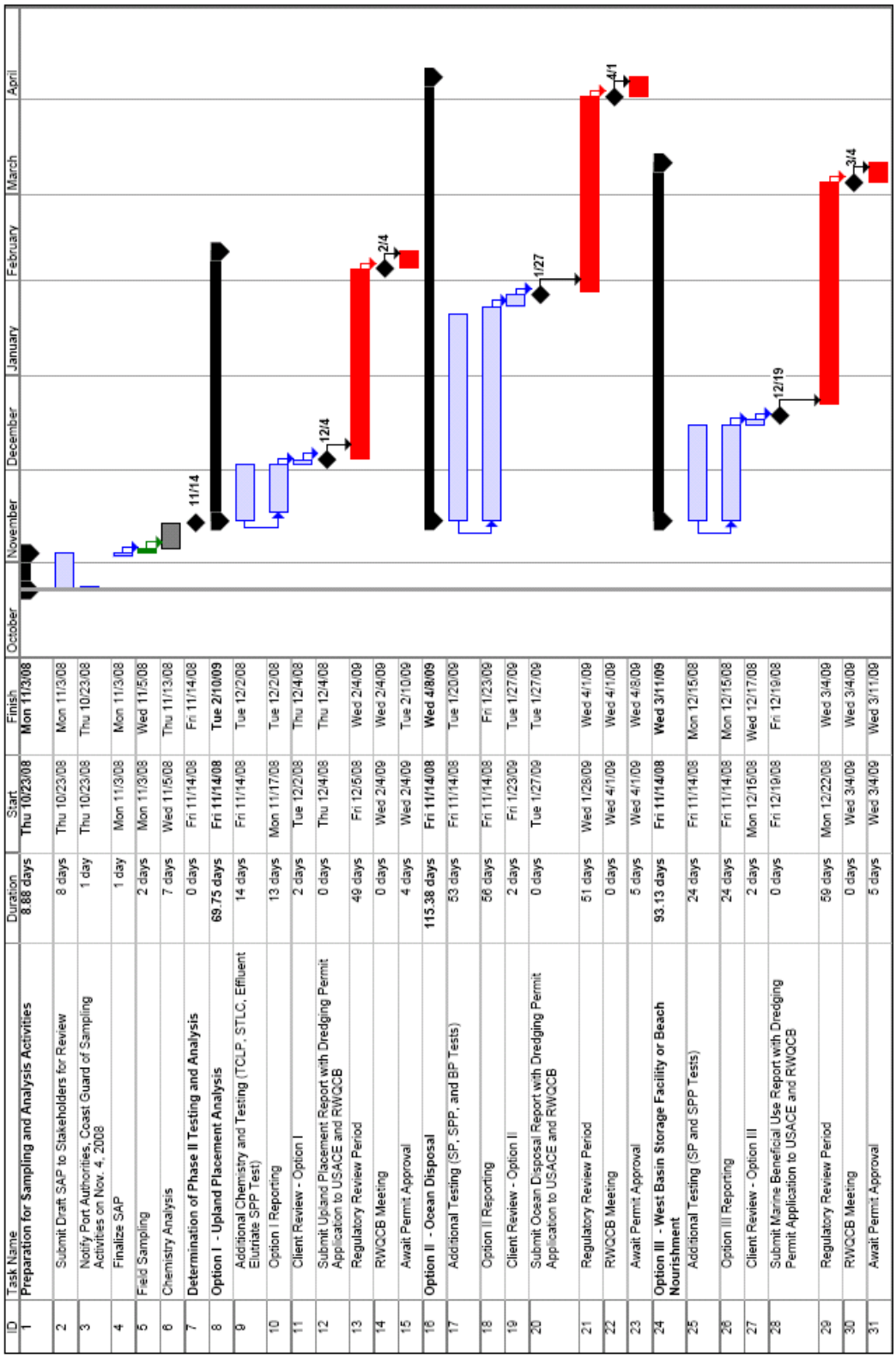
2.7.2 Team Responsibilities

In addition to conducting the field sampling, WESTON will coordinate all field logistics, including contacting the Port and Coast Guard prior to sampling.. Seaventures will provide the research vessel for vibracore sampling and WESTON will provide sampling equipment necessary to collect core samples to

the project depth. Analytical chemistry for sediment and tissues will be provided by CRG Marine Laboratories, Inc. (CRG) of Torrance, California. WESTON's Carlsbad laboratory will perform biological testing for SP and SPP tests as well as grain size and specific gravity analyses. NewFields *Northwest*, LLC will perform BP tests. WESTON will review all analytical data, will perform all data analyses, and will produce the final reports with review and approval by Carnival.

2.8 Schedule

Scheduling of proposed activities will be dependent on final approval of the SAP. Once initiated, field sampling activities are anticipated to take approximately two days. Upon completion of the field sampling effort, chemical analysis of dredged material will be completed in approximately seven days.. After receipt of chemical analyses, the Carnival project manager will be contacted to discuss continuation of biological and chemical testing. Based on analytical chemistry results, WESTON in consultation with CH2M Hill and Carnival will initiate the appropriate Phase II testing program within 3 weeks of sampling. Once all data have been collected and undergone QA/QC review, a draft report will be prepared (Figure 5).



ID	Task Name	Duration	Start	Finish
1	**Preparation for Sampling and Analysis Activities**	**8.88 days**	**Thu 10/23/08**	**Mon 11/3/08**
2	Submit Draft SAP to Stakeholders for Review	8 days	Thu 10/23/08	Mon 11/3/08
3	Notify Port Authorities, Coast Guard of Sampling Activities on Nov. 4, 2008	1 day	Thu 10/23/08	Thu 10/23/08
4	Finalize SAP	1 day	Mon 11/3/08	Mon 11/3/08
5	Field Sampling	2 days	Mon 11/3/08	Wed 11/5/08
6	Chemistry Analysis	7 days	Wed 11/5/08	Thu 11/13/08
7	**Determination of Phase II Testing and Analysis**	0 days	Fri 11/14/08	Fri 11/14/08
8	**Option I - Upland Placement Analysis**	**69.75 days**	**Fri 11/14/08**	**Tue 2/10/09**
9	Additional Chemistry and Testing (TCLP, STLC, Effluent Elutriate SPP Test)	14 days	Fri 11/14/08	Tue 12/2/08
10	Option I Reporting	13 days	Mon 11/17/08	Tue 12/2/08
11	Client Review - Option I	2 days	Tue 12/2/08	Thu 12/4/08
12	Submit Upland Placement Report with Dredging Permit Application to USACE and RWQCB	0 days	Thu 12/4/08	Thu 12/4/08
13	Regulatory Review Period	49 days	Fri 12/5/08	Wed 2/4/09
14	RWQCB Meeting	0 days	Wed 2/4/09	Wed 2/4/09
15	Await Permit Approval	4 days	Wed 2/4/09	Tue 2/10/09
16	**Option II - Ocean Disposal**	**115.38 days**	**Fri 11/14/08**	**Wed 4/8/09**
17	Additional Testing (SP, SPP, and BP Tests)	53 days	Fri 11/14/08	Tue 1/20/09
18	Option II Reporting	56 days	Fri 11/14/08	Fri 1/23/09
19	Client Review - Option II	2 days	Fri 1/23/09	Tue 1/27/09
20	Submit Ocean Disposal Report with Dredging Permit Application to USACE and RWQCB	0 days	Tue 1/27/09	Tue 1/27/09
21	Regulatory Review Period	51 days	Wed 1/28/09	Wed 4/1/09
22	RWQCB Meeting	0 days	Wed 4/1/09	Wed 4/1/09
23	Await Permit Approval	5 days	Wed 4/1/09	Wed 4/8/09
24	**Option III - West Basin Storage Facility or Beach Nourishment**	**93.13 days**	**Fri 11/14/08**	**Wed 3/11/09**
25	Additional Testing (SP and SPP Tests)	24 days	Fri 11/14/08	Mon 12/15/08
26	Option III Reporting	24 days	Fri 11/14/08	Mon 12/15/08
27	Client Review - Option III	2 days	Mon 12/15/08	Wed 12/17/08
28	Submit Marine Beneficial Use Report with Dredging Permit Application to USACE and RWQCB	0 days	Fri 12/19/08	Fri 12/19/08
29	Regulatory Review Period	59 days	Mon 12/22/08	Wed 3/4/09
30	RWQCB Meeting	0 days	Wed 3/4/09	Wed 3/4/09
31	Await Permit Approval	5 days	Wed 3/4/09	Wed 3/11/09

Red Bars Indicate Tasks Involving Regulatory Review That Are Outside of WESTON's control

Figure 5. Project Schedule

3.0 REFERENCES

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Plumb, R.H., Jr. 1981. Procedure for Handling and Chemical Analysis of Sediment and Water Samples. Technical Report EPA/CE-81-1. U.S. Army Waterways Experimental Station, Vicksburg, MS.

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Appendix A
Point-of-Contact Information

Organization	Point of Contact	Address	Phone/FAX	E-mail
Carnival Corporation & PLC	Mr. Remco Buis	Carnival Corporation & PLC 231 Windsor Way Long Beach, CA 90802	(562) 901-3232	rbuis@carnival.com
CH2M Hill	Mr. Milind Desai	CH2M Hill 3 Hutton Centre Drive, Suite 200 Santa Ana, CA 92707	(714) 435-6203	milind.desai@ch2m.com
Weston Solutions, Inc.	Dr. Shelly Anghera Dr. Wendy Hovel Mr. Brian Riley	Weston Solutions, Inc. 2433 Impala Drive Carlsbad, CA 92010	(760) 795-6901 (760) 931-1580	Shelly.anghera@westonsolutions.com Wendy.Hovel@westonsolutions.com Brian.Riley@westonsolutions.com
NewFields Northwest, LLC	Dr. Jack Word	NewFields Northwest, LLC PO Box 216, 4729 NE View Drive Port Gamble, WA 98364	(360) 297-6068	jdword@newfields.com
CRG Marine Laboratories	Mr. Rich Gossett	CRG Marine Laboratories 2020 Del Amo Blvd., Suite 200 Torrance, CA 90501	(310) 533-5190 (310) 533-5003	rgossett@crglabs.com

Appendix B
Field Core Log

WESTON SOLUTIONS

SOIL AND SEDIMENT CORING LOG

PROJECT/SURVEY	DATE	PROJECT MANAGER	RECORDER

STATION ID	NAV DATUM	LATITUDE	LONGITUDE
	WGS 84		

WATER DEPTH (FT)	TIDE (FT)	MLLW (FT) = WATER DEPTH - TIDE	SAP DEPTH (FT)
NA	NA	NA	

TARGET CORE LENGTH (FT) (SAP DEPTH -	FINAL CORE LENGTH (FT)	PENETRATION (FT)	CORE LENGTH COLLECTED FOR ANALYSIS (

CORE DIAMETER (IN)	ATTEMPT	TIME STARTED	TIME FINISHED
	of		

PEN. DEP.(FT)	RETRV. DEP.(FT)	SUBSTRATE TYPE	ODOR	COLOR (HUE_VALUE/CHROMA)	SAMPLE ID BY DEPTH	MISC
1	1					
2	2					
3	3					
4	4					
5	5					
6	6					
7	7					
8	8					
9	9					
10	10					
11	11					
12	12					
13	13					
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22	22					
23	23					
24	24					
25	25					

NOTES

Appendix C
Chain-of-Custody Form

WESTON SOLUTIONS

☐ 2433 Impala Drive • Carlsbad, CA 92010 • (760) 795-6900, FAX 931-1580
☐ 1440 Broadway, Ste. 910 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710

CHAIN OF CUSTODY
1760

DATE_____ PAGE_____ OF_____

PROJECT NAME / SURVEY / PROJECT NUMBER					CONTAINER TYPE / VOLUME	TOTAL NUMBER OF CONTAINER	ANALYSIS/TEST REQUESTED									FOR WESTON USE ONLY	
PROJECT MANAGER / CONTACT																	
COMPANY / CLIENT																	
ADDRESS																	
PHONE / FAX / EMAIL																	
SITE ID (Location)	SAMPLE ID	DATE	TIME	MATRIX											PRESERVED HOW	SAMPLE TEMP. (°C) UPON RECEIPT	WESTON LAB ID

Sample Matrix Codes: FW= fresh water GW=ground water SLT=salt water SW=storm water WW=waste water SED=sediment A=air BIO=biologic SS=soil T=tissue O=other (specify) _____

Container Code: G=glass P=plastic B=bags ☐ O=other _____

Shipped By: ☐ Courier ☐ UPS ☐ FedEx ☐ USPS ☐ Client drop off ☐ Other _____

Turnaround Time: ☐ 2-day ☐ 5-day ☐ 7-day ☐ 10-day ☐ 14-day ☐ Standard ☐ Other _____

Reporting Requirements: ☐ PDF ☐ EDD ☐ Hard Copy ☐ Email ☐ Other _____

SAMPLED BY: PRINT **SIGNATURE**

COMMENTS / SPECIAL INSTRUCTIONS

RELINQUISHED BY				RECEIVED BY			
Print Name	Signature	Firm	Date/Time	Print Name	Signature	Firm	Date/Time
1.							
2.							
3.							
4.							
5.							
6.							

WHITE – return to originator • YELLOW – lab • PINK – retained by originator