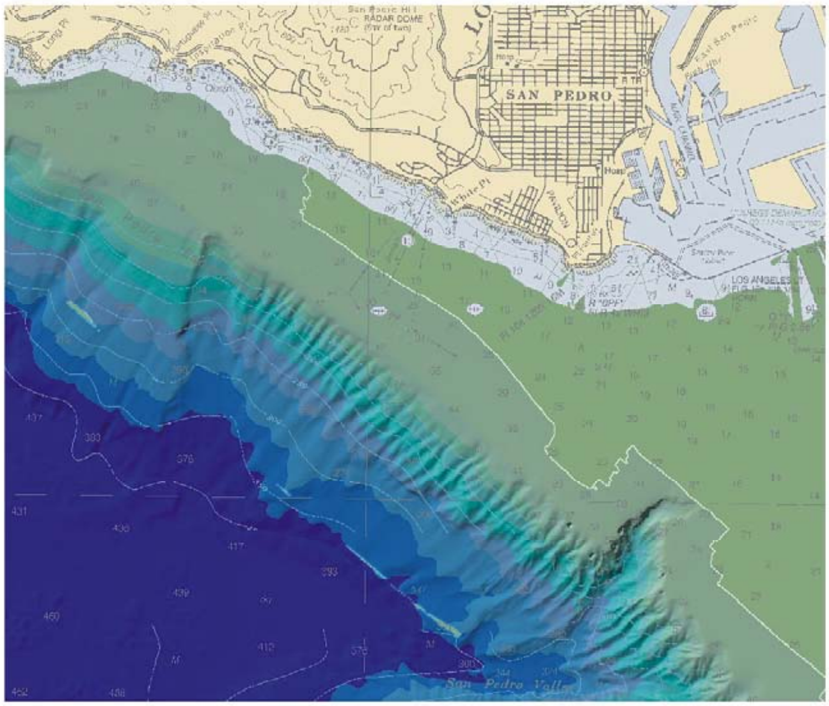
Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Interim and Post-Cap Monitoring
Volume I



Prepared for:

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Revision 03

April 2003

Prepared by:

Science Applications International Corporation
Admiral's Gate
221 Third Street
Newport, RI 02840
SAIC Report Number 505

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OVERVIEW
(Revision 03)

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), Region IX is currently evaluating alternatives for restoration of contaminated sediments on the Palos Verdes (PV) Shelf off the coast of Los Angeles, California. One restoration alternative under consideration is *in-situ* capping, which involves placement of a covering or cap of clean material over contaminated sediment, thereby isolating the contaminated material. EPA is collaborating with the U.S. Army Corps of Engineers (USACE) to conduct a Pre-Design Data Collection and Studies related to the capping alternative.

This Project Work Plan addresses the interim and post-cap portions of the pilot capping project as described in Monitoring Plans developed by USACE (Fredette 2000; Palermo 2000). The following sections provide a brief site description, site history, project overview, project objectives, organization and responsibilities, and Project Work Plan overview.

2.0 SITE DESCRIPTION

The PV Shelf is located within the Southern California Bight (an area of the coastal Pacific Ocean between Point Conception, California and Cape Colnett, Baja California), offshore from Point Fermin to Point Vicente on the PV peninsula (Figure 2-1). The Palos Verdes Shelf contains contaminated sediments that are present on the continental shelf and continental slope. The continental shelf in this region is narrow, with a width of 1.5 to 4 kilometers (km) and a bottom slope of 1 to 4 degrees. A shelf break (i.e., a zone of transition from the relatively flat shelf to the steeper slope) occurs at water depths of 70 to 100 meters (m). The continental slope extends seaward from the shelf, with a width of approximately 3 km and a mean slope of 13 degrees (Lee 1994), to a depth of approximately 800 m.

In general, the PV Shelf region is characterized by (1) hard-bottom habitat from shore to at least 20 m deep; (2) soft-bottom habitat over most of the remainder of the shelf and slope region to at least 600 m depth; and (3) pelagic or water column zones. The exception to this pattern is the hard-substrate, artificial reef habitat represented by the Joint Water Pollution Control Plant (JWPCP) outfall pipes that extend primarily over soft bottom to approximately 60 m depth, some scattered hard-bottom areas on the shelf, and more extensive hard-bottom areas along parts of the shelf break. General oceanographic, geological, and biological conditions, and distributions of effluent-affected (EA) sediments, on the PV Shelf and slope are described briefly in the following sections.

2.1 Physical Oceanographic and Geological Conditions

Dominant circulation patterns in the Southern California Bight include the southward-flowing California Current, the northward-flowing California Countercurrent, and seasonal influences by the northward-trending Davidson Countercurrent (Drake et al. 1994; Hickey 1992). Surface and bottom waters are typically separated in spring through fall by a pycnocline (a zone having strong vertical gradients in seawater density) occurring at depths of 10 to 30 m. Currents below the pycnocline on the shelf generally flow to the northwest, parallel to bathymetric contours. In contrast, surface currents flow predominantly southeastward, although they shift to a westerly flow in late autumn and winter when westerly winds weaken (Hickey, 1992).

Currents in the vicinity of the JWPCP outfalls vary seasonally as a result of changes in wind patterns and periodic storms, typically in winter or early spring. Average current velocities near the bottom are 7-10 centimeters per second (cm/sec) throughout the year (LACSD 1995). Storm waves generated during winter typically have maximum heights of 3 to 4 m, although wave heights up to 7 m were observed during major storms occurring in the 1980s (LACSD 1995).

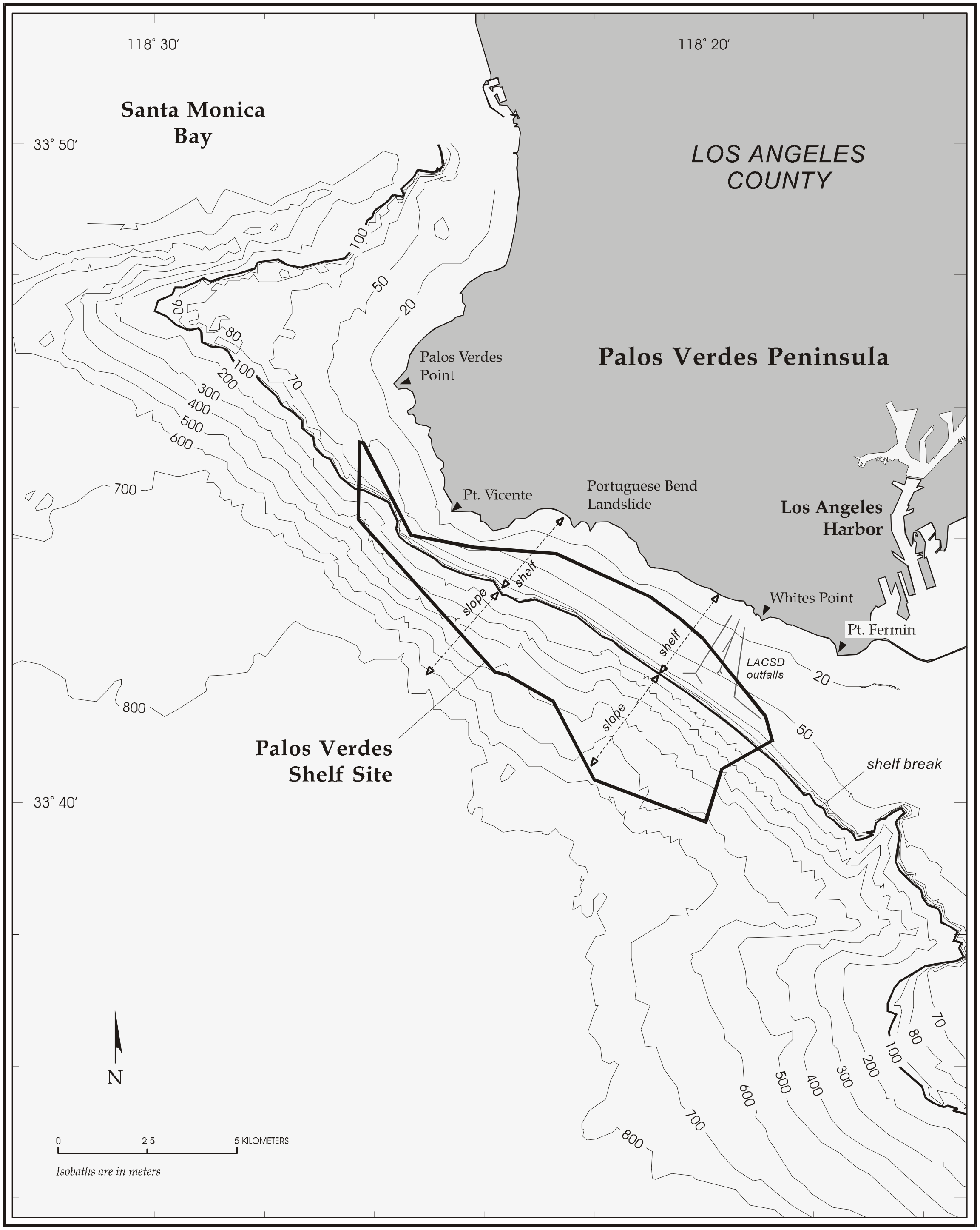

Figure 2-1. Palos Verdes Shelf Site Map

Sediment transport follows the predominant direction of the near-bottom flow, extending northwestward along the shelf (Drake et al. 1994). This is also reflected in the alongshore shape of the EA sediment deposit and resulting contaminant "footprint," extending away from the JWPCP outfalls.

The Portuguese Bend landslide and the JWPCP effluent discharge have dominated the recent supply of solids to the PV Shelf. Since 1988, the rate of erosion from the Portuguese Bend landslide has decreased as a result of stabilization projects, which reduced movement to about 10 percent of former rates. Redondo Canyon and San Pedro Canyon bound the PV Shelf to the northwest and southeast, respectively, and limit sediment transported from adjacent shelf areas. Los Angeles-Long Beach Harbor and its breakwater obstruct nearshore sediment transport (Drake et al. 1994).

The thickness of naturally occurring shelf sediments varies, ranging from 32 m on the southeastern part of the shelf to less than 10 m near Pt. Vicente. As a result of near-bottom currents, a patchy, thin sediment layer with areas of bare rock occurs at the shelf break (Palermo 1994). Similar bedrock outcrops also occur over the seafloor to the east of the outfall and over the Redondo Shelf to the west (Lee 1994). Less than one meter of sediment covers the Redondo Shelf (Drake et al. 1994).

2.2 Biological Environment

Diverse marine habitats and biological communities typify the PV Shelf and slope and the broader Southern California Bight region.

<u>Soft-Bottom Subtidal Habitats</u>

Soft-bottom habitats grading from sand to mud typify the majority of the sea bottom deeper than approximately 20 m off Palos Verdes. Key inhabitants include infaunal and epifaunal invertebrates, both of which live in close association with the sediments and typically are resident (especially infauna) in discrete areas as adults. Numerous bottom-feeding fish also are characteristic of these habitats, but typically are much more motile than the invertebrates. Some fish species migrate over a broad depth range.

Infaunal Community - The infaunal community (invertebrates living in soft sediments) on the shelf and slope is dominated by deposit feeders, primarily polychaete worms and small bivalves, but includes the full range of feeding types, including particle/suspension feeders and predators, representing numerous phyla (LACSD 1995). This community represents an important food source for many fish species and other invertebrates.

Based on results from surveys conducted by the Los Angeles County Sanitation District (LACSD 1995), the greatest number of individuals occurs in the outfall area (>10,000 individuals per square meter [individuals/m^2]), although the number of organisms is also high (>7,500 individuals/m^2) at locations off Point Vicente, Long Point, and Portuguese Bend at depths ranging from 30 to 152 m. Fewer individuals (<2,500 individuals/m^2) occur in the deeper (i.e., 305 m) areas of the slope. Biomass is enhanced near and offshore of the outfall as a result of discharges of organic material. In general, the number of taxa and diversity are highest on the shelf and lowest on the slope. Diversity is also lower northwest of the outfall, in the general area of highest chemical contamination, although temporal trends have shown an increase in diversity in this area.

Epifaunal Invertebrate Community - Spatial patterns in the epifaunal community are primarily related to depth, sediment type, and effects from the wastewater discharge (Stull 1995). Analysis of southern California trawl data from 1971 to 1984 classified the Palos Verdes samples as having a unique low diversity assemblage. In the 1980s, the unique assemblage declined and was replaced by an assemblage that was more typical of shelf assemblages in other areas of the Southern California Bight (Stull 1995). The distribution and diversity of the epibenthic macroinvertebrates have increased since the 1970s. Some of the changes may be attributed to improved habitat quality, although other environmental variables such as El Niño events have had significant effects on these populations (Stull 1995).

Fish Community - Trawl catches of fish on the PV Shelf have varied greatly over time. Conditions which may have influenced these changes include variations in water temperature, El Niño events, advection of water masses having varied physical and chemical characteristics, upwelling of deep waters onto the shelf, kelp coverage, food availability, habitat variability, and contaminants from the outfall (LACSD 1995).

<u>Nearshore Hard-Bottom Habitats</u>

Hard-bottom habitats in the PV region exist primarily in the region from shore to approximately 20-m depth, although scattered outcrops and reefs also occur in some deeper shelf areas. Within these habitats the most diverse communities, including numerous epifaunal invertebrates, fish, and plant (algae and surfgrass) species, are associated with kelp beds. These communities are generally at shallower water depths than the principal areas of chemically contaminated sediment on the PV Shelf.

Kelp Community - The giant kelp (*Macrocystis pyrifera*) is a keystone species that provides refuge and a source of food for many fish and invertebrate species, although the extent of kelp beds has been extremely variable over time. In 1911, kelp canopy coverage near Palos Verdes was estimated to be over 1,500 acres (LACSD 1995). By the late 1950s, giant kelp had disappeared from Palos Verdes rocky subtidal areas attributed, in part, to wastewater discharges that introduced toxicants, buried the substrate, and reduced water clarity (Stull 1995). Transplantation efforts helped to re-establish kelp in the vicinity of the PV peninsula, although the kelp beds suffered severe damage during winter storms in 1983 and 1988. Kelp beds near Palos Verdes were estimated at 1,124 acres in 1989, but declined to 300 acres in 1993. This may have been due to El Niño events and overgrazing by sea urchins (LACSD 1995). In addition, the Portuguese Bend landslide also contributed to increased sedimentation and turbidity, which continued to impact some kelp bed populations (LACSD 1995; Stull 1995).

Pelagic Habitats

The pelagic environment, which includes the water column from near the bottom to the sea surface, provides habitat for many species of plankton, invertebrates, fish, seabirds, and marine mammals.

2.3 Distribution of EA Sediments

The JWPCP outfalls discharge treated municipal and industrial wastewater at a depth of approximately 60 m on the PV Shelf, offshore from Whites Point. Effluent-affected (EA) sediments in the area of the outfalls and those transported away from Whites Point by ocean currents and deposited on the ocean floor serve as the main repository for contaminants. Contaminated sediments on the shelf are characterized by two layers: an EA deposit covering "clean" native sediments that were present prior to the start of sewage discharges from JWPCP ocean outfalls. The EA sediments are comprised of a surface layer of more recently deposited and moderately contaminated materials covering a buried layer of highly contaminated materials that were deposited prior to 1980.

The spatial distributions of 1,1,1-trichloro-2,2-bis (p-chlorophenyl) ethane (DDT), DDT metabolites, and polychlorinated biphenyl (PCB) concentrations and contaminant masses in shelf and slope sediments were evaluated extensively as part of the Trustees' site investigation for the NRDA (Lee 1994). The EA sediment deposit is characterized by a lower density and finer grain size than the native sediment. It ranges in thickness from 5 centimeters (cm) to greater than 60 cm, and is underlain by firmer native shelf sediments. The total volume of the EA deposit is over 9 million cubic meters, with approximately 70 percent of this volume lying on the shelf and the remainder on the slope. Virtually all of the deposit is contaminated with DDT (and its metabolites) and PCBs. Sediments containing total DDT concentrations greater than 1 mg/kg (part-per-million; ppm) in the region of the Palos Verdes Shelf cover a seafloor surface area of approximately 42 square kilometers. The areas of the shelf and slope with surficial (top 0 to 4 cm) sediment concentrations of p,p'-DDE, the primary DDT metabolite, exceeding 5 ppm and 10 ppm are approximately 12 km^2 and 3 km^2, respectively.

The highest DDT concentrations in surface sediments occur near the JWPCP outfall, and then decrease with increasing distance from the outfall (Figure 2-2). Concentrations decrease rapidly from the outfall in northeasterly and southeasterly directions, whereas horizontal changes to the northwest of the outfall, in the direction of predominant current flow, are relatively smaller. Sediments from nearshore locations in water depths less than approximately 30 meters generally contain DDT concentrations below 1 mg/kg. Spatial and vertical distributions of PCB are generally similar to those for DDT, although the magnitude of the total PCB concentrations is consistently lower than that of DDT. Maximum total DDT and PCB concentrations in the buried layer exceed 200 mg/kg and 40 mg/kg, respectively. On the shelf, these peak concentrations occur at depths of 30-40 cm in the sediment, while on the slope they are much closer to the sediment surface. Concentrations in the surface layer on the shelf are relatively lower than the peak concentrations but still significantly elevated compared to other locations within the Southern California Bight. This vertical distribution of contaminant concentrations generally reflects the history of effluent deposition, with some post-depositional alterations due to physical and biological mixing.

Results from studies conducted as part of the LACSD compliance monitoring program, the Trustees' NRDA investigation, and other regional and site-specific programs have provided considerable evidence for biological uptake and accumulation of DDT and PCB in the vicinity of the PV Shelf. In particular, studies by Young et al. (1989) and Schiff and Allen (1997) demonstrated that lipid-normalized concentrations of DDT and PCB in tissues of a flatfish from the PV Shelf were directly proportional to the respective organic carbon (OC)-normalized concentrations in shelf sediments, suggesting a benthic coupling for contaminant transfer to biota (Spies 1984). Concentrations of DDT in whole fish collected during 1997 from the PV Shelf were up to three orders of magnitude higher than in fish from other parts of the Bight (Allen et al. 1999). Fish collected during the 1980s and 1990s from the PV Shelf contained concentrations of DDT and PCB that were up to severalfold higher than the respective Food and Drug Administration (FDA) action and tolerance levels. DDT and PCB concentrations in some species also exceed guidelines issued by Office of Environmental Health Hazard Assessment (OEHHA) for human consumption of seafood.

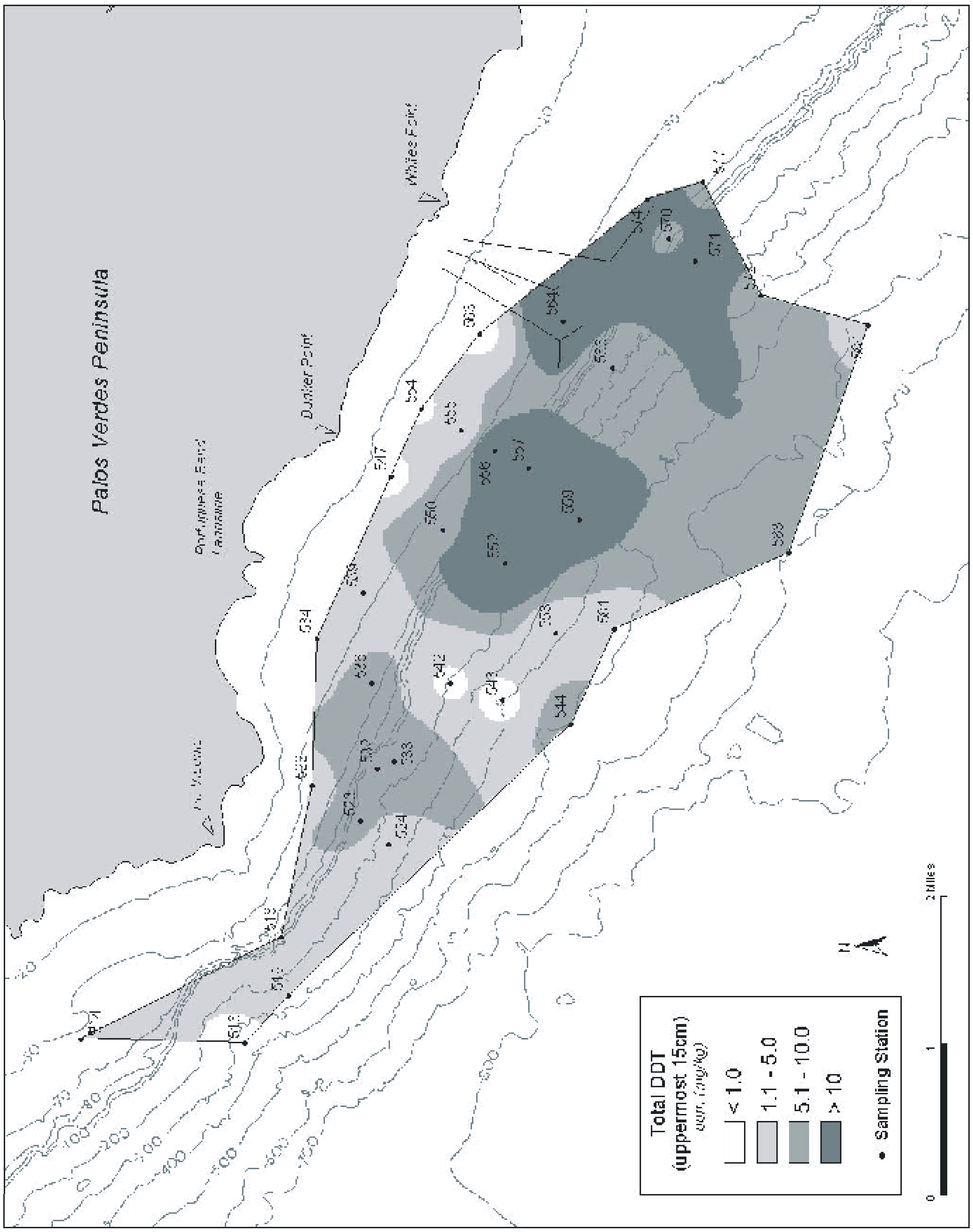

Figure 2-2. Total DDT footprint based on USGS measurements (concentrations averaged over the uppermost 15 cm).

3.0 SITE HISTORY

LACSD initiated wastewater discharges in 1937 at depths of 30 to 45 m from an outfall at Whites Point. Wastewater from the JWPCP was later discharged through submarine outfalls located approximately 3 km offshore from Whites Point to a water depth of 63 m (Drake et al. 1994). The JWPCP outfalls have discharged approximately 4 million tons of suspended solids since 1937, 50 percent of which was discharged from 1964 and 1976. Starting in 1947, Montrose Chemical Corporation produced DDT at a manufacturing plant in Los Angeles County. Wastes from the manufacturing process, containing DDT residues, were discharged to the JWPCP until 1971, and a large amount of the DDT was subsequently released with the effluent from the JWPCP to the ocean. Similarly, PCBs were discharged to the municipal sewage system from several sources within the Los Angeles area and subsequently released to the marine environment with wastewater from the sewage treatment plant. Peak annual mass emissions of effluent solids (167,000 metric tons), DDT (21.1 metric tons), and PCB (5.2 metric tons) occurred in 1971. Subsequent improvements to treatment processes and better source control, along with cessation of these discharge practices by Montrose Chemical Corporation and others, reduced the mass emissions and supply of organochlorines to the marine environment (Eganhouse and Venkatesan 1993). DDT discharges declined to 0.03 tons per year in 1985 (Drake et al. 1994). By 1995, the solids mass emission was less than one fifth of that discharged in 1971, and trace contaminant discharges were a few percent of 1971 values (Stull 1995). The heavily contaminated sediment in the area of the outfalls has been gradually buried by less contaminated effluent and natural sediment.

As of 1992, the site contained an estimated 100 metric tons of DDT and 10 metric tons of PCB (Lee 1994). These mass estimates are lower than those calculated previously based on sampling conducted during the 1980s. This suggests that contaminant concentrations and masses are decreasing with time, although accurate determinations of these changes are difficult to make given the high spatial variability in contaminant distributions. Additionally, rates of change over time in concentrations of DDT in surface sediments have been smaller than reductions in mass emission rates from the JWPCP. This also implies that contaminants in historically deposited sediments are being remobilized and contribute to concentrations in the more recently deposited materials.

4.0 PROJECT OVERVIEW

USACE (Palermo et al. 1999) evaluated *in-situ* capping alternatives at the Palos Verdes site for EPA. The evaluation included prioritizing areas of the PV Shelf to be capped, determining appropriate cap designs, developing an equipment selection and operations plan for placement of the cap, developing a monitoring plan to ensure successful cap placement and long term cap effectiveness, and developing preliminary cost estimates.

USACE (Palermo et al. 1999) considered two primary capping alternatives: (1) placement of a thin cap (design thickness of 15 cm) that would reduce potentials for biological remobilization of sediment contaminants by shallow-burrowing benthic organisms, as well as reduce contaminant concentrations in surficial sediments and contaminant flux into overlying waters; and (2) placement of an isolation cap (design thickness of 45 cm) which would be of sufficient thickness to effectively isolate contaminated sediments from the majority of benthic organisms, reduce contaminant bioaccumulation, and effectively prevent contaminant flux for the long term within those areas of the site covered by a cap. The area considered for capping lies on the shelf between the 40- and 70-m depth contours (this area was defined as two separate capping prisms: prism A centered over the "hot spot," and prism B located northwest of the "hot spot"). Cap placement on the slope was considered infeasible due increased potential for flow failure under seismic loading. Capping operations would be undertaken in an incremental fashion, until the total selected area was capped. Since the area that could be capped is large (on the order of several square kilometers), cap placement cells measuring 300 m by 600 m were defined for purposes of managing the placement of material and monitoring.

EPA Region IX recently entered into an interagency agreement with the USACE, Los Angeles District (LAD) to provide technical support for the implementation of a pilot study for cap placement. The pilot study will consist of controlled operations for placement of capping material within three pilot capping cells on the PV Shelf and associated monitoring prior to, during, and following the placements. The locations of the pilot capping cells in relation to the shoreline, JWPCP wastewater outfalls, kelpline, as well as cap placement targets and moored instrument arrays, are shown in Figure 4-1. The pilot study will include tasks related to pre-design data collection and studies. Operational aspects for the pilot include selection of appropriate placement areas, capping materials, and placement techniques. The associated monitoring program for the pilot study is designed to evaluate the following: areal extent and thickness of the cap; mixing of cap and contaminated sediments; resuspension of contaminated sediments during cap placement; short term biological recolonization of the cap; and short term physical and chemical characteristics of the cap and underlying sediments immediately after capping and following initial sediment consolidation.

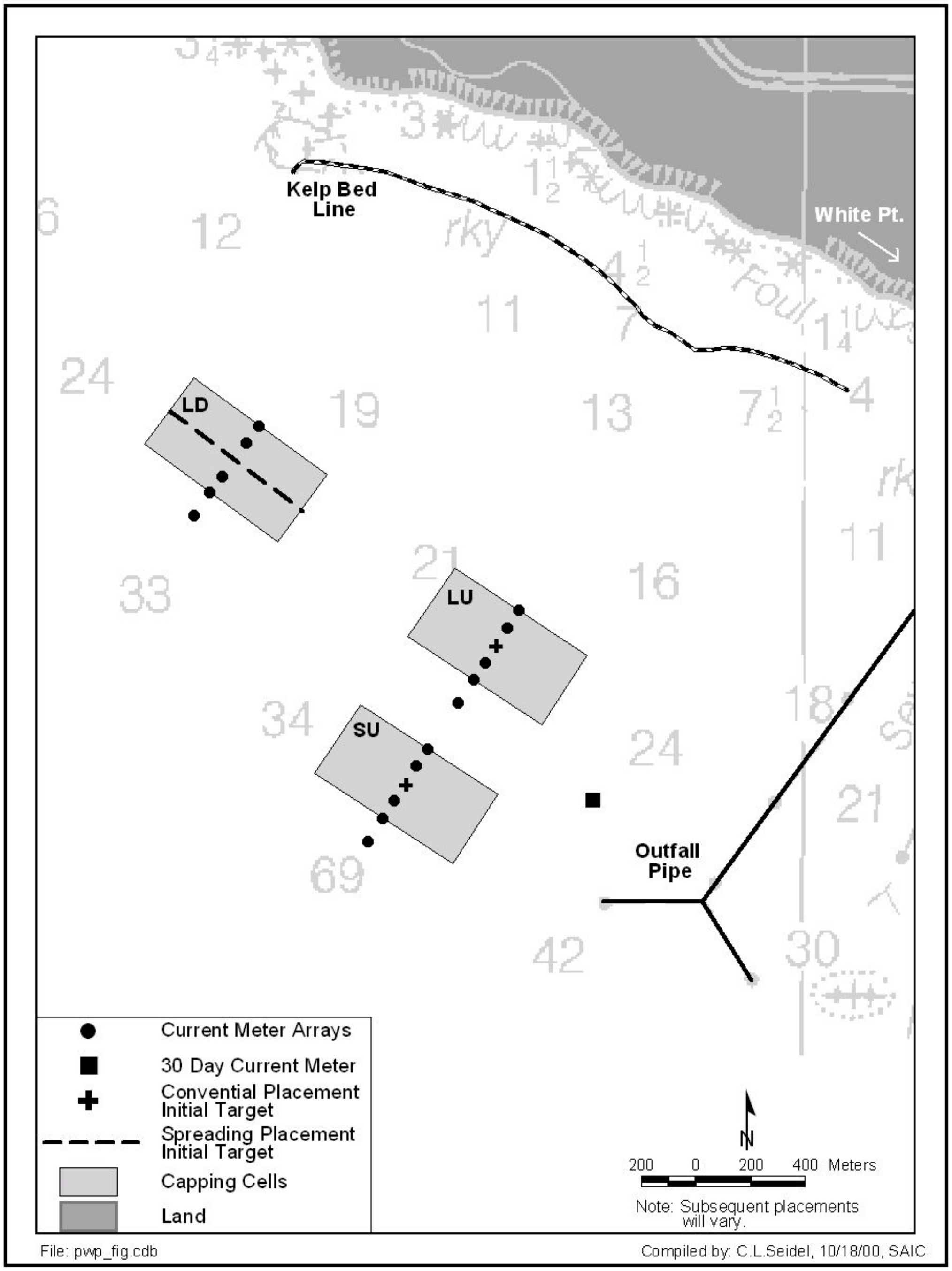

Figure 4-1. Map showing the Pilot Capping Cells on the Palos Verdes Shelf, target cap placement locations within each cell, locations of moored instrument arrays, the Palos Verdes shoreline, the kelp line, and the sewage outfall.

Palermo (2000) developed an Operations and Monitoring Plan for the Pilot Capping Project to be conducted in summer of 2000. Fredette (2000) developed a companion document that specifies the scope of work for monitoring activities that will be conducted during the Pilot Capping Project. These two documents (attached as appendices to the Data Quality Objectives section of this PWP) present a technical approach/design that was developed by EPA and LAD, following the work of Palermo et al. (1999). The reader should refer to these documents for justification of the sampling design and analytical techniques addressed in this Project Work Plan.

5.0 PROJECT OBJECTIVES

The overall objective of the field pilot study is to demonstrate that a cap can be placed on the shelf as intended by the design, and to obtain field data on the short-term processes and behavior of the cap as placed.

Specific objectives addressed by the pilot capping project (Palermo 2000) include:

- Demonstrate that an appropriate cap thickness can be placed with an acceptable level of variability in cap thickness.
- Demonstrate that excessive resuspension of existing sediments and excessive mixing of cap and contaminated sediments can be avoided.
- Demonstrate that excessive losses of cap materials can be avoided.
- Determine, to the degree possible, the effect of variable cap material type, bottom slope, water depth, and placement method (e.g., conventional versus spreading) on cap thickness and sediment displacement and resuspension.
- Demonstrate the effectiveness of the cap with respect to short-term isolation of contaminants during the initial phase of sediment consolidation.
- Demonstrate the ability to monitor cap placement operations.
- Evaluate and modify, where needed, all operational and monitoring approaches.
- Improve the knowledge-base contributing to decisions on implementation of a full-scale cap.

An initial phase of the monitoring program consisted of sampling and analysis to characterize baseline (pre-capping conditions) within four cells considered by USACE as sites for cap construction (one of the four cells, SD, was subsequently eliminated from further study during the interim and post-capping phases of the Pilot Project). The general objectives of the baseline monitoring task are described in a separate Project Work Plan (SAIC 2000). The study design developed by USACE (Palermo 2000) expects that the information obtained during the baseline monitoring will be appropriate and sufficient to use as a basis for comparisons to physical and chemical conditions within the proposed pilot capping cells during and following construction of pilot caps.

Construction of the pilot cap is anticipated to occur over a period of several weeks to months, and the associated monitoring effort is designed to address short term processes. The pilot study would therefore meet several objectives related to capping operations and processes occurring during and shortly after cap placement. Site monitoring will involve characterizing the cap material and evaluating conditions on the seafloor and in the water column prior to, during, and following cap placement operations (defined as baseline, interim, and post cap monitoring, respectively). A full-scale monitoring program, which would be conducted during construction of a full-scale cap on the PV Shelf and in the years to follow, would additionally include activities aimed at long-term processes not easily observed during the relatively short time period available for the pilot study. This could include, for example, erosion during storm events or migration of contaminants due to diffusive processes.

6.0 ORGANIZATION AND RESPONSIBILITIES

Science Applications International Corporation (SAIC) will support USACE LAD and EPA with oceanographic monitoring and data compilation for the pilot capping project. The team organization for the pilot study interim and post-cap monitoring is illustrated in Figure 6-1. Dr. Scott McDowell, based in Newport, RI, will serve as SAIC's Project Manager. In this role, he will serve as the main SAIC point-of-contact with LAD and affiliated agencies (e.g., EPA Region IX, WES, et al.) and he will have ultimate responsibility for the timeliness and technical quality of all SAIC project deliverables. Dr. McDowell will provide managerial and technical oversight of the project and direct the activities of the SAIC team. He also will be responsible for SAIC’s budget, scheduling and contractual issues. Assisting him with these latter functions will be Ms. Mary Magee (Project Administrator) and Ms. Christine Lepore (Contract Officer), who are both based in Newport, RI.

The monitoring effort is logistically complex because it involves sampling using several different techniques, as well as sample analyses and data reduction, within a short time period. Mr. John Evans, based in San Diego, will serve as SAIC's Logistics Coordinator. Mr. Evans is well-suited for this role because he is based locally, experienced with all sampling techniques, and familiar with the sampling requirements and local logistical resources. As Logistics Coordinator, Mr. Evans will assist the Project Manager in locating and hiring suitable survey vessels, locating suitable shoreside support facilities, scheduling and staffing of surveys, and shipping and tracking of discrete samples.

SAIC's Project Team also includes a QA/QC Officer and Project Safety Officer. Mr. Ray Valente will serve as the QA/QC Officer. In this role, he will prepare and update, as necessary, the Quality Assurance Project Plan, interact with the Project Manager and Team Leaders to develop quality assurance requirements and procedures, monitor strict adherence to the QA requirements and procedures, conduct technical audits as necessary, organize and oversee reviews of program deliverables, and report to the Project Manager on adherence to the QAPP. Mr. Valente is a senior marine scientist with over fourteen years of diverse experience in marine environmental monitoring and impact assessment. He has managed numerous investigations involving biological and chemical sampling to characterize marine and estuarine habitats and evaluate the effects of anthropogenic activities on aquatic ecosystems. Mr. Valente is familiar with QA/QC associated with oceanographic data collection and marine monitoring activities. He currently serves as SAIC's Quality Assurance Officer on the Disposal Area Monitoring System (DAMOS) program sponsored by the U.S. Army Corps of Engineers New England Division to examine the effects of dredged material disposal at open-water sites in New York's Long Island Sound and throughout coastal New England. From 1991 to 1994, Mr. Valente was a key participant in the design and implementation of the US EPA's Environmental Monitoring and Assessment Program (EMAP-Estuaries), a large-scale marine environmental monitoring effort involving extensive biological and chemical sampling in estuaries throughout the United States. As the EMAP-

Estuaries Quality Assurance Manager, Mr. Valente was responsible for developing and documenting field sampling protocols and laboratory methods, writing the Quality Assurance Project Plan and managing a comprehensive QA/QC Program. Mr. Valente is familiar with all of the QA/QC requirements entailed in the pilot capping program, but he will not be directly involved in data collection and analysis for the monitoring program.

Mr. John Nakayama is the Project Health and Safety Officer for the interim and postcap monitoring. The Project Health and Safety Officer will be responsible for ensuring that the requirements of the Health and Safety Plan are rigorously followed by all SAIC field personnel and subcontractors, and that all necessary personal protective equipment, health and safety training, and supplies are available to the field team. In addition, the Safety Officer will ensure that subcontractors are both informed of the applicable provisions of SAIC's Health and Safety Plan and have a health and safety program to protect their employees and those of SAIC. The responsibilities of the Project Safety Officer are described in detail in the Health and Safety Plan.

SAIC's project organization identifies Team Leaders for each of the major logistical/technical areas, including data management. Each of these technical areas is further broken down into the logical components of field sampling, sample/data analysis, and reporting. Task leaders are responsible for assisting Dr. McDowell with coordination of sampling, sample analyses (as appropriate), data management, and reporting for each of the task (sampling technique) areas. Additionally, task leaders are responsible for tracking progress of the individual elements, and reporting the status, as well as any problems and corrective actions, to Dr. McDowell.

The monitoring program will also utilize subcontractor laboratories for geotechnical and chemical analyses of sediment samples that will be extracted from sediment cores and sediment samples collected from hopper dredges. Chemical analyses of sediment core and seawater samples will be performed by Woods Hole Group (Falmouth, MA). Helder Costa will be the laboratory coordinator. Geotechnical analyses of sediment core samples will be performed by Applied Marine Sciences (College Station, TX). Mr. Ken Davis will be the laboratory coordinator.

As mentioned, SAIC’s role is to provide technical support to USACE and EPA on specific tasks as requested by USACE. Overall program management will be performed by USACE, and final decisions regarding study design, program objectives, and analyses and interpretations of the data collected for the monitoring program will be performed by USACE. Additionally, quality assurance oversight, including document review and approval, external audits of contractors, and reviews and assessments of project data and data quality, will be performed by USACE.

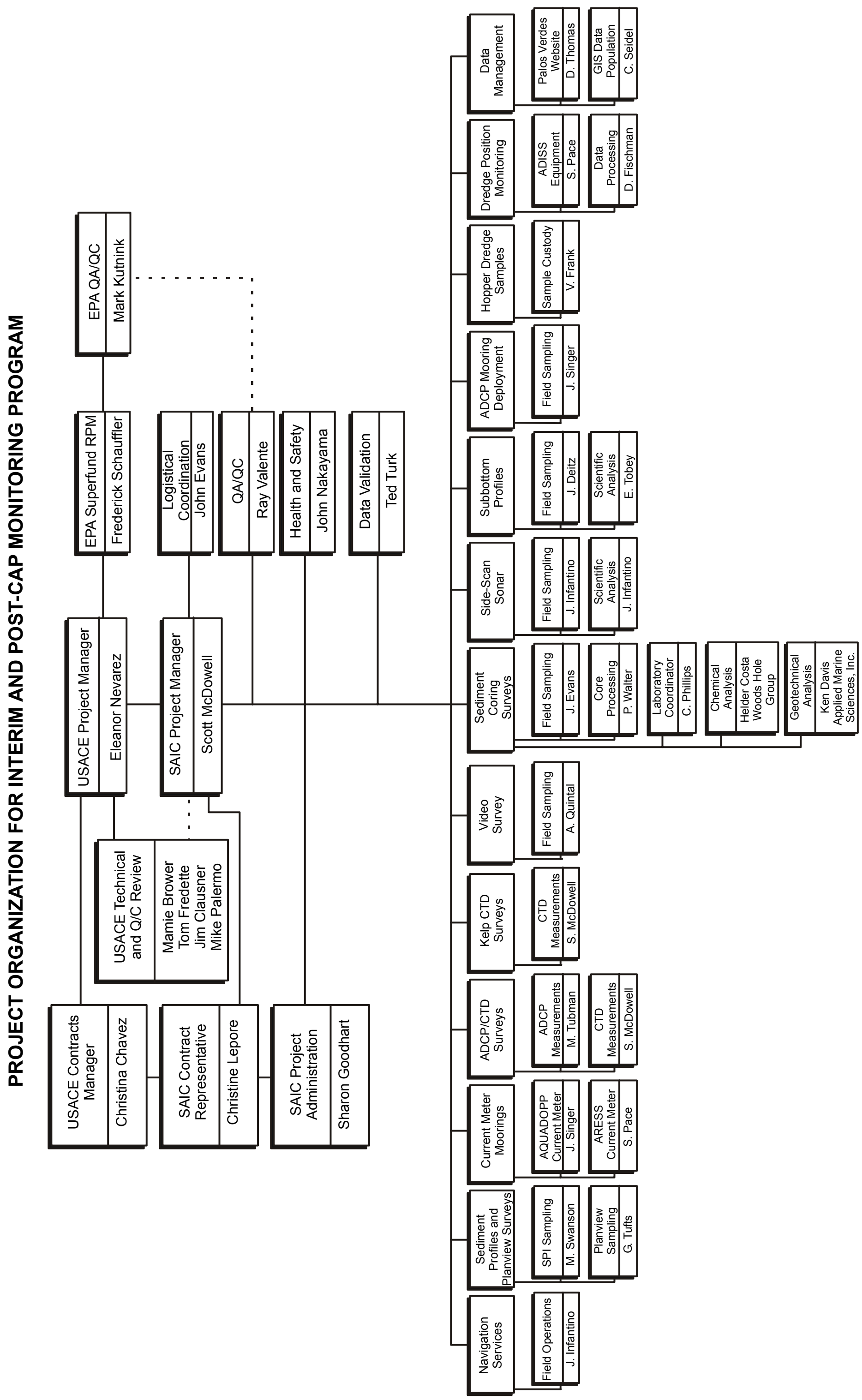

Figure 6-1. SAIC Organization Chart for the Pilot Study Interim and Post-Cap Monitoring.

7.0 PROJECT WORK PLAN OVERVIEW

This Project Work Plan is comprised of the following sections: Data Quality Objectives, Field Sampling Plan, Quality Assurance Project Plan, and Health and Safety Plan. The Project Work Plan addresses the interim and post-cap portions of the pilot capping project. The baseline phase of the monitoring program is addressed in a separate, stand-alone document SAIC (2000).

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APPENDIX A
Palermo 2000

Field Pilot Study of In-Situ Capping of Palos Verdes Shelf Contaminated Sediments- Operations and Monitoring Plan

Background

Region 9 of the U.S. Environmental Protection Agency (EPA) is currently evaluating alternatives for sediment restoration of DDT and PCB contaminated sediments on the Palos Verdes (PV) shelf off the coast of Los Angeles, California. One option under consideration is in-situ capping, which is defined as the placement of a covering or cap of clean material over the in-situ deposit of contaminated sediment.

The U.S. Army Corps of Engineers (USACE) has performed an evaluation of insitu capping options for Region 9. The evaluation included prioritizing areas of the PV shelf to be capped, determining appropriate cap designs, developing an equipment selection and operations plan for placement of the cap, developing a monitoring plan to ensure successful cap placement and long term cap effectiveness, and developing preliminary cost estimates. The complete capping options study is published as USACE Waterways Experiment Station report TR-EL-99-2 (http://www.wes.army.mil/el/elpubs/pdf/trel99-2.pdf).

EPA region 9 has recently entered into an interagency agreement with the USACE Los Angeles District (LAD) to provide technical support for ongoing needs at the PV Shelf Site to include tasks related to Pre-Design Data Collection & Studies. One aspect of the pre-design studies is a field pilot study of cap placement on the shelf. This document serves as the operations and monitoring plan for the field pilot study.

Description of In-Situ Capping Options

Two capping approaches were considered in TR EL-99-2 for selected areas of the shelf: 1) placement of a Thin Cap (design thickness of 15 cm) which would isolate the contaminated material from shallow burrowing benthic organisms, providing a reduction in both the surficial sediment concentration and contaminant flux, and 2) placement of an Isolation Cap (design thickness of 45 cm) which would be of sufficient thickness to effectively isolate the majority of benthic organisms from the contaminated sediments, prevent bioaccumulation of contaminants and effectively prevent contaminant flux for the long term.

The shelf area presently under consideration for capping lies between the 40- and 70-m depth contours (in TR EL-99-2, this area was defined as two separate capping prisms: prism A centered over the “hot spot,” and prism B located northwest of the “hot spot"). If capping is selected as a remedy for the PV Shelf, the operations would be done in an incremental fashion until the total selected area was capped. Since the area that could be capped is large (on the order of several square kilometers), capping placement cells 300 by 600 m have been defined for purposes of managing the placement of material and monitoring[1].

Pilot Study Objectives and Approach

The overall objective of the field pilot study is to demonstrate that a cap can be placed on the shelf as intended by the design and to obtain field data on the short-term processes and behavior of the cap as placed.

Specific objectives to be addressed as a part of the pilot include:

1. Demonstrate that an appropriate cap thickness can be placed with an acceptable level of variability in cap thickness.
2. Demonstrate that excessive resuspension of existing sediments and excessive mixing of cap and contaminated sediments can be avoided.
3. Demonstrate that excessive losses of cap materials can be avoided.
4. Determine, to the degree possible, the effect of variable cap material type, bottom slope, water depth, and placement method (e.g., conventional vs spreading) on cap thickness and sediment displacement and resuspension.
5. Demonstrate the effectiveness of the cap with respect to short-term isolation of contaminants during the initial advective flow resulting from sediment consolidation.
6. Demonstrate the ability to monitor operations and success.
7. Evaluate and modify, where needed, all operational and monitoring approaches.
8. Improve the knowledge base contributing to decisions on implementation of a full scale cap.

The construction of the field pilot study cap is anticipated to occur over a time period of several weeks, and the associated monitoring effort is anticipate to address short term processes. The pilot study would therefore meet several objectives related to capping operations and processes occurring during and shortly after cap material placement. A full-scale monitoring program to be conducted during any placement of a full-scale cap and in the years to follow would additionally include activities aimed at long-term processes which could not be easily observed during the time period available for a pilot study (e.g. erosion during storm events or migration of contaminants due to diffusive processes). Depending on the time scales in which the pilot cap is left in place prior to any full scale cap placement, there may be opportunity to obtain data from the pilot area related to such long-term processes, but such activities are not included in the present pilot scope.

The pilot study approach consists of controlled operations for placement of capping material within selected areas on the PV shelf and associated monitoring prior to, during, and

1 It should be noted that a grid of 56 capping placement cell locations was defined in TR EL-99-2 for purposes of volume and cost estimates for various capping options, however, these cell locations are not considered "cast in concrete" for purposes of either the pilot or any full scale capping operation. A new grid has been defined for purposes of the pilot with cells extending over a larger area at the south east end of the site, as compared to the locations in TR EL-99-2.

following the placements. Operational aspects for the pilot include the selection of appropriate placement areas for the pilot, capping materials, and placement techniques. Monitoring aspects for the pilot include cap thickness as placed, mixing of cap and contaminated sediments, resuspension of contaminated sediments during cap placement, short term cap benthic recolonization, and short term physical and chemical characteristics of the cap and underlying sediments immediately after capping and following initial sediment consolidation.

Selection of Pilot Capping Placement Areas

Specific considerations for selection of the pilot placement locations include:

1. To the extent possible, placement locations for the pilot should be representative of the overall range of conditions within the total anticipated capping prism for a full scale remediation.
2. Different pilot placement locations will be necessary to demonstrate the effect of water depth, bottom slope, cap material type, and placement method on cap thickness and sediment resuspension.
3. Physical bottom material type in the pilot placement areas should be clearly distinguishable from capping material. This requirement would be met by any location with surficial fine-grained EA sediment, since the capping material is anticipated to be composed of fine sandy sediment.
4. The thickness of the EA sediment in the pilot placement areas should be sufficient to potentially measure the degree of mixing of cap and contaminated sediment and the effects of advection due to consolidation. The mixing requirement would be met with any location with surficial fine-grained EA sediment thickness in excess of 10 cm. The thicker the EA deposit, the easier the measurement of advection effects.
5. The level of surficial sediment contamination (upper few cm) for the pilot placement areas should provide representative data on resuspension and water column contaminant release. Areas with lower ranges of surficial contamination (i.e. a few mg/kg) have low potential for water column release. Areas with higher ranges of surficial contamination (i.e. 10 to 20 mg/kg) would provide conservative (worse-case) data on resuspension and water column release.
6. There are concerns related to placement of capping materials directly over or immediately adjacent to the LACSD outfall pipes. Until the nature of cap accumulation is demonstrated, cap placements should NOT be located directly over or immediately adjacent to LACSD outfall pipes.
7. Locations should be selected to minimize the potential for recontamination of the pilot cap both during and following cap placement. The prevailing bottom current is from southeast to northwest, so locations to the southeast are preferable from this standpoint.
8. The southeastern boundary of capping Prism A as defined in TR EL-99-2 is currently based on the EA sediment footprint as defined by the 1994 USGS box core data. LACSD data indicate that EA sediment extends well to the southeast of this boundary. Data collected for the pilot may further define the most appropriate boundary which should be considered for capping, and selection of the pilot capping

locations at the southeast end of prism A would provide the opportunity to collect data as a part of baseline monitoring.

9. The size of the pilot placement area(s) should be sufficiently large to avoid interference between intentionally separate placements using different options and to allow for demonstrating the effect of adjacent placements in building the desired cap thickness. Modeling results indicate the size of a footprint of measurable cap thickness accumulation resulting from a single conventional placement is about the size of a single 300 by 600 meter capping cell. Therefore adjacent and/or overlapping placements within a single capping cell would be sufficiently large to observe the buildup effect.

Based on the above considerations, four 300 by 600 meter capping placement cells are recommended for the pilot. One pair of cells would be located adjacent to the landward limit of the capping area in a comparatively shallow site with comparatively flat bottom slope (40 m to 45m depth contour with an average slope across the cell of about 1.5 degrees). A second cell pair would be located adjacent to the seaward limit in a comparatively deeper site with steeper bottom slope (60 to 70 m depth contour with average slope across the cell of about 2 degrees). The two cell pairs would be separated by a full cell length in the along-shore direction to avoid the potential for interferences during monitoring.

The four cell locations are labeled LU (Landward Upstream), LD (Landward Downstream), SU (Seaward Upstream), and SD (Seaward Downstream) in Figure x. The cell grid in Figure x may be adjusted following the collection of baseline data as described below. Pilot placements would occur within the limits of these four cells, but the area monitored would extend to adjacent cells as described below.

Note: two locales are presently currently under consideration for the pilot cells - SE end and NW middle of Prism A.

The locale recommended for the placement cells is at the southeastern end of capping prism A, in the area roughly bounded by the 40 and 70 m depth contours and between LACSD transects 9 and 10. This area is to the southeast of the terminus of the outfalls, on the "upstream" end of the capping area with respect to prevailing bottom currents. There is little USGS boxcore data for this area, however, available LACSD data indicates the EA sediment thickness in this area easily exceeds 10 cm (refer to Figure 60 in Lee et al 1994) and the surficial DDE concentration is about 2 mg/kg (refer to Figure 5 in Lee et al 1994). Note: this locale has the advantage of "upstream" wrt bottom currents, but the disadvantage of thin EA sediment thickness and low DDE concentration wrt the overall area.

A possible alternate locale for pilot placement is to the northwest of the terminus of the outfalls (Note that no specific area for this secondary locale has been discussed in detail, but the conditions are roughty consistent from the outfalls to the NW boundary of Prism A). This secondary locale could be considered as a contingency if revised placement methods are needed once the pilot placement operations are underway. Note: Also, this locale could be selected as the primary if there are serious LACSD concerns regarding placements upstream of the outfalls. (Note: Also, there is still some unresolved issues with locating the pilot here and the consideration of using an area with surficial concentrations in the low range. This locale has the disadvantage of being "downstream" wrt bottom currents, with the higher potential for surface recontamination. But the sediment thickness is better for consolidation effects and the surficial DDE is at 10 to 20, yielding better resolution potential for cores and worse-case resuspension data).

(Note: An initial exercise for the GIS will be to determine how much of the area within each pilot cell and within the overall area of the pilot has a bottom slope > 2 degrees).

Selection of Cap Material Sources

LAD surveyed the region for potential cap material sources as a part of the capping options study and is currently updating available information on borrow sources. Dredged sediments from navigation channels (primarily the Queen's Gate deepening project) and sand borrow areas were identified as the two primary borrow sources, and the cap designs and placement approaches were developed based on those potential sources. Available data for these sources indicate that the materials are variable and are mixtures of fine sands, silts and clays. LAD is currently arranging for additional exploration of both the Queen's Gate and Borrow Areas.

The cap material used for the pilot study must be representative of the materials which would be available for a full scale capping remedy. Other drivers in selection of pilot capping materials are cost and schedule. Use of dredged material from on-going navigation projects will be far less expensive than excavation from borrow sites, since the operational cost attributable to the pilot would be limited to the difference in transportation and disposal cost to the PV shelf as compared to the selected disposal sites. But use of dredged material from the on-going project is dependent on close coordination of navigation dredging schedules and contracts. Use of dredged material from an approved navigation project can also be advantageous for the overall schedule, since the dredging impacts in the channel areas and ocean disposal of the sediments will have already been evaluated, thus making the NEPA process and other regulatory considerations for the pilot project more straight-forward.

The Queen's Gate project is the only on-going navigation project identified to date with sufficient volumes of clean material to conduct the pilot project described in this plan. The material has an in-situ mean grain size of approximately 0.1 mm. Recent sampling has indicated that there may be localized areas with coarser mean grain size. Also, dredging operations for Queen's Gate and any subsequent placement of the materials in rehandling sites such as the West Anchorage site, results in some losses of fines during overflow and placement, with a subsequent "coarsening" of the material. Modeling to date indicates that the Queen's Gate material can be used for cap construction if the conventional method of placement is used. LAD has indicated that the finer material mixtures from Queen's Gate may be representative of much of the material available from the borrow areas. Therefore, in the context of the pilot, use of Queen's Gate is appropriate for demonstration of conventional placement techniques with a finer material type available in the Los Angeles region. LAD is currently considering additional borings in selected areas within and adjacent to the present navigation project to locate coarser grained materials. If such areas are found, they would be appropriate for demonstration of spreading placement techniques with a coarser material type.

Sand borrow areas outside the harbor breakwaters (designated as AII and AIII) have in-situ mean grain sizes in excess of 0.2 mm based on available data. However, these materials are also highly variable, and available data do not allow for fine resolution of grain size distributions within the larger borrow areas. There are also environmentally sensitive areas located within the larger borrow areas corresponding to submerged aquatic vegetation (SAV) and rock "pinnacles" with high fisheries values. LAD is planning to obtain borings in selected portions of borrow area AIII (water depths less than 80 ft and outside known sensitive areas) to define a source of coarser material for the pilot.

Modeling conducted to date indicates that use of mixtures of fine sand and silt/clay cap material (such as material from Queen's Gate) results in a larger proportional dispersion off-site, and potentially greater spread downslope as compared to a coarser sand (such as from the sand borrow areas). The finer materials will be placed using conventional release from the hopper dredge. The coarser materials will be placed using a spreading method of placement.

Placement Equipment and Contract Arrangements

Use of hopper dredges was identified as a preferable placement equipment type in TR EL-99-2, and use of a hopper is anticipated for the pilot. A hopper dredge is the equipment of choice for the pilot capping on the PV shelf for the following reasons:

a. Hopper dredges are currently the most readily available equipment for the pilot work.
b. Hopper dredges provide better control of placement in the open ocean environment and allow for more flexibility in placement options to include pumpout capabilities.
c. Hopper dredges remove material from channels by hydraulic means, resulting in a breakdown of any hardpacked material and addition of water as material is stored in the hopper for transport. Material from hopper dredges is therefore more easily dispersed in the water column, and would therefore settle to the seafloor with less energy and less potential for resuspension of the contaminated sediment.

Current plans call for use of the NATCO Manhattan-class dredge *Sugar Island* for the pilot placements. The *Sugar Island* utilizes a split-hull hopper opening mechanism that can be used to control the rate of release. This dredge is also equipped with a hopper pumpout capability over the bow and water jets to aid in pumpout operations. Pumpout can also be accomplished through the adjustable skimmers within the hopper. NATCO has indicated that, with minor modifications, pumpout can be accomplished through one of the two dragarms, allowing for a submerged point of discharge. Any of these methods of placement could potentially be utilized during the pilot, if needed.

Pilot Cap Thickness and Volume

Two objectives of the pilot are drivers in determining the volumes of material necessary for placement for the pilot: 1) the need to determine differences in cap material behavior for differing placement options, and 2) the need to determine if a full design cap thickness can be constructed as intended. Time and cost limitations for the pilot make it impractical to undertake construction of the full design thickness for each possible combination of cap material type, water depth, bottom slope, and placement technique. Therefore the pilot should include some combination of small placement volumes and larger placed volumes. Data on various placement methods and variable material types can be obtained from a few hopper placements with small placement volumes. The most likely placement method and material type to be employed full scale should be evaluated for construction of a full cap design thickness over a sufficient area to determine the process of cap thickness buildup for adjacent placements. Since the bottom slope only slightly increases with water depth for areas between the 40 and 70 meter depth contours, a comparison of shallow and deeper placement areas for the pilot would provide the needed information for both depth and slope.

Based on these considerations, a total of four types of pilot placements are anticipated:

Fine material/ conventional placement/ shallow cell
Coarse material/ spreading placement/ shallow cell
Fine material/ conventional placement/ deep cell
Coarse material/ spreading placement/ shallow cell

Small Volume Pilot Placements

Placement of a relatively small volume should be sufficient to observe the differences between conventional vs. spreading placement methods, finer vs. coarser material types (cap material sources) and shallow vs. deeper cells. Based on the modeling conducted to date, the spreading method of placement is appropriate for the coarser material type. Placement of coarser material using conventional methods is not considered desirable, at least for the initial layer of cap material, because of the higher potential for sediment displacement and resuspension.

Removal of large volumes from the sand borrow area may require extensive and time-consuming studies. Large volumes of coarse material have not be identified within the scope of the current Queen's Gate project. For these reasons, placement of coarser material for a full cap thickness over a large area is not anticipated for the pilot, and should be evaluated with small volume placements. The small volume placements should be at least a few hopper loads (say four to five hopper loads) to confirm the rate of buildup of cap thickness and spreading and dispersion behavior.

The anticipated hopper load for a Manhatten class dredge is approximately 1200 cubic meters (hopper or "bin" volume)[2]. Coarse cap material should be placed using spreading methods only, but placed in both shallow and deep cells, so multiple small volume placements would be required. Therefore, on the order of 20,000 cubic meters (in hopper volume) is required from a coarse grained site.

[2] Personnal communication with Bill Pagendarm, NATCO.

Full Design Cap Placements

Designs of 15 cm for a thin cap and 45 cm for an isolation cap were recommended in TR EL-99-2. Sufficient material should therefore be placed during the pilot to determine if these cap thicknesses can be constructed over a larger area with acceptable rates of buildup and acceptable variability in cap thickness, considering the overlapping effect of adjacent placements. The major consideration here is to observe the rate of sediment accumulation as a function of distance from clusters of individual hopper dredge placements. It may not be necessary to construct a full 45 cm cap thickness to obtain the needed field data on full design cap placement. If a 15 cm cap can be constructed over a larger area, then the same methods of placement can be used to construct a 45 cm cap. However, the pilot scope should plan for construction of the 45 cm thickness.

Data on placement behavior for the full design cap thickness are needed for both shallow and deep pilot cap placement areas. The source of fine grained cap material will be Queen's Gate and this material source would be used to build the design cap thickness in both shallow and deep locations. Data for cap buildup can be obtained from a minimum thickness of 15 cm, but a 45 cm thickness would be desirable over at least a portion of the area. A 15 cm coverage over one 300 by 600 m cap cell equates to 27000 cubic meters in-cap volume. For Queen's Gate sediment, 27000 cubic meters in-cap is equivalent to approximately 58000 cubic meters in-hopper or approximately 42000 cubic meters in-source volume. For a 45 cm coverage over one cell, approximately 174,000 cubic meters in-hopper would be needed. To accumulate these thicknesses uniformly over a total cell, a larger volume must be placed, with some of that material going onto adjacent cells and some being lost during placement. So, the required total volume of Queen's Gate material placed on the shelf for two cells capped at 45 cm would be in the range of 300,000 to 500,000 cubic meters in-hopper volume[3].

The present cap designs and recommended operational approaches call for placement of the needed volumes uniformly over each of the capping cells, to include those adjacent to the seaward capping limit at the 70 m depth contour. However, there are concerns regarding the potential for flow of cap material over the shelf break during placement. The need for placement of materials uniformly over a deeper cap cell may depend on the observed behavior of cap placements at the shallower depths. The limits of seaward placement locations may be established at depths landward of the 70 m depth contour, and this may limit the cap thickness which can be constructed down to 70 m.

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[3] A detailed discussion of the volumes required to construct the design cap thicknesses is found in Appendix E of TR-EL-99-2. The ratios of in-channel, in-source, in-hopper, and in-cap volumes used here are given in Table E6 of TR EL-99-2. Note that NATCO currently estimates an average in-situ density for Queen's Gate material of 1.936, and an average in-hopper density of 1.4, and these represent volume relationships similar to those in Table E6.

Refined Model Predictions

The USACE MDFATE model was used to predict the rate of cap material buildup for specific sediment characteristics, various water depths over the shelf and various placement approaches. The USACE STFATE model was used to predict cap material dispersion during placement and velocities of bottom impact for further evaluation of spreading behavior using the SURGE model. These predictions were based on a broad range of assumed properties for the cap material. Once specific cap material sources are selected, refined predictions using the specific site conditions and cap material properties should be made. Results of the refined predictions will determine any needed adjustments in the operational approach and monitoring station placement for the initial placements for the pilot. The models will also be used during the course of the pilot placements to refine operational methods for full cap placements constructed as a part of the pilot.

Sequence of Placement Operations

A sequence of the pilot placements must consider the need to observe the basic behavior of single hopper dredge placements for finer vs. coarser cap material, seaward vs. shoreward cell locations, and spreading vs. conventional placement methods. In this way, if the behavior of a given placement exceeds acceptable limits on spread or dispersion or resuspension, adjustments can be made to the operation prior to placement of larger volumes over a larger area during the pilot.

The proposed Placement/ Monitoring sequence is as follows:

> Event #0 - Prior to any actual pilot placement on the site, releases of the Queen's Gate material with conventional placement methods at the disposal sites now in use should be observed to determine the nature and rate of release from the hopper. Placements of coarser material with the spreading method of placement should also be observed at the disposal sites now in use or at the borrow source to determine the rate of release from the hopper and any tendency of the material to bridge. These can be considered "practice releases" for purposes of the pilot and must be conducted outside the potential capping prism.
>
> Event #1 Single Conventional Discharge LU - The first pilot placement would be a single hopper load of the finer material from Queen's Gate discharged at the center cell LU (see Figure 1). This load would be placed using the conventional placement method. Approximately one week of downtime following this single placement should be planned to assess the adequacy of the monitoring equipment and techniques, shift instrumentation for the next placement, and analyze the monitoring results for this single placement.
>
> Event #2 Small Volume with Spreading Discharge LD - If a suitable coarse material source is available, this event would be a single hopper load followed by a small volume placement discharged ~~at~~ along the centerline of cell LD (see Figure 1). A single load would be placed using the spreading method of placement. The direction of travel of the

hopper should proceed downstream to upstream along the landward boundary of cell LD beginning at the northwest corner of the cell to allow for any overshoot of the placement away from the outfalls. Once the data from a single hopper placement have been assessed, placement of up to 4 additional hopper/barge loads will occur with the intent of creating a thicker cap using this method. Once it has been determined that data collection is complete for Event #2, (i.e. data such as SPC images are captured), Event #3 could proceed from a scheduling standpoint prior to complete initial analysis of data from Event #2.

Event #3 Full Cap Thickness LU - Event 3 is the essentially uninterrupted placement of a full cap thickness over landward upstream cell LU. Event #3 can proceed if the spreading and dispersion observed for the Event #1 single placement is acceptable, and the initial placements for Event #3 would not interfere with Events #4 and #5 in the seaward cells SU and SD located downslope from cell LU. The Event #3 operation would be conducted using conventional placement techniques and finer material from Queen's Gate. Additional hopper placements would be made at the same release point as used for Event #1 until a cap thickness of ~ 15 cm is constructed. Then placement locations would be shifted to the next placement point and the process repeated to build the thickness over a larger area. Once a cap thickness of ~15cm is constructed over the total area of cell LU, operations would be repeated until a cap thickness of ~45 cm is constructed. (Note that the present monitoring scope does not include multiple placements in LU, and this is an item which should be discussed). Spacing between placements of 200 feet is recommended in TR EL-99-2, and this spacing will be refined based on additional modeling. Once placements are completed along the entire landward lane, the placements would be shifted to the next lane. Spacing between lanes would initially be set at 200 feet. Both the lane and placement spacings may be adjusted, during the cap placement, depending upon observed rates of buildup. Event #3 also would include the placement of additional hopper loads of coarser material using the spreading method in cell LD until the total of 4 to 5 hopperloads are placed.

Event #4 Single Conventional Discharge SU - This placement is similar to Event #1 except in a deeper seaward cell. A single hopper load of the finer material from Queen's Gate would be discharged at the center of cell SU which is at the ~60 to 65 m depth. This load would be placed using the conventional placement method. Essentially no dredge downtime would be needed to analyze the monitoring results for this single placement if previous data from Event #1 indicates no interference from on-going cap placement during Event #3. Once it has been determined that data collection is accomplished for this event, and instrumentation is shifted, the next event could begin.

Event #5 Small Volume with Spreading Placement SD - Event #5 would be similar to Event #2 except in a deeper seaward cell. If a suitable coarse material source is available, this event would be a single hopper load load followed by a small volume placement discharged along the centerline of cell SD. This load would be placed using the spreading method of placement. The direction of travel of the hopper should proceed downstream to upstream along the landward boundary of cell SD beginning at the northwest corner of the cell to allow for any overshoot of the placement away from the outfalls. Once the data from a single hopper placement have been assessed, placement of up to 4 additional hopper/barge loads will occur with the intent of creating a thicker cap using this method. Once it has been determined that data collection is accomplished for this event, and instrumentation is shifted, the next event could begin.

Event #6 Full Cap Thickness SU - Event 6 is the essentially uninterrupted placement of a full cap thickness over the seaward upstream cell SU. Event 6 can proceed if the spreading and dispersion observed for the Event #4 single placement is acceptable. This operation would be conducted using conventional placement techniques and finer material from Queen's Gate. Initial placements start at landward boundary of cell SU. Spacing between placements would initially be set at 200 feet. Once placements are completed along the entire landward lane, the placements would be shifted to the next lane. Spacing between lanes would initially be set at 200 feet. Both the lane and placement spacings may be adjusted, during the cap placement, depending upon observed rates of buildup. Depending on observed behavior, placements on lanes near the 70m depth contour (near the seaward boundary of cell SU) may be limited to avoid excessive buildup of capping material in areas with steeper slopes. Event #6 also would also include the placement of additional hopper loads of coarser material using the spreading method in cell SD until the total of 4 to 5 hopperloads are placed.

GIS-Based Project Management Tools

Once the placement operations begin, data will be available from side-scan surveys, sediment profile surveys, etc. in hours. Decisions to continue placement with an initial operational approach or to change the approach must be made in a matter of a day or two throughout the period of the pilot. This will require a reliable and flexible data management tool. GIS-based approaches are proving to be invaluable in such project environment. Such a system is now in use in management of the HARS ocean remediation site off New York Harbor. Similar approaches will be developed and used for the PV Shelf pilot project and could be later used for a full scale cap placement.

Monitoring Requirements

Key Questions to be Addressed

Monitoring of the Pilot project will enable the EPA to address five key short and intermediate term questions relative to capping on the Palos Verdes Shelf. These questions are:

- Does placement occur as modeled?
- Can we construct a uniform cap?
- Can we limit disturbance to in-place sediments?

- ♦ Does the cap remain clean?
- ♦ Does the cap remain stable?

Each of these questions (with slight variation in wording) and the generic monitoring approach was addressed in Appendix H of TR EL-99-2, but we will briefly review the environmental concerns that relate to these issues here. The detailed scope of work to accomplish this monitoring is attached as Appendix A to this document.

Does placement occur as modeled? This question and its associated monitoring will incorporate several concerns that have been raised about the placement of sediments from vessels at the ocean surface onto the seafloor below. These concerns include:

- how far the sediments spread,
- how thick the material is once it comes to rest on the bottom,
- the effect of depth, slope, and material type,
- and the potential for the creation of turbidity flows or mudwaves.

For example, modeling predicts that one hopper load of sediment placed by split-hull methods will produce a deposit approximately 500 meters in diameter with a maximum thickness of 3 cm at the center and thinning to 0.1 cm at the edge.

Several monitoring tools will be used to measure the actual distribution and thickness of the deposit during several phases of the Pilot project and under several different scenarios (Table x). Combined these will allow an assessment of how actual field conditions reflect those predicted by the model.

Can we construct a uniform cap? This question involves the ability to place multiple loads of sediment over an area without creating many areas that are too thick and others that are too thin. The ability to control placement will be assessed both during the series of barge placements and once they are complete. Many of the same tools used for the above effort will be utilized in these interim surveys with the addition of sub-bottom profiling and possibly bathymetric surveys.

Can we limit disturbance to in-place sediments? Sediments released from the placement vessel will fall through the water column, impact the bottom, and then spread laterally. This process has the potential to disturb the in-place sediments both at the direct point of impact, and to a lesser degree in the area where lateral spread occurs. The Operations Plan is intended to minimize potential disturbance by only disposing directly on the EA sediment with the initial hopper load. Following this first hopper load, the next several will be directed to the same location so that disturbance of the EA sediment will be insulated by the sediments already in place from the first load. From that point on, all subsequent disposal will always occur over cap sediments that have already reached their position on the seafloor through lateral spreading.

The amount of disturbance to the EA sediments will be assessed both at the point of impact and in the area of lateral spreading. The sediment profile camera and coring will be the principal methods used to assess this level of disturbance. In particular, the absence or thickness of the sediment's oxidized layer, which will be measured prior to disposal, will provide a very good marker for this assessment.

A second concern regarding mixing is the effect on water quality. Again, because of the operational approach, resuspension of EA sediment should be greatly reduced after the initial placement, but the amount of contaminant in the plume will be monitored to assess this expectation. This effort will involve tracking the plume and measuring suspended solids and contaminant concentration relative to background.

Does the cap remain clean? In the short and intermediate term this question will be addressed as part of the assessment of mixing of the EA and cap sediments. Both direct coring with chemical analyses and the sediment profile photographs will be useful for evaluating whether the cap was placed with minimal mixing. Some presence of contaminants in the cap can be expected, because of the natural resuspension and transport of EA sediments that will occur during the cap construction process, along with resuspension caused by the operations themselves. However, the monitoring will allow measurement of what levels can be expected immediately after capping. These data will then be useful for determining any changes in the sediment or contaminant profiles in future cores.

Does the cap remain stable? The stability of the cap both during and immediately after construction will be determined by the combination of surveys that are being conducted to assess the distribution of the cap over the EA deposit. The bottom mounted arrays will document the changes in bottom lateral surge speeds that occur during the placement process. Side-scan, sediment profile photography, and coring will all be used to map the actual extent of the deposit. Side-scan in particular, will be useful for assessing the down slope spread of material in assessing the potential for turbidity flow.

Table x. Monitoring tools and applications.

Monitoring Tool	**Applications**
Sediment Profile Camera	Sediment layer thickness, lateral extent, layer mixing, grain size, biological condition
Coring	Sediment layer thickness, layer mixing, grain size, chemical profile, cap stability
Side-scan sonar	Sediment distribution, bottom disturbance features, bottom

	topography
Sub-bottom chirp profiler	Cap thickness
Bathymetry	Cap thickness
Acoustic Doppler Current Profiler (ADCP)	Current speed, surge speed, plume location
Optical Back Scatter	Plume location and relative concentration
Water samples	Suspended solids, contaminant concentrations

Monitoring Program Components

The monitoring program, as detailed in the appendix, consists of several integrated components. The lists below provide a summary of these components, the tools, and the data that will be collected.

Baseline Data Collection

Vane shear for in-situ sediments
Relative density/ water content of in-situ sediments
Grain size
Chemistry from cores
Sediment profile camera photographs

Hopper Dredge Operation Data

Transit route
Positioning during placement
Time to release material

Hopper Load Monitoring

Hopper load curves for all loads
Samples of hopper inflow and overflow for GSD, TSS, and TOC
(Samples for each load for small placements; 5% of loads for full cap)

Data Collection During Placement

OBS/ADCP bottom array
Ship deployed OBS/ADCP
Water column samples
Sediment profile camera photographs (for cap buildup and extend of accumulation)

Sediment cores
Side-scan sonar survey

Post Cap Monitoring

Subbottom profiling
Sediment profile camera photographs
Bathymetry (pending technical evaluation)
Sediment cores

Longer Term Questions

The monitoring scope that has been developed for the Pilot project does not far field or long term, though this scope will be prepared when requested by the EPA project managers. TR EL-99-2 provides the outline for that effort, but briefly, it would include coring, sediment profile camera surveys, sub-bottom profiles.

Several other items related to monitoring are not explicitly addressed in this plan. This includes determination of the abundance of deep burrowers, reductions in water column contaminant concentrations, verification of the diffusion model, and reductions in tissue levels in resident benthic or fishery species.

Presence of deep burrowers on the Palos Verdes Shelf and their effects on sediment mixing has been addressed by a number of investigators (list them). Video camera surveys have clearly shown evidence of burrower presence (ref), yet there are other investigations that suggest that even if these burrowers are present, they are having little influence on the long-term burial of the EA deposit (ref). In either event, direct assessment of deep burrower abundance may not be necessary, since the monitoring approach as described in TR EL-99-2 is intended to directly address the mixing that they would cause.

Verification of the diffusion model will be reliant on data from longer term cores collected from the pilot cells or from the full cap. The broad scale changes in water quality and fishery contamination can only be addressed once the full scale project has been completed. Investigations by xxxxx (199x) and xxxxx (199x) suggest that both water quality and contaminant tissue levels of some fishery species exhibit a decreasing gradient away from the Palos Verdes Shelf. Thus, if a decision is made to proceed with the full cap, designing a monitoring program to assess changes in these parameters appears to hold promise as reasonable means to include as measurements of success.

Reports and Interpretation

Data reports from the monitoring contractor should be provided as data is collected.
A post-cap comprehensive report will be prepared (joint effort USACE/ Contractor).
An addendum following the 6 mos/ 1 year monitoring will be prepared (joint effort USACE/ Contractor).

References

USACE Los Angeles District. "Project Management Plan (PMP) For U.S. Environmental Protection Agency, Region IX on Palos Verdes Shelf Superfund Site, Los Angeles County, California," Prepared by U.S. Army Corps of Engineers Los Angeles District.

Palermo, Michael, Paul Schroeder, Yilda Rivera, Carlos Ruiz, Doug Clarke, Joe Gailani, James Clausner, Mary Hynes, Thomas Fredette, Barbara Tardy, Linda Peyman-Dove, and Anthony Risko. 1999. “Options for In Situ Capping of Palos Verdes Shelf Contaminated Sediments,” Technical Report EL-99-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. http://www.wes.army.mil/el/elpubs/pdf/trel-99-2.pdf

APPENDIX B
Fredette 2000

Palos Verdes Shelf Pilot Project Monitoring Scope of Work

Background

The contractor is to become familiar with the monitoring sections of Palermo et al. (1999). In particular, the contractor should become familiar with the objectives of the work and the purpose (null hypotheses) of the monitoring (Chapter 5 and Appendix F). The objectives of this monitoring work are to assist in constructing, evaluating and demonstrating the ability to cap in-place, effluent affected (EA) sediments on the Palos Verdes Shelf during the pilot project. The contractor is also to become familiar with the Operations and Monitoring Plan prepared for this effort. The contractor is to review additional information collected for this Pilot Project (e.g., sediment physical and chemical data) and recommend modifications to the monitoring plan if necessary. This will include identification of needed changes to the null hypotheses. This is an experimental effort and the contractor is to build flexibility into the monitoring schedule and approaches in order to incorporate necessary adjustments in placement schedule or approaches.

Task 1. Collection of Additional Background Data and SOW Revision
Task 2. Placement Surge Video Documentation
Task 3. Hopper Dredge Operation Data
Task 4. In-hopper Sediment Data
Task 5. Flex Surveys
Task 6. Monitoring of Cell LU (Events #1 and#3a)
Task 7. Monitoring of Cell LD (Events #2 and 3b)
Task 8. Monitoring of Cell SU (Events #4 and #6a)
Task 9. Monitoring of Cell SD (Events #5 and #6b) **(Eliminated from Scope)**
Task 10. Evaluation of Bathymetry Surveying **(Eliminated from Scope)**
Task 11. Disposal Plume Transport Survey
Optional Task 12. Cap Erosion Analysis Samples
Task 13. Reporting
Optional Task 14. Water Current Monitoring

Task 1. Collection of Additional Background Data and SOW Revision

Background: The distribution of the effluent affected (EA) deposit has been studied by both the USGS and the LACSD. Conceptual cap prism design is described in Palermo et al. (1999). The Field Pilot Study Operations and Monitoring Plan (Palermo et al. 2000) recommends that the pilot project be carried out on four cells to the north-west of the outfalls. Prior to conducting the pilot project there is a need to more fully characterize these pilot cells to provide a well-defined baseline to which post-capping samples can be compared. These investigations will be carried out in the weeks and days prior to cap placement.

Objectives:

1. Provide baseline sediment chemistry and physical characteristics in the target pilot cells.

2. Re-evaluate this scope of work in response to the new information collected, review of relevant documents provided by the Corps Project Manager, and the approved Project Work Plan (developed under a separate scope). Based on those reviews the contractor will recommend changes to this SOW.

Approach:

A. The contractor will collect 9 gravity cores or vibracores (minimum 20 cm length) from each of the four pilot cells for analysis of sediment chemistry and physical data. Note that these locations will be at points where the sub-bottom profile lanes will cross (see figure 1). Repeating these stations in the post-cap monitoring will assist in the interpretation of the sub-bottom data. Cores will be sectioned into 4 cm increments (0-4, 4-8, 8-12, 12-16, 16-20 cm). The increments will be analyzed for p,p' DDE, bulk density, and grain size. The Contractor will collect field QC samples (i.e., duplicates, ambient conditions and equipment rinsate blanks, and matrix spike/matrix spike duplicates [MS/MSDs]) using the methods and in the frequencies described in the *Draft Project Work Plan for the Palos Verdes Pilot Capping Project: Baseline Monitoring Activities* (SAIC, 2000).

B. From the nine core stations (above) the contractor will randomly select two of these stations at which a second core will be taken for each cell. Vane shear measurements will be made on these two cores for the full length of the core. Subsamples of the cores from 0-20 cm will be taken to create a composite sample on which bulk density and Atterberg limits will be determined. If the core penetrates into a visually distinctive sediment horizon (e.g., change in color, consistency or visually apparent grain size) a sample of this sediment will be taken for bulk density and Atterberg limits and up to four vane shear measurements will be taken, evenly distributed along the length of the horizon.

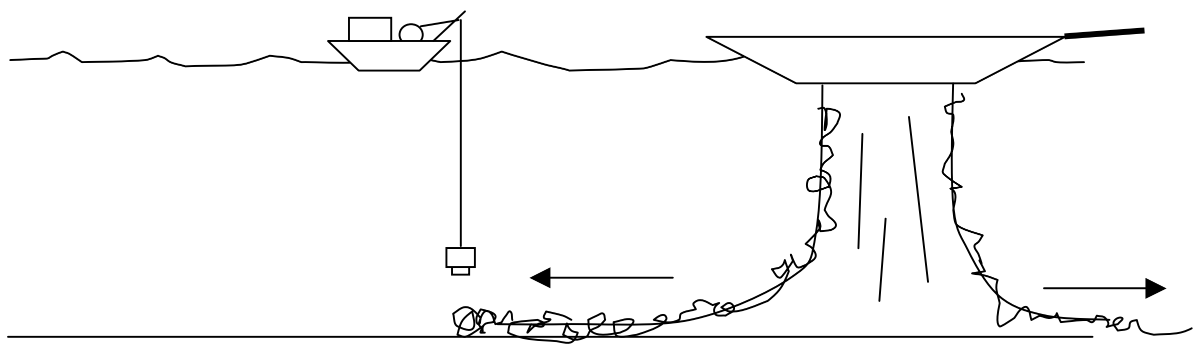
C. The raw data from the top 2 increments of the cores in Task A, above, will be submitted in a report to the Corps Project Manager 4 weeks after field collection. A full data report will be submitted to the Corps Project Manager 8 weeks after field collection. The data will be added to the project GIS at the time of the full report submission.

D. The contractor will perform a base-line, high resolution sub-bottom profiler and high resolution, dual frequency digital side scan survey at each of the four pilot cells (figure 3). The sub-bottom profiler should be adjusted to maximize resolution in the top meter of the sediment column. Later surveys will be compared to these surveys as part of the tools used to assess cap thickness and distribution.

E. The contractor will evaluate the new data collected in the previous approaches, review relevant documents provided by the Corps Project Manager, and the approved Project Work Plan (developed under a separate scope). Based on those reviews the contractor will recommend changes to this SOW by reallocating survey effort within the overall level of effort already planned (including the flex surveys identified in Task 5). These changes may include modifications to the approaches, station numbers, sampling methods, and so on. The contractor may also recommend modifications to the monitoring effort beyond the existing level of effort, but these will require thorough explanation as to why they can not be achieved through reallocation of effort.

Task 2. Placement Surge Video Documentation

Objective: Provide video documentation of the bottom surge that occurs during placement of cap material during conventional placement operations.



Approach: The contractor will use a video camera to record the bottom surge as it moves past fixed points varying distances from the release point of the capping sediments. This array should be capable of operating both when resting on the bottom and suspended above the bottom from the survey vessel. The contractor will need to adjust the camera position, through field trials, based on visibility and the thickness of the surge along the bottom. This information will be used to complement the quantitative data that are being collected by bottom instrument arrays measuring current speed, suspended sediment, and other surge characteristics.

The contractor will deploy a video camera array/sled equipped with lights during initial disposal at cell LU, SU, and two other events to be determined in coordination with the Project Manager, to visually document the lateral spread of the bottom surge during placement events. The Contractor will visually document the plume varying distances from the point of sediment release (e.g., 50 m, 75m, 100m, 200m). The intent will be to illustrate the characteristics (speed, thickness) of the surge with increasing distance from the point of release out to the point where the surge is minimal or not present.

The contractor will provide an edited, annotated videotape of these placement events along with a narrative report. In addition, at least 6 video clips (30-60 second duration) will be provided in digital format for use in PowerPoint presentations or other media.

Task 3. Hopper Dredge Operation Data

Objective: The contractor will collect hopper dredge positioning data during transit to and during the cap placement operations. The contractor also will collect information on the time and rate of material discharge to monitor where sediment placement occurs.

Approach: The contractor will coordinate with the dredging contractor to install and maintain an automated electronic tracking system on the placement vessel during the pilot project operations. This system will acquire and store DGPS vessel positions at regular intervals (i.e., 10-min intervals) during loading and transit to the PV Shelf placement locations. Upon approach to the placement location(s), the system will automatically increase the rate of position recording (i.e., to 6-sec intervals). The DGPS locations of the dredge during placement will be corrected to report the center of the hopper dredge bin. Additionally, hopper dredge draft and/or tonnage data will be acquired from the dredging contractor during all placements events (updated every 10 seconds or less during placement events). This time series information will be merged with the dredge position data to yield an accurate record of placement location/volume/rate for each load. Further, for all intensively monitored placement events (single hopper placement surveys, first four loads of the interim placements), the contractor will coordinate with the dredging contractor to obtain hopper filling tonnage data.

Associated data services will include: 1) daily data updates presenting the start time/position and end time/position for each placement event, optionally on a Web Site, 2) weekly reports presenting tabular data and graphic plots of dredge sediment release positions for each event, 3) weekly updates of placement data on DAN-LA to provide the project team with access to placement results for MDFATE modeling. Additionally, the DAN-LA database will maintain a record of loading position for each load of cap material.

Task 4. In-hopper Sediment Data

Objective: Data on the physical characteristics of the sediment in the placement vessels will be needed as part of the evaluation of how well actual field results compare to the expected spread and thickness of sediments at the capping cells. Additionally, data on the chemical characteristics of sediments that may be dredged from borrow areas (e.g., A2 and A3) will need to be acquired for later comparison of chemical concentrations within the cap and underlying EA sediment, if borrow area sediments are used for capping.

Approach: The contractor will obtain assistance from the dredging contractor for collection of sediment samples from the hopper for the following events during the pilot cap monitoring program: 1) the first three loads of cap material transported to each cell of the capping area, 2) up to 25 of the loads during continuous capping operations, and 3) the first three loads of any cap material originating from borrow areas. For each load, three samples will be collected (one each from bow, center and stern of hopper) and composited to achieve a single composite sediment sample from each load.

The contractor will be responsible for providing sample containers, instructions to the dredging contractor for sample collection, sample custody, and laboratory analysis of geotechnical properties (grain size, bulk density, specific gravity, water content, and atterberg limits) of each composite sediment sample. Additionally, chemical analysis of p,p' DDE will be conducted for composite sediment samples from the first three loads acquired from the borrow areas. Raw sediment grain-size data from the first three loads for each cell will be provided to the Corps Project Manager within 24 hours of sample collection.

All the results will be presented in a report upon completion of the pilot cap monitoring program. The data also will be entered into the database of DAN-LA within one week as the results become available.

Task 5. Flex Surveys

Approach: In addition to the survey efforts requested in Tasks 6-9, the contractor will plan on 60 additional SPC/PVC stations, 20 additional sediment cores (all for visual core descriptions, 8 for p,p' DDE sampled at three intervals as described in the Post Cap sections below), and 25 additional water samples (all for TSS, 5 for p,p' DDE). These extra samples will be used to augment, as needed, the surveys already planned in Tasks 6-9 or to conduct separate supplementary surveys during the course of the placement operations. This will permit maximum survey flexibility and allow immediate investigation of areas of uncertainty. Collection of these additional samples will be at the request of the Corps Project Manager and may be based on recommendations of the contractor.

Task 6. Monitoring of Cell LU (Landward – upstream) (Events #1 and #3a)

Background: This portion of the project will involve the conventional placement of hopper loads of sediment from the Queen's Gate entrance channel. Initially, the placement vessel will be directed to the center point of the capping cell that has been denoted as the landward and upstream cell (LU). Following the first placement, approximately 7 days will be provided for collection and analysis of the monitoring data before any additional placement occurs (figure 2). Once the data have been assessed, additional placement will occur with the intent of creating a 15 cm cap over the entire cell.

Objectives

Objective 1: Assess the thickness and lateral distribution of capping sediments during placement operations.

Objective 2: Assess plume TSS and p,p' DDE concentrations and extent for two hours following hopper placement.

Objective 3: Assess extent of surge during placement operations.

Objective 4: Assess mixing of cap sediments with the in-situ sediments.

Objective 5: Evaluate monitoring approaches.

Approach

A. Baseline Survey. The contractor will conduct a 25 station pre-placement sediment profile camera/plan view camera (SPC/PVC) survey at the cell named LU(#1) (Figure 1). Three replicate photographs will be obtained from each station (75 photographs total) for full analysis of infaunal successional status and sediment physical conditions.

B. Single Hopper Placement Survey (Event #1).

i.) Prior to the first placement event the contractor will deploy at least four (4) and preferably five (5) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent (the contractor's ARRESS tripods are acceptable] and a self-recording OBS gage. One of these arrays will also be outfitted with an upward-looking ADCP to augment assessment of plume behavior. Three of these arrays will be deployed in a transect down slope of the planned placement point at distances of 75, 150, and 250 meters. The fourth will be placed up slope 75 meters from the planned placement point. The fifth current meter can be placed either 150 m upslope or adjacent to the inner most downslope current meter to verify the Aquadopp and ARESS current meters are producing comparable results. The array at 150 m downslope will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments after the placement event, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement event will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval.

ii.) The contractor will use acoustic Doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the plume created by the placement of cap material for two hours. The contractor will take up to 27 water samples for total suspended solids (TSS) analysis and 6 samples for total (combined particulate and dissolved) p,p' DDE. The p,p' DDE samples will be taken in the centroid of the plume within 2 meters of the bottom (where concentrations can be expected to be greatest) at 5, 20, 40, 60, 90, and 120 minutes after placement. Prior to the placement event the contractor will take 3 background samples from within 2 meters of the bottom. Samples will be analyzed for total p,p' DDE and TSS.

iii.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1). The contractor will randomly select these 5 stations from among the 37 SPC/PVC stations in the previous task. Four of the five will be selected from inner stations expected to have cap accumulation and one selected from the outer stations expected to be free of cap. These cores will be used as an independent check on the SPC measurements. Cores will be extracted, vertically split, photographed, and visually described within 24 hours of collection to assess the thickness of cap material and the degree of mixing between the cap and EA sediment. The contractor will also collect sufficient cap material from either one core or a composite of the cores and analyze the sample for grain size distribution and bulk density.

v.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

C. Interim Placement Surveys (Creation of 15cm Cap) **(Event #3a).**

i.) Prior to the next series of four placement events the contractor will deploy at least four (4) bottom-moored arrays (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. One of these arrays will also be outfitted with an upward-looking ADCP to augment assessment of plume behavior. Three of these arrays will be deployed in a transect down slope of the planned placement point at distances of 75, 150, and 250 meters. The fourth will be placed up slope 75 meters from the planned placement point. The fifth will be placed up slope 75 meters from the planned placement point. The array at 150 m downslope will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments once the four placement events have occurred, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement events will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval.

ii.) The contractor will map the location, concentration, and extent of the plume created by the placement of cap material of the second and third placement for two hours. The contractor will repeat the approach used for the Single Hopper Placement Survey.

iii.) The contractor will conduct two 14 station sediment profile camera/plan view camera surveys, one after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point, and the second two thirds of the way through the 15 cm cap placement (figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 2 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1), one after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point, and the second two thirds of the way through the 15 cm cap placement. Cores will be extracted, vertically split, photographed, and visually described as for the Single Hopper Placement Survey. The contractor will also collect sufficient cap material from either one core or a composite of the cores at the first interim survey and analyze the sample for grain size and bulk density.

D. Post Cap Monitoring

i.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

ii.) The contractor will conduct a sub-bottom, chirp acoustic profile of the capping cell to assess cap thickness. The survey should consist of 3 longitudinal transects and 7 cross sections (figure 1).

iii.) The contractor will collect 9 gravity cores or vibracores from the capping cell. These cores will penetrate at least 20 cm into the EA sediment. The cores will be split, photographed, visually described, and sampled. Particular attention should be given to the condition of the transition between the EA and cap sediments. Sediment grain size, bulk density, specific gravity, water content, atterberg limits (if sufficient fines), and chemistry samples will be taken from four of these cores (randomly selected from the nine). Samples will be taken at the sediment/water interface (top of core), 3 cm and 7 cm above the interface/mixed layer and 4 cm and 8 cm below the interface/mixed layer. The "7 cm" and "8 cm" samples will be archived. The "0, 3 and 4 cm" samples will be analyzed for the physical parameters listed above and p,p' DDE.

iv.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

Task 7. Monitoring of Cell LD (Landward, downstream) (Events #2 and #3b)

Background: This portion of the project will involve the spreading placement of a single hopper load of sediment from the coarse sediment borrow site. The placement vessel will be directed to the center lane of the capping cell that has been denoted as the landward and downstream cell (LD). Following placement of the first hopper load in this cell, approximately 7 days will be provided for collection and analysis of the monitoring data, though if the data from the first LU event provides good confirmation of predictions, placement Event #3a will begin during this 7 days (figure 2). Once the data have been assessed, additional placement of several hopper loads will occur (Event #3b), with the intent of creating a thicker cap, using this method.

Note if the direct pump-out through the drag arm option is exercised, the dredged material will be injected at a depth of approximately 20-22 m. The exit velocity will be approximately about 1 m/sec, indicating the dredged material will reach the bottom in cell LD in 30 seconds.

Objectives: As in described for Task 6.

Approach

A. Baseline Survey. The contractor will conduct a 25 station pre-placement sediment profile camera/plan view camera survey at the cell named LD(#2) (Figure 1). Three replicate photographs will be obtained from each station (75 photographs total) for full analysis of infaunal successional status and sediment physical conditions.

B. Single Hopper Placement Survey (Event #2).

i.) Prior to the first placement event the contractor will deploy at least four (4) bottom-moored arrays and preferably five (5) (see figure 4) consisting of a recording current meter [Nortek Aquadopp current meters (see www.NortekUSA.com for more information) or equivalent] and a self-recording OBS gage. One of these arrays will also be outfitted with an upward-looking ADCP to augment assessment of plume behavior. Three of these arrays will be deployed in a transect down slope of the planned placement point at distances of 75, 150, and 250 meters. The fourth will be placed up slope 75 meters from the planned placement point. The fifth current meter/obs gage will be deployed 150 m upslope. The array at 150 m downslope will have the upward looking ADCP. The instruments will be set to record once per second. The contractor will retrieve the instruments after the placement event, download, and analyze the data to assess the surge from sediment placement. The raw data from the hour around the cap placement event will be graphed and provided to the Corps Project Manager within 48 hours of array retrieval. If the spreading occurs as planned, there will be no bottom surge associated with the particle settling. Also the path the dredge takes will be quite long. Therefore the need for the bottom mounted current meters and OBS gages will be primarily to document the negative, i.e., to show that in fact individual particle settling did occur.

ii.) The contractor will use acoustic doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the plume created by the placement of cap material for two hours. For this scenario, the ADCP will be used to estimate the fall velocity of the individual particles and estimate the point at which they impact the bottom. For surface spreading using a cracked hull, a 0.2 mm particle should reach the bottom in 45 m of water in about 30 minutes. A 0.3 mm particle should reach the bottom in 45 m of water in about 15 minutes. A 0.4 mm particle should reach the bottom in 45 m of water in about 11 minutes. The contractor will take up to 27 water samples for total suspended solids (TSS) analysis and 6 samples for total (combined particulate and dissolved) p,p' DDE. The p,p' DDE samples will be taken in the centroid of the plume within 2 meters of the bottom (where concentrations can be expected to be greatest) at 5, 20, 40, 60, 90, and

120 minutes after placement. Prior to the placement event the contractor will take 3 background samples from within 2 meters of the bottom. Samples will be analyzed for total p,p' DDE and TSS.

iii.) After the placement event the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

iv.) The contractor will take gravity cores at 5 stations (figure 1). Four will be selected randomly from among the SPC stations in the cell and one randomly selected from among the SPC stations outside the cell. Cores will be processed and analyzed for visual descriptions, grain size and bulk density as in previous tasks.

v.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

C. Interim Placement Surveys. (Event#3b) Eliminated from Scope

D. Post Cap Monitoring

i.) After all placement events the contractor will conduct a 37 station sediment profile camera/plan view camera survey at the cell named LD(#2) (Figure 1). One photograph will be obtained from each station, though triplicates will be obtained at 4 randomly selected stations. These photographs will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

ii.) The contractor will conduct a high resolution, dual frequency digital side-scan survey over the cell to assess distribution of cap sediment. Preliminary results on cap distribution will be provided to the Corps Project Manager within 24 hours of survey completion.

Task 8. Monitoring of Cell SU (Seaward, Upstream) (Events #4 and #6a)

Background: This portion of the project will involve the conventional placement of hopper loads of sediment from the Queen's Gate channel. The placement vessel will be directed to the center point of the capping cell that has been denoted as the seaward and upstream cell (SU). Following placement of the first hopper load in this cell, approximately 6 days will be provided for collection and analysis of the monitoring data, during which time other placement may occur concurrently (figure 2). Once the data have been assessed, additional placement (no more than several hopper loads) will occur with the intent of creating a 15 cm cap at this point, only. Full capping of the entire cell will not occur at this time.

Approach: The contractor will repeat all surveys conducted for cell LU during the placement of cap at this cell with the exception of Tasks C(i) and C(ii) which will not be performed for cell SU and only one survey will be done under each of tasks C(iii) and C(iv) about two thirds of the way through creation of a 15 cm cap at a single disposal point.

Task 9. Monitoring of Cell SD (Seaward, Downstream) (Events #5 and #6b)

Task Eliminated from Scope

Task 10. Evaluation of Bathymetry Surveying

A. Task Deleted from Scope

Task 11. Disposal Plume Transport Survey

Background: Potential transport of suspended solids towards regional kelp forests is a concern. An assessment as to whether plumes would reach these locations and their extent and level of turbidity if they reach the kelp forests is needed.

Objectives: The contractor will contact local experts to determine the known location of the kelp forests nearest to the pilot demonstration area. The contractor will determine and map the extent and concentration of plume suspended sediments in the upper water column during expected on-shore transport events.
Approach:

1. The contractor will contact local experts to determine the location and extent of kelp forests near to the pilot study area. The contractor will acquire or develop a GIS data layer to contain this information.

2. The contractor will use an acoustic Doppler current profiler (ADCP) and optical back scatter (OBS) equipment to map the location and extent of the upper water column plume (upper 30 m) created by the placement of cap material for two hours. This will be accomplished 3 separate times during the period of the pilot study when placement of finer cap sediments are being placed in the Land ward cells. This will also occur when oceanographic conditions are expected to move the surface waters towards shore. The contractor will select these times in coordination with the Corps Project Manager. The contractor will take up to 27 water samples for total suspended solids (TSS) analysis in each plume to assist in mapping plume concentration.

Optional Task 12. Cap Erosion Analysis Samples

Background: The potential for the cap to be susceptible to erosion is one of the concerns that has been raised with the planned capping. One means of evaluating this possibility, will be to take samples of the in-place cap and test them in an erosion flume. The contractor will be responsible for collection of the samples for delivery to the analytical labs as specified. The actual testing of these samples is not a responsibility of the contractor under this scope of work.

Objective: Collect sediments for evaluation of the relative erosion potential of the in-place cap sediments.

Approach

A. After the completion of all other post-capping pilot surveys identified in this scope the contractor will collect sediment samples from near the center of cells LU and SU. At each of the two cells, the contractor will collect 120 liters of sediment using a Smith- McIntyre Grab and 3 cores (5 to 9 cm diameter by minimum 60 cm long, maximum 100 cm long). The 120 liter samples will be stored in sealed 12-liter buckets. Each bucket will be labeled to indicate location of samples.

B. The buckets and two cores from each of the two sites will be palletized and shipped to:

Dr. Rich Jepsen
Department of Energy
Sandia National Laboratory
4100 National Parks Highway
Carlsbad, NM 88220
(505) 234-0072
rajepse@sandia.gov

A brief letter will be submitted at completion of task to document samples collected including Latitude, Longitude, Area, Date, Time, and Water Depth at sample locations. The cores should remain upright and be padded to reduce vibrations. The samples should not be frozen and should be kept between 4 and 20 degrees centigrade. The cores should be split into 20 cm sections prior to shipping, and recapped and sealed.

One core from each site and a second copy of the letter documenting the sample locations, etc., should be sent to:

Dr. Marian Rollings
USAERDC
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199
ATTN: CEERD-GP
(601) 634-2952
rollingm@wes.army.mil

Task 13. Reporting

A. The contractor will provide daily updates via phone, e-mail, or fax to the Corps Project Manager during the operational portion of the Pilot capping. Weekly project meetings will be held with the Corps Project Manager to discuss progress and issues.

B. Within 3 weeks of the completion of monitoring the contractor will provide a cruise report to the Corps Project Manager. This report should provide a log of monitoring operations and a compilation of the data that are immediately available (qualified, as appropriate, regarding their preliminary or final validated status).

C. The contractor will prepare a detailed report (divided into chapters as appropriate) evaluating the results of the surveys. Methods used and data produced will be presented and analyzed. The report will address the objectives of the work and the purpose (null hypotheses). This report will include identification of needed changes to the null hypotheses, evaluation of the monitoring and operational approaches used, and recommendations. The contractor will produce both a final and draft report. The report will include an Executive Summary, Table of Contents, List of Figures, List of Tables, Introduction, Methods, Results, Discussion, Recommendations, References, Index, and Appendices. Ten copies of the draft report will be delivered to the Corps Project Manager 10 weeks following completion of all field work. The report will be delivered both in paper format and on electronic disk in MSWord 97 SR-2 format. Six (6) weeks following receipt of comments from the Corps Project Manager, the contractor will submit a ten copies of the final report. In addition to the paper and MS Word versions, the final report will also be submitted in PDF format on CD-ROM.

D. All data will be entered into the project GIS/Database and submitted to the Corps Project Manager on CD-ROM at the time of draft report submission.

Optional Task 14. Water Current Monitoring

Objective

Document the water current behavior in the area of the pilot capping cells for a 30 day period during the cap placement operations. These data will be used as input for hindcast modeling that may be done following the pilot project as part of the evaluation of field observations.

Approach

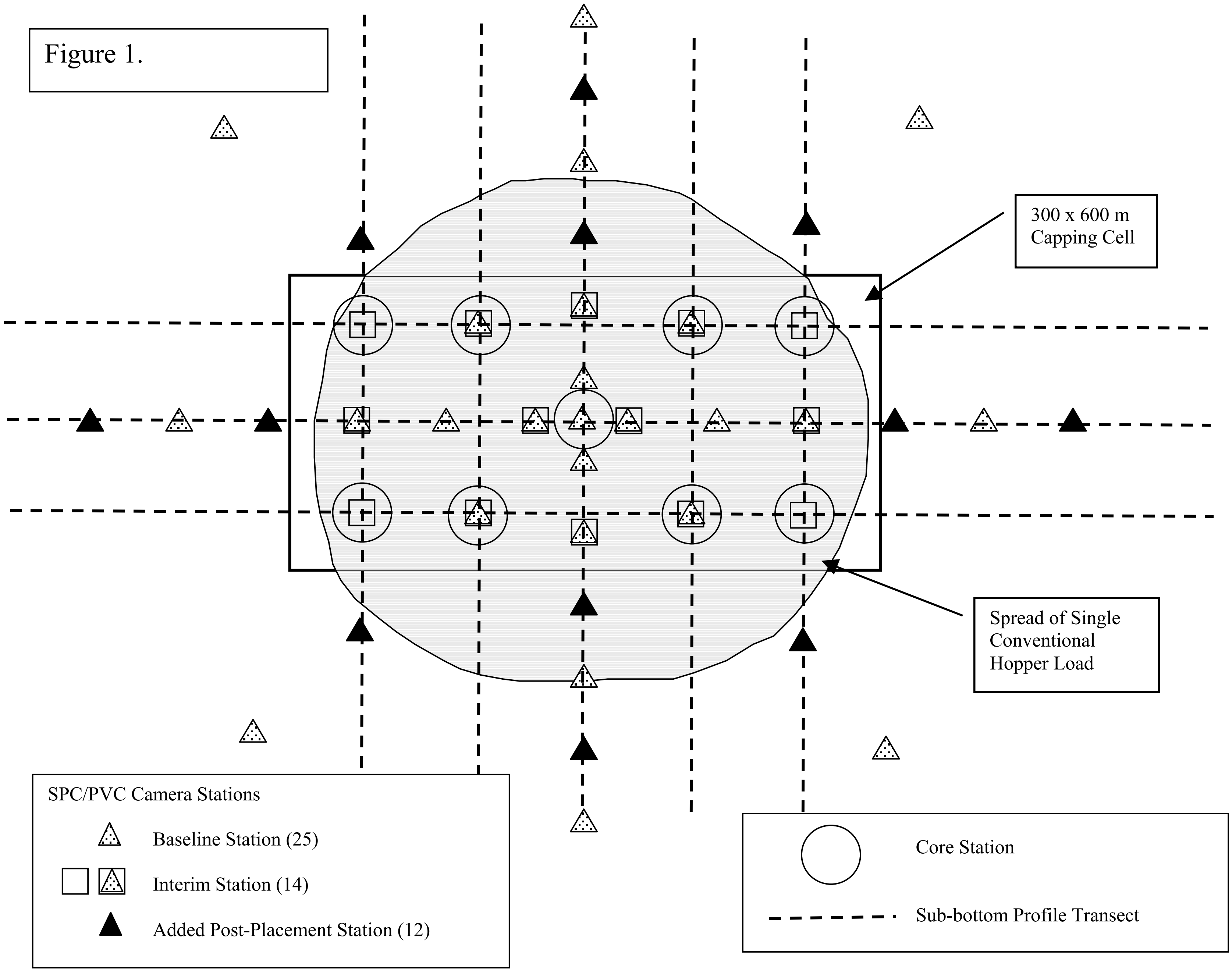
The contractor will deploy a bottom-moored, upward-looking ADCP on the Palos Verdes Shelf at a location near the pilot cells in coordination with the Project Manager. This instrument will be programmed to collect water column current data in multiple horizons (4 minimum) for a 30 day deployment period during the time that active placement of cap is occurring. If a shorter deployment period is sufficient, the Corps Project Manager will coordinate this change with the contractor. Data will be burst sampled on a minimum of an hourly basis. At a minimum the unit will be serviced once during the deployment period to assure the equipment is operating, unless for a shorter deployment period this is viewed as unnecessary during coordination with the Corps Project Manager. Sampling rates, horizons, and service schedule will be finalized and coordinated with the Project Manager. Data will be incorporated into the overall project report described in Task 13.

Palermo, M., P. Schroeder, Y. Rivera, C. Ruiz, D. Clarke, J. Gailani, J. Clausner, M. Hynes, T. Fredette, B. Tardy, L. Peyman-Dove, and A. Risko. 1999. Options for In Situ Capping of Palos Verdes Shelf Contaminated Sediments.

Palermo, et al. 2000. Field pilot study of in situ capping of Palos Verdes Shelf contaminated sediments – Operations and Monitoring Plan.

Lee, H. J. (1994). "The distribution and character of contaminated effluent-affected sediment, Palos Verdes Margin, Southern California," Expert Report.

Figure 1.


300 x 600 m
Capping Cell
Spread of Single
Conventional
Hopper Load
SPC/PVC Camera Stations
Baseline Station (25)
Interim Station (14)
Added Post-Placement Station (12)
Core Station
Sub-bottom Profile Transect

Task	Planned Star	Duration in Days	Planned Finish
Baseli Monitori	4/30/0	91	7/30/0
Event	7/1/0	4	7/5/0
Event #1 Convent./Fi	7/6/0	0	7/6/0
Monitoring	7/6/0	7	7/13/0
Event #2 Spreading/Coa	7/14/0	0	7/14/0
Monitoring	7/15/0	7	7/22/0
Event #3a Fine to	7/17/0	15	8/1/0
Monitoring	7/17/0	18	8/4/0
Event #4 Convent./Fi	7/20/0	0	7/20/0
Monitoring	7/20/0	6	7/26/0
Event #5 Spreading/Coa	7/22/0	0	7/22/0
Monitoring	7/22/0	3	7/25/0
Event #3b Coarse	7/27/0	3	7/30/0
Monitoring	7/27/0	5	8/1/0
Event #6a Fine to	8/2/0	15	8/17/0
Monitoring	8/2/0	18	8/20/0
Event #6b Coarse	8/18/0	3	8/21/0
Monitoring	8/18/0	5	8/23/0

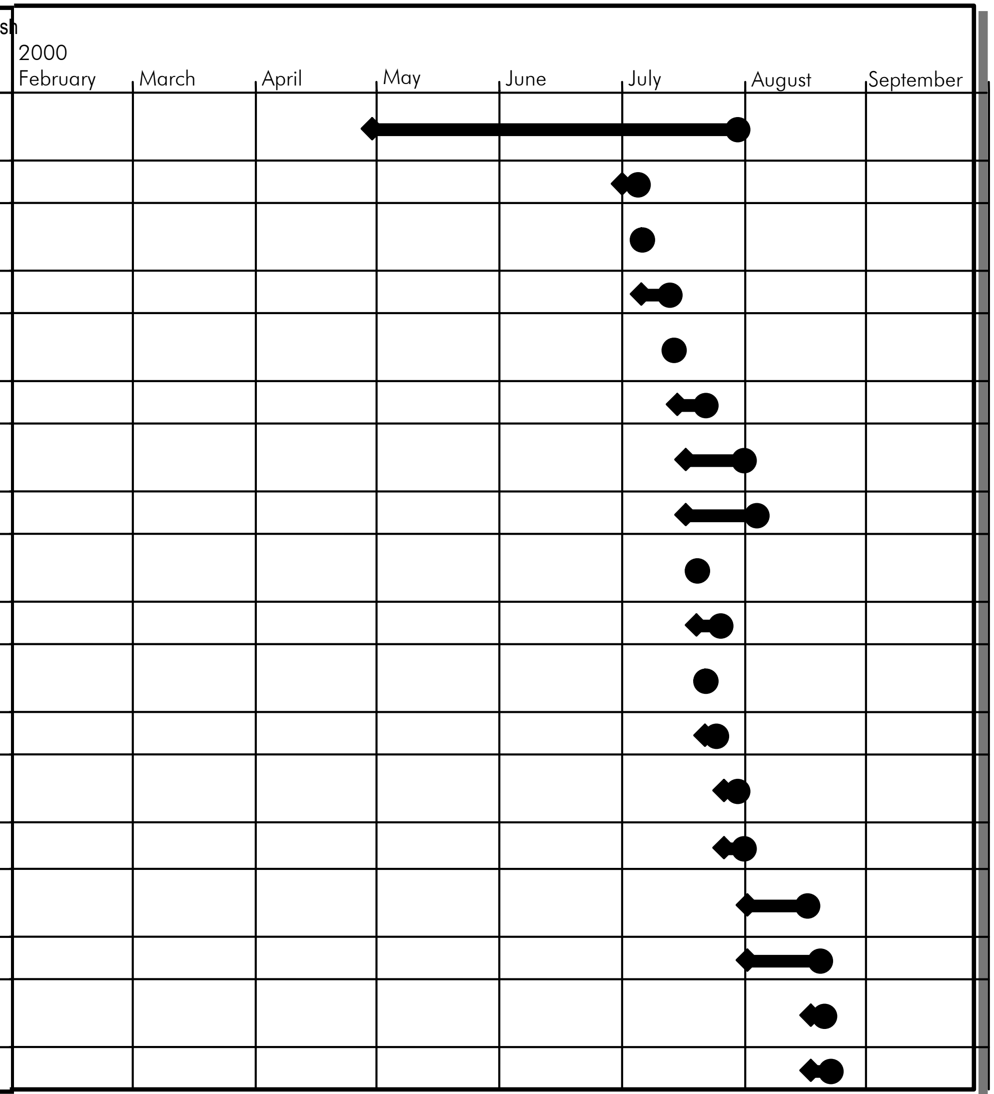
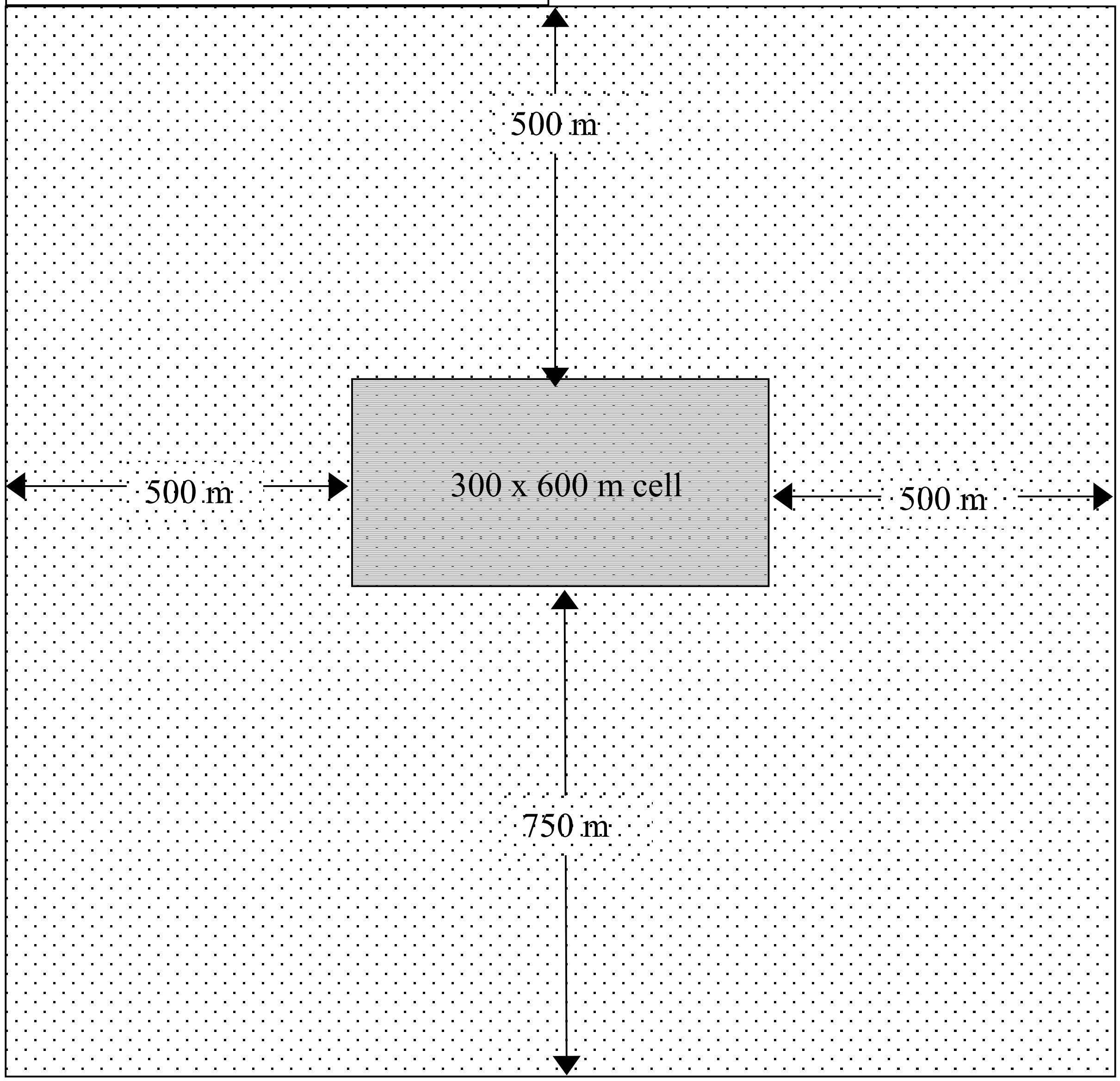


Figure 2. Conceptual Pilot Project Time Line.

Figure 3. Side-scan survey area.



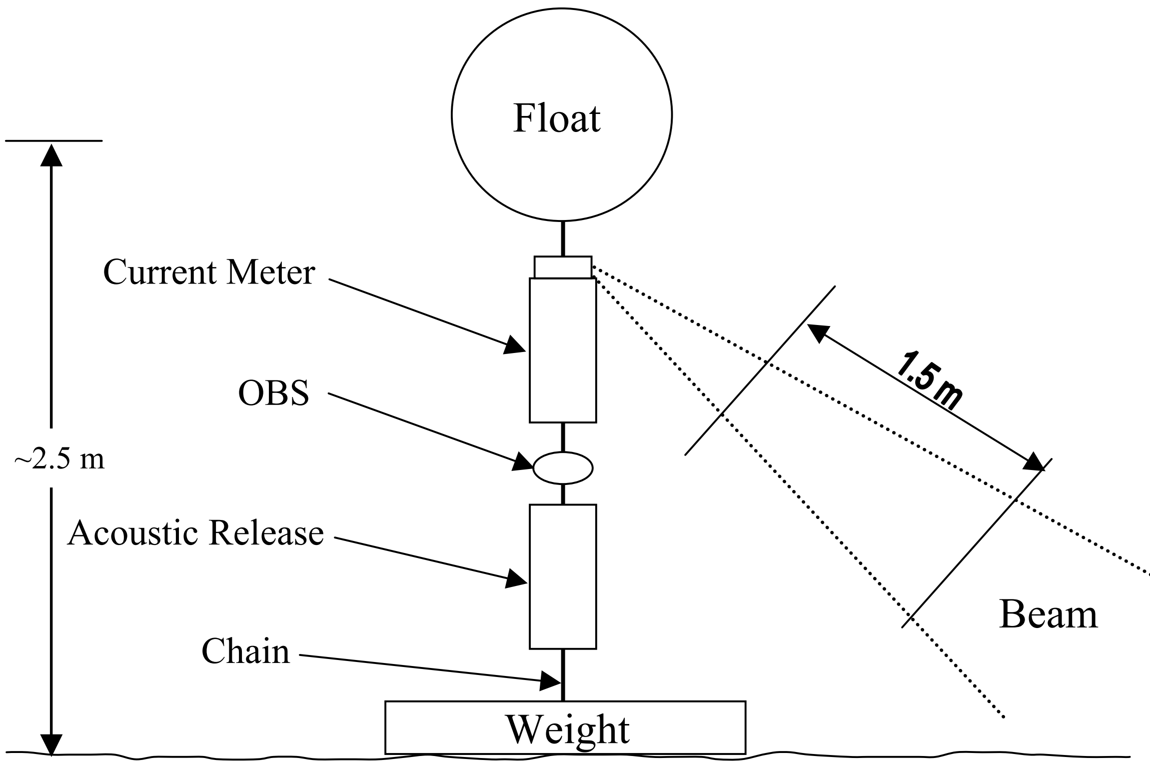


Figure 4. Schematic of Bottom Array.

Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Interim and Post-Cap Monitoring Activities

DATA QUALITY OBJECTIVES

(Revision 03)

Prepared for:

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1.0 INTRODUCTION

Data Quality Objectives (DQOs) are qualitative and quantitative statements that clarify the study objectives, define the most appropriate types of data to collect, determine the most appropriate conditions under which to collect data, and specify acceptable levels of decision errors that are used to establish the quantity and quality of data needed for decision-making (USEPA 1994).

The overall objective of the Palos Verdes Pilot Capping Project is to demonstrate whether a cap can be placed on the shelf as intended by the design (Palermo et al. 1999). Specific objectives of the Project are presented in the Overview section of this Project Work Plan.

In response to the need to test whether a cap can be constructed as designed, Palermo (2000) and Fredette (2000) developed a monitoring program for the Pilot Capping Project. According to Palermo (2000), results from interim and post-cap monitoring are expected to provide information for addressing the following five key questions:

- Does cap placement occur as modeled?
- Can a uniform cap be constructed?
- Can disturbance to in-place sediments be limited?
- Does the cap remain clean?
- Does the cap remain stable?

Palermo (2000) and Fredette (2000) formulated specific monitoring objectives, developed monitoring tasks, and described monitoring tools and applications appropriate for addressing these questions (Table 1-1). While these source documents prepared by the U.S. Army Corps of Engineers (USACE) define the most appropriate conditions (i.e., spatial and temporal extent for individual sampling approaches), they do not describe how the data will be used to evaluate the key questions or provide assessments of the appropriateness (i.e., acceptable levels of decision errors) of the data. It is important to note that some of the monitoring objectives, and associated monitoring approaches, are largely qualitative in nature. Thus, some monitoring objectives defined for the project will not be addressed quantitatively (e.g., statistical testing of hypotheses), and assessments of the robustness of data collected for these monitoring objectives will be subjective. Interpretations of data collected for the monitoring program, comparisons with results from the Baseline Monitoring and other studies, and evaluations of monitoring objectives will be performed by USACE. Consequently, this document will focus on the measurement quality of individual monitoring techniques that will be used for the interim and post-cap phases of the Pilot Cap Monitoring project.

Table 1-1. Problem Statements, Monitoring Objectives and Techniques

Problem Statement	Monitoring Objectives	Monitoring Techniques
Does placement occur as modeled?	Measure the distribution and thickness of the cap during separate phases and under different cap placement scenarios; Provide information/data for comparisons with USACE model predictions of sediment accumulation/spreading within the capping areas.	1) Sediment profile imaging 2) Sub-bottom profiling 3) Side-scan sonar 4) Coring for sediment chemical and physical parameters 5) Hopper dredge sampling 6) ADCP water column current measurements
Can a cap with uniform thickness be constructed?	Determine the ability to control cap placement, spatial variability/uniformity of the cap thickness, and validate model predictions.	1) Sediment profile imaging 2) Sub-bottom profiling 3) Coring
Does resuspension of in-place sediments and water column dispersion of capping material occur as modeled?	Provide information/data for comparisons with model predictions of surge following cap placement, the lateral extent of disturbance, and evaluate effect of EA sediment resuspension on water column concentrations of TSS and contaminants relative to background levels.	1) Current and optical backscatter measurements to detect surge 2) Plume mapping and water column sampling for TSS and DDE 3) Video documentation 4) Sediment profile imaging 5) Sub-bottom profiling and side-scan sonar.
Does the cap remain clean?	Determine contaminant concentrations in the cap immediately following placement, and the extent of mixing of EA sediments and cap material.	1) Sediment profile imaging 2) Coring
Does the cap remain stable?	Determine the stability of the cap during and immediately after cap construction by assessing the cap distribution over the EA deposit and changes in lateral surge velocities during cap placement.	1) Sediment profile imaging 2) Coring 3) Side-scan sonar 4) Currents and optical backscatter measurements

Measurement data quality for individual monitoring techniques are described in the following sections. The relationships between individual measurement techniques and monitoring tasks are described in the Palos Verdes Shelf Pilot Project Monitoring Scope of Work (Fredette 2000; see Appendix A). The sampling design and associated quality assurance procedures are described in the Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP), respectively, and are consistent with the overall sampling design described by Fredette (2000) and Palermo (2000; see Appendix B). In some cases, specific decisions regarding sampling protocols, such as the location and timing of water quality sampling and plume tracking activities, may be left to the discretion of the

Chief Scientist/Task Leader. Additionally, it may not be possible to delineate the footprint of cap materials on the seafloor based on the defined station array (i.e., the cap boundary may extend beyond the presently defined sampling area). The monitoring program described by Fredette anticipates these issues by incorporating some flexibility into the study design. Therefore, some deviations from the sampling plan may occur at the request of, and in consultation with, the USACE Program Manager to maximize potentials for achieving data quality objectives for this monitoring program.

2.0 DQOs FOR SEDIMENT PROFILE IMAGING AND PLAN VIEW PHOTOGRAPHY

Sediment-profile and plan view camera imaging will be used during interim and post-cap phases of the Palos Verdes pilot capping project to evaluate the thickness of cap material, examine any mixing of cap material and underlying EA sediments, and evaluate recolonization of the cap material by benthic organisms, as specified in Palermo (2000).

Sediment profile imaging is a benthic sampling technique that uses a specialized camera to obtain vertical cross-section photographs (profiles) of the upper 15 to 20 cm of the seafloor. This technique is useful for rapid collection and mapping of data on seafloor characteristics, such as surface sediment types and layering, benthic habitat quality, disturbance gradients, and biological recolonization. This technique is commonly referred to as sediment-profile imaging (SPI) or sediment vertical profile sampling (SVPS).

Plan view (i.e., horizontal plane) photographs of the seafloor surface will be obtained in conjunction with the sediment profile images. The photographs are taken immediately prior to landing of the frame on the bottom, providing an undisturbed record of the sediments before penetration of the sediment profile camera prism. The plan view image analysis consists of qualitative descriptions of key sediment characteristics (e.g., sediment type, bedforms and biological features) based on careful scrutiny of the projected 35-mm slides. Biological features (e.g., shells, shell debris, tubes, and burrow openings) and, where possible, the epifaunal or infaunal organisms themselves, are identified and enumerated. Additional details on field and laboratory methods for sediment-profile imaging and sediment plan view photography are provided in the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP).

Specific monitoring objectives for sediment profile and plan view camera applications are summarized in Table 2-1 and discussed below.

Primary measurement objectives for this sampling effort relate to navigational accuracy, sampling completeness, camera prism penetration, and image clarity. Sampling methods and measurement quality objectives for the interim and post-cap monitoring should be consistent with those for the Baseline Monitoring to support comparisons of pre- and post-cap conditions. To meet the objectives of defining the areal extent of capping materials, sampling must occur with a high degree of positional accuracy. Samples must be collected within a 5-m radius watch circle of the target station location. As described in the FSP, a differential GPS system will be used for vessel navigation during all surveys. The accuracy of this system is on the order of ±3 m.

Table 2-1. Monitoring Objectives and Approach for Sediment Profile and Plan View Imaging

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine thickness of cap layer and mixing or erosion of EA sediments.	Thickness of depositional layers Grain size major mode Plan view surface features RPD depth	Collect sediment-profile/ plan view camera images at specified sampling stations following a single hopper load and at specified intervals during and following cap construction for both conventional and spreading placement methods (see FSP).	One image will be collected at each station, with replicate (triplicate) images from randomly selected stations at specified frequency (100% completeness goal). To the extent possible, the prism of the sediment profile camera should penetrate below the cap layer/EA layer boundary. Image must be collected within 5-m radius watch circle. Methodology and performance specifications should be identical to those used for Baseline Monitoring.
Determine lateral extent of capping materials.	Same as above. Sediment grain size Sediment color Sediment fabric RPD depth	Same as above.	Same as above. Sediment grain size, color, fabric, and RPD should be clearly distinguishable in each profile image.
Determine biological conditions (i.e., recolonization) of cap layer.	Infaunal successional stage Organism-Sediment Index	Same as above.	Not specified, in part, because recolonization will reflect the time since cap placement.

To meet the monitoring objectives, it is important that a complete set of images is obtained. The sediment profile imaging field procedures and associated QA/QC are designed to ensure that the 100% completeness goal is met. These procedures are described in detail in the FSP and QAPP. Briefly, back-up camera systems and a complete inventory of spare parts will be available to avoid loss of data due to mechanical or electronic equipment malfunction. The film will be developed and reviewed immediately following the completion of each day's field work. Any images that were missed due to over- or under-penetration of the sediment profile camera prism will be identified, and samples can be recollected the following field day.

A second monitoring objective is to map the spatial distribution and thickness of the cap layer. This requires that photographic images provide adequate sensitivity to distinguish capping material from EA sediments and that the camera prism penetrates the cap layer to the cap/EA sediment boundary (Table 2-1). The physical characteristics which are likely to be key discriminators include grain size, color, fabric, and depth of the RPD. If the capping material is different from the existing EA sediments in any of these physical parameters (for example, has a slightly different color or differs from the EA sediment by at least one grain size class (phi) interval), then it is expected that the sediment profile images will have sufficient resolution to detect such differences. This objective is also dependent on the characteristics of the capping materials and the expected differences in the characteristics of the EA sediments. Prism penetration depths can be adjusted by adding weights, lowering the "stops" or adding "snow shoes" to allow successful image acquisition.

Through the use of color film, subtle differences in these parameters can be detected and used as distinguishing factors. Furthermore, in marine sediments, a distinct color change is typically associated with the change in redox state between aerobic, near-surface sediments and underlying anaerobic sediments. The boundary between the lighter colored surface sediments and darker underlying sediments is measured in sediment profile images as the apparent RPD. When sediments are capped, the light-colored, aerobic surface sediments above the RPD can persist for several months as a distinct sediment horizon at depth. This horizon can serve as a benchmark against which to measure the thickness of the depositional cap layer. Therefore, the presence/absence and depth of the RPD in each pilot placement area is another characteristic that can be used to distinguish EA sediments from cap material (Table 2-1). The computer image analysis system used for sediment profile images is capable of making linear measurements of depositional layer thickness with a precision of 1 cm or less. Where such layers occur at each sampling station, they will be described and measured. Note that the ability of this monitoring approach to completely map the cap layer is dependent in part on the spatial coverage of the sampling stations. If cap materials accumulate in areas beyond the sampling grid, it will not be possible to delineate the complete outer boundary of the footprint. However, this is not considered essential to meet the SPC objective of validating model predictions of cap layer thickness at specific distances locations within each cell. Furthermore, the spatial extent of the sampling grid can be expanded, as appropriate, for the single hopper placement survey tasks by using some of the sampling effort contained in the Flex Survey task. Regardless, results provided by the SPC/PVC sampling are expected to provide sufficient data for validating model predictions of cap layer thickness and distribution on the seafloor.

Information from sediment profile and plan view camera images also will be evaluated for evidence of short-term biological recolonization of the cap layer. This information will be largely descriptive (i.e., relative proportions of benthic organisms of different feeding types) and will reflect, to a large degree, the time interval between cap placement and sampling.

3.0 DQOs FOR SUB-BOTTOM PROFILING AND SIDE-SCAN SONAR

Sub-bottom seismic profiling is a standard technique for determining boundaries between sedimentary layers of different acoustic impedance. In a sub-bottom profiling survey, the vessel travels along consecutive lanes or transects, in a manner similar to that used for bathymetric surveys. Acoustic signals are sent to the seafloor and received back on a near-continuous basis. Sediments having different geotechnical characteristics (e.g., bulk density) will have different acoustic impedances, and therefore sound will reflect from the boundary between layers of sediment having different densities. The depth of sound penetration and the degree of vertical resolution are dependent on the frequency and pulse width of the seismic signal, and the characteristics of the penetrated material.

Side-scan sonar is a standard survey technique used to generate 2-dimensional maps of seafloor features. The system consists of a vessel-based data acquisition system linked to a "towfish" which contains acoustic transmitting and receiving circuitry. The towfish is towed behind the survey vessel along predetermined survey lanes. Acoustic signals projected from both sides of the towfish are used to obtain information on seafloor characteristics at 90-degree angles from the vessel track. Physical objects as small as 0.5 m in size and small scale sedimentary features (e.g., rock outcrops, sand ripples, trawl scour marks, etc.) can be clearly delineated from the side-scan records. Side-scan sonar can be conducted simultaneously with sub-bottom profiling.

Sub-bottom profiling and side-scan sonar were used during the Baseline Monitoring to determine the physical characteristics of the existing surface sediments and the thickness of the EA deposit in each of the pilot placement cells. During interim and post-cap monitoring, sub-bottom profiling and side-scan sonar will be used to provide a measure of cap distribution and material thickness. The baseline sub-bottom profiling and side-scan results also will provide a benchmark against which changes from cap material placement can be evaluated. The objectives for sub-bottom profiling and side-scan sonar for interim and post-cap monitoring are summarized in Table 3-1 and discussed below.

To address the objectives listed in Table 3-1, sub-bottom profile data will be collected continuously along a series of transects encompassing the pilot placement cells and their surroundings. Rationale for transect lengths and spacing is provided in Palermo (2000) and Fredette (2000).

Continuous records will be obtained along each survey transect. A comparison of the results obtained along each transect will provide an indication of the degree of variability in cap characteristics within and surrounding each pilot placement cell. As with sediment profile imaging, one of the measurement quality objectives for sub-bottom profiling and side-scan sonar relates to the positioning accuracy of the survey vessel. This will be addressed through

Table 3-1. Monitoring Objectives and Approach for Sub-bottom Profiling and Side-Scan Sonar

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine distributions of cap sediments, bottom disturbance features, and topography following single placement event.	Delineate cap footprint and provide information regarding spatial coverage that can be used by USACE to verify model predictions; Describe broad-scale features of the sediment surface, including: Sediment type (e.g., sand, mud) Small-scale boundary roughness (e.g., ripples, bedforms)	Collect high resolution, dual frequency side-scan sonar records following a single placement event for both conventional and spreading placement methods.	Navigational accuracy should be ±3 m. Completeness goal is 100% (obtain continuous records from all survey lanes).
Determine distributions of cap sediments, bottom disturbance features, and topography following cap placement.	Delineate cap footprint and broad-scale features of the sediment surface.	Collect high resolution, dual frequency side-scan sonar records post-capping for both conventional and spreading placement methods.	Navigational accuracy should be ±3 m. Completeness goal is 100% (obtain continuous records from all survey lanes).
Determine cap thickness following placement.	Provide information regarding cap layer thickness that can be used by USACE to verify model predictions.	Collect continuous sub-bottom profiling data along a series of transects in three pilot placement cells following cap placement for both conventional and spreading placement methods.	Navigational accuracy should be ±3 m. Completeness goal is 100% (obtain continuous sub-bottom records from all survey lanes).

the use of a differential GPS navigation system for all survey work. Details on the use of this system are provided in the FSP.

Another measurement objective for this sampling effort is to achieve 100% completeness. Procedures for ensuring that the 100% completeness goal is met are described in detail in the FSP and QAPP. One of the advantages of the intersecting survey transects is that "duplicate" sub-bottom profile records will be obtained at the points of intersection. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method. It is expected that there will be high degree of agreement between results for the two different survey transects at each point of intersection. Specifically, both records should show the same features (i.e., sub-bottom reflectors) are present, and there should be reasonable agreement in the measured thickness of the cap layer.

The side-scan sonar system will be configured to collect seafloor imagery data 100 m to either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing established for each cell, side-scan data coverage within each cell will be approximately 200%. Continuous side-scan records will be obtained along each survey transect. A comparison of the results obtained along each transect will provide an indication of the degree of variability in sediment surface features within and surrounding each pilot placement cell.

Procedures for meeting the 100% completeness goal for side-scan sonar are described in the FSP and QAPP. One of the advantages of the proposed 200% bottom coverage, as well as the intersecting survey lanes, is that "duplicate" side-scan sonar records will be obtained over relatively broad areas. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method.

Based on experience during the Baseline portion of the monitoring program, the vertical resolution of the sub-bottom technique in the study area (water depths ranging from 40 to 70 m) is expected to be ±20 cm, but this will also depend in part on the characteristics of the cap materials. Therefore, sub-bottom profiling is not expected to distinguish the presence of a thin (<20 cm) cap layer on the edge of the footprint. At locations where the cap thickness is less than 20 cm, cap layer thickness will be determined from other measurement techniques (sediment profile images and sediment core features). Sediment coring and sediment profile imaging data will be obtained at the sub-bottom points of intersection. If there are any discrete depositional layers on or near the sediment surface with thickness less than about 20 cm, measurements from both coring and sediment profile imaging should be capable of determining the thickness of these layers. This provides a means to independently confirm the sub-bottom results. Distinct sediment horizons or depositional layers greater than 20 cm also may be detected through core sampling, depending on the depth of core penetration. The results of the sub-bottom survey can be compared qualitatively with both the sediment profiling and coring results.

4.0 DQOs FOR SEDIMENT CORING

Sediment coring will be used during interim and post-cap monitoring to provide data on the thickness of the cap layer as well as the vertical distributions (i.e., layers) of many physical and chemical characteristics of the sediment column for assessments of mixing between cap material and EA sediments. Specifically, cores will be inspected visually and photographed to distinguish patterns in texture, color, debris, and other parameters that may be indicative of different sediment types (e.g., EA sediments and cap material). Individual core strata will be sampled, and each section tested separately, to determine vertical patterns in characteristics as a function of distance below the sediment surface or distance above the EA sediment/cap layer boundary. Sediment coring also was performed for the Baseline Monitoring program to characterize vertical distributions within the EA sediments of geotechnical properties and contaminant concentrations. It is important that coring methods used for the interim and post-cap monitoring are consistent with those used for the Baseline Monitoring. Therefore, for interim and post-cap monitoring, sediment cores will be collected using a gravity corer.

Monitoring objectives and approach for sediment coring are listed in Table 4-1.

Table 4-1. Monitoring Objectives and Approach for Sediment Coring

Monitoring Objectives	Data Requirements	Monitoring Approach	Field Decision Criteria/ Performance Specifications
Determine cap layer thickness.	Provide data on a cap layer thickness for validation/ground truthing USACE model predictions.	Collect gravity cores following a single placement event, after a 10-cm cap layer has accumulated, and after a 15-cm cap layer has accumulated. Visually inspect and photograph whole cores. Prepare core log. Analyze grain size and density from the cap layer portion of one core or a core composite.	Samples must be collected within the 5-m radius watch circle and navigational accuracy should be ±3 m. Fingers at bottom of corer closed. Overlying water is present and clear. No significant disturbance of sediment surface. Use Unified Soil Classification System for visual description. Identifiable strata, changes in appearance, notable features to be measured from core surface to nearest 1 cm. If inspection indicates smearing or mixing between strata precludes meeting this specification, note vertical layering characteristics in core log and qualify data accordingly.
Determine lateral extent of cap materials.	Same as above.	Same as above.	Same as above. Sufficient accuracy for distinguishing sediment layers is defined as being able to discern, with the naked eye, a difference between the EA sediments and cap material for the "visual" parameters.

Table 4-1. Monitoring Objectives and Approach for Sediment Coring (continued)

Determine the post-capping extent of mixing between the cap and EA sediment layers.	Vertical distributions of physical/ chemical parameters that can be used to distinguish EA sediments and cap materials (e.g., DDE and grain size).	Collect post-capping cores and analyze for sediment grain size, bulk density, specific gravity, vane shear, water content, Atterberg limits and DDE concentrations in selected core horizons.	For post-cap monitoring, core must penetrate at lease 20 cm into EA layer. Adequate sediment volume for testing must be obtained for each core strata sampled. Decontamination of sampling tools between samples to prevent cross contamination and use of clean subsampling techniques. See QAPP for methods, detection limits, and other QA limits.

The locations of sediment cores should be determined with a high degree of accuracy to maximize comparability with data from other interim and post-cap monitoring techniques and with Baseline Monitoring data. All cores should be collected within the 5 m radius watch circle, and vessel positioning accuracy should be ±3 m. This will be addressed through the use of a differential GPS navigation system for all survey work. Details on the use of this system are provided in the FSP.

The numbers and locations of cores, minimum core lengths, and specific parameters are specified in the Monitoring Plan for the Pilot Capping Project (Fredette 2000). Two key physical parameters that will be used to distinguish cap materials from EA sediments are grain size and bulk density. Cap material will be coarser than EA sediments. Bulk density (mass divided by volume) is a measure of water content. Sediments with high water content typically have lower bulk density than sediments with low water content. Water content is affected by grain size and the length of time over which the sediment has consolidated. Finer or recently deposited sediments tend to have lower bulk density than coarser or more consolidated sediments. Note that the sampling design for the sediment coring task provides limited spatial coverage, and it may not be possible to use the data obtained from these samples to accurately map the areal extent of capping materials. In contrast, the data are expected to be useful for validating USACE model predictions regarding spreading and deposition of cap materials on the seafloor.

Additional information on the physical characteristics of surface sediments will be obtained from visual inspection of the cores, as described below. If distinctive sediment layers (strata) or other notable features are present within the sediment cores, their depth and thickness will be measured to the nearest 1 cm. The purpose of these measurements is to assist in interpreting 1) vertical patterns (e.g., layering) in sediment physical and chemical characteristics collected using other measurement approaches (above), and 2) the interface between EA sediments and cap material, including any mixing between the two. Visual inspection of the collected cores will provide qualitative physical information about the cores that will supplement the quantitative data collected under other objectives. Visual inspection will assist in identifying strata in the sediment column based on observations of grain size, texture, color, odor, debris, organic material, and other parameters using the Unified Soil Classification System (USCS). The distance from the sediment surface to interfaces between strata and other notable features will be measured to the nearest 1 cm. Visual observations will be correlated with data from the physical and chemical testing of core sections to determine if there are measurable differences among the strata in the tested parameters. In addition, strata identified though inspection of sediment cores will be compared to those identified through sediment profile imaging (Section 2.0). For comparisons of measurements from the same sampling location, the depth to strata interfaces should match within 2 cm (1 cm error for each method).

If visual inspection of a split core reveals that significant disturbance of the sediment sample (e.g., mixing of the strata, cap material, and EA sediments) has occurred, this will be noted in the core log to aid interpretation of results from geotechnical and chemical analysis of extracted samples. If mixing is extensive, the core will be subsampled as specified, and the vertical layering/mixing of core strata will be described carefully in the core log.

Cores collected during the post-cap survey will be subsampled and analyzed for p,p'-DDE for determining the extent of mixing between the cap material and EA sediments. Because p,p'-DDE is typically present in the EA sediment deposit at concentrations of 1 ppm or greater, it will be readily quantifiable using standard analytical techniques (e.g., gas chromatography/electron capture detection or gas chromatography/mass spectrometry), without significant analytical problems (e.g., interferences) that could affect data accuracy, precision, or comparability. The QAPP describes the detection limits and other QA control limits for the chemical analysis. During field sampling, it will be important to effectively decontaminate the sampling equipment between sample collections in order to prevent cross contamination of samples. Clean sampling techniques are addressed in the FSP and QAPP.

Adequate sample volume (mass) is an important issue for low-level chemical testing. The Monitoring Scope of Work (Fredette 2000) specifies that post-cap monitoring cores will be subsampled for DDE at the surface/water interface, 3 cm above the interface/mixed layer, and 4 cm below the interface/mixed layer. Additional samples from 7 cm above and 8 cm below the interface/mixed layer will be collected and archived. Based on experience from the Baseline Monitoring program, a sample mass of 100 g (wet) will be sufficient for analyses of DDE concentrations, including quality assurance samples. This sample mass can be obtained from a 1-cm thick section. Analyses of grain size, bulk density, and water content will require an additional 500 g of sediments, which can be obtained from the 2 cm sections immediately above and below the layer subsampled for DDE analyses. Atterberg limits samples may be collected depending on the amount of fine-grained sediment present. Vane shear measurements will be made throughout the length of the core at the shore-based laboratory; thus, separate aliquots for vane shear analyses are not required.

5.0 DQOs FOR PLACEMENT SURGE VIDEO DOCUMENTATION

Underwater video documentation is a qualitative technique that will be used to record evidence for resuspension and lateral displacement of sediments following placement of cap materials. Video records will compliment quantitative information from moored current meter/optical back-scattering sensors that will be deployed concurrently to measure surge currents and suspended sediment levels (DQO Section 8.0). The monitoring objectives and approach for video documentation are listed in Table 5-1.

Table 5-1. Monitoring Objectives and Approach for Surge Video Documentation

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Record visual evidence for and characteristics (speed and thickness) of near-bottom surge with increasing distance from the point of release to a point where surge is minimal	Edited video record of surge (as indicated by visual changes in particle concentrations, particle velocities, and erosion, resuspension, or mass movement of bottom sediments) at specific distances from point of release	Deploy video camera at locations in cell LU, SU, and two other events at 50 m, 75 m, 100 m, and 200 m from disposal point and collect video records immediately following placement events	Navigational accuracy for both the camera location and cap placement location; Acceptable video quality record (adequate light, depth of field, directional orientation)

Specific measurement objectives for video documentation are related to navigational accuracy and video quality. Navigational accuracy is important because the video records are intended to compliment simultaneous current and optical back-scattering measurements obtained by moored arrays.

To ensure video quality, an underwater video system comprised of a color camera, two 150-watt lights, a video processing console, and an S-VHS video recorder will be deployed. The video camera will be mounted to an array that will support the underwater lights, an underwater compass for orientation, and a depth gauge within the camera's field of view. The array also will allow the camera to operate when resting on, or suspended above, the seafloor. During all video-surveying operations, the camera will be in a downward looking position and will be adjusted vertically to document the lateral spread of the bottom surge during placement events.

The quality of the video recorded by this system can be affected in two primary ways: environmental conditions of the water and through the adjustments of the camera system's accessories. Extremely turbid conditions prior to cap material placement will make successful video documentation difficult if not impossible for two reasons. First, under extremely turbid conditions, the video system simply will not be able to "see" through the suspended particulates and distinguish the presence of any bottom surge. Secondly, even if the video camera is able to resolve suspended sediments in the water column under these conditions, suspended sediments that are attributable to cap placement and/or resuspension of EA sediments would not be distinguishable from those materials in the "background." Under these conditions, the video survey would be conducted as a best effort for video data acquisition.

A second factor that would affect video quality is the adjustment of the video camera system's accessories. If a sediment plume is identified and bottom surge is being recorded, adjustments to the focus and light intensities of the system will be important factors in obtaining quality bottom surge footage. In turbid conditions, too much light will tend to reflect too brightly on the suspended sediments, and the camera will not be able to resolve or focus on the movement or scattering of particles as they pass by the lens. Conversely, a water column that has a low concentration of suspended sediments will require more light and a finer focus to accurately distinguish and resolve the transported sediments. To accommodate both conditions, the video system used during this project will allow the operator to adjust all of the camera's accessories from the deck-mounted control console of the video unit in real-time. A 10-inch color monitor that displays the real-time video will allow the operator to adjust the light intensity and focus of the camera based on the visual conditions during the survey. The compass and depth gauge will provide direction and depth data for complete documentation of surge conditions by adjusting the camera vertically. It should be noted, however, that this system is a free hanging system and the direction of the video array can not be controlled from the surface. In addition to the depth gauge that is mounted upon the array, the cable and deployment wire used to lower and retrieve the system will be incrementally marked for depth. The depth of the system based on the length of the cable that is paid out also will be recorded in the video documentation field logbook.

Because the surge video documentation task is experimental, some trial and error will be required to obtain good quality video records that clearly show evidence for bottom surge associated with cap placement events.

6.0 DQOs FOR HOPPER DREDGE OPERATION DATA

The primary objective of the Hopper Dredge Operation Data task is to accurately record the locations of loading and placement positions of the hopper dredge during the Pilot Capping project. The determination of loading and placement depends on an accurate record of vessel draft and pump activity as well as vessel position. Hopper dredge operation data consists of accurate position, time, and draft information acquired during cap material loading and placement. The position and draft information is used to establish both the source location of cap material gathered and the placement location at the test sites. Time and rate of material discharge data are acquired to determine the amount of sediment placed at target locations. These data are needed as input to the MDFATE model for defining coordinates for release of capping materials relative to the target location, volumes/mass of cap material released for each dredge load, and rates of release. Monitoring objectives and approaches are listed in Table 6-1.

Table 6-1. Monitoring Objectives and Approach for Hopper Dredge Operation Data

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Record transit routes for hopper dredges during individual disposal events	Near-continuous navigational position data for individual barge transits to cap site	Install automated electronic tracking system on vessel to acquire and record navigational fixes/ coordinates during transit to capping sites	Navigational data based on differential GPS with accuracy of 3-5 meters
Record time and rate of release of cap materials	Near-continuous record of barge draft during discharge	Record vessel draft and tonnage during placement events	Pressure sensor is factory calibrated and checked prior to installation
Record locations of individual placement events	Navigational data for individual placement events	Merge timing of discharge events with transit routes	Navigational data based on differential GPS with accuracy of 3-5 meters

Hopper dredge operation information for the Pilot Capping project will be acquired using an automated disposal surveillance system (ADISS) that documents the loading and placement activities of the hopper dredge by recording the vessel position, draft, orientation, and pump operation. Vessel position is accurately determined by differential GPS, with an accuracy of 3-5 m. Differential GPS is an industry standard for determining accurate vessel position. Accurate time is also received from the GPS satellites, which utilize precise clocks to determine position. Vessel draft information is obtained from a pressure sensor installed in the ram well of the hopper dredge, and pump information is acquired with a switch located on ADISS. Both inputs are needed to determine when the load leaves the hopper and approximately where it is deposited on the seafloor. The rate of sediment discharge can be determined from the time, position, draft, and pump information.

To validate hopper operation data acquired by the ADISS system, calibration procedures and system checks for the receivers and sensors inputting information to the database will be performed. These are described in the FSP and QAPP.

Performance audits of the ADISS system (including ADISSPlay) are conducted prior to loading operations for each placement. The audit consists of proper system responses to set up commands and good reception from the sensors and receivers, including:

- Checks for proper logging sequences and proof of file storage
- Checks of pressure sensor function and correlation with visual draft measurement values
- Checks of pump switch function and proper recording
- Checks of correct compass readout with vessel gyro compass
- Checks of differential and GPS signal reception

Data validation will include determinations of the quality of the differential and GPS satellite position fixes using the information recorded in the data strings, as well as the raw pressure counts of vessel draft and the compass bearing information. Plots of position data will also be reviewed to identify outlier values. Database contents will include the time and date of each position and orientation, pump activity, vessel draft, load volume, and the identities for the target, vessel, and project. Draft time series and vessel track lines will be plotted and reported on the project web site.

7.0 DQOs FOR PLUME MAPPING

Sediment plume mapping surveys will be conducted for two measurement objectives:

1. To determine whether there is a detectable near-bottom plume of suspended sediment that results from placement of cap material. Plume mapping techniques will be used to determine the spatial extent, direction of transport, and temporal variability in suspended sediment concentrations during the first two hours following placement of cap material from single placement events. Plume mapping will consist of remotely sensed measurements of suspended sediments in the lower portion of the water column along multiple transect lines following a cap placement event. These measurements will be made in conjunction with collection of discrete water quality samples, as described in DQO Section 9.0. Post-survey laboratory analysis of water samples for total suspended solids (TSS) concentration will aid interpretation of the rate which suspended sediments resettle to the seafloor. Post-survey laboratory analysis of water samples for DDE concentration will help to distinguish whether the suspended material contains significant concentrations of EA sediment or it is mainly composed of cap material.

2. To determine whether suspended, fine-grained cap material is transported toward shore and adjacent kelp beds prior to settling on the seafloor immediately following placement within capping cells. Plume mapping techniques will be used to determine the spatial extent, direction of transport, and temporal variability in near-surface suspended sediment concentrations during the first two hours following placement of cap material from single placement events. Plume mapping will consist of remotely sensed measurements of suspended sediments in the upper water column along multiple transect lines following a cap placement event. These measurements will be made in conjunction with collection of discrete water quality samples, as described in DQO Section 9.0. Post-survey laboratory analysis of water samples for total suspended solids (TSS) concentration will aid interpretation of the rate which suspended sediments resettle to the seafloor, and whether plumes of elevated TSS concentration reach the inshore kelp forests. Water samples will not be analyzed for DDE concentration because the suspended material will have originated from uncontaminated cap material.

Monitoring objectives and approaches for the plume mapping task are summarized in Table 7-1.

Table 7-1. Monitoring Objectives and Approach for Plume Mapping

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine the spatial extent and transport directions of resuspended sediment plumes created by conventional and spreading placement of cap materials.	Three dimensional distribution of water column properties consistent with presence of high suspended particle concentrations for a period up to 2 hours following the single cap placement and the second and third placement events for both conventional and spreading placement.	Use an ADCP and transmissometer to track the vertical and horizontal boundaries and centroid of the suspended sediment plumes created by placement of cap materials for 2 hours following a placement event.	Plume delineation from ADCP measurements will be somewhat subjective and dependent upon the acoustic backscatter characteristics of the near-bottom suspended particulates that exist prior to cap placement. Plume delineation using light transmittance measurements will be somewhat subjective because the presence of natural particles as well as suspended cap particles will likely contribute to a variable background signal.
Determine the fall velocity and point of impact of individual cap material particles.	Measurements of sinking velocities for particles of varying size released from placement vessel and location of initial impact on the bottom.	Use an ADCP to measure particle sinking rates for cap materials for a single spreading placement event.	Particle sinking rate determinations from ADCP measurements will be somewhat subjective and dependent upon the acoustic backscatter characteristics of the near-bottom suspended particulates that exist prior to cap placement.
Determine potentials for onshore transport of cap materials and associated turbidity levels in vicinity of nearshore kelp beds.	Spatial distributions, relative to locations of nearshore kelp bed, of turbidity and suspended particle concentrations in the upper water column following cap placement events.	Use an ADCP and transmissometer to track the direction and extent of suspended sediment plumes in the upper water column for 2 hours following a placement event. Up to 27 TSS samples will be collected in conjunction with ADCP and OBS measurements.	Plume delineation from ADCP measurements will be somewhat subjective and dependent upon the acoustic backscatter characteristics of the near-bottom suspended particulates that exist prior to cap placement. Plume delineation using light transmittance and TSS measurements will be somewhat subjective because the presence of natural particles as well as suspended cap particles will likely contribute to a variable background signal.

The objectives of this monitoring task will be accomplished using an ADCP system operated by WES and light transmittance measurements using a transmissometer attached to a CTD/rosette system that is also being used to collect water quality samples/data (see DQO Section 9.0). Similar to the video documentation task, plume mapping may require some trial and error to achieve the monitoring objectives. For example, it will not be possible to define *a priori* the sensitivity of the ADCP system for distinguishing between suspended cap material, resuspended EA sediments, and other natural (pre-placement) suspended particles, or for measuring the sinking rates of individual particles as described in the Monitoring Plan Scope of Work (Fredette 2000). Additionally, logistical considerations, such as the need to deploy the ADCP and CTD/transmissometer from separate vessels (or in an alternating mode from a single vessel) may, in practice, limit the spatial coverage achievable with these systems.

Regardless, coordination between the sampling vessels and cap placement vessel, positioning accuracy for the survey vessels, and accurate recording of sampling times will be important for ensuring that measurements and data collected by concurrent sampling tasks can later be merged and properly interpreted. Note that the ADCP and transmissometer measurements performed for this task will not be able to distinguish suspended cap particles from resuspended EA sediments.

8.0 DQOs FOR MOORED CURRENT AND OPTICAL BACKSCATTERING MEASUREMENTS

The purpose for measuring near-bottom currents and water clarity/turbidity is to determine whether there is a detectable surge in bottom current velocities that is caused by the downward momentum of cap material as it impacts the seafloor during cap placement. The study design indicates that measurements of near-bottom current velocities and turbidity can be used to determine whether surge-induced currents and elevated suspended sediment concentrations at varying distances from the cap placement site can be related directly to the active placement of cap material. Consequently, a combination of near-bottom current velocity measurements and concurrent monitoring of near-bottom turbidity (optical backscatter) will be used to evaluate whether release of capping material within specific cells results in near-bottom plumes of suspended particulates. The field measurements will provide information on the spatial characteristics and intensity of any resultant plume because instrument arrays will be placed both up slope and down slope of the cap placement location; topographic effects on the lateral spreading of surge plumes is a major topic of interest that will be evaluated. Additionally, these results represent valuable input to numerical models that will be used to predict the three-dimensional characteristics of near-bottom plume spreading and dissipation (both velocity and turbidity concentrations). Note, however, that the optical measurements of near-bottom turbidity will not allow distinction between the three potential sources of suspended particles: ambient (pre-placement) particles; cap material; and resuspended EA sediments. This question can only be addressed by the water sampling field program (see objectives in Section 9.0).

The monitoring objectives and approach for this sampling task are listed in Table 8-1.

Table 8-1. Monitoring Objectives and Approach for Moored Current and Optical Backscattering Measurements

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine extent of current surge caused by placement of cap materials.	Surge velocities at varying distances from discharge point.	Measure currents during a single placement and interim placement events at varying distances from the planned placement point using multiple moored ADCP system for both conventional and spreading placement.	Geographic accuracy of both the moored arrays and cap placement point should be within 5 meters of specified coordinates.
Determine suspended particle levels in plume created by cap placement	Suspended sediment levels at specified distances from the cap placement location following placement event.	Measure suspended particle loads using moored optical backscatter sensor.	Same as above.

During each measurement period (deployment event), boundaries of this task are determined by the measurement plan (instrument/sensor placement) within the specified disposal cells. Placement of the instruments is related to the expected size and location of the release point for the cap placement event. The objective is to provide measurements at a series of cross-isobath sites that are closely placed up and down slope from the cap placement location. These observations will provide a basis for examining characteristics of any movement of suspended material. Instrument placement is to be as close to the capping site as can be supported given the operational limitation of cap material placement. It is expected that three instrument platforms will be placed 75, 150 and 250 m down slope from the cap placement site. An additional (fourth) platform will be placed 75 m up slope of the site. The fifth current/OBS sensor will either be placed 150 m up slope or on/adjacent to the 75 m down slope instruments to provide a basis for intercomparison of moored instruments. Any resuspension cloud may extend above the local bottom. However, an inherent assumption is that if surge occurs, it will be more prominent and easily detected near the bottom.

For the present program, all water current measurements will be made with equipment that relies on an acoustic signal being reflected from particles moving with the ambient currents back to the transducer. An inherent assumption is that, on average, the reflecting particles are moving at the velocity of the associated water parcels. Velocity is estimated by measuring the Doppler shift to the outgoing acoustic signal after it has been reflected by the moving particles in the water column. The Doppler shift is directly related to the speed of the reflecting particles as they move toward or away from the transducer. Multiple transducers on each instrument allow different components of velocity to be estimated. These are referenced to geographic coordinates and combined to produce a total velocity vector at the location of the reflecting particles.

The parcel of water being examined is determined by the time required for the signal to go out and return. Clearly, acoustic reflections further from the source will take longer for the round trip (out and back). By using a time gate and an estimate of the speed of sound in water, the Doppler shift information can be related to conditions at a specific distance from the transducer. Typically, the time separation is such that a volume of water (or bin) is sampled and a velocity estimate is created for that bin. If instrument circuitry is such that multiple bins above the transducer are sampled, a current profile can be obtained. If only one bin is sampled, a point current estimate is created.

Three current measuring devices will be used in this program. An Acoustic Doppler Current Profiler (ADCP) will provide information on the vertical profile of horizontal velocity. The ADCP will be placed in an instrument mount on the seafloor. It will provide valid velocity estimates in 1-m bins from approximately 2-3 m above the transducer heads to within approximately 3 m of the water surface. On three bottom mounted instrument platforms (ARESS), acoustic current meters will be placed at two levels (approximately 0.5 and 1.25 m above the local bottom.) At one other site, an acoustic current meter representing a different make/model than those incorporated in the ARESS system (consistent with the specifications of the scope of work for the monitoring program; see Fredette (2000) as well as QAPP Section 9.0 and the associated SOP in Volume II of this PWP) will be placed approximately 1 m above the local bottom. It is also planned that a second acoustic current meter, of different make/model than those incorporated in the ARESS system, will be attached to one of the ARESS platforms for intercalibration.

Measures of local turbidity will be made using Optical Backscatter Sensors (OBS). These instruments measure the amount of emitted light that is reflected back to the sensor. The greater the reflections, the greater the quantity of material in the water parcel being measured. A time series of measured OBS values provides a history of total suspended solids in the water column. OBS measurements will be made according to the following:

- OBS at two levels on each of the three ARESS platforms.
- OBS at one level on each acoustic current meter.
- No OBS measurements will be made in conjunction with the ADCP observations.

For the present task, errors are related to the specifications of the various instruments. All equipment was selected to provide observations that should be appropriate for the expected current and turbidity conditions. While the OBS measurements will provide a temporal record of turbidity patterns following a cap placement event, the sensors will not distinguish between suspended cap materials and resuspended EA sediments.

Observations will be made at temporal sampling rates (one observation per second) which should provide a basis for relating specific near-bottom current and turbidity events to the precisely timed placement of the dredged material.

To support development of a decision rule, all sensors will be in place before and following placement of cap material. Measurements obtained prior to and after cap material placement will help characterize the specific local background conditions. Information concerning background or unaffected conditions will support isolation of potential impacts from the specific placement of cap materials.

9.0 DQOs FOR WATER QUALITY MEASUREMENTS

Cap placement is expected to create a plume of sediments which will result in elevated suspended sediment levels and may result in elevated dissolved and particulate contaminant concentrations in near-bottom waters within the immediate vicinity of the pilot cap. The level of contaminant elevation depends on the relative proportions of resuspended EA sediments and sediments used for capping. Following the initial resuspension event, total suspended solids (TSS) concentrations are expected to decrease with time due to particle settling and dispersion by near-bottom currents. The purpose of these measurements is to determine the magnitude of TSS and total DDE concentrations in the near-bottom portion of the water column up to 2 hours following a disposal event. This water quality sampling task will be coordinated with the plume mapping task described in DQO Section 7.0. Monitoring objectives and approaches for water quality measurements are listed in Table 9-1.

Table 9-1. Monitoring Objectives and Approach for Water Quality Measurements

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Determine suspended sediment concentrations in the plume caused by resuspension of EA sediments following cap placement.	Background and post-placement water column TSS concentrations within near-bottom plumes.	Collect water samples for TSS analyses at varying times following a single hopper cap placement event for both conventional and spreading placement methods.	Coordination (timing and geographical locations) between the placement vessel and survey vessels supporting water quality measurements and plume mapping is critical for providing data that can be subsequently merged and used to evaluate the monitoring objectives.
Determine contaminant concentrations in the plume up to 2 hours following cap placement.	Background and post-placement water column total (dissolved + particulate) DDE concentrations.	Collect water samples from the centroid of plume, within 2 m of bottom, for total DDE analyses following single hopper placement events for both conventional and spreading placement methods.	Same as above; Adequate sample volume is needed to ensure that sufficient contaminant mass is present to detect and measure concentrations at levels appropriate for determining background concentrations, and numerical changes to these levels following cap placement.

Monitoring objectives and data requirements for the monitoring task will be addressed by collecting discrete water samples within the near-bottom plume of resuspended sediments at varying times following a cap placement event. Samples will be collected in standard oceanographic water bottles attached to a rosette system that is lowered to the bottom using a hydrowire. Individual bottles can be closed, thus defining the time and location of sampling, by activating a deck control box. Single or multiple samples can be obtained at specific locations and/or sampling times following a cap placement event.

The sampling design intends for water quality sampling to occur in close coordination (spatially and temporarily) with the concurrent plume mapping task. Therefore, an important performance specification for this task is navigational accuracy and accurate, complete documentation of the timing of individual and continuous sampling and measurement events. These conditions are necessary for subsequent merging of geographically and temporally referenced data from specific sampling events. Vessel positioning accuracy for these sampling tasks should be ±3 m.

The objective of the water column DDE measurements is to determine the extent to which cap placement causes increases above background conditions in seawater DDE concentrations. Because background DDE concentrations are expected to range from approximately 1-3 ng/L within the project area (based on the results of recent analyses of two “background” water samples), the detection limit for DDE measurements (0.25 ng/L) will be sufficient to support evaluations of changes in DDE levels following cap placement events. Additionally, this detection limit value is lower than the EPA ambient water quality criterion (chronic) for DDE (0.59 ng/L). Thus, data obtained from water quality measurements could be compared to this criterion.

An objective of the water column TSS measurements is to determine the extent to which cap placement causes increases above background conditions in concentrations of suspended solids. Because background TSS concentrations are expected to range from approximately 1-5 mg/L within the project area (based on recent analyses of two “background” water samples, each containing 2 mg/L TSS), the detection limit for TSS measurements (0.78 mg/L) will be sufficient to allow evaluations of the changes in TSS levels following cap placement events. Based on existing information concerning background TSS and DDE concentrations in bottom waters, the volumes of water provided by sample bottles, and the detection limits associated with the analytical methods, adequate sample volume can be obtained by the sampling approach (described in the FSP portion of this PWP) to achieve objectives for this sampling task.

10.0 DQOs FOR IN-HOPPER SEDIMENT SAMPLING

In-hopper sediment sampling consists of collection and analyses of representative samples from the hopper barge prior to release at the pilot capping area. These data are needed to refine information provided by previous sediment testing concerning the characteristics of the cap material and to validate cap material characteristics used by USACE for cap placement modeling. Monitoring objectives and approaches are summarized in Table 10-1.

Table 10-1. Monitoring Objectives and Approach for In-Hopper Sediment Sampling.

Monitoring Objective	Data Requirements	Monitoring Approach	Field Decision Criteria/Performance Specifications
Confirm grain size and geotechnical characteristics of cap materials (needed for cap placement modeling).	Grain size and geotechnical properties of representative cap material samples.	Collect samples from (1) the first three hopper loads transported to each of the three cells of the capping area, (2) up to 25 loads during continuous capping operations, and (3) the first three loads of any cap material originating from the borrow area (A3), and analyze for grain size, bulk density, water content, specific gravity, and Atterberg limits.	Samples with adequate mass/volumes, collected and preserved as specified in SOPs, and transferred with proper sampling documentation.
Confirm contaminant concentrations in cap materials from borrow sites for later comparisons with post-capping concentrations in cap and EA sediment layers.	DDE concentrations in representative materials from the borrow areas.	Collect samples from the first three loads of any cap material originating from the borrow area and analyze for DDE concentrations.	Samples collected using non-contaminating methods and adequate sample volumes with appropriate documentation.

Under the direction of SAIC, the samples will be collected by the dredging contractor from three locations within the hopper bin, from specific loads designated by the SAIC Program Manager. These samples will be composited to provide a representative sample, and subsequently analyzed for specific geotechnical and chemical parameters. The three individual samples will be homogenized at the shore based laboratory. The composited samples will be split, with separate samples prepared for eventual shipment to the subcontractor chemistry and geotechnical laboratories, as appropriate, and one aliquot prepared for transfer to the Montrose consultants, as directed by EPA.

Data requirements for this monitoring task consist of representative grain size, geotechnical properties, and contaminant (DDE) concentrations. The sampling design specifies collection of three samples, from the bow, stern, and middle portions of the hopper bin, with subsequent compositing, to minimize potentials for small-scale (i.e., within-load) variability that would affect the representativeness of a single sample. Additionally, composite samples from multiple loads during initial and continuous capping operations will be collected and analyzed to characterize larger scale variability in geotechnical properties of the capping materials. Finally, analytical quality assurance procedures (such as duplicate analyses as described in the QAPP) will be performed at specified frequencies to permit assessments of the representativeness of the analytical data. Sediments from the borrow area only will be analyzed for DDE because sufficient data presently exist to characterize DDE concentrations in cap materials obtained from Queens Gate Channel.

11.0 REFERENCES

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Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Interim and Post-Cap Monitoring Activities

FIELD SAMPLING PLAN
(Revision 03)

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DGPS	Differential Global Positioning System
DQO	Data Quality Objectives
EA	Effluent Affected
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
GIS	Geographic Information System
HSP	Health and Safety Plan
LAD	Los Angeles District
NAD	North American Datum
NOAA	National Oceanic and Atmospheric Administration
PVC	Plan View Camera
PV	Palos Verdes
PWP	Project Work Plan
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
SCMI	Southern California Marine Institute
SOP	Standard Operating Procedure
SPC	Sediment Profile Camera
USACE	U.S. Army Corps of Engineers
USCG	United States Coast Guard

1.0 OBJECTIVES AND SCOPE

1.1 Objectives of the Pilot Capping Project

The U.S. Environmental Protection Agency (EPA), Region IX is currently evaluating alternatives for restoration of contaminated sediments on the Palos Verdes (PV) Shelf off the coast of Los Angeles, California. One restoration alternative under consideration is *in-situ* capping, which entails placement of a cap of clean material over contaminated sediment, thereby isolating the contaminated shelf sediments. EPA is collaborating with the U.S. Army Corps of Engineers (USACE) to conduct pre-design data collection studies related to this capping alternative. Palermo et al. (1999) evaluated various scenarios for *in-situ* capping at the PV site. This evaluation included prioritizing areas of the PV Shelf to be capped, determining appropriate cap designs, developing an equipment selection and operations plan for placement of the cap, developing a monitoring plan to ensure successful cap placement and long-term cap effectiveness, and developing preliminary cost estimates.

Recently, Palermo (2000) developed an Operations and Monitoring Plan for a Field Pilot Study of capping on the PV Shelf. This Plan outlines a pilot capping study to be conducted in Summer of 2000 using cap material dredged from the Queen's Gate navigation channel and/or suitable borrow sites (to be determined by USACE). The pilot study consists of controlled operations for placement of cap material within selected areas on the PV Shelf, and associated monitoring prior to, during, and following the placements. The pilot study will include tasks for pre-design data collection and operational design refinement. Operational aspects for the pilot study include selection of appropriate placement areas, capping materials, and placement techniques. The associated monitoring program for the pilot study is designed to evaluate the following topics: areal extent and thickness of the cap; mixing of cap and contaminated sediments; resuspension of contaminated sediments during cap placement; short-term benthic recolonization of the cap; and short-term physical and chemical characteristics of the cap and underlying sediments immediately after capping, and following initial sediment consolidation.

Fredette (2000) developed a companion document to the Palermo (2000) Operations and Monitoring Plan that specifies monitoring activities to be conducted during the pilot capping project. The Field Sampling Plan presented herein addresses the interim and post-cap monitoring activities specified by Fredette (2000). The Baseline phase of the Pilot Cap Monitoring program is addressed in a separate project work plan (SAIC 2000).

This Field Sampling Plan, essentially one chapter of the Project Work Plan for interim and post-cap monitoring, addresses the following activities associated with the field sampling activities that will commence in July 2000:

- Project Organization and Responsibilities
- Field Activities
- Sample Activity Documentation and Chain of Custody Procedures
- Control of Investigation-Derived Wastes
- Field Quality Control
- Field Data Management, Validation, and Corrective Actions
- Schedule of Project Activities

1.2 Scope of Interim and Post-Cap Field Sampling Activities

As indicated above, this Field Sampling Plan addresses the interim and post-cap sampling activities of the pilot capping project which entail the following measurement techniques:

- Sediment Profile Imaging and Plan View Photography
- Sediment Coring
- Side-Scan Sonar Surveying
- Subbottom Profile Surveying
- Surge Measurements Using Moored Instruments
- Hopper Dredge Operations Data
- Water Quality Sampling
- Plume Mapping
- Surge Video Documentation
- In-Hopper Sediment Sampling

These measurement techniques are specified for individual monitoring tasks by Fredette (2000). Data Quality Objectives and the Quality Assurance Project Plan for the interim and post-cap monitoring activities are addressed in separate chapters of the Project Work Plan. Likewise, the Health and Safety Plan for the pilot capping project is provided in the Project Work Plan.

2.0 ORGANIZATION AND RESPONSIBILITIES FOR FIELD ACTIVITIES

This section describes the project organization and identifies SAIC personnel who have been assigned key responsibilities for project management, field sampling, data management, and other significant activities of the interim and post-cap monitoring phases of the Pilot Cap Monitoring Program (Figure 2-1).

2.1 Project Manager for USACE Los Angeles District

The USACE Los Angeles District (LAD) is responsible for overall management of the Palos Verdes Pilot Cap Monitoring Program. Ms. Ellie Nevarez, the LAD's Project Manager, will be responsible for: providing monitoring objectives via definitive Statements of Work; leading the inter-agency technical review committee for the Palos Verdes Monitoring Program; and review/approval of all deliverables produced by the monitoring contractor. Ms. Nevarez will be the contractor's single point of contact within the LAD for all technical issues and schedule. Contractual issues will be addressed between contract representatives at SAIC and within the LAD.

2.2 SAIC Project Manager

Dr. Scott McDowell, SAIC's Project Manager for the Palos Verdes Pilot Cap Monitoring Program, will have overall responsibility for SAIC's portion of the sampling program. In this capacity, he will be the primary SAIC point of contact with the LAD's Project Manager, as well as with other USACE and EPA participants on the Pilot Cap Program. Dr. McDowell has extensive experience with management of multidisciplinary oceanographic field programs, and was the SAIC Project Manager for the previous (Baseline) phase of the Pilot Cap Monitoring Program.

As Manager of SAIC's Marine Environmental Sciences and Information Management Division, Dr. McDowell can commit the necessary human resources and equipment from multiple SAIC facilities to accomplish the monitoring program. His key responsibility for the sampling program is to ensure that SAIC conducts all field sampling activities according to the Data Quality Objectives, Field Sampling Plan, and Quality Control requirements outlined in the Project Work Plan for the Pilot Cap Project. Progress during the interim and post-cap survey operations will be communicated to the LAD Project Manager on a daily basis. If problems are encountered, and/or if circumstances arise that impact the schedule or completeness of the measurements, such matters will be addressed on a near real-time basis, corrective actions will be implemented, and the LAD Project Manager will be contacted immediately, apprised of the situation, and given the opportunity to propose alternatives measures.

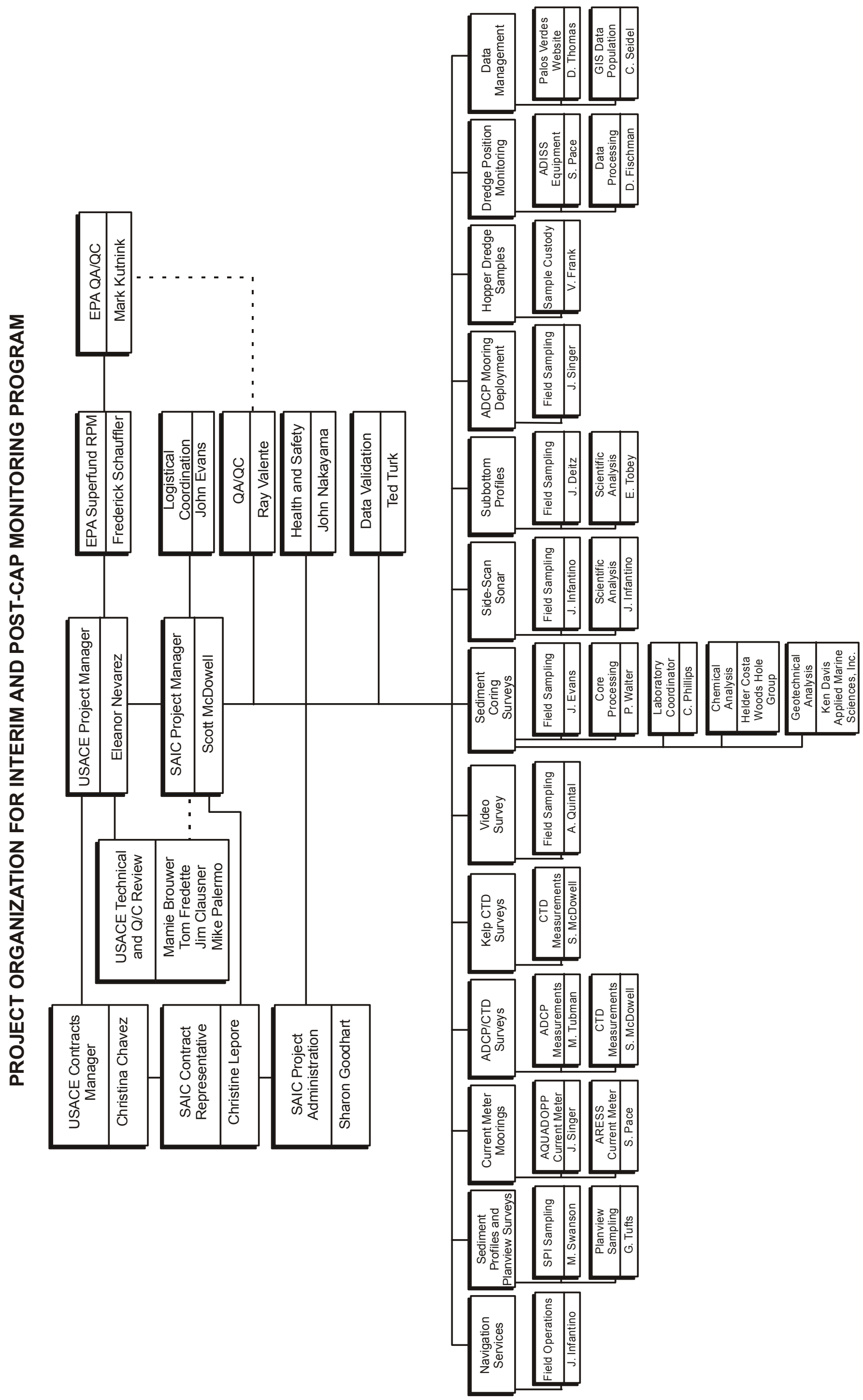

Figure 2-1. SAIC Organization Chart for the Pilot Cap Monitoring Program.

2.3 Additional Project Management Support

The SAIC Project Manager will be supported by Ms. Christine Lepore for contract administration and Ms. Sharon Goodhart for fiscal support with project administration and subcontract management. Both individuals have considerable experience assisting Dr. McDowell with management of contracts under which SAIC has conducted multidisciplinary oceanographic monitoring programs for multiple USACE Districts and the USACE Waterways Experiment Station (WES).

Technical support for QA/QC and Health & Safety issues of the interim and post-cap phases of the monitoring program will be provided by Mr. Ray Valente and Mr. John Nakayama, respectively. Mr. Valente has been involved with the baseline phase of the Pilot Cap Monitoring Program and has a thorough understanding of both the scientific/ engineering objectives and the measurement technologies to be utilized during the monitoring activities. His responsibilities for this project are: prepare and update, as necessary, the Quality Assurance Project Plan; interact with the Project Manager and Team Leaders to develop quality assurance requirements and procedures; monitor strict adherence to the QA requirements and procedures; conduct technical audits as necessary; organize and oversee reviews of program deliverables; and report to the Project Manager on adherence to the QAPP.

Mr. John Nakayama, the designated Project Health and Safety Officer, is experienced with Health and Safety aspects of marine environmental measurement programs. He performed in the role of Safety Officer for the baseline phase of the Pilot Cap Monitoring Program. His principal responsibilities for this project are given below:

- Obtain a qualified technical review of the Health and Safety Plan (HSP)
- Ensure that all personal protective equipment specified in the HSP is available for use at the site
- Ensure that subcontractors are provided a copy of the HSP and return the completed acknowledgement form
- Ensure that a qualified Site Safety Officer is designated for each planned field activity.
- Complete the Project Debriefing Questionnaire upon completion of the field work.

2.4 Logistics Coordinator

One of the most important elements in the successful conduct of the sampling program centers around field logistics, including: scheduling of field personnel, survey vessels and specialized equipment; accessibility of shore-based mobilization facilities; and prearranged shipment of samples to subcontracted analytical laboratories. Mr. John Evans has been assigned this role for the monitoring program based on his demonstrated experience providing similar logistical coordination on numerous oceanographic monitoring programs along the central and southern California coast. Mr. Evans served in the same capacity during the baseline phase of the monitoring program. This experience will ensure that the monitoring activities meet all schedule and Data Quality Objectives.

Mr. Evans will be responsible for conducting "readiness review" meetings as part of the mobilization effort for each field surveying effort. At a minimum, a meeting will be conducted with the field team on the day prior to initiation of a sampling task to assess staff and equipment readiness. Any potential problems will be discussed with the SAIC Project Manager to identify solutions.

2.5 Sediment Profiling and Plan View Photography Surveys

Ms. Melissa Swanson and Mr. Greg Tufts have been designated as lead scientists for the sediment profiling and plan view photography elements, respectively, of the interim and post-cap phases of the monitoring program. In these roles, they will oversee field sampling to ensure that they meet specific Data Quality Objectives, monitor the quality of all associated data, and develop all scientific results as input to project deliverables. Ms. Swanson, lead for the sediment profiling, is well qualified for this role based on four years experience conducting sediment profiling operations in various coastal environments. Similarly, Mr. Tufts will lead the plan view field operations and data analysis activities, having experience from other seafloor photography programs on the U.S. East Coast. Both task leaders will collaborate during data interpretation and analysis. During the field operations, they will be assisted by additional field technicians and the survey navigator. Ms. Swanson will be responsible for approving release of the data to the project data base.

2.6 Sediment Coring Surveys

Mr. Charles Phillips has been designated as lead scientist for the sediment coring element of the monitoring program. In this role, he will monitor the progress and quality of sample collections, quality of all associated data, and develop all scientific results as input to project deliverables. Mr. Phillips is well qualified for this role as he has managed numerous monitoring projects offshore southern and central California involving field collection of sediments, management of subcontract laboratories for analysis of chemical contaminants, and scientific interpretation of chemical and biological results.

Under the direction of Mr. Phillips, Mr. John Evans will be the field leader for the sediment coring operations. Mr. Evans will be responsible for mobilizing staff and equipment according to the project schedule, and conducting the coring operations according to the sampling plan. He also will be responsible for documentation of field sampling operations and determining whether sediment core samples meet the minimum sampling requirements specified in the data quality objectives. Mr. Evans performed successfully in this role during the Baseline monitoring phase of the project, with the result of 100% recovery of all planned sediment cores. During the field surveys, Mr. Evans will be assisted by additional field technicians and a survey navigator.

Ms. Pamela Walter will be the lead scientist responsible for processing of core samples in the field laboratory that SAIC will establish for the summer project. Ms. Walter performed successfully in this role during the Baseline monitoring phase of the project, with 100% acquisition of core photographs, core descriptions, and sediment samples that were shipped to subcontracted laboratories. Ms. Walter also will be responsible for local custody of data and samples resulting from core processing.

Analyses of sediment cores by subcontractor laboratories will be coordinated by Mr. Phillips, who will oversee chemical analyses of sediments performed by Woods Hole Group. He also will coordinate sediment chemistry data validation, which will be performed by SAIC. Ms. Pam Walters will be responsible for oversight of analyses of geotechnical parameters (e.g., grain size, Atterberg limits, bulk density, water content) performed by Applied Marine Sciences.

2.7 Side-Scan Sonar Surveys

Mr. Jason Infantino has been designated as the field engineer and data analyst for the side-scan sonar element of the interim and post-cap phases of the monitoring program. In this role, he will lead the field sampling activities and conduct the post-survey processing of the digital side-scan data. Mr. Infantino is well qualified for this role as he recently conducted the side-scan monitoring of the Baseline phase, in addition to having conducted other side-scan measurement programs on the U.S. East Coast using state-of-the-art, digital side-scan technology. During the field surveys, he will be assisted by additional field technicians and the survey navigator.

Mr. Infantino and Dr. McDowell will be responsible for scientific interpretation of the side-scan data. Additionally, they will: ensure that all measurements meet the specific measurement objectives; monitor the quality of all associated data; and formulate scientific results as input to project deliverables.

2.8 Subbottom Profile Surveys

Mr. John Dietz has been designated as lead scientist and field engineer for the subbottom profiling element of the interim and post-cap phases of the monitoring program. In this role, he will lead the field sampling activities to: ensure that all measurements meet the specific measurement objectives; monitor the quality of all associated data; and develop all scientific results as input to project deliverables. Mr. Dietz is well qualified for this role as he has recently conducted the subbottom profile measurements for the Baseline phase, in addition to having conducted other field measurement programs using state-of-the-art digital technology. During the field surveys, he will be assisted by additional field technicians and the survey navigator. Note that the subbottom profiling operations will be conducted simultaneously with the side-scan sonar surveying, but only during two surveys. Dr. McDowell will be responsible for approving release of side-scan and subbottom profile data to the project database.

2.9 Surge (Bottom Current and Turbidity) Measurements

Mr. Jim Singer and Mr. Steve Pace have been designated as the lead engineers for bottom measurements of potential sediment resuspension and horizontal transport (surge) during cap placement operations. This monitoring activity will be accomplished using two types of current and turbidity measurement technologies. Both engineers have extensive experience deploying this type of specialized oceanographic instrumentation, as well as analyzing data collected by moored instrument arrays. Mr. Singer will be responsible for mobilization, deployment, and data return from Aquadopp current meters and associated turbidity sensors, whereas Mr. Pace will be responsible for similar technical activities for SAIC's Automated Resuspension Surveillance Systems (ARESS). During the field surveys, they will be assisted by additional field technicians and the survey navigator. Following recovery of instrumentation from each deployment event, initial data processing and quality control will be conducted at the San Pedro project facility by experienced technicians; Dr. Scott McDowell will oversee the data processing and conduct quality assessments of the preliminary results. More detailed data processing and analysis will be conducted by scientists at SAIC's Raleigh, NC facility.

As a separate monitoring element, an Acoustic Doppler Current Profiler (ADCP) will be deployed for a period of 30 days to acquire quantitative data on horizontal currents throughout the water column profile. Mr. Jim Singer will be responsible for the deployment of ADCP equipment and recovery of data from this monitoring element. Assistance during the field operations will be obtained from additional technicians and the survey navigator.

2.10 Hopper Dredge Operations Monitoring

Mr. Steve Pace will be the lead engineer for hopper dredge monitoring operations using SAIC's Automated Disposal Surveillance System (ADISS) during cap placement operations. Mr. Pace has performed similar roles on several USACE-sponsored dredged material disposal monitoring programs on the U.S. East and West Coasts. As the design engineer for ADISS, Mr. Pace is highly experienced with installation and operation of ADISS, as well as trouble-shooting if technical problems arise. Mr. Pace will be assisted throughout the program by Mr. David Fischman for ADISS data retrieval and system maintenance, as Mr. Fischman will remain at the project site throughout the monitoring program.

2.11 Plume Monitoring Surveys using CTD and ADCP Technologies

A Conductivity-Temperature-Depth (CTD) profiling system interfaced to an optical beam transmissometer will be used to acquire data on near-bottom suspended sediment concentrations during and shortly after cap placement operations. A Rosette water sampling device interfaced to the CTD profiler will be used for collection of discrete water samples (see Section 2.12 below). The CTD/rosette system will be provided by and operated by an experienced field technician from the Wrigley Institute. Dr. Scott McDowell will be responsible for leading the CTD field sampling operations and conducting post-survey quality assurance of the CTD data. During the field surveys, he will be assisted by additional field technicians and the survey navigator.

Mr. Michael Tubman of the U.S. Army Engineer Waterways Experiment Station (WES) will be responsible for operation of the WES Acoustic Doppler Current Profiling system. He also will conduct the processing of ADCP data following the surveys.

2.12 Water Sampling During Plume Monitoring Surveys

Dr. McDowell will be the lead scientist for water sampling during plume monitoring surveys, including deployment of the CTD and collection of discrete water samples for post-survey laboratory analysis. Dr. McDowell has extensive experience on water sampling programs and collection of samples using rosette systems. A technician from the Wrigley Institute will provide support for operation of the CTD and rosette sampler.

2.13 Surge Video Surveys

Mr. Allan Quintal will be the lead engineer for operation of the underwater video system to be used for documentation of any near-bottom turbidity plumes associated with cap placement operations. During the field surveys, he will be assisted by additional field technicians and the survey navigator.

2.14 In-Hopper Sediment Sampling

Mr. David Fischman is the lead scientist responsible for obtaining representative samples of cap materials from the hopper dredge. Mr. Fischman will interact with the dredge operators, provide the required sampling equipment and log forms, conduct the sample collection, and take custody of the samples. Ms. Victoria Frank will be responsible for shipment of samples to the subcontracted analytical laboratories and quality assurance of results.

2.15 Data Management

One of the critical elements for successful conduct of the monitoring program is the assurance that survey results and data have high quality and be provided to the LAD Project manager and other members of the Palos Verdes Project Team in a timely fashion, as specified by the Project Work Plan. Immediately following data processing and transcription (where applicable), each data set and/or data product will be subjected to quality review by the lead scientist for the specific monitoring element (see Figure 2-1). This review will include assessment of data quality, accuracy, and completeness as addressed in further detail in the Quality Assurance Project Plan. Laboratory data quality for chemical analysis (p,p'-DDE) of sediment core samples will be evaluated using a formal data validation process, as described in the QAPP. The chief scientist for each of the respective sampling tasks will review field data for accuracy and completeness.

Following acceptance of the processed data by the respective lead scientists, all data will follow two paths for data dissemination: data population within the DAN-LA GIS with data updates via CD-ROMs; and more rapid dissemination of data and information via a password-protected, Palos Verdes Monitoring Project Website (PV-Web).

During the interim and post-cap phases of the monitoring program, Ms. Christine Seidel will be co-located with the SAIC field team to facilitate custody of the field data and preliminary results (i.e., side-scan sonar and subbottom profile data products, sediment core photographs, sediment profile images and plan view photographs) from the survey activities. Upon receipt of preliminary data products, Ms. Seidel will post the key data files on SAIC's electronic data archive to be established for the Palos Verdes Project. Note that this data archive will be accessible by SAIC employees from any location nationwide, but the archive will be password protected to guarantee data security and prevent access by unauthorized interrogators.

Ms. Diane Thomas, residing in Newport, Rhode Island, will be responsible for cataloging the preliminary data products, survey reports, and other pertinent survey information posted by Ms. Seidel. She will then facilitate electronic links to these multidisciplinary data files and graphical products on the PV-Web, which will provide all members of the Palos Verdes Project Team with direct electronic access to the results from monitoring surveys within a few days after completion of data processing.

Ms. Seidel also will be responsible for transfer of all data files to the team responsible for populating the DAN-LA database with information from the monitoring surveys.

2.16 Navigation and Vessel Positioning

Mr. Jason Infantino will be responsible for vessel navigation and station positioning on all monitoring surveys. With assistance from other trained navigators, Mr. Infantino will be responsible for the following tasks associated with navigation and record keeping:

- Calibrate the DGPS positioning system(s) prior to surveying,
- Install the positioning equipment aboard the survey vessel and conduct pre-survey operational tests,
- Input target positions for fixed sampling stations,
- Input survey lanes for side-scan sonar and subbottom profiling surveys,
- Operate the positioning equipment during the surveys and perform routine maintenance,
- Maintain a Navigation Log documenting all sampling events,
- Ensure that all digital positioning data are recorded, archived, and stored in duplicate copies, and
- Provide the positioning data from each survey in a timely fashion to data analysts responsible for processing and analysis.

2.17 Field Sampling Personnel

As indicated above, each of the field sampling efforts of the monitoring program will be led by designated field leaders. On all surveys, the field leaders will be assisted by additional field engineers and technicians as necessary to accomplish the survey objectives. These individuals are from SAIC offices in San Diego, CA, Bothell, WA, Raleigh, NC, and Newport, RI, depending upon the specific technical capabilities required for each survey element.

3.0 FIELD ACTIVITIES

Field activities performed for the interim and post-cap phases of the Pilot Cap Monitoring Program will be conducted by SAIC personnel, using facilities and equipment resources, and in accordance with procedures described in this Field Sampling Plan. The SAIC Project Manager will assign responsibilities for field activities to specific personnel, and the Project Manager, Logistics Coordinator, and Task Leaders may delegate specific tasks to other experienced personnel as appropriate. The SAIC Project Manager and/or Logistics Coordinator will convene a pre-survey meeting with all SAIC key personnel to review assignments, schedules, contingencies, and equipment/supplies. Prior to the start of daily sampling activities, the Task Leader of designated Chief Scientist for the specific survey will convene a sampling overview that will address sampling objectives, schedules, assignments, and health and safety issues.

The Monitoring Plan developed by Fredette (2000) describes specific sampling tasks for the interim and post-cap phases of the monitoring program. Each task consists of one or more of the monitoring approaches described in the following sections. The specific monitoring techniques required for individual tasks are described by Fredette (2000) and summarized in Table 3-1.

Table 3-1. Summary of Monitoring Tasks and Associated Measurement Techniques

Task	Single Placement Event	Interim Monitoring	Post-Cap Monitoring
1: Background Data	None	None	None
2: Placement Surge Video	Collect video records during initial placement events at Cell LU, SU, and two other events, at four distances from point of release.	None	None
3: Hopper Dredge Operation Data	Collect and record positioning and discharge data for all cap placement events.	Collect and record positioning and discharge data for all cap placement events.	None
4: In-Hopper Sediment Data	Collect and analyze representative samples from first three loads transported to each cell and first three loads from borrow areas.	Collect and analyze representative samples from 25 loads during continuous capping operations.	None
5: Flex Surveys	Collect 60 additional SPC/PVC images, 20 additional cores, 25 water samples to augment as needed planned sampling for Tasks 6-9 (for both single placement and interim phase).	Collect 60 additional SPC/PVC images, 20 additional cores, 25 water samples to augment as needed planned sampling for Tasks 6-9 (for both single placement and interim phase).	None

Table 3-1. Summary of Monitoring Tasks and Associated Measurement Techniques (continued)

6: Monitoring of Cell LU	Bottom surge (current velocity and OBS) measurements at 5 sites; ADCP, light transmittance measurements, and water quality sampling up to 2 hours following placement, SPC/PVC at 37 stations, sediment coring at 5 locations, and side-scan sonar profiling over cell.	Bottom surge measurements at 5 sites; plume mapping using ADCP and light transmittance measurements up to 2 hours following second and third placement events; SPC/PVC at 14 stations each of two times, and sediment coring at 5 locations each of two times.	SPC/PVC at 37 stations, sediment coring at 9 locations, and side-scan sonar and sub-bottom profiling over cell.
7: Monitoring of Cell LD	Bottom surge measurements at 5 sites; ADCP, light transmittance measurements, and water quality sampling up to 2 hours following placement, SPC/PVC at 37 stations, sediment coring at 5 locations, and side-scan sonar profiling over cell.	None.	SPC/PVC at 37 stations, sediment coring at 9 locations, and side-scan sonar over cell.
8: Monitoring of Cell SU	Bottom surge measurements at 5 sites; ADCP, light transmittance measurements, and water quality sampling up to 2 hours following placement, SPC/PVC at 37 stations, sediment coring at 5 locations, and side-scan sonar profiling over cell.	SPC/PVC at 14 stations and sediment coring at 5 locations.	SPC/PVC at 37 stations, sediment coring at 9 locations, and side-scan sonar and sub-bottom profiling over cell.
9: Monitoring of Cell SD	Eliminated	Eliminated	Eliminated
10: Evaluation of Bathymetry	Eliminated	Eliminated	Eliminated
11: Disposal Plume Transport Study	Track plume using ADCP and light transmittance for 2 hours following three separate placement events.	Track plume using ADCP and light transmittance for 2 hours following three separate placement events.	None
12: Cap Erosion Analysis Samples	Eliminated	Eliminated	Eliminated
14: Water Current Monitoring	Current profile measurements for 30 days using a bottom-mounted ADCP.	Current profile measurements for 30 days using a bottom-mounted ADCP.	None

3.1 Vessels and Logistics

The Pilot Cap Monitoring Program will utilize several facilities in the San Pedro area including research vessels, marine support facilities, offices, and lodgings. Field sampling activities and data processing activities will be consolidated as much as possible throughout the program to enable the highest quality results within the project's accelerated schedule requirements. Additionally, field reports and preliminary results can be disseminated more efficiently to the identified client locations as defined in the Scope of Work. For these reasons, the Southern California Marine Institute (SCMI) Fish Harbor Facility will be utilized for both vessel-based marine operations, as well as overall field survey-related support. This facility was also used during the baseline phase of the monitoring program.

SCMI is a shared resource representing eight California State University campuses, the University of Southern California, and Occidental College which were merged to form the largest consolidated marine institute in California. SCMI provides additional laboratory space as well as convenient seaside access to their fleet of research vessels.

The SCMI Fish Harbor Facility is located at 820 South Seaside Avenue, Terminal Island, California. The facility is ideally located for the Pilot Capping Program marine survey activities due to its proximity to: the proposed cap sites, the site of the Queen's Gate dredging operation, and the local infrastructure. Figure 3-1 illustrates the relative locations of the SCMI, the Palos Verdes work site, Queen's Gate harbor entrance, and San Pedro Bay including Los Angeles and Long Beach Harbors. The SCMI Facility is located approximately 10 miles from the capping site or approximately 30 minutes steaming time via survey vessel.

3.1.1 Survey Vessels

Due to both the stringent schedule requirements and the technical complexity of the Monitoring Program, several marine survey vessels have been identified for potential use during the sampling program. For the interim and post-cap monitoring activities, we anticipate multiple vessels may be used simultaneously, depending upon the project scheduling requirements.

First consideration will be given to two survey vessels operated by SCMI: the R/V SEA WATCH and the R/V YELLOWFIN, both of which are available for charter and fully capable of conducting the planned sampling activities (e.g., station handling, deck equipment, etc.). Additionally, two other local vessels have been identified for potential use: the M/V TUNA, operated by Pacific Tugboat Service in San Diego, and the EARLY BIRD, operated by Seaventures in Dana Point. The latter two vessels can be employed as backup vessels in the event of scheduling conflicts with the primary SCMI vessels. The four vessels range from 36 to 75 ft in length, and are equipped with A-Frames, winches, and deck equipment. All vessels operate with experienced crews that specialize in multidisciplinary marine science surveys, and they have extensive experience working in the Southern California area using proposed coring, sediment vertical profiling, side-scan sonar and subbottom profiling technologies.

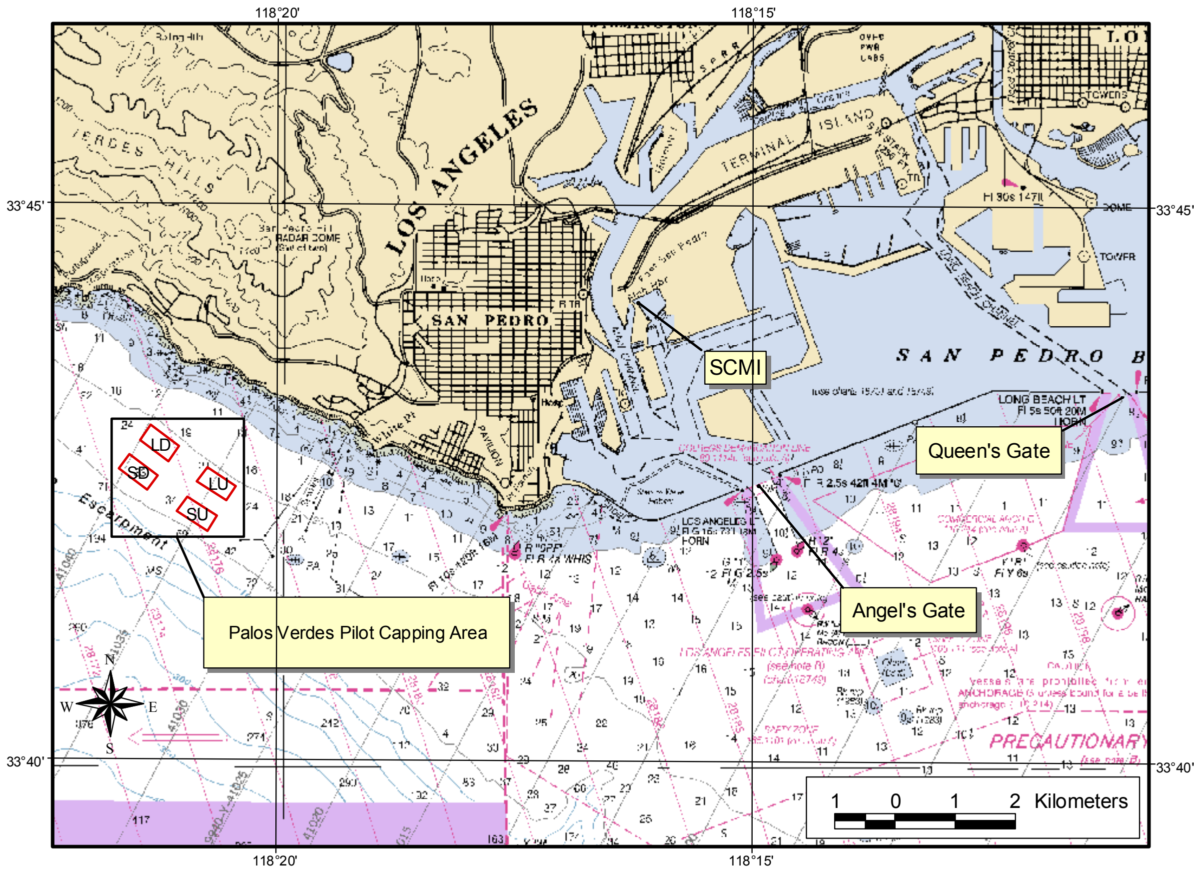

Figure 3-1. Palos Verdes Pilot Capping Area and locations of SCMI, Queen's Gate harbor entrance, and San Pedro Bay including Los Angeles and Long Beach Harbors.

Specifications for the four candidate vessels are given in Tables 3-2a through 3-2d. Note that vessels will not be required to provide electronic navigation equipment because SAIC will temporarily install DGPS navigation equipment for each survey.

3.1.2 Shore-Based Logistical Facilities

The SCMI Fish Harbor Facility will be utilized for vessel access, equipment mobilization and demobilization, and short-term storage of equipment and field supplies. The facility contains more than 13,000 square feet of usable space, including offices, classrooms, fully equipped laboratories, and a machine shop. Additionally, SCMI has 10,000 square feet of deep harbor space able to accommodate five research vessels.

SCMI utilizes the combined assets of personnel and well-equipped vessels to provide the capability of meeting a variety of research and educational needs in both coastal and offshore waters. Of particular interest to the monitoring program are the offices and research laboratories which can be used to: 1) split and log sediment cores, 2) process sediment core and water samples for shipment to analytical laboratories, 3) process sediment profile and plan view photographs for quick analysis of bottom characteristics and cap thickness during the monitoring effort, and 4) data processing and analysis of side-scan and subbottom profile data, 5) mobilization of other monitoring equipment and 6) data management activities. Additional warehouse and staging areas will provide access for equipment mobilization and demobilization. SCMI's two primary research vessels give SAIC the added confidence of being able to perform marine survey tasks with a minimum of scheduling conflicts. Further, small boats will help facilitate unforeseen or otherwise unplanned equipment and personnel exchanges, therefore maximizing labor resources on this demanding field program. These small vessels also could be used for transport of time-critical survey data to shore, prior to the end of the survey day.

Meeting rooms and offices will provide access for SAIC personnel to compile and process data prior to delivery to USACE. The machine shop, fork lifts, and other equipment be available for vessel mobilization activities, as well as facilitating necessary equipment testing and repairs. Finally, SCMI retains numerous pieces of scientific and electronic equipment available use on marine programs.

Table 3-2A. Specifications of Survey Vessel R/V SEA WATCH

Operator:	Southern California Marine Institute
Home Port:	Terminal Island, CA
Hull Construction / Year Built (Modified):	Plywood fiberglass / 1978
Dimensions:	65-foot LOA, 24-foot beam, 5-foot draft
Main Propulsion:	Twin 465 HP (12-71 Detroit) 920 S.H.P.
Speed:	10.5 knots cruising
Fuel Capacity:	1800 gallons
Water Capacity:	Not Available
Electronics:	Phone, 2 VHF Transceivers, 48 mile Furuno RADAR, Magnetic Compass, Recording fathometer; Furuno Cellular FE-881, Trimble 100A Loran-C, Magnavox MX 100 GPS and MX200 DGPS, Alden Weather Fax, kHz transducer
Deck Equipment:	Hydrographic davit on port quarter with 2,500' of 5/32" wire rope and lift capacity 400 lbs. Main drag winch aft on main deck with 4,000' of 3/8" IWRC wire rope and lift capacity of 1,800 lbs.; Stern `A' Frame maximum lifting capacity 2,500 lbs. 13' vertical clearance under block; 8' horizontal clearance between the frame; 7' horizontal clearance over the stern.
Special Equipment:	12 ft. Avon inflatable with 15 h.p. outboard, 17 ft Boston Whaler with 90 h.p. outboard, flow through sorting table and extensive list of portable scientific equipment is also available
Gross Tons / Net Tons:	97 / Not Available
Official Number:	297-291
Area of Operation:	Southern California Coastal

SCMI Contact Information:

Vessel Charters and Equipment Leases – Dan Warren
Southern California Marine Institute
820 South Seaside Ave.
Terminal Island, CA 90731

Phone: (310) 519-3172
Fax: (310) 519-1054
E-mail: cdwarren@csulb.edu

SEA WATCH: http://www-bcf.usc.edu/~scmi/xseawatch.html

Table 3-2B. Specifications of Survey Vessel R/V YELLOWFIN

Operator:	Southern California Marine Institute
Home Port:	Terminal Island, California
Hull Construction / Year Built (Modified):	Aluminum / 1987
Dimensions:	76-foot LOA, 24-foot beam, 8.6-foot draft
Main Propulsion:	Twin 350 HP (8v92 GM Detroit) 720 S.H.P.
Speed:	10 knots cruising
Fuel Capacity:	4600 gallons
Water Capacity:	Makes 600 gallons per day
Electronics:	Cellular Phone, 2 VHF Transceivers, 1 - SSB Transceiver, Furuno Fathometer, 2,000 meters, Trimble GPS, Furuno and Raytheon Loran C, Raytheon 64 mile plotting radar, R41 Raster Scan 32 mile radar, Wood Freemen Autopilot, Navtac XL / Echo XL
Deck Equipment:	Hydrographic winch starboard mid ship with 1,500 meters 5/16" wire rope; lift capacity 500 lbs. at mid drum, ne additional spool of 330 meters of 8 conductor 3/8" electromechanical cable, articulating crane starboard mid ship; maximum lifting capacity 1,000 lbs. Main drag winch aft on main deck with 5,000 meters of 7/16" torque balanced galvanized wire rope; lift capacity of 5,000 lbs. at mid drum. Stern 'A' Frame maximum lifting capacity 2,500 lbs.
Special Equipment:	12 ft Avon inflatable with 15 h.p. outboard, 17 ft Boston Whaler with 90 h.p. outboard, flow through sorting table and extensive list of portable scientific equipment is also available
Gross Tons / Net Tons:	109 / Not Available
Official Number:	537-119
Area of Operation:	Southern California Coastal
SCMI Contact Information:	Vessel Charters and Equipment Leases – Dan Warren Southern California Marine Institute 820 South Seaside Ave. Terminal Island, CA 90731 Phone: (310) 519-3172 Fax: (310) 519-1054 E-mail: cdwarren@csulb.edu YELLOWFIN: http://www-bcf.usc.edu/~scmi/xyellowfin.html

Table 3-2C. Specifications of Survey Vessel M/V TUNA

Operator:	Pacific Tugboat Service
Home Port:	San Diego, California
Hull Construction / Year Built (Modified):	Aluminum / 1970
Dimensions:	40-foot LOA, 16-foot beam, 3.5-foot draft
Main Propulsion:	500 horsepower twin engines thought Allison 1:1 transmissions to 28-inch propellers
Speed:	11 knots cruising
Fuel Capacity:	1,100 U.S. gallons
Water Capacity:	200 U.S. gallons
Electronics:	3 VHF Radios, SSB, Autopilot, Plotter, GPS, 16-mile Radar
Deck Equipment:	Deck-mounted drum winch with capstan and 600-foot wire rope. Upper-level pullmaster has 2,500 feet of 1/40-inch wire rope. Both winches fairlead to A-frame block and to articulating A-frame 12 feet high and 8 feet wide with 4,000-pound capacity.
Special Equipment:	Salvage equipment, including dive compressor, lift bags, and dewatering pumps.
Gross Tons / Net Tons:	28 / 19
Official Number:	528 294
Area of Operation:	Coastwise, California and Mexico
PTS Contact Information:	Vessel Charters – Bob Kinsella San Diego Towing and Marine Services, Inc. 2435 Shelter Island Drive San Diego, CA 92106 Phone: 619.222.7084 Fax: 619.222.6077 E-mail: bob@pacifictugboatservice.com TUNA: http://www.pacifictugboatservice.com/Pages/other_boats_available.htm

Table 3-2D. Specifications of Survey Vessel M/V EARLY BIRD

Operator:	Seaventures
Home Port:	Dana Point, California
Hull Construction / Year Built (Modified):	Plywood fiberglass / Not available
Dimensions:	36-foot LOA, 15-foot beam, 3-foot draft
Main Propulsion:	Not Available
Speed:	Not Available
Fuel Capacity:	Not Available
Water Capacity:	Not Available
Electronics:	Color Simrad Fathometer with 200 fathom capability, 48-mile Simrad Radar, Trimble and Northstar Differential GPS
Deck Equipment:	17 x 12 feet of usable flat deck space, 1,500-lb. Deck winch with 3,000 feet of ¼ in. stainless cable, 10,000-lb. Boom winch with 500 feet of ¼ in. stainless cable, removable 'A' Frame
Special Equipment:	12 KW three-phase generator, Air compressor, flying bridge, swim step with dive ladder
Gross Tons / Net Tons:	Not Available
Official Number:	Not Available
Area of Operation:	Coastal in-shore, bays in Southern California

Seaventures Contact Information: Vessel Charters – Kenny Nielson
Seaventures
33222 Acapulco Dr.
Dana Point, CA 92629

Phone: 714.248.4208
714.492.3143
E-mail: N/A

EARLY BIRD: N/A

3.2 Navigation and Vessel Positioning

3.2.1 Rationale

Accurate positioning of the survey vessel during all sampling activities is an essential requirement for the monitoring program. This positioning capability must include: 1) pre-survey establishment of accurate positions for all sampling locations and survey lanes; 2) a real-time helmsman display of vessel position to aid the vessel's crew in maneuvering to predetermined stations and lanes; and 3) acquisition and automatic digital recording of accurate vessel positions for the duration of each survey. Only proven navigation equipment and data acquisition/recording procedures will be used throughout the surveys to ensure high accuracy and repeatability in vessel position information.

Vessel positioning accuracy of ±3 m will be achieved during the pilot surveys via use of the U.S. government-maintained Global Positioning System (GPS) with enhancements to positioning accuracy that can be achieved via differential GPS (DGPS) corrections that are provided in real-time by USCG transmitters located in San Diego and Point Conception. This DGPS capability meets the pilot cap program requirements for vessel positioning accuracy while requiring minimal manpower and equipment investments, in contrast to significantly more effort and equipment that would be required to establish a temporary shore-based navigation system having accuracy and resolution equivalent to DGPS. This vessel positioning accuracy represents the rated accuracy of the navigation system as specified by the system manufacturer.

3.2.2 Navigation Equipment

For all surveys, SAIC will be responsible for installation, operation, and maintenance of the DGPS navigation system aboard the survey vessel. Identical hardware and navigation software will be used for all surveys to ensure positioning accuracy and data format compatibility. If two survey vessels are being used simultaneously, as during monitoring of placement operations, the navigation systems and procedures used aboard both survey vessels will be identical.

An industry standard software product, Hypack, will be used for survey vessel positioning on all surveys. This product offers a simple user interface for entry of target station locations and survey lanes, as well as excellent real-time display and data recording capabilities. A Global Positioning System (GPS) receiver will provide continuous GPS vessel position data, and a DGPS receiver will be used to acquire real-time DGPS corrections from USCG beacons in San Diego and Point Conception. The GPS and DGPS receivers will be interfaced to a personal computer with a 400 MHz processor for real-time display of vessel positions and data storage.

3.2.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

The objective for acquisition of navigation data during the surveys is to achieve continuous vessel position data to an accuracy of ±1 to 3 m. All DGPS navigation data will be recorded and displayed in latitude and longitude coordinates, referenced to the North American Datum 1983 (NAD 83) geographic coordinate system.

Calibration and Quality Control

Prior to each survey, calibration of the DGPS system will be verified by acquiring 60 min of DGPS data at a shore-based location with a known geodetic position. These positions will be averaged to quantify the absolute accuracy of the DGPS data acquisition system. Absolute accuracy will be acceptable if the average error is less than 3 m.

3.2.4 Mobilization

Prior to initiation of the first survey, the DGPS navigation equipment, PC-based data acquisition system, and software will be installed aboard the survey vessel, then tested at the pier to validate GPS and DGPS signal reception, as well as overall system functionality.

3.2.5 Data Acquisition and Dissemination

During sampling operations, vessel positions will be logged (i.e., a navigation fix recorded) at the exact time that the sampling equipment reaches the seafloor or the target sampling depth. The acceptance criteria for collection of discrete samples, or placement of moored instrumentation, is that the sample must be collected within a 5-meter watch circle of the specified sampling coordinates.

Vessel positions will be logged continuously at a sampling interval of 0.5 sec during the side-scan sonar and subbottom profiling surveys. The exact position of the towfish will be determined by adjusting the vessel position according to the “lay-back” (horizontal displacement behind the vessel’s DGPS antenna) of the towfish. These towfish positions will be merged with the geophysical data to yield an accurate position for each acoustic measurement.

Throughout the survey operations, the SAIC Navigator will be responsible for operation of the DGPS navigation system and manually recording all significant events and any problems encountered in the Navigation Log. Upon completion of each survey, the Navigator will provide to the Field Sampling Leader both the Navigation Log and a digital copy of all navigation data recorded during the survey. The Field Sampling leader will review the log for accuracy and completeness. The Navigator also will provide one additional copy of all vessel navigation data to the data archive maintained by the DAN-LA GIS.

3.3 Sediment Profile Imaging and Plan View Photography

3.3.1 Rationale

The Sediment Profile Camera (SPC) provides a cross-section photograph of surface and near-surface sediment on 35 mm slides. Each photographic image provides a 20 cm high by 14 cm wide "profile" of the surface and near-surface sediments. SPC images provide information describing sediment grain-size, sedimentary fabric, benthic infauna, and physical and biological processes. This technology has been used extensively to map the extent of sediment caps and deposits.

During monitoring activities, SPC sampling will also incorporate plan view underwater photography. This technique generates a plan view (top down) photograph of the seafloor immediately prior to penetration of the SPC prism. This information complements the SPC data by documenting surficial features on the seafloor.

3.3.2 Sampling Equipment

Sediment profile images will be acquired using a Sediment Profile Camera. Figure 3-2 provides a schematic diagram of the camera and the sequence of operation on deployment. The camera consists of a wedge-shaped prism with a Plexiglas face plate; light is provided by an internal strobe. The back of the prism has a mirror mounted at a 45-degree angle to reflect the profile of the sediment-water interface toward the camera which is mounted horizontally on the top of the prism. The prism is filled with distilled water, through which the photographs are obtained. Because the object (sediment) to be photographed is directly against the face plate, turbidity of the ambient seawater is not a limiting factor.

The camera prism is mounted on an assembly that can be moved up and down by allowing tension or slack on the hydrowire. The rate of prism penetration into the bottom sediment is controlled by an adjustable, "passive" hydraulic piston.

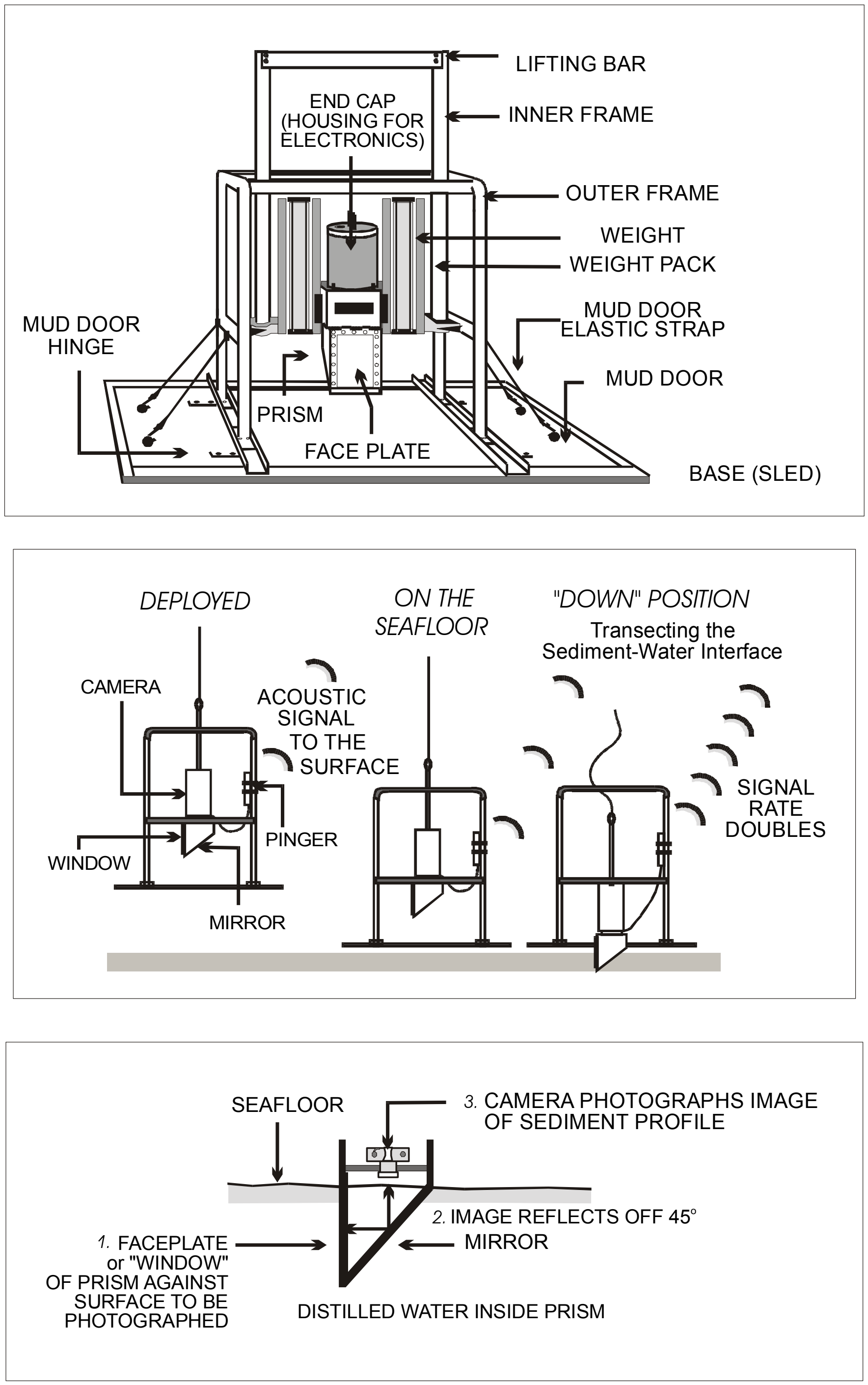

Figure 3-2. Schematic diagram of sediment-profile camera and sequence of operation on deployment.

The equipment and expendable supplies associated with the SPC sampling operations are listed below:

- Sediment Profile Camera
- 25 lb. lead weights (5 sets of 2)
- 7.2 volt rechargeable battery packs
- Pinger and hydrophone
- ASA 100 color slide film (36 exposures per roll)
- "Mud" doors to prevent over penetration into soft sediment
- Glass cleaner and paper towels
- Distilled water
- Winch and hydrowire
- Swivel for hydrowire
- SPC Field Log
- DGPS navigation system and sampling stations
- SPC tool kit with stainless hardware spares

Plan view images of the seafloor will be acquired using a downward-looking underwater 35 mm camera and strobe light, which are mounted on the sediment profile camera frame. Primary components that will be mobilized for the baseline sampling include:

- Underwater 35-mm Camera and Strobe Light
- Synchronized Camera and Strobe Trigger Assembly
- ASA 200 Color Slide Film (250 exposures per roll)

3.3.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Sediment profile imagery and plan view photography sampling objectives for the monitoring program are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette 2000), sediment profile images will be acquired following single hopper placement and during interim and post-cap monitoring at each station of the sampling plan. As described below, stations will be reoccupied and additional images and/or photographs will be acquired if good-quality images were not obtained during the first attempt at each station. The need to re-occupy stations will be determined following the first day of sampling operations and prior to mobilization for “make-up” stations.

Calibration and Quality Control

Prior to survey mobilization, the SPC camera head will be "bench-tested" to ensure that the camera is in focus and firing properly, and that the strobe is operational. The acceptance criteria for a bench test are that the strobe light must fire properly and at the correct time interval following activation of the trigger (typically 13 to 15 seconds), the film must advance, and the readout on the illuminated frame counter must show an advance by one. Spare camera parts, fully-charged battery packs, and an adequate number of film rolls will be stored aboard the vessel to ensure uninterrupted sample acquisition. The plan view camera (PVC) also will be tested to ensure that the camera is firing properly and the strobe is operational. A fully charged spare plan view camera and strobe will be available as backup.

A real-time verification that the electronics within the sediment profile camera are functioning properly is provided by the pinger, which doubles its ping rate when the camera fires successfully (i.e., the pinger is synchronized with the strobe within the camera - if the strobe does not fire, it indicates that the camera has not been triggered properly or an electronic problem exists. If the strobe fires, it indicates that an image has been acquired and the film within the camera has been advanced. Therefore, firing of the strobe and the resulting doubling of the pinger rate are indicators that the camera is functioning properly).

During the plan view test shot the motor winder is audible and the strobe flash is visible, indicating the system is functioning properly. At regular intervals during each survey day, the frame counter is checked to make sure that the correct numbers of images have been taken. If images have been missed or the penetration depth is insufficient, then proper adjustments are made (e.g., weight is added to the frame) and additional images are taken. Two weight packs, each capable of holding 125 pounds of lead (in 25-pound increments), can be added to increase penetration (e.g., for work in sandy or high shear strength, compacted sediments). If penetration is too great, adjustable stops can be lowered to control the distance the prism can descend. In addition, "mud" doors can be attached to each side of the frame to increase the bearing strength of the entire unit.

3.3.4 Sampling Plan

The SPC/PVS stations will be located within and surrounding each of the three pilot capping cells LU, LD, and SU. The sampling plan varies from cell to cell. In addition, 60 SPC/PVC stations may be sampled for the flex survey. Table 3-3 provides a summary of SPC/PVC field survey efforts for the capping project. The images from the additional (flex) stations will be used to augment the data from the fixed station sampling efforts.

For the plan view photographs acquired at each SPC station, typically, one photograph will be obtained for each SPC photograph (penetration event). For replicate images, the camera is raised about 2 m above the bottom and then lowered back into the sediment. Because the survey vessel typically experiences some minor lateral movement while sampling, the action of raising the camera with the winch wire results in lateral movement of the camera. In this way, the camera rarely penetrates into sediment that previously has been disturbed by prior penetrations. Disturbances to the sedimentary features caused by prior penetration of the camera would be obvious in the sediment profile and plan view images. In these instances, the station would be re-occupied on a subsequent sampling day.

Table 3-3. Summary of the SPC/PVC sampling effort.

Monitoring Type	Capping Cell(s)	**Number of Stations**	**Sampling Frequency**	**Total No. of Images to be Analyzed (includes all cells)**	**Level of Analysis**
Single Hopper Placement	LU, LD, SU	37 stations per cell, 15 stations within the cell and 22 stations surrounding the cell	1 replicate image at each station, at 4 randomly selected stations 3 replicates will be analyzed	(4 stations x 3 replicates + 33 stations x 1 replicate) x 3 cells = **135 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments
Interim Placement	LU x2, SU	14 stations per cell, all stations within the cell	1 replicate image at each station, at 2 randomly selected stations 3 replicates will be analyzed	(2 stations x 3 replicates + 12 stations x 1 replicate) x 3 surveys = **54 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments
Post Cap	LU, LD, SU	37 stations per cell, 15 stations within the cell and 22 stations surrounding the cell	1 replicate image at each station, at 4 randomly selected stations 3 replicates will be analyzed	(4 stations x 3 replicates + 33 stations x 1 replicate) x 3 cells = **135 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments
Flex Survey(s)	As needed	Up to 60 stations in total	1 replicate image at each station	60 stations x 1 replicate = **60 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments

The station designation will consist of cell, survey, station number, and replicate according to the following convention: cell-survey-station-replicate. For example, Interim station I9, second replicate, in cell LU will be designated LU-I-I9-B. Tables 3-4 through 3-7 present the target station designations for cell LU, which is used as the example. Station coordinates will be determined prior to commencement of each survey.

Cell LU

After conventional placement of a single hopper load of cap material in Cell LU, a 37 station SPC/PVC survey will be conducted (Figure 3-3). This survey will include stations I1-I15 and O1-O22. These images will be analyzed for thickness of cap material and evidence of mixing or erosion of the Effluent-Affected (EA) sediments.

There will be two interim placement SPC/PVC surveys in Cell LU. The first interim survey will occur after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point. The second interim survey will occur when placement of the 15 cm cap over the entire cell is approximately two-thirds complete. Each survey will consist of 14 sampling stations (I1-I3, I5, I7, I9, I11, and I13-I19; Figure 3-4). These images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

Table 3-4. SPC/PVC Station Locations for the Single Hopper Placement Survey in Cell LU

CELL LU	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLANE COORDINATES NAD 83	
			X	Y
Single Hopper Placement Station Number				
LU-SH-I1				
LU-SH-I2				
LU-SH-I3				
LU-SH-I4				
LU-SH-I5				
LU-SH-I6				
LU-SH-I7				
LU-SH-I8				
LU-SH-I9				
LU-SH-I10				
LU-SH-I11				
LU-SH-I12				
LU-SH-I13				
LU-SH-I14				
LU-SH-I15				
LU-SH-O1				
LU-SH-O2				
LU-SH-O3				
LU-SH-O4				
LU-SH-O5				
LU-SH-O6				
LU-SH-O7				
LU-SH-O8				
LU-SH-O9				
LU-SH-O10				
LU-SH-O11				
LU-SH-O12				

Table 3-4. SPC/PVC Station Locations for the Single Hopper Placement Survey in Cell LU (continued)

LU-SH-O13				
LU-SH-O14				
LU-SH-O15				
LU-SH-O16				
LU-SH-O17				
LU-SH-O18				
LU-SH-O19				
LU-SH-O20				
LU-SH-O21				
LU-SH-O22				

Table 3-5. SPC/PVC Station Locations for the First Interim Survey in Cell LU

	LATITUDE (N)	LONGITUDE (W)	STATE PLANE COORDINATES NAD 83	
CELL LU	NAD 83	NAD 83	X	Y
1st Interim Station Number				
LU-1I-I1				
LU-1I-I2				
LU-1I-I3				
LU-1I-I5				
LU-1I-I7				
LU-1I-I9				
LU-1I-I11				
LU-1I-I13				
LU-1I-I14				
LU-1I-I15				
LU-1I-I16				
LU-1I-I17				
LU-1I-I18				
LU-1I-O19				

Table 3-6. SPC/PVC Station Locations for the Second Interim Survey in Cell LU

CELL LU	LATITUDE (N) NAD 83	LONGITUDE (W) NAD 83	STATE PLANE COORDINATES NAD 83	
			X	Y
2nd Interim Station Number				
LU-2I-I1				
LU-2I-I2				
LU-2I-I3				
LU-2I-I5				
LU-2I-I7				
LU-2I-I9				
LU-2I-I11				
LU-2I-I13				
LU-2I-I14				
LU-2I-I15				
LU-2I-I16				
LU-2I-I17				
LU-2I-I18				
LU-2I-O19				

Table 3-7. SPC/PVC Station Locations for the Post Cap Monitoring Survey in Cell LU

	LATITUDE (N)	LONGITUDE (W)	STATE PLANE COORDINATES NAD 83	
CELL LU	**NAD 83**	**NAD 83**	**X**	**Y**
Post Cap Monitoring Station Number				
LU-PC-I1				
LU-PC-I2				
LU-PC-I3				
LU-PC-I4				
LU-PC-I5				
LU-PC-I6				
LU-PC-I7				
LU-PC-I8				
LU-PC-I9				
LU-PC-I10				
LU-PC-I11				
LU-PC-I12				
LU-PC-I13				
LU-PC-I14				
LU-PC-I15				
LU-PC-O1				
LU-PC-O2				
LU-PC-O3				
LU-PC-O4				
LU-PC-O5				
LU-PC-O6				
LU-PC-O7				
LU-PC-O8				
LU-PC-O9				
LU-PC-O10				
LU-PC-O11				
LU-PC-O12				

Table 3-7. SPC/PVC Station Locations for the Post Cap Monitoring Survey in Cell LU (continued)

LU-PC-O13				
LU-PC-O14				
LU-PC-O15				
LU-PC-O16				
LU-PC-O17				
LU-PC-O18				
LU-PC-O19				
LU-PC-O20				
LU-PC-O21				
LU-PC-O22				

Sediment Profiling Stations
Palos Verdes Single Hopper Placement Survey and Post Cap Monitoring Survey

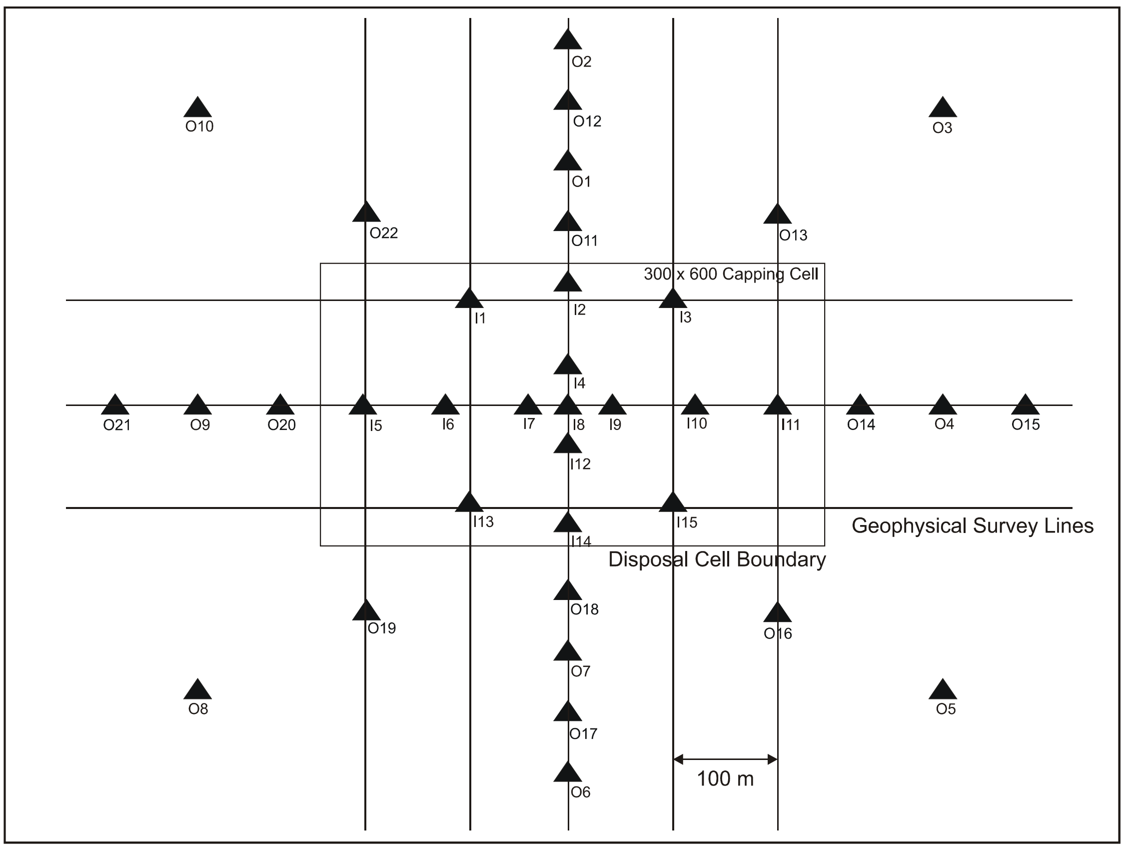

Figure 3-3. Schematic representation of SPC/PVC stations occupied in each of the three capping cells during the single hopper placement and post cap monitoring surveys.

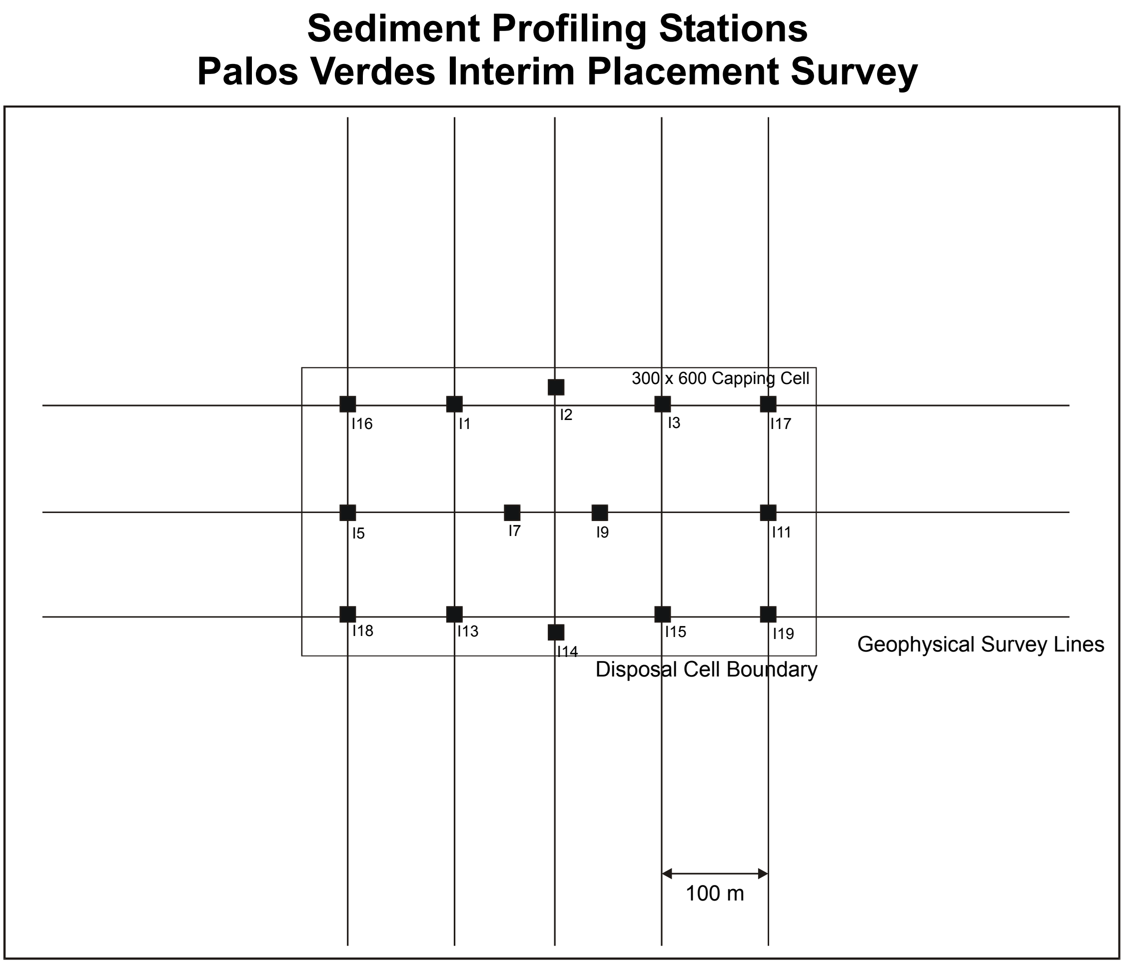

Figure 3-4. Schematic representation of the distribution of SPC/PVC stations occupied during the interim placement surveys in cells LU and SU.

After placement of cap material in Cell LU is complete, a 37 station SPC/PVC survey will be conducted which will include stations I1-I15 and O1-O22 (Figure 3-3). Images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

Cell LD

After placement (spreading) of a single hopper load of cap material in Cell LD, a 37 station SPC/PVC survey will be conducted which will include stations I1-I15 and O1-O22 (Figure 3-3). Images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments. No interim placement monitoring using SPC/PVC will be conducted.

After placement of the cap material in Cell LD is complete, a 37 station SPC/PVC survey will be conducted which will include stations I1-I15 and O1-O22 (Figure 3-3). Images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

Cell SU

Following conventional placement of a single hopper load of cap material in Cell SU, a 37 station SPC/PVC survey will be conducted (Figure 3-3). Images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

One interim placement SPC/PVC survey at Cell SU will occur when placement of the 15 cm cap at the single placement location is approximately two thirds complete, and will consist of 14 sampling stations (I1-I3, I5, I7, I9, I11, and I13-I19; Figure 3-4). These images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

After placement of the cap material in Cell SU is complete, a 37 station SPC/PVC survey will be conducted that will include stations I1-I15 and O1-O22 (Figure 3-3). Images will be analyzed for thickness of cap material and evidence of mixing or erosion of the EA sediments.

Flex Survey

In addition to the planned sampling described above, SPC/PVC images will be collected at 60 other stations. This sampling will be conducted at the request of the USACE Project Manager, and will be used to augment data obtained from the fixed sampling grid. The specific sampling sites will be determined based on communications between the SAIC Project Manager and the USACE team. This approach will provide USACE with flexibility for enlarging the spatial coverage and/or addressing other specific objectives based on preliminary results obtained from interim and post-cap sampling conducted as part of the other tasks.

3.3.5 Mobilization

Prior to survey mobilization, the SPC camera head will be "bench-tested" to ensure that the camera is focused, firing properly, and that the strobe is operational. Spare camera parts, fully charged battery packs, and slide film will be kept aboard the survey vessel to ensure uninterrupted sampling operations.

At the beginning of each survey day, the time within the data loggers mounted on the SPC and PVC will be synchronized with the navigation system clock. Each SPC/PVC station replicate will be identified by the time recorded on the film and the corresponding time and position recorded by the navigation system. Redundant sample logs will be maintained by the field crew. Prior to actual sampling operations, test shots are fired on deck at the beginning of each roll of film to verify that all internal electronics systems are working according to specifications.

The DGPS navigation system will be monitored before the start of the survey to ensure that positional data are being recorded by the computer on data storage medium (diskette). The navigation system also will be checked to ensure that the proper SPC/PVC sampling locations are entered into the survey database. The GPS master antenna will be installed as close as possible to the position where the hydrowire enters the water (A-frame) so that the correct sampling position is recorded by the navigation system. The location of the master antenna will be recorded in the navigation log and used in the final position computations.

3.3.6 Data Collection

Sampling Operations

The SPC frame is attached to the hydrowire on the vessel's winch. The camera prism is mounted on an assembly that can be moved up and down by producing tension or slack on the winch wire. As the camera is lowered, tension on the wire keeps the prism in the "up" position (see Figure 3-2). Once the camera frame contacts the bottom, slack on the wire allows the prism to vertically descend into the seafloor. The rate of descent of the optical prism into the sediment is controlled by a passive hydraulic piston. This allows the optical prism to descend at approximately 6 cm per second. The camera trigger is tripped by the prism assembly, activating a 13-second time delay on the shutter release, which gives the prism sufficient time to obtain maximum penetration before a photo is taken.

A pinger is attached to the camera and outputs a constant 12 kHz signal of one ping per second; upon discharge of the camera strobe, the ping rate doubles for 10 seconds. Monitoring the pinger's signal using a hydrophone suspended from the vessel allows confirmation that the camera/strobe unit fired; confirmation that a good-quality image was obtained cannot, however, be determined until the film is developed.

As the camera is raised off the bottom, a wiper blade automatically cleans any sediment from the prism faceplate. The film is automatically advanced by a motor drive, the strobe capacitor is recharged, and the camera can be lowered for another image.

When the camera is brought to the surface, the frame count is noted/verified by looking at digital counter display, and the camera prism penetration from the previous lowering is estimated from a penetration indicator that measures the distance the prism descended, relative to the camera base. If penetration is minimal, weight packs can be added to the camera frame to give the assembly increased penetration. If penetration is too great, adjustable stops (which control the distance the prism descends) can be lowered, and "mud" doors can be attached to each side of the frame to increase the bearing surface and reduce frame penetration into the seafloor. Because the SPC equipment is not used to collect samples for chemical analysis, there is no need to decontaminate the equipment between sampling stations.

Three replicate images will be acquired at each SPC station, and at least one image per station will be analyzed as shown in Table 3-3 (the other images are collected as specified in the SOP to ensure that at least one acceptable quality image per station is obtained). In cases where only one of the three replicates is to be analyzed, the image will be selected based on the best professional judgment of SAIC scientists. Typically, the image selected will be the one which best exemplifies the characteristics of the station and which is of the highest quality for subsequent analysis (e.g., optimal penetration of the camera prism into the sediment, sediment-water interface clearly observed, sediment features clearly visible, lack of artifacts such as streaking or smearing).

After a full roll of film has been exposed from multiple lowerings, the camera will be brought on deck of the vessel, and the film replaced. All completed rolls will be stored in a secure, dark location aboard the vessel. At the end of each survey day, the film will be developed by SAIC personnel using a portable film developer to ensure that adequate image quality was obtained and allow for "quick-look" analysis prior to the next day's survey. The developing will occur in a secure location and developed film will either be kept in this secure location or held in the custody of the Field Leader at all times during the field operations. Any stations where three good quality images are not acquired are considered "make-up" stations and are re-occupied on the next survey in order to acquire the required three images.

<u>Plan View Photography</u>

The plan view camera system is mounted on the SPC frame. Photographs are taken using a weighted tension trigger that is suspended below the SPC frame. Just before the SPC reaches the bottom, the tension on the suspended trigger is released, and the plan view camera and strobe are fired simultaneously. The film is automatically advanced by a motor drive, and the strobe is immediately recharged for the next photograph.

Three replicate photographs will be acquired at each SPC station, and at least one image per station will be analyzed as shown in Table 3-3 (the other images are collected as specified in the SOP to ensure that at least one acceptable quality image per station is obtained). At the end of each survey day, the exposed film will be removed from the plan view camera and developed to ensure that adequate image quality was obtained. If fewer than three good quality photographs were acquired at a particular station, the station will be reoccupied to acquire additional photographs.

3.3.7 Processing of Sediment Profile Images and Plan View Photographs

Following each day of SPC survey operations, the rolls of photographic film from both the sediment profile camera and the plan view camera will be transferred to the shore-based laboratory for development and sediment profile image processing. Information from the SPC Field Log, which documents daily sampling operations and vessel position data from the vessel-based DGPS navigation system, will be used during the analysis of survey results.

SPC images will be analyzed for the following:

- Optical prism penetration depth
- Sediment grain size determination
- Boundary roughness
- Sedimentary methane
- Apparent Redox Potential Discontinuity (RPD) depth
- Infaunal successional stages
- Organism-Sediment Index (OSI)

The plan view photograph analysis supplements the more detailed and comprehensive SPI characterization of the seafloor. The plan view analysis consists of qualitative descriptions of key sediment characteristics (e.g., sediment type, bedforms and biological features) based on careful scrutiny of projected 35 mm slides. Since the surface sediment descriptions are based on visual observations and therefore are somewhat subjective, only the obvious presence of rock, gravel, sand and/or fines can be noted. Likewise, the presence of shell debris and any evidence of epifaunal or infaunal organisms (e.g., tubes, burrow openings, etc.) can be recorded. A scale bar is not present in the photographs; however, each photograph covers an area of seafloor measuring roughly 0.48 m x 0.71 m (roughly 0.34 m^2).

The presence of recently deposited cap material overlying EA sediments should be apparent in the plan view photographs, especially when the origin of the cap material is from the coarse-grained borrow pit area.

3.3.8 Dissemination of Survey Results

On the day following completion of the SPC survey, a brief Survey Report summarizing sampling operations will be prepared and submitted to the LAD Project Manager or technical point of contact for review. Following LAD approval, this report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants. Additionally, SPC and PVC images will be posted on the Website within three days of survey completion; these images will be accompanied by a map indicating locations of all sampling stations, in relation to pilot cell boundaries.

Photographic images and tabular results from interpretations of the SPC images will be populated on the DAN-LA GIS via CD-ROM updates, roughly two weeks after survey completion.

3.4 Sediment Coring

3.4.1 Rationale

Coring is a simple and effective field sampling technique for collection of sediment samples. A variety of coring devices are available for collection of marine sediments; selection of the optimum device depends on specific sampling objectives, such as depth of sediment penetration, volume of core sample needed, acceptable disturbance of sample during coring, and capabilities of lifting devices aboard the survey vessel.

The sediment coring requirement for monitoring Tasks 5-8 is to collect undisturbed cores with minimum sediment penetration of 20 cm below the cap/effluent affected (EA) sediment interface from specified locations in the study area. To meet this sampling objective, a conventional gravity corer will be used in the field, and sealed core samples will be transported to shore daily for post-survey processing and analysis. Analyses will include photography and visual description of all cores, as well as subsampling for select geotechnical and chemical analyses from discrete depths within the core.

Monitoring Task 12 requires collection of sediment cores having lengths between 60 and 100 cm, from within cells LU and SU. Additional weight will be added to the gravity corer to achieve the required penetration through the cap material. If insufficient penetration is achieved during three repeated coring attempts at a given station location, sampling will be redirected to another station near the center of the cell. If fewer than three 60-cm cores can be obtained as a result of coring attempts at a total of four coring stations, the LAD Project Manager will be contacted to discuss sampling alternatives or potential rental of a larger coring device.

3.4.2 Sampling Equipment

Sediment cores will be acquired using a conventional gravity corer. This device consists of a long aluminum or steel core barrel, having an outside diameter of 4-in, attached to a weight stand (core head). The weight stand is constructed of heavy-gauge steel and is designed to accommodate varying amounts of weight. Individual lead weights approximately 50 lbs. each, slip over a center spindle and can be adjusted for varying sediment types and consolidation characteristics. The weight stand is designed to accommodate a maximum of 800 to 900 lbs. Additionally, the weight stand is equipped with a check valve, at the top of the spindle and in line with the core barrel, to allow water to pass freely through the aperture on descent through the water column and prevent sample washout on the ascent to the surface. There are four "fins" at the top of the weight stand to minimize rotation on descent. The entire device is manipulated by either a crane or winch and an A-Frame via a lifting bail on top of the weight stand.

For each coring station, a 3.5-in inside diameter butyrate core liner will be inserted into the core barrel and retained mechanically by a steel core cutter that is attached at the end of the core barrel to facilitate impact with the seafloor. The core cutter is the sharp nose or edge of the corer that first penetrates the sediment and holds the core liner and core catcher in place.

The following field equipment and supplies will be mobilized for collection of sediment cores:

- Gravity corer (2 each)
- 4-in OD aluminum core barrels. Several barrel sections will be available on the vessel for repeat sampling or to replace damaged barrels
- Core cutter and core catcher; spares will be kept aboard the vessel
- 3.5-in ID core liners; 50% spares will be kept aboard the vessel to allow multiple coring attempts at stations where poor penetration is achieved on initial coring attempt
- 3.5-in endcaps for core liner storage during transit to shore processing facility
- Additional lead weights to increase sediment penetration, if necessary
- Coring Field Log
- Sterile gloves for handling core liners and sediment
- Appropriate PPE as specified in the Health and Safety Plan (Tyvek, foul weather gear, steal toed boots, had hats)
- Permanent markers for labeling core liners
- Electrical (33 or 99 wt.) tape for securing endcaps
- Complete mechanical tool set for assembly/disassembly of gravity corer
- Equipment for collecting and retaining excess site sediment and associated waters.

3.4.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Sediment core sampling objectives for the survey program are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette, 2000), cores will be collected at cells LU, LD and SU. Field duplicate samples for quality assurance analyses will be removed from single core intervals (see Section 3.4.6).

Calibration and Quality Control

There are no calibration issues associated with this sampling task. All cores will be labeled according to station/core naming convention as well as top/bottom indicators. Documentation of sampling operations in the Coring Field Log, and handling of cores constitute the only activities that will require field documentation.

3.4.4 Sampling Plan

The general sampling plan shown in Figure 3-3 applies for each of the three pilot cells. Sediment cores will be collected at a subset of stations, randomly selected from among the designated SPC/PVC stations. All stations are located either along or at the intersection of survey lanes for the side-scan sonar and subbottom profiling surveys. A more detailed description of the core sampling effort for the individual cells can be found in Table 3-8 and the written descriptions below.

Core identification number will consist of cell, survey, station number, and duplicate core number to ensure that each core has a unique identification number for the interim and post-cap coring surveys.

Table 3-8. Summary of Core Sampling Numbers and Frequencies.

	Cell LU (Task 6)		**Cell LD (Task 7)**	**Cell SU (Task 8)**		**Flex Surveys (Task 5)**
Event Number (Fredette 2000)	**Event 1**	**Event 3a**	**Event 2**	**Event 4**	**Event 6a**	**Variable**
Total Number of Cores per Event	5	19	5	5	14	20
Frequency	Single Hopper Placement	10 Cores during two Interim Placement surveys (5 at 10 cm thickness, 5 when 15 cm cap is two-thirds complete) 9 Cores Post Cap Placement	Single Hopper Placement	Single Hopper Placement	5 Cores Interim Placement 9 Cores Post Cap Place-ment	As needed to supplement Tasks 6-8

<u>Cell LU</u>

Five gravity cores will be collected as part of the Single Hopper Placement Survey (Event 1) at five stations selected randomly from among the 37 SPC/PVC stations . Four of the five will be selected from inner stations expected to have cap accumulation, and one will be selected from the outer stations expected to be outside of the footprint. Cores will be extracted, vertically split, photographed, and visually described within 24 hours of collection to assess the thickness of cap material and the degree of mixing between the cap and EA sediment. Sufficient cap material from either one core or a composite of the cores will be analyzed for grain size distribution and bulk density. Compositing will occur only when necessary to provide adequate sample mass for specified geotechnical analyses. To create a composite, equal volumes of cap material from the same interval will be taken from each core and placed in a sealable plastic bag. The material in the bag will be kneaded by hand until it is completely homogenous with respect to color and texture. After the sediments are thoroughly mixed, samples will be removed and placed in the appropriate containers and labeled.

Ten gravity cores will be collected as part of the Interim Placement Surveys (Event 3a). Five cores will be collected after the predicted number of loads to create a 10 cm cap have been placed at the first disposal point. When cap placement over the entire cell is two-thirds complete, a second interim survey will be conducted to collect five additional gravity cores. Following the field surveys, cores will be extracted, vertically split, photographed, and visually described. Sufficient cap material from either one core or a composite of the cores from the first interim survey will be analyzed for grain size and bulk density. Compositing will occur only when necessary to provide adequate sample mass for specified geotechnical analyses. To create a composite, equal volumes of cap material from the same interval will be taken from each core and placed in a sealable plastic bag. The material in the bag will be kneaded by hand until it is completely homogenous with respect to color and texture. After the sediments are thoroughly mixed, samples will be removed and placed in the appropriate containers and labeled.

Nine gravity cores will be collected following completion of capping in cell LU (Event 3a). These cores will penetrate at least 20 cm into the EA sediment. The cores will be split, photographed, visually described, and sampled. Particular attention will be given to the condition of the transition between the EA and cap sediments. Sediment grain size, bulk density, vane shear, specific gravity, water content, Atterberg limits (if sufficient fines), and chemistry (DDE) samples will be taken from four of these cores (randomly selected from the nine). Samples will be collected at the sediment/water interface (top of core), 3 cm and 7 cm above the interface/mixed layer and 4 cm and 8 cm below the interface/mixed layer. The 7 cm and 8 cm samples will be archived. The 0 cm, 3 cm, and 4 cm samples will be analyzed for geotechnical properties and p,p'DDE. Archived samples will be sent to the laboratories conducting the analysis and refrigerated at 4 degrees Celsius (for geotechnical analysis) or frozen (for p,p'DDE analysis).

<u>Cell LD</u>

Five gravity cores will be collected as part of the Single Hopper Placement Survey (Event 2). Four will be selected randomly from among the SPC/PVC stations in the cell, and one randomly selected from among the SPC stations outside the cell. Cores will be extracted, vertically split, photographed, and visually described within 24 hours of collection to assess the thickness of cap material and the degree of mixing between the cap and EA sediment. Sufficient cap material from either one core or a composite of the cores will be analyzed for grain size distribution and bulk density. Compositing will occur only when necessary to provide adequate sample mass for specified geotechnical analyses. To create a composite, equal volumes of cap material from the same interval will be taken from each core and placed in a sealable plastic bag. The material in the bag will be kneaded by hand until it is completely homogenous with respect to color and texture. After the sediments are thoroughly mixed, samples will be removed and placed in the appropriate containers and labeled.

Cell SU

Five gravity cores will be collected as part of the Single Hopper Placement Survey (Event 4). The five stations will be randomly selected from among the 37 SPC/PVC stations identified in Figure 3-3). Four of the five will be selected from inner stations expected to have cap accumulation, and one selected from the outer stations expected to be outside of the footprint. These cores will be used as an independent check on the SPC measurements. Cores will be extracted, vertically split, photographed, and visually described within 24 hours of collection to assess the thickness of cap material and the degree of mixing between the cap and EA sediment. Sufficient cap material from either one core or a composite of the cores will be analyzed for grain size distribution and bulk density. Compositing will occur only when necessary to provide adequate sample mass for specified geotechnical analyses. To create a composite, equal volumes of cap material from the same interval will be taken from each core and placed in a sealable plastic bag. The material in the bag will be kneaded by hand until it is completely homogenous with respect to color and texture. After the sediments are thoroughly mixed, samples will be removed and placed in the appropriate containers and labeled.

When capping is two-thirds complete, an interim survey will be conducted to collect five cores from cell SU (Event 6a). Cores will be extracted, vertically split, photographed, and visually described. Sufficient cap material from either one core or a composite of the cores will be analyzed for grain size and bulk density. Compositing will occur only when necessary to provide adequate sample mass for specified geotechnical analyses. To create a composite, equal volumes of cap material from the same interval will be taken from each core and placed in a sealable plastic bag. The material in the bag will be kneaded by hand until it is completely homogenous with respect to color and texture. After the sediments are thoroughly mixed, samples will be removed and placed in the appropriate containers and labeled.

Nine gravity cores will be collected following completion of capping in cell SU (Event 6a). These cores will penetrate at least 20 cm into the EA sediment. The cores will be split, photographed, visually described, and sampled. Particular attention should be given to the condition of the transition between the EA and cap sediments. Sediment grain size, bulk density, vane shear, specific gravity, water content, Atterberg limits (if sufficient fines), and chemistry (DDE) samples will be taken from four of these cores (randomly selected from the nine). Samples will be collected at the sediment/water interface (top of core), 3 cm and 7 cm above the interface/mixed layer and 4 cm and 8 cm below the interface/mixed layer. The 7 cm and 8 cm samples will be archived. The 0 cm, 3 cm, and 4 cm samples will be analyzed for geotechnical properties and p,p'DDE. Archived samples will be sent to the laboratories conducting the analysis and refrigerated at 4 degrees Celsius (for geotechnical analysis) or frozen (for p,p'DDE analysis).

Flex Surveys

In addition to survey efforts requested in Tasks 6-8, 20 additional sediment cores may be collected as part of the Flex Surveys. All of the cores will be processed for visual descriptions; 8 will be sampled for p,p'-DDE at the following three intervals: (1) the surface/water interface; (2) 3 cm above the cap/EA interface of mixed material; and (3) 4 cm below the cap/EA interface of mixed material. Two additional horizons 7 cm above and 8 cm below the cap/EA interface will be collected and archived. Collection of these additional 20 cores will be at the request of the Corps Project Manager, and the specific sampling locations will be determined based on communications between the SAIC Project Manager and the USACE Project team.

3.4.5 Mobilization

Prior to the survey, all components of the gravity coring system and a supply of core liners will be transferred to the survey vessel. The inventory list will include a sufficient supply of spare equipment, core liners, and caps to ensure that all sampling objectives can be met without delays caused by equipment availability.

Before the start of the survey, the DGPS navigation system will be installed aboard the vessel and tested to ensure that accurate DGPS position data are being recorded by the computer on the printer, plotter, and data storage medium (diskette). The navigation system also will be checked to ensure that the proper core sampling locations are entered into the survey database. The GPS master antenna will be installed as close as possible to the position where the hydrowire enters the water (A-frame) so that the correct sampling position is recorded by the navigation system; its position will be recorded in the navigation log.

The shore-based core processing facility also will be mobilized prior to survey initiation to ensure that all equipment and supplies are ready on the day cores are brought to shore. All equipment used for core processing during the baseline survey will again be used according to the same procedures. Additionally, all arrangements will have been made for overnight shipment and chain of custody for sediment samples being shipped to the geotechnical and chemical laboratories.

3.4.6 Sample Collection

The sampling objective is to obtain good quality (relatively undisturbed) sediment samples to a depth of at least 20 cm into the effluent affected (EA) sediment.

Horizontal positioning of the survey vessel to the target station location will use the DGPS navigation system described in Section 3.2. When the survey vessel is positioned on station, the gravity corer, tethered by wire rope from a winch, will be lowered to the seafloor. The vessel aligns itself above the target location such that current and wind set are accounted for, allowing the vessel to slowly drift onto station location. During this slow drift the gravity corer is suspended approximately 10-20 meters above the seafloor. Once the winch line is vertical, the captain of the vessel is notified and the vessel is at the target location, the corer is permitted to free-fall to seafloor. An ongoing dialog between the captain of the vessel and the deck crew is a necessity. During the free-fall of the gravity corer, the deck crew must maintain that the winch wire is vertical, and the navigator must ensure that the vessel is within the specified 5-m watch circle. Corer impact with the seafloor will be apparent from a sudden decrease in tension of the winch wire. During gravity coring of the baseline survey there were no difficulties detecting the core's impact with the bottom. Vessel position is logged at the time the sampler impacts the bottom. If the vessel is outside the watch circle, the vessel will be repositioned, and another core sample will be collected.

The actual depth of sediment inside the core liner (sample recovered) may be less than the core barrel's penetration into the bottom sediment, depending on the degree of sediment compaction during penetration, and any potential loss of sample out of the bottom of the core liner (past the core catcher). In unconsolidated fine-grained sediments, typical sample recoveries using gravity corers range from 75 to 85 percent of the penetration depth. If the bottom sediments are composed of coarser-grained materials, there is typically less compaction, but core penetration is usually shallower due to difficulty in penetration in harder substrate. In such cases where insufficient core penetration is encountered, more weight will be added to the weight stand of the corer and another core attempt will be made at that station.

When the corer is brought aboard, the core cutter and catcher are removed from the lower end of the core barrel, a core cap is placed on the end of the liner, taped in place, and the core liner is removed from the barrel. The core liner is then removed from the core barrel, held vertically, and a waterproof marker is used to mark, on the core liner, the level of the sediment-water interface. (If this interface is not immediately visible, then the core liner is held vertically until all suspended sediment has settled and the interface is apparent.) A core cap is secured on the top end of the core liner and the liner is labeled with the station number, core replicate, and core top/bottom indicators. The cores will be stored upright on wet ice (at approximately 4˚C) and kept in darkness until brought ashore at the end of the sampling day. All cores will be returned to the shore-based laboratory and stored as stated above until processed. Excess sediments retrieved with the corer will be returned to the laboratory for disposal; none of the excess sediments will be disposed in the ocean.

Core liners are dedicated, one-time use items. A supply of core liners will be pre-cut to accommodate desired core lengths. Decontamination procedures are included in the SOP for coring.

During at sea operations, all information concerning the collection of cores will be entered in a Field Log. This information will include at a minimum: station number, date, time of collection, DGPS position, water depth at station, visual indicators of the depth to which the corer penetrated the sediment, and any other features that may affect the quality of the coring results.

3.4.7 Core Sectioning and Sample Processing

Shore-Based Processing of Cores

Cores will be transported to the shore-based processing facility on the day they are collected. Processing of cores, including splitting, core photography, visual descriptions, and subsampling will occur on the day after collection. See appropriate sections of the Standard Operating Procedures (SOP) for Core Processing that can be found in Volume II of this PWP for more details on analyses, processing, and equipment.

Extraction of Sediment Core Samples for Geotechnical and Chemical Analyses

The following equipment and supplies will be used for subsampling sediment cores:

- Chemically inert or decontaminated stainless steel scoops for sediment aliquots and transfers
- EPA 3000 Certified clean jars (with certification) with Teflon lined caps for chemistry samples (consistent with EPA, 1992. *Specifications and Guidance for Contaminant Free Sample Containers.* OSWER Directive #9240 0-05A)
- Polyethylene containers (10 cc) for bulk density samples
- Coolers for sample shipping
- Preservatives (wet ice) for shipping samples
- Resealable plastic bags for grain size and bulk density samples
- Chain of Custody Forms
- Sample Labels

Sample parameters, frequency, and sampling intervals for sediment core sampling are summarized in Table 3-9. Sample containers, preservation, and holding times are listed in Table 3-10.

Sediment cores will be stored in the dark on wet ice (approximately 4° C) at SCMI until processed. Prior to splitting the core liners, any excess length of core liner will be cut off immediately above the sediment/water interface. The

Table 3-9. Summary of Chemistry and Geotechnical Samples from Sediment Cores and In-Hopper Sampling

Parameter	Matrix	Monitoring Type	Frequency	Sampling Stations	Sampling Interval
Grain size, bulk density, specific gravity, water content, Atterberg limits	Sediment	HOPPER DREDGE SURVEY	First 3 loads of cap material to LU and SU	Bow, center and stern samples from a single hopper load combined to create a single composite sample per load	Bow, center, and stern of hopper
			up to 25 loads during capping operations	Bow, center and stern samples from a single hopper load combined to create a single composite sample per load	Bow, center, and stern of hopper
			First 3 loads from borrow area.	Bow, center and stern samples from a single hopper load combined to create a single composite sample per load	Bow, center, and stern of hopper
p,p' DDE	Sediment	HOPPER DREDGE SURVEY	First 3 loads from borrow area	3 samples to be composited	Bow, center, and stern of hopper
Visual description and photograph	Sediment core	FLEX SURVEY	20 gravity cores	At request of the USACE Project Manager	Entire core
p,p'DDE	Sediment core	FLEX SURVEY	8 of 20 gravity cores	Randomly selected from 20 collected cores	Surface; 3 cm above and 4 cm below cap/EA
Visual description and photograph	Sediment core	SINGLE HOPPER PLACEMENT SURVEY Cells LD, LU & SU	5 gravity cores	4 cores randomly selected from inner stations 1 core from outer station not expected to have cap material	Entire core
Grain size, bulk density			For each cell, 1 of 4 cores	1 core or composite of the 4 cores expected to have cap material	Collect cap material from 1 core or composite until sufficient material
Visual description and photograph Grain Size, bulk density	Sediment core	INTERIM PLACEMENT SURVEY Cell LU	5 cores collected; after ~10 cm accumulation	5 stations within cell 1 of 5 cores for geotechnical analysis	Entire core Collect cap material from 1 core or composite cores until sufficient material
Visual description and photograph	Sediment core	INTERIM PLACEMENT SURVEY Cells LU & SU	5 cores collected; after ~2/3 of cap in place	5 stations within cell	Entire core
Visual description and photograph	Sediment core	POST CAP SURVEY Cells LU & SU	9 gravity cores	9 stations within cell	Entire core

Table 3-9. Summary of Chemistry and Geotechnical Samples from Sediment Cores and In-Hopper Sampling (continued)

Grain size, bulk density, specific gravity, water content, p,p'DDE, Vane Shear	Sediment core	POST CAP SURVEY Cells LU & SU	For each cell, 4 of 9 cores, randomly selected	9 stations within cell	Sediment/water interface (0 cm) 3 cm and 7 cm (archived) above sediment/mixed layer interface 4 cm and 8cm (archived) below sediment/mixed layer interface
Atterberg limits, bulk density	Sediment core	POST CAP SURVEY Cells LU & SU	4 of 5 nonsampled cores	9 stations within cell	Sample interval based on fines and mixing of cap/EA, bulk density analysis will be done on all the Atterberg sample intervals.

Table 3-10. Sample Containers, Preservatives, Sample Mass, and Holding Time Requirements for Sediment Core Samples.

Parameter	Container	Preservative	Min. Sample Mass	Holding Time
p,p'-DDE	250-mL wide-mouth glass jar, certified clean, with lids lined with chemically-inert material	4° C, freeze upon receipt at laboratory	100 g wet weight (includes primary analysis [20 g] and QC analyses and archival material)	14 days if not frozen; up to 1 year if frozen; 40 days for extracts
Grain Size/Density	Resealable plastic bags	4° C	500 g for grain size; approximately 15 g (10 cc) for bulk density	6 months
Vane Shear	None; measured in laboratory	4° C	Not applicable	Analyzed in laboratory upon splitting of core
Atterberg Limit	Resealable plastic bags (1 gal size)	4° C	Approximately 600 g	6 months

excess core liner will be retained for future disposal as hazardous waste. The remaining core (with the sediment sample) will be placed on the core splitting table and the external surface of the core liner scored using a hand-held core liner cutting tool. Note that this tool does not cut all the way through the liner to the sediment sample. The core liner will then be cut using a decontaminated utility knife, and the sediment core split vertically into two halves using a hand-held taut wire (core splitting device). Each core is visually described and photographed prior to subsampling for sediment chemistry and geotechnical analysis. Core samples will be collected according to the task objectives as stated in the sampling plan (Section 3.4.6). Sample volumes and methods for sample extraction are as follows:

Samples for Chemistry Analysis for p,p'DDE.

A 100-g sediment sample will provide adequate mass for analyses of p,p'DDE (approximately 20 g wet weight) plus quality assurance samples (e.g., matrix spike/matrix spike duplicates). Chemistry samples will not be composited or homogenized prior to placement in sample jars. For selected core intervals, two subsamples of approximately 50 g each will be removed and placed in separate jars. The second subsample will constitute a field duplicate sample, and these will be collected at an overall frequency of 10%. Samples for chemical testing will be handled in such a manner as to preclude the contamination of, or loss of, any of the sampled sediments. Sample containers will be sealed to prevent any moisture loss and/or possible contamination, and a custody seal will be signed and affixed by the sample collector.

Equipment used to section the sediment cores and subsample the sediment core intervals will be scrubbed with laboratory-grade detergent, rinsed with potable water, ASTM reagent water or equivalent reagent-grade water, pesticide grade methanol, and pesticide-grade hexane, in that order. All equipment used to dispense ASTM Type II reagent grade water or equivalent reagent water, pesticide-grade methanol, and pesticide-grade hexane will be glass or suitable inert material. Plastic dispensing devices will not be used.

Equipment rinsate blanks will be prepared for sampling tools used to remove the sediment core intervals. Equipment rinsate blank data assess the efficiency of equipment decontamination procedures in preventing/minimizing cross-contamination between samples. Equipment rinsate blanks will be collected by pouring ASTM Type II reagent water or equivalent reagent water into/through/over sampling equipment that has been decontaminated and then collecting the water into prepared sample bottles (e.g., 1.0 liter brown glass bottles with screw cap lids with liners of inert material). One equipment rinsate blank will be prepared for every 20 sediment interval samples collected. The equipment rinsate blanks will be handled and analyzed in the same manner as the sediment samples.

The field blank will be prepared at the SMCI facility as the sediment core intervals are processed. The field blank will be prepared by pouring ASTM Type II or other equivalent reagent water used for equipment decontamination into prepared sample bottles (e.g., 1.0 liter brown glass bottles with screw cap lids lined with a chemically inert material). The field blanks will be handled and analyzed in the same manner as the marine sediment samples.

Samples for Geotechnical Analysis

The sediment water content, specific gravity, and grain size samples (approximately 500 g) will be placed in sealable plastic bags. Duplicate samples for grain size will be removed from the sample container with the primary sample after the material has been homogenized. For the single hopper and interim placement core samples from inside each cell, which are expected to contain a discrete layer of cap material, the sample for grain size and bulk density analysis will be taken from either one of the cores or several of the cores, depending on the volume of material present in each core (see Table 3-9). If each of the individual cores contains an insufficient volume of material, then material will be taken from more than one core (the actual number to be determined by the core processing technician in consultation with the Corps Project Manager or designee), and the resulting sample will represent a composite of those cores. To create such a composite, equal volumes of cap material from the same interval will be taken from each core and placed in a sealable plastic bag. The material in the bag will be kneaded by hand until it is completely homogenous with respect to color and texture. Bulk density samples will be collected in plastic tubes (10 cc capacity). The tubes containing sediments will be placed inside a plastic resealable bag. Duplicate samples will be collected in the same manner, at an overall frequency of 10%. After sample containers are filled, sealed, and labeled they will be processed for shipment to the laboratory.

Selected samples collected during the post cap surveys of LU and SU will be tested for Atterberg limits. This will require additional material volume. During the post cap surveys of Cells LU and SU, 9 cores will be collected, four of which will be analyzed for geotechnical properties and p,p'DDE. Of the remaining 5 cores (to be visually described and photographed), four will be randomly selected for Atterberg limit analysis. The selected sampling region will be dependent on the amount of fine-grained material present and the degree of mixing between the cap material and EA sediments. An additional bulk density sample will be collected from the material tested for Atterberg limits.

Excess sediments and used core liners will be stored on site, and later disposed as hazardous wastes. Labels will be placed on sample jars containing sediments for chemical analysis. An example of a sample label is shown in Figure 3-5.

SAIC 221 Third Street Newport, RI 02840
1-800-729-4210
PALOS VERDES PROJECT
Collected by: Pam Walter 8/8/00
ATTN: WHG; Helder Costa
Analysis: p,p' DDE
Survey: LU Cap
Sample ID: LU-C-57-A-1

Figure 3-5. Example label for sediment chemistry samples removed from cores. The sample ID shown in this example is based on the following naming convention: LU = placement cell; C = cap survey; 57 = core number; A = core replicate; 1 = horizon in core (1 = 0-3 cm below surface, 2 = 7 cm above cap/EA sediment interface, 3 = 3 cm above cap/EA sediment interface, 4 = 4 cm below cap/EA sediment interface, 5 = 8 cm below cap/EA sediment interface).

All samples will also be listed on a chain-of-custody (COC) form, which will accompany the sample shipment. An example of a chain-of-custody form is shown in Figure 3-6. Sample jars will be placed in insulated coolers containing wet ice, along with a temperature blank, sealed, and transferred to the custody of an overnight carrier for air shipment to the appropriate subcontractor laboratory. Temperature blanks will be prepared by filling 40-mL vials with refrigerated (i.e., to 4^{o}C) potable water and placed in the cooler with the environmental and field QC blank samples immediately before the sample cooler is packaged for shipping to the laboratory. The temperature of the cooler blank will be taken immediately after the sample cooler is opened at the laboratory and the data recorded on the chain-of-custody form. Cooler blank data assess the effectiveness of the ice used to maintain the cooler temperature between 4^{o}C and 8^{o}C.

3.4.8 Dissemination of Survey Results

On the day following completion of the coring survey, a brief coring survey report summarizing sampling operations will be prepared and submitted to the LAD Project Manager or her designated technical point of contact. Following LAD approval, this report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

SAIC® An Employee-Owned Company — Science Applications International Corporation

Chain of Custody Record

Science Applications International Corporation/ 221 Third Street/ Admiral's Gate/ Newport RI 02840 phone (401) 847-4210 fax (401) 849-9786

Project:	Client Name and Contact:

Sample No.	Containers No.	Containers Type	Collection Date	Collection Time	Sample Description	Requested Parameters
Total :						

Packed/Released By Signature: Printed Name:	Date	Time	*Received By* Signature: Printed Name:	Date	Time	Remarks:
Released By Signature: Printed Name:	Date	Time	*Received By* Signature: Printed Name:	Date	Time	
Final Destination:			Contact Name and Phone Number:			Shipping Method: Page ______ of ______

Figure 3-6. Example of chain of custody form to be used for shipment of sediment chemistry samples to Woods Hole Group environmental laboratory.

Results from the basic processing of the sediment cores, including core photographs and visual core descriptions, will be available within seven days of completion of the coring operations. This preliminary information will be posted on the PV-Web; images will be accompanied by a map indicating locations of all coring stations, in relation to pilot cell boundaries. These data will later be populated on the DAN-LA GIS via CD-ROM updates.

Chemical and geotechnical results from laboratory analysis will be provided via the DAN-LA GIS according to a schedule discussed in the QAPP.

3.5 Side-Scan Sonar

3.5.1 Rationale

One of the most commonly used systems for generating two-dimensional maps of seafloor features is side-scan sonar. This system consists of a vessel-based data acquisition system connected electronically to a “towfish” which contains acoustic transmitting and receiving circuitry. In normal operation, the towfish is towed behind the survey vessel while traversing predetermined survey lanes. Acoustic transducers on the towfish project acoustic signals outward from both sides to obtain information on seafloor characteristics at 90-degree angles from the vessel track. The acoustic beam propagates through the seawater and ensonifies the seafloor. A portion of the incident acoustic energy is reflected backward, with part of the return signal reaching the acoustic receivers of the side-scan towfish. Although the acoustic return signals are weak, amplifiers in the side-scan electronics boost the amplitude of the return signals so that high-resolution data on seafloor characteristics can be obtained at considerable distances on both sides of the vessel track. Physical objects as small as 0.5 m in size, and small-scale sedimentary features (e.g., rock outcrops, sand ripples, trawl scour marks, etc.) can be clearly delineated from the side-scan records.

Digital data acquisition systems provide high resolution of side-scan data, and also allow direct merging of vessel position and digital data storage for post-survey processing and preparation of image mosaics. These capabilities are needed for the monitoring program to provide adequate resolution for distinguishing spatial variations in seafloor topographic characteristics as they relate to cap material and EA sediments.

This surveying technique will be used to assess seafloor characteristics in the vicinity of the three pilot cells. Information obtained on the spatial extent of cap material will compliment data and information to be acquired from sediment cores, sediment profile images, and plan view photographs of the seafloor at a limited number of station locations. The side-scan data also will be compared with subbottom profile results obtained acoustically along the same side-scan survey lanes, as described in Section 3.6.

3.5.2 Sampling Equipment and Methods

For the surveys associated with the Pilot Cap Monitoring Program, a state-of-the-art side-sonar system will be used for acquisition of two-dimensional seafloor data in the vicinity of the pilot cells. The system will consist of an digital side-scan towfish interfaced to a top-side sonar data acquisition system. The towfish is a dual-frequency system capable of simultaneously emitting and receiving sound waves at both 100 and 500 kHz frequencies. All sonar returns are digitized to 12-bit high-resolution data within the towfish, merged with vessel heading information from the built-in compass, and transmitted to the top-side data acquisition unit via a high-speed digital uplink.

Aboard the survey vessel, the towfish interfaces to the sonar acquisition system for archiving and display of the digital side-scan data. The sonar acquisition system integrates the raw sonar image data with towfish position information provided by the onboard, DGPS-based vessel navigation system. The merged data are stored on Magneto-Optical disks for playback and post-processing.

In addition to data storage, the high-resolution sonar imagery is displayed in real-time on a computer monitor. Vessel speed over the bottom and slant range corrections are applied in real-time to the data so that images are displayed with the correct aspect ratio. In this manner, the geodetic position of targets and other seafloor features can be determined in near real time.

Hardcopy side-scan records are generated on a high-resolution thermal printer. The hardcopy record is annotated with event marks at equally spaced intervals, listing the date, time, towfish position, speed over the bottom, and associated filename for correlation with the digitally stored sonar data.

3.5.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Side-scan sonar survey objectives are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette, et al., 2000), side-scan lanes will be spaced at 100-m intervals. The side-scan system will be operating with 100-m range (on each side of the vessel track) to achieve 100% bottom coverage in the pilot cells. The resulting bottom coverage will provide excellent data sets to identify spatial variations in seafloor characteristics (e.g., bottom roughness) related to the placement of the cap material. Furthermore, the side-scan sonar results will also provide a spatial context to the "point measurements" of sediment characteristics derived from the sediment cores and the sediment profile images.

Calibration and Quality Control

As described in Section 3.5.5, electronic tests of the side-scan system and towfish will be conducted prior to deployment for survey operations to ensure that all system components are fully operational. For purposes of quality control during survey operations, side-scan sonar data will be acquired along intersecting survey lanes, which will allow post-survey comparison of data from two independent measurements at 15 locations in each pilot cell surveyed. These data will be used to assess the repeatability of the seafloor characteristics information (as inferred from the side-scan data) and any dependence upon survey operations such as vessel speed and heading, sea state and water depth.

3.5.4 Survey Plan

For the interim and post-cap placement surveys, side-scan sonar data will be acquired repeatedly over an area that spans Cells LU, LD, and SU (Figure 3-7). Data will be acquired along both parallel and intersecting survey lanes spaced 100 meters apart, as prescribed by the Monitoring Program for the Palos Verdes Pilot Cap Project (Fredette 2000).

Within each cell, five survey lanes will be oriented perpendicular to the long axis (600-m boundary) of the cell, whereas three lanes will be oriented perpendicular to the short axis (300-m boundary) of the cell. The middle lane in each direction will pass through the geometric center of the cell. Table 3-11 provides a summary of the side-scan sonar field survey efforts for the capping project.

Table 3-11. Summary of Side-scan Sonar Survey Operations.

Monitoring Type	Capping Cells	Sampling Area	Level of Analysis
Single Hopper Placement	LU, LD, SU	Over entire cell	Assess distribution of cap sediment
Post Cap	LU, LD, SU	Over entire cell	Assess distribution of cap sediment

<u>Cell LU</u>

Side-scan sonar surveys within Cell LU will be conducted following a single hopper placement event (Event 1) and for post-cap monitoring (Event 3a). Data collected during both surveys will be used to evaluate the distributions of cap material within and immediately outside the cell.

<u>Cell LD</u>

Side-scan sonar surveys within Cell LD will be conducted following a single hopper placement event (Event 2) and for post-cap monitoring (Event 3b). Data collected during both surveys will be used to evaluate the distributions of cap material within and immediately outside the cell.

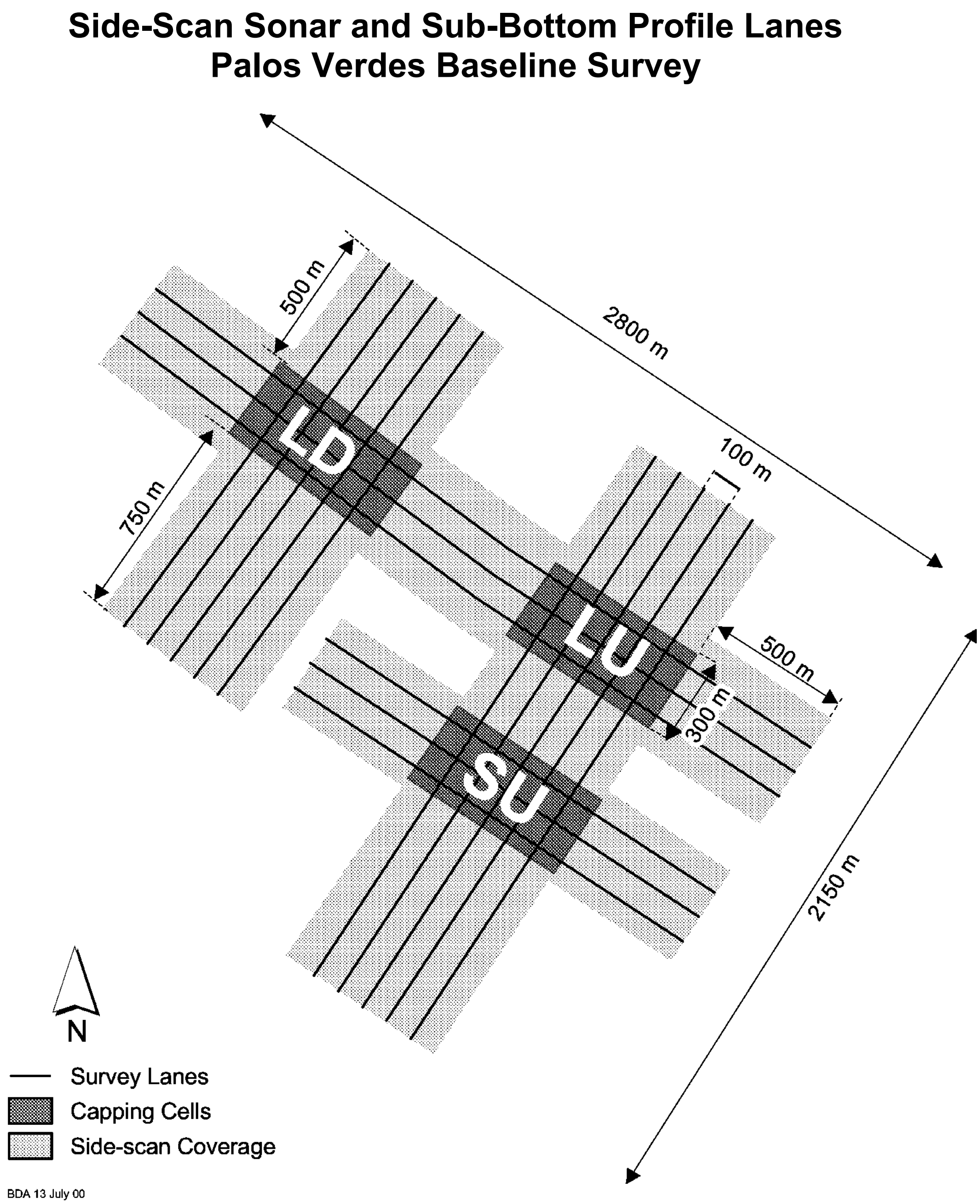

Figure 3-7. Schematic representation of survey lanes and nominal side-scan sonar coverage over three capping cells for the pilot cap study.

Cell SU

Side-scan sonar surveys within Cell SU will be conducted following a single hopper placement event (Event 4) and for post-cap monitoring (Event 6a). Data collected during both surveys will be used to evaluate the distributions of cap material within and immediately outside the cell.

3.5.5 Mobilization

Prior to the survey operations, SAIC technicians will install all necessary navigational and positioning equipment on the survey vessel. The side-scan sonar data acquisition system will be installed and data communication interfaces will be tested for proper operation. A hydraulic winch equipped with a 300-m length of double-armored coaxial signal/tow cable and an electrical slip-ring will be used for towing and data acquisition. The signal/tow cable will be led through a shieve on the articulated A-Frame. Offset distances between the tow point (shieve) and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

On deck "rub-tests" will be conducted while the side-scan towfish is operating on deck. The purpose of this test is to check that the acoustic transducers on both sides of the towfish are working properly and that the amplitude of both data channels (port and starboard) are matched. Any problems encountered will be remedied prior to survey operations.

3.5.6 Data Collection

The side-scan sonar data acquisition system will be configured to collect seafloor imagery data 100 m to either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing established for each cell, side-scan data coverage within each cell will be approximately 200%. The sampling rate will be 150 msec, equivalent to approximately six measurements per second.

During survey operations along each lane, the survey vessel will maintain a constant course and speed of approximately 4 knots to achieve clear seafloor images. Towfish position will be determined continually, and to an accuracy of approximately 5 to 10 m, using the DGPS navigation system, based on the vessel position, speed, heading, and length of cable behind the vessel.

Four channels of data (port and starboard channels from both the 100 kHz and 500 kHz frequencies) will be both archived on disk and displayed in real time aboard the survey vessel. During survey operations, the towfish will be maintained at an altitude above the seafloor equivalent to 8 to 20% of the range scale selected (e.g., 8 to 20 m above the seafloor for the 100 m range scale) to achieve optimum surveying resolution.

3.5.7 Data Processing

Following the survey, side-scan data will be processed with map software. Data from each survey lane will be analyzed for surficial sediment texture and identification/location of objects or features on the seafloor. Screen grabs of the individual targets will be generated and stored in the GIS relational database so the location and the image can be accessible for future analyses.

The side-scan data from each survey lane will be mapped and composited using the position data that are merged with the side-scan data. This process results in a geo-referenced, two-dimensional, gray-scale image called a "mosaic" that is compatible with other spatial mapping applications.

3.5.8 Dissemination of Survey Results

On the day following completion of a side-scan survey, a brief Side-Scan Survey Report summarizing surveying operations will be prepared and submitted to the LAD Project Manager or technical point of contact for review. Following LAD approval, this Side-Scan Survey Report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Preliminary data products including a side-scan coverage map and a high-resolution screen grabs for selected features or objects will be posted on the PV-Web within five days of survey completion.

Within two weeks, all processed side-scan results will be provided on CD-ROM. These results will include a side-scan mosaic of the pilot study area, a tabular listing of targets observed on the seafloor and their location, as well as example images of targets and seafloor substrates presented at full resolution**.**

3.6 Subbottom Profiling

3.6.1 Rationale

Subbottom seismic profiling is an acoustic, remote sensing technique for determining relative changes in sediment characteristics beneath the sediment-water interface. Acoustic profiling systems, which have transmitters and receivers in a submersible towfish, are used to acquire high-resolution digital data on the acoustic impedance of seafloor sediments beneath the survey vessel as it travels along predetermined survey lanes. Acoustic impedance is a function of the density of a sedimentary layer and the speed of sound within that layer. The depth of acoustic penetration into the sediments and the ability to resolve sedimentary layering (stratigraphy) from the returned acoustic signals are both dependent on the frequency and pulse-width of the transmitted acoustic signal, and the characteristics of the sediments being profiled.

During the baseline phase of the pilot cap monitoring program, high-resolution subbottom profiling was used to assess the vertical and spatial variability of sediment characteristics in the vicinity of the pilot cells. Data acquired along individual survey lanes were used to evaluate the horizontal extent and thickness of the EA sediments. Future subbottom surveys will be conducted to assess the thickness of cap material above the EA sediments.

Results from the subbottom profiling will compliment the side-scan sonar survey results that reveal spatial variations in surface sediment characteristics. For example, if the side-scan results reveal a horizontal gradient in sediment characteristics or bottom roughness at a specific location, the subbottom profile results can be used to determine whether this surface transition is also associated with horizontal gradients in cap material or EA sediments.

Sediment characteristics determined from geotechnical analysis of cores will be useful for visual correlations of remotely sensed data from both the subbottom profiling and the side-scan sonar. For example, if a distinct layer of cap material is identified in a sediment core, then assessment of a cap material layer in the subbottom results could be visually correlated. Although these independent measurements are intended to be complimentary, acceptance of the subbottom profile data quality is not based on specific criteria for agreement with other measurement data (e.g., maximum acceptable difference). The subbottom profile results from the interim and post-cap surveys can be compared with subbottom profile results acquired along the identical tracks during the baseline survey to assess the spatial coverage and potential spreading of cap material.

3.6.2 Sampling Equipment and Methods

High-resolution subbottom profile data will be acquired using a ChirpII acoustic profiling system. The acoustic transducers of the ChirpII system are mounted in a towfish and lowered using the winch and crane aboard the survey vessel. The electronic signal cable from the towfish is mated to a mechanical tow cable with brass clips. The amplified return signal of the transducers are sent through an A/D converter to an on-board data acquisition system for data storage to 8 mm magnetic tape, real-time color data display, and hard-copy printouts of profile data.

Aboard the survey vessel, the ChirpII system integrates towfish position information provided by the DGPS-based vessel navigation system. The merged data are stored on Magneto-Optical disks for playback and post-processing.

Hardcopy subbottom profile records are generated on an high-resolution thermal printer. The hardcopy record is annotated with event marks at equally spaced intervals listing the date, time, towfish position, speed over the ground, and associated filename for correlation with the digitally stored subbottom data.

3.6.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

Measurement objectives for subbottom profile techniques are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette 2000), subbottom profile data will be acquired along the identical survey lanes established for the side-scan sonar survey. This horizontal coverage will provide an excellent data set from which to assess spatial variations in cap thickness. The results will also provide a spatial context to the "point measurements" of sediment characteristics derived from the sediment cores and sediment profile images.

Calibration and Quality Control

As described in Section 3.6.5, electronic tests of the subbottom profile system and towfish will be conducted prior to deployment for survey operations to ensure that all system components are fully operational. Although there is no quantitative method of calibration for the subbottom profiling system, information obtained from the sediment cores will offer the best means for calibrating the remotely-sensed subbottom profile data (see discussion below).

For purposes of quality control during survey operations, subbottom profile data will be acquired along intersecting survey lanes, which will allow post-survey comparison of data from two independent subbottom measurements of cap thickness at 15 locations in each pilot cell surveyed. These data will be used to assess the repeatability of the cap thickness data and any dependence upon survey operations such as vessel speed and heading, sea state, and water depth.

As indicated in Section 3.6.1 (Rationale), sediment cores will be acquired at the intersection of a subset of subbottom profile lanes. The geotechnical results from core samples will be used for "ground-truthing" of the subbottom profile results, via correlation between actual sediment grain size (and bulk density) and prominent sedimentary layers (e.g., cap material or EA sediments) as deduced from the remotely sensed subbottom profile data.

3.6.4 Survey Plan

For post-cap monitoring surveys, subbottom profile data will be acquired simultaneously along the same survey lanes (see Figure 3-7) as side-scan sonar data (Section 3.5.4). Unlike side-scan sonar technology which acquires data in broad swaths on both sides of the vessel track, the subbottom profiler acquires data only beneath the vessel as it travels along the survey lane. Therefore, the subbottom data represent continuous vertical profiles of the upper sedimentary layers along vessel tracks. The horizontal (spatial) resolution provided by this technique is a direct function of the number of survey lanes traversed within the study area. Table 3-12 provides a summary of the subbottom sampling efforts for the capping project surveys. It should be noted that features to be examined by subbottom profiling typically have large horizontal spatial scales. This is true of the natural geology in the area and largely true for the cap. Due to the relatively large spatial scale of the features of interest, the coverage of the subbottom survey can be substantially less than the side-scan sonar coverages and still meet the sampling goals.

Table 3-12. Summary of Subbottom Monitoring Surveys

Monitoring Type	Capping Cell(s)	Number of Survey Lanes	Level of Analysis
Post Cap	LU, SU	3 longitudinal and 5 cross cell lanes	Assess cap thickness

<u>Cell LU</u>
A subbottom profile survey within Cell LU will be conducted as part of post-cap monitoring (Event 3a). The survey will consist of three longitudinal lanes and five cross cell lanes. Data collected during the survey will be used to evaluate the distribution of cap material within and immediately outside the cell.

<u>Cell SU</u>
A subbottom profile survey within Cell SU will be conducted as part of post-cap monitoring (Event 6a). The survey will consist of three longitudinal lanes and five cross cell lanes. Data collected during the survey will be used to evaluate the distribution of cap material within and immediately outside the cell.

3.6.5 Mobilization

Prior to the survey operations, the subbottom profile system will be installed and data communication interfaces will be tested for proper operation. The subbottom signal cable will be mated to a mechanical tow cable mounted the vessel's winch. Offset distances between the tow point (shieve) and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

Electronic tests of the subbottom profile system and towfish will be conducted prior to survey operations to ensure that all system components are fully operational.

3.6.6 Data Collection

The Chirp II subbottom profiling system generates a frequency-modulated pulse that sweeps over an acoustic range of 2-10 kHz. For this program, the minimum vertical resolution of sedimentary layers will be ±20 cm, depending upon the characteristics of the sediments.

The pulse rate will be set to 8 pulses per second for optimum performance of the output devices. At 8 pulses per second, traveling at an average vessel speed of 4 to 5 knots, a subbottom measurement will be acquired every 34 to 43 cm along the vessel track. Each subbottom return signal will be recorded digitally and stored with a geodetic positional fix.

The Chirp II profiler generates a relatively narrow (13°) acoustic beam which translates to a 12-m wide swath on the seafloor along each survey lane for an average water depth of 55 m. Swath width will vary proportionally with water depth and the depth at which the fish is towed. For the baseline survey, the towing depth will be approximately 10 m. With a lane spacing of 100 meters, approximately 12% bottom coverage will be obtained over the survey area.

3.6.7 Data Processing

Following the survey, subbottom profile data stored on magnetic optical disk will be reviewed and analyzed to identify any subbottom horizons or features that may be used to distinguish cap materials. The subbottom data will be displayed on the PC monitor as both a continuous profile, duplicating the shipboard display, as well as individual pulses. The processed digitized data are stored in data files containing the geodetic position and the vertical distance (depth) from the first return (sediment-water interface) to the subsurface layer for each sonar ping. A relational database of survey lanes and screen images of subbottom profiles will be compiled for incorporation into the DAN-LA GIS database.

3.6.8 Dissemination of Survey Results

On the day following completion of the subbottom profiling survey, a brief Subbottom Survey Report summarizing surveying operations will be prepared and submitted to the LAD Project manager for review. Following LAD approval, this survey report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Preliminary data products including a survey trackline map and examples of subbottom profile images from selected lanes will be posted on the PV-Web within five days of survey completion. Within two weeks, all processed subbottom results will be provided on CD-ROM. These results will include graphical subbottom profiles for all lanes of the pilot study area.

3.7 Surge (Bottom Current and Turbidity) Measurements

3.7.1 Rationale

When cap material is released from the Hopper Dredge, the majority of the material will descend rapidly (i.e., 1-2 meters per second) and deposit on the seafloor. During impact with the bottom, the downward momentum of the cap material is partially absorbed by the seafloor, with the remainder being converted to horizontal momentum. If this horizontal momentum is substantial, it should be detectable as intensified near-bottom currents that are directed radially outward from the disposal position. Additionally, this near-bottom current (surge) may contain elevated concentrations of suspended sediments, whose origin may be cap material and/or resuspended EA sediments.

The objective of the surge monitoring activity is to use moored, near-bottom current and turbidity sensors to determine the extent (magnitude and speed) of the surge associated with cap placement and how this changes with distance and position (upslope and downslope). This information ultimately will be used to evaluate potentials for turbidity flows, verify model predictions, and modify cap designs as necessary. Measurement sensors will be moored across isobaths and concurrent observations will be made to help identify the magnitude of the dispersive wave that may result from cap placement, as well as document the relative increase in near bottom suspended sediment concentrations due to the initial outward surge as cap material impacts the bottom. These instruments also will provide information on conditions prior to and following cap placement.

Near-bottom current velocities and turbidity will be measured at five sites, located 75 m, 150 m and 250 m down slope, and 75 m and 150 m up slope of the respective release site. In addition to the near-bottom current measurements on each array, an upward-looking current profiler also will be deployed at the 150 m down slope site to monitor horizontal currents throughout the water column.

For the first two measurement events, equipment will be deployed at only four sites (at all but the 150 m up slope location). For these two events, two different types of current meter technology (the acoustic current sensors of the ARESS units, and the Aquadopp current sensors) will be mounted in close proximity on the array at the 75 m down slope location to facilitate intercomparison of measurement technologies. For subsequent deployments, no intercomparison data will be acquired; instrumentation will be moored at all five locations (including the 150 m up slope location) to achieve additional information on the spatial extent of any near-bottom surge plume(s).

3.7.2 Sampling Equipment and Methods

Current (surge) velocity will be measured with three different instrument types, all of which depend on Doppler shifts in a transmitted acoustic signal. The velocity estimate is proportional to the magnitude of this Doppler shift. The current measuring equipment include:

- Acoustic Current Meters (a component of the ARESS measurement platform)
- Aquadopp Current Meters
- Acoustic Doppler Current Profiler (ADCP)

Measurements of local near-bottom turbidity will be made using Optical Backscatter Sensors (OBS). These instruments measure the amount of emitted (infrared) light that is reflected back to the sensor. The greater the reflections, the greater the quantity of material in the volume of water being measured. A time series of measured OBS values provides a history of local total suspended solids in the water column. OBS measurements will be made at two levels on each of the three ARESS platforms and at one level on each Aquadopp current meter. In each case, data are recorded as part of the current measurement system. No OBS measurements will be made in conjunction with the ADCP observations.

3.7.3 Data Quality Objectives, Calibration, and Quality Control

The specific objective of this measurement approach is to determine, via field measurements, if during and as a result of the placement of cap materials within specified cells and by means of specified placement practices, existing sediments are resuspended and/or scoured and transported as a surge cloud from the immediate vicinity of the placement site. These measurements (near bottom currents and turbidity) can be used to help determine the effect of placing cap materials of known characteristics at a specified site, and the spatial and temporal extent of any bottom surge and suspended sediment transport.

All sensors will be deployed for periods that extended well prior to and following cap placement. Availability of these observations leading up to and after cap placement will help characterize local background conditions that exist without the placement of cap material in the specific cell and according to the specific placement scenario. Information concerning “background” or “unaffected” conditions can be used to determine the relative magnitude of potential impacts resulting from the placement of cap materials.

All three of the current measuring instruments used in this program will measure current speed based on the speed of sound in water. The current sensor operates with an assumed speed of sound in water of 1500 m/s. The Aquadopp can be programmed for a particular speed of sound or it can calculate a speed of sound based on a programmed salinity and the measured temperature at the instrument. The ADCP calculates a speed of sound based on a programmed salinity and the temperature measured by the instrument. The resulting speed measurements on all three instruments can be corrected for the actual speed of sound in water if temperature and salinity data are available. Salinity data from CTD casts made in the vicinity of the instrument mooring along with temperature data collected by the instruments are adequate to make the appropriate corrections.

The turbidity meter and the OBS sensor are factory calibrated for specific FTU ranges based on the formazin standard for measuring water turbidity. Procedures for re-calibration with turbidity standards or sediments are presented in D&A Instrument Company (1991).

3.7.4 Sampling Plan

The objective of this task is to provide measurements at a series of cross-isobath sites that are closely placed up and down slope from the center of the placement site, but with adequate spatial coverage to evaluate, to the extent possible, distances from the placement site at which the extent of bottom surge processes are reduced to background levels. Instrument placement is to be as close to the release site as can be supported given the operational limitation of cap material placement. It is expected that one ARESS instrument platform will be placed at each of three sites located at 75, 150 and 250 m down slope from the target placement site. An additional (fourth) Aquadopp platform will be placed 75 m up slope of the cap placement site. For the first two measurement events, the fifth current/OBS sensor (Aquadopp) will be placed adjacent to the 75 m-down slope instrument, to provide a basis for intercomparisons of ARESS and Aquadopp observations. For subsequent measurement events, no intercomparison data will be acquired; instrumentation will be moored at all five locations (including the 150 m up slope location) to achieve additional information on the spatial extent of any near-bottom surge plume(s). Suspended sediment plumes may extend above the local bottom; however, an inherent assumption is that if a plume and surge occurs, it will be most prominent near the bottom. Table 3-13 provides a summary of the current measurements that will be made using bottom moored arrays during cap placement activities.

Table 3-13. Summary of Current Measurements using Bottom-Moored Arrays

Monitoring Type	Capping Cell(s)	Number of Arrays	Sampling Frequency	Level of Analysis
Single Hopper Placement	LU, LD, SU	4 to 5	75, 150, 250 meters downslope of planned placement location, 75 meters upslope of planned placement location, and either adjacent to 75 meter downslope array (for first 2 measurement events only) or 150 m upslope	Assess the surge from sediment placement. Process time series data from current and turbidity sensors.
Interim Placement	LU. One deployment spanning the second, third, fourth and fifth placement events	4 to 5	75, 150, 250 meters downslope of planned placement location, 75 meters upslope of planned placement location, either adjacent to 75 meter downslope array (for first two measurement events only) or 150 meters upslope	Assess the surge from sediment placement. Process time series data from current and turbidity sensors.

Cell LU

Surge measurements will be made within Cell LU during two measurement (deployment) periods: during placement of a single hopper load (Event 1) and during the subsequent four placement events (Event 3a). Instrument platforms will be deployed at specified distances from the intended cap material release points, as described above. The instrument platforms will be retrieved, and the data downloaded from the instruments, following the first and fifth cap placement events.

Cell LD

Surge measurements will be made during a single deployment period within Cell LD, during placement of a single hopper load (Event 2); no measurements will be performed during interim placement events in cell LD. Instrument platforms will be deployed at specified distances from the intended cap material release point, as described above. The instrument platforms will be retrieved, and the data downloaded from instruments, following the first cap placement event within Cell LD.

Cell SU

Surge measurements will be made during a single deployment period within Cell SU, during placement of a single hopper load (Event 4); no measurements will be performed during interim placement events in cell SU. Instrument platforms will be deployed at specified distances from the intended cap material release point, as described above. The instrument platforms will retrieved, and the data downloaded from instruments, following the first cap placement event within Cell SU.

3.7.5 Mobilization

Instrument moorings used for this task will be mobilized at SCMI prior to deployment. Detailed procedures for predeployment tests and set-up are given in the Standard Operating Procedures for Current Meters (Volume II).

3.7.6 Data Collection

ARESS data (currents velocity and turbidity) are collected at 3.6 Hz and Aquadopp data (current velocity and turbidity) are output at 1 Hz following internal averaging of observations taken at 33 Hz. RDI ADCP data are averaged from 30-minute ensembles or more frequently. Actual ADCP sampling rates, vertical sampling bins (layers) and a servicing schedule will be finalized and coordinated by the SAIC Project Manager.

3.7.7 Data Processing

Each of the data logging instruments (ARESS, Aquadopp/OBS and ADCP) records, in internal memory, data arriving from the various sensors to which they are linked. Data sampling rates and the start-sampling time are programmed into the instrument prior to deployment. Following recovery, collected data are downloaded through an RS-232 interface to a computer and stored as raw data files.

Following each instrument deployment, recorded data are recovered and stored as above. Using appropriate, and where possible, manufacturer developed and provided software, the instrument data are converted to engineering units. The engineering units will be presented as preliminary summary tables and/or graphs. Generally, a “hardcopy” of these data products will be made in the field within several days of each instrument recovery.

Preliminary data products will be used for quasi-real time evaluation of the quality of observations from each sensor. This first-order evaluation can involve a review of the values of variables (in engineering units), as well as an initial examination of the individual and joint patterns of both currents and turbidity. An on-site oceanographer experienced with these types of data will review data quality by: (1) examining actual observed values, in particular the background current velocity and turbidity; (2) evaluating the consistency of values and patterns of change between proximate sensors; and (3) evaluating how well the observations conform to the levels and variability that might be expected for these measurement sites. As the number of deployments increases, the observational database available for use in evaluating data quality will also increase.

3.7.8 Dissemination of Data

Data time series will be available for review following each deployment and after data transcription, initial quality review and graphic presentation have been completed. This initial review is primarily to help with measurement optimization for subsequent deployments. When field operations are completed, all data will be transferred to the Raleigh office of SAIC where more detailed data management, quality control, and preliminary processing will occur. Following data processing, the observations will be provided to the LAD program manager in digital form along with documentation and graphical representations that will support a consideration of final data quality and completeness.

3.8 Hopper Dredge Operation Data

Hopper dredge positioning data will be collected during the transit and cap placement operations. Time and rate of material discharge information also will be acquired to determine where sediment placement occurs.

3.8.1 Rationale

Accurate hopper dredge position and time data will be acquired using signals received from the Differential Global Positioning System (DGPS) during the transit and cap placement operations. Position accuracy from DGPS is approximately ±2-5 m. Accurate time information also is received from the GPS satellites, which utilize precise clocks to determine position. DGPS has been used on previous capping projects in California to determine accurate hopper dredge position and disposal time.

Hopper dredge draft and pump information is acquired to identify where sediment collection and placement occurs. The draft information is obtained during the vessel loading and placement operations from a pressure sensor mounted within the vessel's hull. Pump information is acquired with a manually operated switch to determine when the vessel loads and dumps. Both inputs are needed to determine when the load leaves the hopper, and approximately where it is deposited on the seafloor. With the time, position, draft and pump information, the rate of sediment discharge can be determined at the capping sites.

3.8.2 Sampling Equipment

The Automated Disposal Surveillance System (ADISS) will be installed on the hopper dredge, *Sugar Island*, and maintained throughout the project to acquire time, position, draft and pump information during the loading, transit, and placement operations. The components of ADISS include:

- GPS and DGPS receivers for acquisition of time and position information
- Submersible pressure sensor to determine hopper dredge draft
- Programmable logger with time, position, and pressure thresholds of sampling
- Flash memory card for storage and portable downloading of data files

In addition to the ADISS equipment installed on the hopper dredge, a helmsman display (ADISSPlay) will be interfaced with ADISS and the vessel's gyro compass to record position and bearing information. ADISSPlay displays the vessel position over a NOAA/NOS chart with superimposed plot of cell boundaries, and records the event data to its database. ADISSPlay components include:

- Laptop computer and display/logging software
- Gyro compass to determine vessel bearing
- Color printer to plot vessel draft and track lines

3.8.3 Data Quality Objectives, Calibration, and Quality Control

Data Quality Objectives

The measurement objective of this task is to record accurate dredge position and time during sediment collection and cap placement events, and provide the location and amount of cap material placed during each event.

Calibration

Both the GPS and DGPS components receive signals transmitted from satellites and base stations, respectively. A documented comparison of position at a known location with ADISS provides system accuracy for the project. The comparison will be made prior to installation on the hopper dredge at a known location within Long Beach Harbor.

The factory calibration of the pressure sensor (and a spare sensor) is checked prior to installation on the hopper dredge. In a laboratory test tank, pressure values at 1-foot depth intervals, over a 0–12-foot range, are recorded. The data for depth of submersion and pressure are correlated and used to convert raw pressure values recorded on the dredge to its draft. The conversion coefficient is stored within the processing software, ADISSPro, and within the ADISSPlay database to convert pressure counts to engineering units (feet). At least once a week, a check of the ADISS draft measurement will be made with the vessel's Silent Inspector system prior to loading and placement operations by noting the respective draft measurements of both systems simultaneously.

The Hopper Dredge 9400 digital compass is maintained by the vessel's crew. The digital compass readout informs the helmsman of the bearing and provides ADISSPlay with an RS-232 readout. Both the helmsman and the ADISSPlay readout will be noted during the disposal at different vessel bearings and compared for accuracy.

Quality Control

Performance audits of the ADISS system (including ADISSPlay) are conducted prior to loading operations for each placement. The audit consists of proper system responses to set-up commands, and good reception from the sensors and receivers, including:

- Checks for proper logging sequences and proof of file storage
- Checks of pressure sensor function and correlation with visual draft measurement values
- Checks of pump switch function and proper recording
- Checks of correct gyro compass readout with ADISSPlay readout
- Checks of DGPS reception
- Checks of GPS signal reception

Chain-Of-Custody (COC) forms accompany the electronic records transferred to shore at the end of the day's field operations. A duplicate copy of the completed COC form will be submitted to the SAIC Project Manager for entry to the project archive. The COC form contains the following information:

- Date and time of ADISS and ADISSPlay downloads
- Name of on-site SAIC technician performing download (signature space provided)
- Date and time of data e-mail transfer to ADISS technician at SAIC's Newport, RI office
- Name of ADISS Technician performing data processing (signature space provided)
- Date and time of data product transfer to SAIC's Data Manager for this monitoring program

The internal quality control checks are preformed during processing of ADISS and ADISSPlay data after both are recovered from the hopper dredge. The ADISS Engineer checks the quality of the data when the ADISS data technician performs data processing.

3.8.4 Sampling Plan

The ADISS system automatically acquires time, position and draft information during the loading process, and at ten-minute intervals during transit to the placement cell. The rate of data acquisition is automatically increased to six seconds as the hopper dredge nears the target capping cell. ADISS records the changes in vessel draft from a pressure sensor, installed in the aft ram well, and pump activities from a switch, which an onboard technician operates. Together, the draft measurements and the pump information are used during data processing to determine when the vessel was loading or releasing material.

The ADISSPlay helmsman display will be installed on the Hopper Dredge *Sugar Island* to display the vessel draft and to record ADISS and compass information. ADISSPlay receives position information from ADISS, and displays the vessel's location relative to the target cell over a chart of the area. The orientation of the dredge during placement activities is determined from bearing information received from a flux-gate compass. During transit to the target, the displays of vessel track line or draft can be toggled as desired by the technician. ADISS data are automatically stored within the ADISSPlay database, and later exported to the DAN-LA GIS for display and analysis. Other information stored in the database, and entered by the Marine Technician through the ADISSPlay interface include:

- Project, vessel and target cell identifications (pull-down entries)
- Volume of material loaded in the hopper (key-board entry)
- Type of operation, either drag-arm or split-hull (pull-down entry)

3.8.5 Mobilization

Mobilization of the ADISS system (including ADISSPlay) consists of software modifications and testing before installation aboard the hopper dredge. Modifications to the ADISSPlay software include input from the 9400 compass and additional data entry fields for project, target, and type of placement identification. It also includes the display of vessel draft from the pressure sensor input. All modifications will be tested before the system is installed on the hopper dredge.

System installation will include the establishment of ADISS and ADISSPlay, complete with pressure sensor and 9400 compass interface deployments. Of the GPS and DGPS antennas placed atop the hopper dredge wheelhouse, only the GPS antenna must have an unobstructed view of the sky to receive signals from available satellites. All receivers and sensors will be tested individually with ADISS and as a complete working system during ongoing loading and placement exercises within Long Beach Harbor before initiation of placement within the capping cells. Should sensors, receivers or ADISS/ADISSPlay units fail, they will be replaced with spare equipment and tested.

3.8.6 Data Collection

ADISS Data Collection

Position, draft, and pump information will be stored in the ADISS portable flash memory card. Pressure and pump data are appended to the position data acquired by the GPS and DGPS receivers and stored in ASCI-II file format. Each line of data is time- and date-stamped at six-second intervals and stored as it is received. Data are recorded for load events, and transits/placements to/at the target cells are stored in separate files. Load and transit/placement files are composed of Latitude-Longitude position, pressure values, and pump on-off information. Information indicating the quality of the position fix is also included in each line (i.e., the number of satellites detected and reception of the DGPS signal). The load data will be gathered at ten-minute intervals for a two-hour duration. Transit data will be acquired at ten-minute intervals until the dredge is within one-half mile of the target cell boundary, when the data interval will increase to six seconds. The placement event will be recorded for 20 to 120 minutes, depending on the mode of disposal. A single point, split hull placement will require less time than the motile dispersion of sediments employing the pump out method through the drag arm. By exercising a variety of ADISS firmware options, sampling parameters can be changed as required.

ADISSPlay Data Collection

The onsite technician operating the ADISS and ADISSPlay system will be trained in its operation by the ADISS Engineer and ADISS technician. Preventative maintenance of the equipment and modification to the software will be the responsibility of the ADISS Engineer and ADISS technician. Weekly service visits to the hopper dredge will be made by either. The onsite technician will be capable of operating the equipment and recovering the data from both ADISS and ADISSPlay memories. The ADISS Engineer will direct the technician's efforts to troubleshoot the ADISS equipment and firmware, should the need arise, while the ADISS technician will guide the technician through potential problems with the ADISSPlay software.

3.8.7 Processing ADISS and ADISSPlay Data

Data analysis takes place during the processing of the ADISS and ADISSPlay data within ADISSPro. The beginning and ending position of each disposal event is selected in a time-vs-draft plot by the technician according to changes in draft and pump activity. After the database is updated with the selection of the placement points, the track line is plotted over the background of the target cell. The ADISSPlay points are checked with those from ADISS before the plot images are exported to DAN-LA GIS data archive and the PV-Web Site for display.

Data reduction, validation and reporting will include either daily or weekly data transfer as required from ADISS and ADISSPlay. Once recovered from the *Sugar Island,* the ADISSPlay database and the ADISS data files will be compressed and e-mailed to the ADISS Technician by on-site personnel. The ADISSPlay data will be processed using ADISSPro, and compared with the information in the ADISS data files before submittal to DAN-LA. Validation will include determining the quality of Differential and GPS satellite position fixes using the information recorded in the data strings, as well as the raw pressure counts of vessel draft and the compass bearing information. Observations will be noted in the posting of the data plots of position, should the quality of the data be compromised or in question. Database contents will include the time and date of each vessel position and orientation, pump activity, vessel draft, load volume, and the identities for the target, vessel and project. Draft-time series and vessel track lines will be plotted and reported on the project web site.

3.8.8 Dissemination of ADISS/ADISSPlay Results

The SAIC Project Manager will be responsible for project data/information acquired during ADISS and ADISSPlay operations. QA summary reports will be sent to the Project Manager, and indications of data quality will be posted on the PV-Web Site with each data set. Processed data and QA reports will be maintained in DAN-LA, and daily backups of the DAN-LA data archive will be part of the routine procedure for reporting to the DAN-LA system.

3.9 Water Quality Sampling

3.9.1 Rationale

Cap placement could potentially create a plume of resuspended EA sediments, resulting in elevated suspended sediment and dissolved and particulate contaminant concentrations in near-bottom waters within the immediate vicinity of the pilot cap. Following an initial resuspension event, concentrations of resuspended EA sediments and associated contaminants are expected to decrease with time due to particle settling and dispersion by near-bottom currents. The purpose of these measurements is to determine the magnitude of Total Suspended Solids (TSS) and total recoverable (i.e., combined dissolved and particulate fractions) p,p'-DDE concentrations in the near-bottom portion of the water column up to 2 hours following a disposal event. These water quality sampling activities will be coordinated with the plume mapping task described in Section 3.10. For example, water samples will be collected during all CTD profiling surveys, both for the near-bottom plume surveys, as well as surveys of near-surface plumes that may be advected toward shore. In general, the sediment plume mapping surveys will be conducted to determine whether there is a detectable near-bottom plume of suspended sediment that results from placement of cap material, and to determine whether suspended, fine-grained cap material is transported toward shore and adjacent kelp beds prior to settling on the seafloor immediately following placement within capping cells.

3.9.2 Sampling Equipment and Methods

The major sampling equipment associated with the water sampling survey includes a rosette water sampler interfaced with a Conductivity, Temperature and Depth (CTD) water column profiler. The rosette is fitted with 12

10-litre Niskin water sampling bottles for water collection. Sub-samples of water will be taken from these bottles for laboratory analysis of TSS and p,p'-DDE.

In addition to the conductivity, temperature and depth sensors, a 25-cm pathlength transmissometer and a sonar altimeter are integrated with the CTD system to provide real-time water column light transmittance measurements and elevation of the instrument package above the seafloor. These instruments will be fully integrated and deployed as a single unit via a single-conductor hydrowire. Real time data will be collected from each of these instruments utilizing the SBE 11 *plus* CTD Deck Unit interfaced to a laptop computer in the survey vessel's laboratory.

Field operations for water quality sampling will use research vessels equipped with a hydraulic A-frame and winches, at least 2,500 feet of hydrographic wire, and complete electronic instrumentation (radar, depth finder, DGPS, radio).

A detailed water sample collection methodology can be found in the SOP for Near-Bottom Marine Water Sample Collection Using a Rosette Water Sampler Interfaced with a Water Profiling CTD, Transmissometer and Altimeter (Volume II of the Project Work Plan).

The following field equipment and supplies will be mobilized for collection of near bottom water samples:

3.9.2.1 Equipment

- Rosette Water Sampler
- CTD including deck box for data acquisition
- Transmissometer
- Sonar Altimeter
- PC laptop computer
- Surge protector for AC power conditioning
- All necessary cables and plugs including spares
- Battery Pack (with 12 spare D cell batteries)
- Computer disks
- Equipment manuals
- Tool box

3.9.2.2 Water Sampling Supplies

- 500 mL plastic or glass sample bottles including labels for TSS
- 1-L certified clean jars (with certification) with Teflon-lined caps for p,p'-DDE
- Large plastic squirt bottle with de-ionized water
- Laboratory paper wipes or paper towels
- Waterproof tape (e.g., electrical tape)

- Clear packaging tape
- Indelible ink pens
- Refrigeration unit or ice-filled cooler to maintain 0-4 degree C sample temperature

3.9.3 Data Quality Objectives, Calibration and Quality Control

Data Quality Objectives
Measurement quality objectives for near-bottom water quality samples are addressed in the Data Quality Objectives section of this Project Work Plan. The primary objective for these sampling efforts is to assess TSS and p,p'-DDE concentrations in any near-bottom plume for two hours following hopper placement of cap material.

Calibration and Quality Control
Calibration of the water-sampling unit includes the sensors on the CTD, transmissometer, and altimeter. There is no calibration of the rosette itself. Factory calibration of these sensors is the best method to ensure data quality, as each of these instruments typically exhibit little drift over time once calibrated. A detailed description of the calibration procedures can be found in the SOP and the instrument's operations manuals.

For this monitoring program, each of the sensors listed below will be factory calibrated prior to the first survey. In addition to factory calibrations, the following field calibrations of the CTD will be performed:

- Temperature: The temperature sensor will be field tested prior to the survey by deploying the CTD with a duplicate temperature sensor mounted on the same instrument for comparison.
- Conductivity (salinity): Discrete water samples are collected and analyzed for salinity with a Guildline Autosal. The Autosal is calibrated with IAPSO standard seawater with each set of samples.
- Pressure: The pressure sensors are very stable and virtually immune to environmental effects. Therefore, the field calibration check that will be performed on this sensor is that the zero (0) pressure reading (or air reading) closely matches the local barometric pressure.

If calibration checks of the above CTD sensors reveal a problem, the instrument will be returned to the manufacturer for troubleshooting and/or re-calibration. A description of the calibration criteria for each of the instruments can be found in the Quality Assurance Project Plan (QAPP).

Field calibration of the transmissometer will be performed by checking the offset voltage and the air reading. The offset voltage is obtained by fully blocking the optical path of the transmissometer when the instrument is clean, dry, and on deck. The air reading is obtained by recording the voltage of the sensor when there is no blockage of the beam. These values are compared to values recorded on the factory calibration sheet. If there is little fluctuation in these values, the instrument retains its calibration. Large discrepancies would require that the instrument be re-calibrated by the manufacturer or in accordance with procedures in the operations manual.

3.9.4 Sampling Plan

Approximately 264 water samples will be collected during the seven (7) events and the Flex Surveys associated with this project (Table 3-14). Samples will be collected in associated with specific placement events in cells LU, LD and SU, as well as during flex surveys, as described in the Statement of Work for the Monitoring Program (Fredette, 2000). All samples will be analyzed for TSS. A total of 70 of these samples will also be analyzed for p,p'-DDE.

Prior to the first survey, a Recovery Verification Sample will be collected from the center of Cell LU and analyzed for TSS and p,p'-DDE. The purpose of this Recovery Verification Sample is to verify that the volumes of water collected will be adequate to meet a nominal reporting limit of 1.0 mg/L TSS and 0.25 ng/L total recoverable p,p'-DDE.

Table 3-14. Summary of Water Sampling Locations, Tasks, Events, and Number of Samples

	Cell LU (Task 6)		**Cell LD (Task 7)**		**Cell SU (Task 8)**		**Plume Transport Survey (Task 11)**			**Flex Surveys (Task 5)**	**Total Samples**
	Event 1	Event 3a	Event 2	Event 3b	Event 6	Event 6a	Event K1	Event K2	Event K3		
Field Samples											
TSS	27	54	27	0	27	0	27	27	27	25	241
p,p'-DDE	6	12	6	0	6	0	0	0	0	5	35
Background Samples											
TSS	3	6	3	0	3	0	0	0	0	0	15
p,p'-DDE	3	6	3	0	3	0	0	0	0	0	15
Quality Control Samples											
Field Duplicates											
TSS	3	6	3	0	3	0	3	3	3	3	27
p,p'-DDE	1	2	1	0	1	0	0	0	0	0	5
Field Blank											
p,p'-DDE	1	2	1	0	1	0	0	0	0	0	5
Rinsate Sample											
p,p'-DDE	1	2	1	0	1	0	0	0	0	0	5
MS/MSD											
p,p'-DDE	1	2	1	0	1	0	0	0	0	0	5
Sub-Total											
TSS	33	66	33	0	33	0	30	30	30	28	283
p,p'-DDE	13	26	13	0	13	0	0	0	0	5	70

Total Suspended Solids (TSS)

Water samples for TSS analysis will be collected within the near-bottom suspended sediment plumes. Because the location of the plume will be determined in real time during survey operations, water quality samples will not be from a pre-determined station location. Plume location and hence, water sample collection locations are dependent upon a number of oceanographic conditions (e.g., currents, stratification etc.). Therefore, specific sampling locations for the TSS samples will be determined by the Water Sampling Field Leader during field operations, and will be based on plume locations from interpretations of CTD data.

p,p'-DDE

The p,p'-DDE samples will be taken from the centroid of the plume and within 2 meters of the bottom, where concentrations of suspended sediments are expected to be the greatest. The sampling design indicates that samples should be collected from the centroid at 5, 20, 40, 60, 90 and 120 minutes after cap placement. Actual sampling times may deviate from this plan if other, concurrent sampling efforts (e.g., ADCP plume mapping operations) conflict with water sampling. However, actual sampling times are not expected to deviate by more than 10 minutes from the planned sampling intervals, and any such deviations will be recorded in the field logs maintained by the Chief Scientist.

Cell LU

Water quality samples will be collected following the first placement event (Event 1) and after the second and third placement events (Event 3a) in Cell LU. Prior to each placement event, background samples will be collected within 2 m of the bottom in the vicinity of the target placement site. Pre-release sampling will generate 3 TSS and 3 DDE samples for each of the three placement events. At times of 5, 20, 40, 60, 90, and 120 minutes following placement of the first three loads, additional water samples will be collected within 2 m of the bottom and spatially near the centroid of the plume. Post-release samples including field and QC samples will generate up to 84 TSS samples and 30 DDE samples.

Cell LD

Water quality samples will be collected following the first placement event (Event 2) in Cell LD. Prior to the placement event, background samples will be collected within 2 m of the bottom in the vicinity of the target placement site. Pre-release sampling will generate 3 TSS and 3 DDE samples for the first placement event. At times of 5, 20, 40, 60, 90, and 120 minutes following placement of the first load, additional water samples will be collected within 2 m of the bottom and near the centroid of the plume. Post-release samples including field and QC samples will generate up to 28 TSS samples and 10 p,p'-DDE samples.

Cell SU

Water quality samples will be collected following the first placement event (Event 6) in Cell SU. Prior to the placement event, background samples will be collected within 2 m of the bottom in the vicinity of the target placement site. Pre-release sampling will generate 3 TSS and 3 DDE samples for the first placement event. At times of 5, 20, 40, 60, 90, and 120 minutes following placement of the first load, additional water samples will be collected within 2 m of the bottom and near the centroid of the plume. Post-release samples including field and QC samples will generate 28 TSS samples and 10 DDE samples.

Flex Surveys

In addition to the planned samples described above, up to 25 additional water quality samples may be collected at the request of the USACE Project Manager. All water quality samples collected for the "flex surveys" would be analyzed for TSS and 5 samples would be analyzed for DDE. The objective for these analyses is to provide information for characterizing water quality conditions outside of the spatial or temporal boundaries defined for the other water quality sampling tasks.

3.9.5 Mobilization

The pre-survey mobilization of the rosette water sampling system will be performed by technicians associated with the Southern California Marine Institute (SCMI) USC Wrigley Institute for Environmental Studies, a subcontractor to SAIC for this project. Prior to survey operations, the system will be transferred to the survey vessel along with all the necessary support documentation (e.g., operating manuals, calibration check sheets). The system will then be integrated with the DGPS navigation system provided by SAIC and fully tested prior to the start of the surveys (see Section 3.2).

3.9.6 Sample Collection

Bulk Water Collection and Sub-Sampling for TSS and p,p'-DDE

Water samples will be collected using the rosette water sampler fitted with 12, 10-liter Niskin bottles. Sub-samples will be taken from these bottles for laboratory analysis of TSS and p,p'-DDE. A detailed description of the sampling technique is provided in the Standard Operating Procedure (SOP) for Near Bottom Marine Water Sample Collection Using a Rosette Water Sampler Interfaced with a Water Profiling CTD, Transmissometer and Altimeter (Volume II of the Project Work Plan).

Water samples will be collected by lowering the rosette system into the water with a single cable hydrowire. When the rosette is at the desired sampling location/depth (as indicated by the transmissometer, altimeter, and CTD), a 10-L sample is collected by "triggering" the sampling bottle using the CTD deck unit. The sample is simultaneously recorded in the field logbook (see methods below). The process is repeated by stepping through the unfilled positions on the rosette until the desired number of samples has been taken.

After the rosette is retrieved on deck, the appropriate sampling bottles are sub-sampled for TSS and p,p'-DDE. Five hundred (500) milliliters of water will be collected for each TSS analysis and two 1-L samples will be collected for each p,p'-DDE analysis according to the methods described in the SOP. Each sample bottle will be labeled immediately upon collection. An example of a sample label is shown in Figure 3-8.

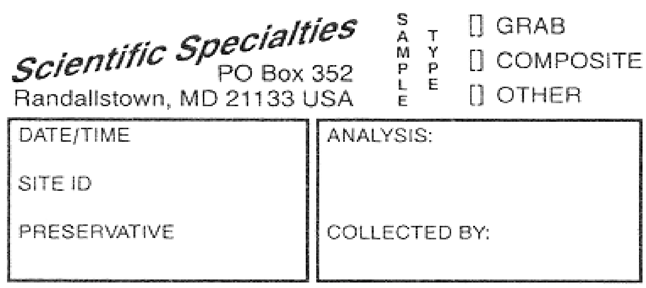
Scientific Specialties
PO Box 352
Randallstown, MD 21133 USA
SAMPLE TYPE
[] GRAB
[] COMPOSITE
[] OTHER
DATE/TIME
SITE ID
PRESERVATIVE
ANALYSIS:
COLLECTED BY:

Figure 3-8. Example label for water samples.

A summary of the water samples and related quality assurance samples that will be collected for the interim surveys is presented in Table 3-15. Table 3-16 summarizes the sample containers, preservatives, required sample volumes, and holding time requirements for water samples.

<u>Water Collection Field Log</u>
During at-sea operations, all information concerning the collection of water samples and water column profiles will be entered in a Water Sample Collection Field Log. This information will include at a minimum: a water sample designation number, date, time of collection, DGPS position, water depth at the collection point, the transmissometer voltage reading at the time of collection and any other features that may affect the quality of the water sample results. Station designation numbers will consist of cell, survey event number, and sample number according to the following convention: cell-survey event number-sample number. For example, the 10th water sample taken during event 3a in cell LU would be recorded on the field log as LU-3a-10. This sample identification number will be identical to the sample identification number on the water sample container. Table 3-17 below represents a sample field log for the water sample collection surveys.

Table 3-15. Summary of TSS and p,p'-DDE Water Samples

Sample Type	Description	Purpose	Numbers of Field Samples
Recovery Verification Sample	6 1-L near bottom water samples will be collected prior to the beginning of survey and analyzed for TSS and p'p'-DDE.	1) Determine whether a total of 1 or 2 liters of water is needed to meet the specified reporting limit of 0.25 ng/L total recoverable p,p'-DDE	1 (6-1L Samples = field sample total)
Background Samples	3 2-L water samples taken from within two meters of the bottom of each cell prior to each placement event. Samples will be analyzed for TSS and p,p'-DDE.	Determine background concentrations of TSS and p,p'-DDE prior to placement of cap materials	TSS & p,p'-DDE Maximum of 15 samples for each
Field Samples	One discrete 500 mL water sample for TSS analysis and one discrete 2-L water sample for p,p'-DDE analysis per each sampling station/location.	Evaluate vertical and horizontal TSS and p,p'-DDE concentrations in suspended plume sediments associated with cap material placement	TSS- Maximum of 241 p,p'-DDE-Maximum of 35
Field Duplicate	Replicate water samples of the Field Samples described above.	Check on laboratory analytical precision.	TSS-27 p,p'-DDE-5
Field Blank	Two 1-L containers of distilled water are opened on the survey vessel deck where the water samples are being collected and left open for the same period of time that the water sample is exposed to air during the water sub-sampling procedure. Sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-L containers is required for analysis - the second represents a back-up sample). No field blanks for TSS.	Check on possible contamination of the water sample from the on-deck processing operation.	p,p'-DDE-5
Niskin Bottle Rinsate Sample	Distilled water is poured through one 10-L Niskin bottle that has been left open during the water sampling survey. Two 1-L volumes are collected and sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-L containers is required for analysis - the second represents a back-up sample). No rinsate samples for TSS.	Check on possible cross-station contamination of the water samples.	p,p'-DDE-5
MS/MSD	Six 1-L water samples are collected as replicates from 1 randomly selected water sample station/location during each of 4 events.	Check on laboratory analytical precision and matrix effects.	p,p'-DDE-5

Table 3-16. Sampling methods, containers, preservatives, volumes, and holding time requirements for water samples

Parameter	Sampling Method	Sample Volume	Preservation	Container	Holding Time
TSS	Rosette/Niskin Bottle	500 mL	4ºC	500 mL plastic bottle or glass jar with Teflon-lined lids.	7 days in dark
p,p'-DDE	Rosette/Niskin Bottle	2 L	4ºC	1 L amber glass jar with Teflon-lined lids.	7 days for extraction; 40 days for extract analysis

Table 3-17. Example of Entry Form for the Water Sample Field Log

Time	Water Sample Name/Number	Location (Lat/Long)	Conductivity	Temperature	Depth	Altimeter Reading	Transmissometer Reading
	LU-3a-1						
	LU-3a-2						
	LU-3a-3						
	LU-3a-4						
	LU-3a-5						

3.9.7 Sample Processing

Field Processing

A sample label (see Figure 3-8) is immediately attached to each sample at the time of collection (extraction from the Niskin bottle on deck). The pre-printed, laboratory supplied label identifies the project title, cruise number, sample type, station number, and sample number. Specific sample information is written in indelible ink for the following:

- Survey number
- Station identification
- Date and time collected
- Sample replicate number
- Collector's name or initials
- Analysis to be performed
- Specific comments (e.g., sample depth, possible interferences)

Sample labels are attached to the container using clear tape to prevent the label from washing off or dissolving. At the end of each day of survey operations, samples will be transferred to the person responsible for shore-based water sample processing (see below). All samples will be placed on ice and refrigerated at 4 ° C immediately after field processing and documentation.

Shore Processing

Shore processing of water samples will consist of inventorying and documenting each sample in preparation for shipment to the laboratory. A chain of custody (COC) form will be completed to document the integrity of all samples and to maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory. The individual in charge of shipping samples to the laboratory is responsible for completing the COC form. This individual also will inspect the form for completeness and accuracy. Any changes made to the COC form shall be initialed by the person making the change.

All samples will be listed on the COC form, which will accompany the sample shipment. An example of a COC form is shown in Figure 3-9. Sample jars will be placed in insulated coolers containing wet ice, along with a temperature blank, sealed, and transferred to the custody of an overnight carrier for transport to the appropriate subcontractor laboratory. Temperature blanks will be prepared by filling 40-mL vials with refrigerated (i.e., to 4°C) water and placed in the cooler with the environmental and field QC blank samples immediately before the sample cooler is packaged for shipping to the laboratory. The temperature of the blank will be taken immediately after the sample cooler is opened at the laboratory and the data recorded on the COC form. Temperature blank data are used to assess the effectiveness of the ice used to maintain the temperature within the cooler between 4°C and 8°C.

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Chain of Custody Record

Science Applications International Corporation/ 221 Third Street/ Admiral's Gate/ Newport RI 02840 phone (401) 847-4210 fax (401) 849-9786

Project:	Client Name and Contact:

Sample No.	Containers No.	Containers Type	Collection Date	Collection Time	Sample Description	Requested Parameters
Total :						

Packed/Released By Signature: Printed Name:	Date	Time	Received By Signature: Printed Name:	Date	Time	Remarks:
Released By Signature: Printed Name:	Date	Time	Received By Signature: Printed Name:	Date	Time	
Final Destination:			Contact Name and Phone Number:			Shipping Method: Page ______ of ______

Figure 3-9. Example of chain of custody form to be used for shipment of water samples.

The COC form will contain the following information:

- Sample number (for each sample in shipment)
- Collection date (for each sample shipment)
- Time sample was obtained/or collected
- Number of containers of each sample
- Sample description (environmental matrix)
- Analyses required for each sample
- Shipment number
- Shipping address of the laboratory
- Date, time, and method of shipment
- Spaces to be signed as custody is transferred.

The following is a description of the procedure followed when transporting environmental samples from the sampling site to the laboratory:

- Log book entries, sample tags, COC forms, and field record sheets with sample identification, date, time, and names or initials of all persons handling the sample in the field are completed.

- After the cooler is filled, the appropriate COC form is placed inside the cooler for shipment to the laboratory.

- Glass sample containers are wrapped or placed with plastic material to prevent contact with other sample containers or the inner walls of the cooler.

The water samples are shore-processed and shipped to the laboratory for analysis within 24 hours of collection.

3.9.8 Dissemination of Survey Results

On the day following completion of the Water Sample Collection survey, a brief survey report summarizing sampling operations will be prepared and submitted to the USACE Project Manager or technical point of contact. Following USACE approval, this report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Within five days of the completion of the water sampling operations, a map indicating locations of all sampling stations will be posted on the PV-Web. These data will later be populated on the DAN-LA GIS via CD-ROM updates.

3.10 Plume Mapping

3.10.1 Rationale

Plume mapping surveys will be conducted to determine (1) the spatial extent, direction of transport, and rate of dispersion of EA sediments that may be resuspended during cap placement and (2) the extent of onshore transport of suspended cap materials in the upper mixed layer of the water column and potentials for impacts to nearshore kelp beds. Two sampling methods will be used to track and delineate suspended sediment plumes: Broad Band Acoustic

Doppler Current Profiler (BBADCP) and light transmittance measurements. These measurements will be made in conjunction with collections of discrete water quality samples, as described in Data Quality Objectives Section 9.0.

3.10.2 Sampling Equipment and Methods

BBADCP measurements will be performed using a system that will be operated by WES. This system is a 5-beam, 600-kHz , BBADCP manufactured by RD Instruments (RDI) in San Diego, CA. Four of the beams are mounted at a 20-degree angle from the vertical, and are used to measure current speed and direction. The 5th beam points straight down and is used solely for measuring acoustic signals from the suspended sediment resulting from the dredged material placement operation.

The BBADCP will be mounted in a hydrodynamically-stable tow body. When surveying using the tow body, the BBADCP is towed behind the survey vessel below the vessel's wake on an electro-mechanical cable along straight survey lines that start and end outside the area of interest. The BBADCP measures a vertical profile of acoustic signals from depths less than 60 m below it. The profile is composed of measurements representing 0.5-m depth cells. The maximum depth to which these signals are useful depends on site-specific conditions related to the turbidity and the temperature and salinity of the water.

During and after the release of dredged material, transects are made to measure the extent of suspended sediments that result from the placement operation. Current shear normally causes the near-surface suspended sediments to be laterally transported at a faster rate than the near-bottom sediments. Therefore, to successfully track the movement of suspended sediments over time, it is normally necessary to concentrate the measurement and vessel positioning on a single layer where the transport does not vary greatly with depth.

The background acoustic measurements are subtracted from the measurements made during and after the placement operation, and the differences are divided by the standard deviations of the background variations as determined from the repeated transects made prior to the placement operation. This results in values of acoustic backscatter above background (ABAB) which are used to map the extent of the suspended sediments resulting from the placement operation.

The BBADCP sampling equipment includes the following:

1. BBADCP
2. tow body
3. tow cable and winch
4. deck cable
5. control unit
6. data acquisition and analysis computers
7. DGPS navigation system
8. pressure sensor on tow body
9. BBADCP data acquisition and acoustic processing software

Light transmittance data collected for these sampling tasks will be collected using the same CTD-mounted transmissometer system described previously for water quality samples (Section 3.9 of this FSP). Discrete water samples for TSS measurements will be collected with the rosette sampler as described in Section 3.9.

3.10.3 Data Quality Objectives, Calibration, and Quality Control

BBADCP

The objectives of the BBADCP measurements are to distinguish the boundaries and transport directions of near-surface and near-bottom plumes, as well as the sinking rates of particles, based on interpretations of the acoustic signal provided by the instrument.

Field calibration and quality control will be performed immediately before a placement operation. Repeated transects are made across the placement area to determine the magnitude and variation of the naturally occurring acoustic background. Current speed and direction are measured in discrete layers above the bottom along each of the transects. Depending on the objective of the survey, either the near-surface or near-bottom sediment plume can be tracked following a particular cap placement event.

At the beginning of each survey day, a test program supplied by the manufacturer (RDI) is run to check for proper operation of the BBADCP system. During the survey, the status of the DGPS navigation system is checked frequently to assure that differential signals are being received and that there is a sufficient number of satellites in view to achieve the desired positioning accuracy. During each step of the data processing, qualitative checks of the results are made to check their reasonableness.

CTD

The measurement, quality objectives, calibration and quality control for CTD mounted light transmittance data are described in Section 3.9 of the FSP.

3.10.4 Survey Plan

Plume mapping using BBADCP, light transmittance measurements (transsmissometer), and discrete water sampling will be conducted concurrently following individual cap placement events. As previously indicated, the plume mapping is being conducted to determine whether there is a detectable near-bottom plume of suspended sediment that results from placement of cap material, and to determine whether suspended, fine-grained cap material is transported toward shore and adjacent kelp beds prior to settling on the seafloor immediately following placement within capping cells. Logistical considerations, such as the availability of multiple survey vessels and field crews, may dictate the extent to which ADCP and light transmittance data can be collected simultaneously, in an alternating fashion on the same vessel, or simultaneously on different vessels. Further, the sensitivity of the ADCP for detecting the plume will affect the extent to which these measurements can be used reliably to direct collections of discrete water samples that are representative of maximum particle concentrations within the plumes. Table 3-18 provides a summary of the plume tracking field surveys that will be conducted during the capping project.

Table 3-18. Summary of Plume Tracking Surveys Using the BBADCP and CTD Transmissometer.

Monitoring Type	Capping Cell(s) and Sampling Frequency	Level of Analysis
Single Hopper Placement (Tasks 6, 7 & 8)	LU- Event 1 LD- Event2 SU-Event 4	Map the location and extent of the plume created by the placement of the cap material
Interim Placement (Task C)	LU x 2 Second and third placement events (Event 3a)	Map the location and extent of the plume created by the placement of the cap material
Plume Transport Survey (Task 11)	3 separate times during placement of finer cap materials in landward cell LU	Map the location and extent of the plume created by the placement of the cap material

<u>Cell LU</u>

Plume mapping measurements will be conducted following the first placement event (Event 1) and the second and third placement events (Event 3a) within Cell LU. Measurements will be made for two hours following the placement events.

<u>Cell LD</u>

Plume mapping measurements will be conducted for two hours following the first placement event (Event 2) within Cell LD. The ADCP will be used to measure the sinking rates of individual particles and locations where they impact the seafloor.

<u>Cell SU</u>

Plume mapping measurements will be conducted for two hours following the first placement event (Event 4) within Cell SU.

<u>Disposal Plume Transport Survey (Task 11)</u>

During placement of finer grained cap materials within landward cell LU, three plume transport surveys will be conducted for periods up to 2 hours following placement events. Near-surface plumes will be tracked using ADCP signals and light transmittance readings, and up to 27 discrete water samples for TSS analyses will be collected in

Niskin bottles using the rosette sampler during these three surveys. Because the purpose of this task is to evaluate potential for onshore transport of plumes comprised of clean cap materials, analyses of seawater for p,p'-DDE will not be performed.

3.10.5 Mobilization

BBADCP

Technicians associated with the USACE and SAIC will perform the pre-survey mobilization of the BBADCP system. Prior to survey operations the system will be transferred to the survey vessel along with all the necessary support documentation (e.g., operating manuals). The system will then be integrated with the Hypack DGPS navigation system that will be provided by SAIC and fully tested prior to the start of the project's surveys (see Section 3.2 and below).

Before the start of the survey, the Hypack DGPS navigation system will be installed aboard the vessel and tested to ensure that accurate DGPS position data are being recorded by the computer on the printer, plotter, and data storage medium (diskette). The GPS master antenna will be installed as close as possible to the position where the hydrowire enters the water (A-frame) so that the correct sampling position is recorded by Hypack; its position will be recorded in the navigation log.

CTD

The approach for mobilizing light transmissometer equipment is described in Section 3.9.

3.10.6 Data Collection

BBADCP

Data from the BBADCP is transmitted by cable to a computer and recorded during the survey. The magnitude of the acoustic signals, and the current speed and direction, can be displayed in real time during the survey; only raw data are recorded, and must be processed to produce final data products. Data are recorded on the computer's hard drive, and displayed during the survey using software supplied with the system by RDI.

Immediately after each survey, the data recorded on the computer's hard drive will be copied onto computer diskettes and stored in a safe place. The data on these computer diskettes are copied onto the hard drive of the computer used for the data analysis.

BBADCP Collection Field Log

During the BBADCP surveys, a log book will be kept to record the designation of each survey line, the start and end data record for each line, the data file name, and the start and end times of each line. Additional notes will include information about the placement operation, the presence of boat wakes in the area, and any other information related to the data. If single-point current measurements are made, the log will record the tow body depth, and the start and end locations and times for the measurements. The navigation data, and the instrument operating parameters, are automatically recorded with the BBADCP data. Table 3-19 below represents a sample field log for the BBADCP surveys.

Table 3-19. Example of Entry Form for BBADCP Field Log

Survey Line	**Data File Name**	**Start Data Record**	**End Data Record**	**Line Start Time**	**Line Stop Time**	**Notes and Remarks**

CTD

Collection of light transmittance data is described in Section 3.9 of the FSP.

3.10.7 Data Processing

BBADCP

BBADCP data are analyzed using software developed by the Coastal and Hydraulics Laboratory (CHL) at the U.S. Army Engineer Research and Development Center (ERDC). A detailed description including data formulas and processes to convert the BBADCP data can be found in the Standard Operating Procedure (SOP) for Broadband Acoustic Doppler Current Profiler (BBADCP) Surveys of Dredged Material Placement Operations located in Volume II of the PWP.

CTD

Methods for processing light transmittance and TSS data are described in Section 3.9.

3.10.8 Dissemination of Survey Results

BBADCP

On the day following completion of the BBADCP survey, a brief survey report summarizing sampling operations will be prepared and submitted to the LAD Project Manager or technical point of contact. Following LAD approval, this report will be posted on the Palos Verdes Monitoring Project Website (PV-Web) for viewing by all project participants.

Within five days of the completion of the BBADCP operations a map indicating locations of all sampling stations will be posted on the PV-Web. These data will later be populated on the DAN-LA GIS via CD-ROM updates.

CTD

Dissemination of light transmittance and TSS data is described in Section 3.9.

3.11 Surge Video Documentation

The objective of this sampling task is to provide video documentation of bottom surge that potentially could occur following cap placement using conventional placement methods (Fredette, 2000).

3.11.1 Rationale

Cap placement using conventional (point-disposal) methods could create a near-bottom surge when the large volume of cap material encounters the bottom. Surge could, in turn, cause resuspension and transport of EA sediments. Video documentation will be collected, in conjunction with surge measurements using bottom-mounted current meters and OBS records, to assess the magnitude and spatial extent of any surge near the cap site.

3.11.2 Sampling Equipment and Methods

A Color Video System that comprises a video camera, underwater lights, a control console, and a VCR will be used to monitor sediment resuspension and transport. Real-time video data from the camera is fed to the surface via a video cable that is connected to the operating and data collection console. The console contains a color viewing monitor, an S-VHS VCR and camera control panel. The video display can be monitored in real-time by the video technician. Any adjustments to the camera (e.g., focusing or light intensity) are performed depending on conditions encountered. The video data are routed directly to the VCR where they are recorded. Real-time audio is overlaid onto the video, noting time "markers," significant events, and any additional information that is relevant to the video data collection.

The video camera will be mounted on an array (frame) that will also support the underwater lights, an underwater compass, and a depth gauge within the camera's field of view. The array will allow the camera to operate when resting on the bottom or suspended above the bottom. During all video-surveying operations, the camera will be in a downward looking position, and the vertical position (elevation) will be adjusted to document the lateral spread and vertical thickness of any bottom surge.

Vessel positioning during the video surveys will be accomplished using the DGPS navigation system. The DGPS will be interfaced to a portable personal computer for real-time display of vessel position and data storage. A detailed discussion of the DGPS system can be found in Section 3.2.

The following field equipment and supplies will be mobilized for collection of surge video photography:

<u>Integrated Color Video System:</u>

- Color CCD Camera
- (2) UWL-200 150 Watt Lights
- 500 ft Video Cable Marked at Five Meter Intervals
- CON-3000 Console
- S-VHS Video Recorder
- Underwater Compass
- Depth Gauge

<u>Field Materials:</u>

- S-VHS video tapes (1 tape per 2 hours of video collection)
- Field Log Book
- Tool box

<u>Navigation System:</u>

- DGPS Navigation System
- Portable Navigation Personal Computer

3.11.3 Data Quality Objectives, Calibration, and Quality Control

<u>Data Quality Objectives</u>

The objectives for the Placement Surge Video Documentation are addressed in the Data Quality Objectives section of this Project Work Plan. As specified in the Monitoring Plan for the Pilot Cap Program (Fredette 2000), the overall objective for the surveys is to provide video documentation of bottom surge at distances of 50, 75, 100 and 200 meters from the point of cap sediment release.

Data capture and significant events (e.g., time markers and observations) observed during the survey will be referenced on the tape in real-time using the audio feature of the system. This will ensure that video data can be correlated with the quantitative data collected simultaneously using bottom instrument arrays.

Calibration and Quality Control

The video system requires no instrument calibration. Pre-survey checks are needed to ensure that all of the features of the camera (e.g., focus and lights) are in proper working order prior to deployment. Refer to the Video Camera Deployment Checklist in Section 17.0 of the Sub-Surface Video Camera SOP for instructions on these tests. The complete system is also bench tested prior to the deployment.

3.11.4 Sampling Plan

The video camera array will be deployed during initial disposal events at pilot capping cells LU and SU, and during two additional events that will be determined in coordination with the SAIC and USACE Project Manager. Placement of the video camera array will be at varying distances from the point of sediment release (e.g., 50 m, 75 m, 100 m and 200 m). The intent is to illustrate the characteristics of the surge with increasing distance from the point of release out to the point where the surge is minimal or not present. Sampling plans are described below.

Cell LU

The video camera system will be deployed at cell LU during the initial placement event and during a minimum of two additional placement events to record surge at four distances from the release points.

Cell SU

The video camera system will be deployed at cell SU during the initial cap placement event to record surge at four distances from the release points.

Cell LD

The video camera system will be deployed at cell LD during the initial cap placement event to record surge at four distances from the release points.

Flex Surveys

The video camera system will be deployed at two other locations/events to be coordinated with the USACE Program Manager.

The objective of these deployments is to provide at least five video segments of 30- to 60-second duration documenting the presence or absence of any surge following cap placement using various cap placement methods.

3.11.5 Mobilization

Prior to the survey, all components of the video camera array will be transferred to the survey vessel. The inventory list will include a supply of spare equipment and blank video tapes to ensure that all sampling objectives can be met without delays caused by equipment availability.

Before the start of the survey, the DGPS navigation system will be installed aboard the vessel and tested to ensure that accurate DGPS position data are being recorded by the computer on the data storage medium (diskette).

3.11.6 Sample Collection

The video system will be deployed according to the SOP for Bottom Surge Documentation Using a Sub-Surface video Camera that can be found in Volume II of the Project Work Plan (PWP). The camera will be lowered to the desired depth and adjusted (e.g., focus and light intensity) accordingly, based on the water clarity conditions encountered.

Video data from the camera are transmitted to the surface via a video cable that is connected to the operating and data collection console. The video data are routed directly to the VCR where they are recorded. Real-time audio is overlaid onto the video noting time “markers”, significant events, and any additional information that is relevant to the video data collection.

A field logbook is kept to document all survey activities.

3.11.7 Sample Processing

The video tape will be edited and annotated for each placement event, and a narrative report will be prepared. At least five video segments of 30 to 60 seconds in duration will also be prepared in digital format.

3.11.8 Dissemination of Survey Results

On the day following completion of the video survey, a brief survey report summarizing sampling operations will be prepared and submitted to the USACE Project Manager or her designated technical point of contact. Following USACE approval, this report will be posted on the Palos Verdes Monitoring Project web site (PV-Web) for viewing by all project participants. This task is expected to yield a video tape(s) with records of bottom video during several cap placement events. No numerical or quantitative data will be generated, with the exception of vessel position.

3.12 In-Hopper Sediment Sampling

The objective of in-hopper sediment sampling is to collect sediments directly from the hopper (cap placement) vessel and analyze geotechnical properties and contaminant concentrations in representative samples of capping materials.

3.12.1 Rationale

The rationale for in-hopper sediment sampling is to provide data that can be used to characterize specified physical and chemical properties of cap materials, including materials obtained from borrow sites. These data are needed to refine information provided by previous sediment testing concerning the characteristics of the cap material and to validate cap material characteristics used by USACE for cap placement modeling. This information is needed by USACE for modeling the spread and thickness of cap materials at the capping site (and/or confirming existing information used by USACE for cap placement modeling). Additionally, analyses of contaminant (DDE) concentrations in borrow site materials are needed to provide information on the chemical characteristics of these materials for later comparisons with contaminant concentrations in cap and EA sediments if borrow site sediments are used for capping.

3.12.2 Data Quality Objectives, Calibration, and Quality Control

Data requirements for this monitoring task consist of representative grain size, geotechnical properties, and contaminant (DDE) concentrations. The sampling design specifies collection of three samples, from the bow, stern, and middle portions of the hopper bin, with subsequent compositing, to minimize potentials for small-scale (i.e., within-load) variability that would affect the representativeness of a single sample. Additionally, composite samples from multiple loads during initial and continuous capping operations will be collected, at the direction of the USACE Project Manager, and analyzed to characterize larger scale variability in geotechnical properties of the capping materials. Finally, analytical quality assurance procedures (such as duplicate analyses as described in the QAPP) will be performed at specified frequencies to permit assessments of the representativeness of the analytical data.

3.12.3 Survey Plan

SAIC will prepare a schedule for sample collection based on the timing of cap placement events, and coordinated with related monitoring events such as hopper navigation data collection, that will be provided to the dredge operators. Updates and changes to the schedule will be provided as appropriate to the dredge operators.

Sediment samples representative of first three hopper loads transported to each cell, and up to 25 loads during continuous capping operations, will be collected and analyzed for grain size, bulk density, water content, specific gravity, and Atterberg limits. Sediment samples representative of first three loads from a borrow area(s) will be collected and analyzed for DDE concentrations.

3.12.4 Mobilization

SAIC will have ultimate responsibility for all of the in-hopper sediment sampling, following the procedures described in the SOP for in-hopper sampling.

3.12.5 Sample Collection

Samples of sediment (cap material) will be collected by the dredging contractor, under the direction of SAIC, from three locations within the hopper bin. These samples eventually will be composited to provide a representative sample, and subsequently analyzed for specific geotechnical and chemical parameters.

3.12.6 Data Processing

Data obtained from subcontractor laboratories will be reviewed by SAIC for completeness, conformance with specifications identified in the QAPP, and reasonableness. Electronic versions of the data will be verified by checking values against the hard copy data reports from the laboratory.

3.12.7 Dissemination of Survey Results

Data from analyses of in-hopper sediment samples will be entered into the DAN-LA database following review and approval.

3.13 Summary of Field Sampling Activities

As indicated in Table 3-1 and discussed in the introduction to Section 3.0, field sampling and data acquisition will be conducted in accordance with Tasks 2 through 8, 11, 12 and 14 of the Monitoring Plan developed by Fredette (2000). These Tasks represent the major environmental monitoring elements of the Pilot Cap Monitoring Program. Tasks 1, 9 and 10 of Fredette (2000) will not be conducted. Task 13 entails reporting and thus does not contain monitoring activities.

Hopper dredge operations data (Task 3) and collection of sediment samples from the hopper dredge (Task 4) will be conducted at various times throughout the cap placement activities as described in Sections 3.8 and 3.12, respectively; these activities will not require chartered survey vessels. In contrast, Tasks 2, 6 through 8, and 11 will entail numerous surveys using a variety of monitoring techniques aboard chartered vessels, as discussed in Sections 3.2 through 3.7 and 3.9 through 3.11. Table 3-20 presents a summary of the monitoring surveys that will be conducted for these tasks, within the three pilot cells, and identified in the table by the specific task numbers given by Fredette (2000). For example, the post-cap sediment coring survey within cell LU is identified as coring survey 6Civ. This table also illustrates that there will be four sediment coring surveys within cell LU, and a total of eight coring surveys within the three cells.

Flex survey sampling activities (Task 5) are not indicated in Table 3-20 because the scheduling of these sampling activities will be determined during the conduct of the field program. Collection of sediment core and sediment grab samples for the cap erosion study (Task 12) will be conducted after all cap placement and other monitoring activities have been completed. Task 14, the 30-day deployment of the ADCP current profiler at a location near the pilot cells, will commence within the first two-weeks of the monitoring program.

Table 3-20. Summary of Survey Activities for Tasks 2, 6, 7, 8 & 11 of Fredette Monitoring Plan V 4.1. Note that table entries represent monitoring event numbers given in Fredette (2000).

	Field Activity		Pre-initial placement	Initial placement	Post-initial placement	During next four placement events	Interim at 10 cm cap thickness	Interim at 2/3rds toward 15 cm cap
Cell LU								
	Sediment profile/photography survey		6A		6Biii		6Ciii	6Ciii
Disposal	Bottom current/OBS measurements			6Bi		6Ci		
to achieve	Plume measurements (ADCP/OBS/CTD)			6Bii		6Cii		
15 cm cap	Sediment coring survey				6Biv		6Civ	6Civ
over entire	Side-scan sonar survey				6Bv			
cell	Subbottom profiling survey							
	Underwater video survey			2i		2ii		
	Plume transport survey					11i	11ii	11iii
Cell LD								
	Sediment profile/photography survey		7A		7Biii		x	x
Spreading	Bottom current/OBS measurements			7Bi		x		
along one	Plume measurements (ADCP/OBS/CTD)			7Bii		x		
line	Sediment coring survey				7Biv		x	x
	Side-scan sonar survey				7Bv			
	Subbottom profiling survey							
	Underwater video survey			2iii		x		
	Plume transport survey					x	x	x
Cell SU								
	Sediment profile/photography survey		8A		8Biii		x	8Ciii
Disposal	Bottom current/OBS measurements			8Bi		x		
at one	Plume measurements (ADCP/OBS/CTD)			8Bii		x		
location	Sediment coring survey				8Biv		x	8Civ
	Side-scan sonar survey				8Bv			
	Subbottom profiling survey							
	Underwater video survey			2iv				
	Plume transport survey					x	x	x

Summary			Total Surveys
	Sediment profile/photography survey		12
	Bottom current/OBS measurements		4
	Plume measurements (ADCP/OBS/CTD)		4
	Sediment coring survey		8
	Side-scan sonar survey		6
	Subbottom profiling survey		2
	Underwater video survey		4
	Plume transport survey		3

4.0 FIELD DOCUMENTATION, CHAIN OF CUSTODY, AND DATA MANAGEMENT

4.1 Field Logs

As described in Section 3, a hard-copy field log will be maintained for each of the main survey activities of the monitoring project. These logs will be used to document all sampling and data recording events, as well as other significant activities or problems encountered during survey operations. Maintenance and custody of these logs will be the responsibility of the field leader for the specific sampling activity, as identified in Section 2. Upon completion of the interim and post-cap monitoring activities, sampling logs will be provided and survey reports prepared and submitted, to the SAIC Project Manager.

If a significant deviation from the Field Sampling Plan is necessitated, the field leader aboard the survey vessel will be responsible for noting such deviations in the field log, and notifying the SAIC Project Manager as soon as possible (e.g., via a telephone call to shore during the survey activities). It will be the responsibility of the SAIC Project Manager to contact the LAD Project Manager to discuss the deviations.

4.2 Samples and Data Records

4.2.1 Photographic Film from Sediment Profiles and Plan View Photography

During survey operations, exposed rolls of 35-mm film from both the sediment profile camera and the plan view camera will be carefully marked according to: project name, date, time, serial number of the camera, and station numbers surveyed. Roll number and all pertinent information will be entered on the appropriate chain of custody (COC) form. At the end of each day of survey operations, film rolls will be transferred to the on site person responsible for shore-based data processing.

4.2.2 Sediment Cores

As described in Section 3.4, core liners containing sediment samples will be clearly marked immediately following core retrieval. A label is attached to all cores at the time of collection. The pre-printed label identifies the project title, cruise number, sample type, station number, and sample number. Specific sample information is written in indelible ink for survey number, station identification, date and time collected, sample replicate number, top/bottom indicators, collector's name or initials, sample depth (if appropriate). Sample labels are attached to the core using clear tape to prevent the label from washing off or dissolving. All pertinent information for each core will be entered on the appropriate COC form. At the end of each day of survey operations, cores will be transferred to the on site person responsible for shore-based core processing.

4.2.3 Digital Data Records from Side-Scan Sonar and Subbottom Profiling

Data from side-scan sonar and subbottom profiling operations will be stored on magnetic computer medium. Each data disk and/or zip-drive will be marked according to project name, instrument type, date, start and stop time of data acquisition, and survey lanes traversed. Additionally, all pertinent information for each digital data record will be entered on the appropriate COC form. At the end of each day of survey operations, data records will be transferred to the on site person(s) responsible for side-scan sonar and subbottom profile data processing.

4.2.4 Water Quality Data

Water quality samples will be clearly labeled at the time of collection. The pre-printed label identifies the project title, cruise number, sample type, station number, and sample number. Specific sample information is written in indelible ink for survey number, station identification, date and time collected, sample replicate number, top/bottom indicators, collector's name or initials, sample depth (if appropriate). Sample labels are attached to the sample bottle using clear tape to prevent the label from washing off or dissolving. All pertinent information for each sample will be entered on the appropriate COC form. At the end of each day of survey operations, water samples and CTD/ADCP data will be transferred to the on site person responsible for shore-based data processing and shipment of water samples.

Data collected using the CTD will be stored electronically on a data disk and/or zip-drive marked with the project name, date, station(s), and specific parameters. At the end of each day of survey operations, data records will be transferred to the on site person responsible for data processing.

4.2.5 Data from Instrumented Arrays

Data logged by moored instrumentation will be downloaded from the instrument following retrieval. Data will be stored electronically on a disk or zip drive, and later transferred to the on site person responsible for data processing.

4.2.6 Data from ADISS

ADISS data are recovered from the hopper dredge on a daily or weekly basis. The ADISS data files will be compressed and electronically transferred to the ADISS data technician located in Newport, RI.

4.3 Chain of Custody

A measurement-specific COC form will be generated for each type of data to be acquired during the surveys. It will be the responsibility of the specific Field Leader to complete the COC form for each day of sampling operations. These COC forms will accompany the samples and/or data records that are transferred to shore at the end of the day's field operations. A duplicate copy of the completed COC form will be submitted to the SAIC Project Manager for entry to the project archive.

4.4 Corrections to Documentation

If errors or omissions in the field logs, sample documentation, or COC records are identified by project personnel involved with the baseline program, these occurrences will be communicated to both the SAIC Project Manager and the QA/QC Manager for the baseline project. The need for any significant corrections will first be documented in writing, then corrections will be made in red ink on the original logs, records, or COC forms; additionally, corrections will be dated and signed by the person affecting the change.

4.5 Data Management and Security

The SAIC Project Manager will be responsible for security of all field records and project data/information acquired during survey operations. Originals of Logs and data records will initially be maintained at the project site in San Pedro, then transferred to a secure storage facility at SAIC's Newport, Rhode Island office. Additionally, back-up copies of all digital data will be stored on magnetic medium in an appropriate storage area. Processed data will be maintained by the DAN-LA GIS and frequent (i.e., daily) backups of the DAN-LA data archive will be part of the routine procedure for maintenance of the DAN-LA system.

5.0 CONTROL OF INVESTIGATION-DERIVED WASTES

5.1 Sediment Profile Imaging and Plan View Photography

Sediment profile images and plan view photographs will be acquired using conventional photographic equipment and commercially available 35-mm film. All used film will be transported to shore at the end of each day's sampling operations for post-survey development. Consequently, no chemicals or other film developing agents will be brought aboard the survey vessel. The only wastes that will be generated during survey operations include: manufacturer's packaging containers for rolls of 35-mm film; glass cleaner and paper towels for periodic cleaning of camera lenses, and distilled water for use in the prism of the sediment profile camera. With the exception of relatively small volumes of distilled water that will be discarded into the sea, all other waste products will be transported to an appropriate shore-based waste facility.

5.2 Sediment Coring

Sediment cores will be collected using reusable steel core barrels with butyrate core liners that are inserted into the core barrel. Sediment samples are retained within the core liners during the coring process. Following retrieval of the corer, the core liner is removed from the core barrel while on deck, sealed, and labeled. During handling of core liners, the following expendables will be used aboard the vessel: sterile gloves, permanent markers, and plastic tape. No wastes from coring operations will be discarded intentionally at sea, although a small volume of residual sediments may be lost during washdown of the corer. Procedures used to minimize the amount of wastes lost are described in the SOP.

Used expendables will be transported to SCMI and stored pending transfer to an appropriate waste facility. Upon return to shore at the end of each day's sampling operations, all core liners containing samples will be transported to the shore-based core processing facility. Any core barrels that were bent during coring operations also will be removed from the vessel and transported to an appropriate recycling facility. All sediment that remains after core processing and subsampling will be held in contaminated waste containers until the end of the field program when they will be transported to an appropriate waste processing facility.

5.3 Side-Scan Sonar Surveying

Survey activities for acquisition of side-scan sonar data will utilize electronic equipment to acquire remotely sensed data on seafloor characteristics. Consequently, no physical samples will be acquired and no cleaning materials nor sample containers will be used during the survey activities. Data will be stored on magnetic computer storage medium and transferred to shore-based processing facilities upon completion of daily survey operations.

5.4 Subbottom Profile Surveying

Acquisition of remotely sensed subbottom profile data will not generate wastes, for the same rationale as described above for side-scan sonar survey operations.

5.5 Water Quality Sampling

Remotely sensed data collected using an ADCP profiler and a CTD transmissometer will not generate wastes that require storage, disposal, or special handling. Water samples collected in Niskin bottles may contain detectable quantities of individual DDT isomers, but at concentrations well below those considered hazardous under applicable Resource Conservation and Recovery Act (RCRA) regulations (see also the accompanying Health and Safety Plan). Therefore, excess water will be returned to the sea at its approximate origin.

5.6 Instrumented Arrays

Equipment deployed to collect current and optical data (ARESS, Aquadopp, ADCP) will not generate wastes that require storage, disposal, or special handling.

5.7 Video Documentation

Similar to the instrumented arrays, video equipment will not generate or collect waste materials that require storage, disposal, or special handling.

5.8 Hopper Location Equipment

The ADISS system will not generate or collect waste materials that require storage, disposal, or special handling.

5.9 Hopper Dredge Sediment Samples

Material to be used for capping will be dredged from either the Queen's Gate navigation channel or from the A-III borrow area outside of Long Beach Harbor. Samples of this cap material taken from the hopper dredge are not considered hazardous because the material has already been tested for contaminants, found to be clean, and determined to be suitable for unrestricted ocean disposal.

6.0 SCHEDULE OF PROJECT ACTIVITIES

The schedule for project activities on the Pilot Cap Monitoring Program is shown in Figure 6-1. Survey activities are scheduled to begin in early August 2000 to coincide with ongoing dredging operations in the Queens Gate Channel. Actual dates for specific monitoring events at the pilot cell location are subject to change based on logistical constraints such as the availability of survey vessels, coordination with dredging operations and USACE, and competing requirements for concurrent sampling operations. Processing of field data and laboratory analysis of sediment samples will begin within 1 to 2 days following completion of each survey element.

Figure 6-1. Schedule of Palos Verdes Pilot Cap Monitoring Activities goes here (large foldout).

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Palermo, M. 2000. Field Pilot Study of *In-Situ* Capping of Palos Verdes Shelf Contaminated Sediments - Operations and Monitoring Plan. Working Draft 23 dated February 2000.

SAIC. 2000. Project Work Plan for the Baseline Portion of the Pilot Cap Monitoring Program

Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Interim and Post-Cap Monitoring Activities

QUALITY ASSURANCE PROJECT PLAN
(Revision 03)

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SAIC Report Number 505

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) describes the quality assurance (QA) program to be implemented and the quality control (QC) procedures to be followed by SAIC in monitoring the capping and post-cap phases of the U.S. Army Corps of Engineers' (USACE) Palos Verdes Shelf Pilot Capping Project. The monitoring program is multifaceted, involving a variety of sampling techniques to characterize biological, chemical and physical conditions on the seafloor and in the water column before (i.e., baseline), during (i.e., interim capping), and after (i.e., post-cap) the controlled placement of cap material in specified study locations. Overall study objectives and the different capping scenarios under investigation are described in the Overview section of this Project Work Plan (PWP).

1.1 Organization of the QAPP

This QAPP is one of several documents (e.g., Field Sampling Plan, Data Quality Objectives, Health and Safety Plan) which together comprise the PWP for the interim capping and post-cap monitoring activities. The U.S. Environmental Protection Agency (USEPA) recommends that a number of topics be addressed in QAPPs (USEPA 1999):

- Quality objectives and criteria for measurement data
- Sampling methods
- Sample handling and custody
- Instrument/equipment calibration and frequency
- Analytical methods
- Data review, verification and validation
- Data management
- Internal quality control checks and frequency
- Performance and systems audits and frequency
- Instrument/equipment testing, inspection, and maintenance
- Specific routine procedures for measurement data
- Assessments and response actions (corrective action)
- Reports to management

Some of these topics are addressed in the accompanying PWP documents and therefore only summarized or referenced herein. Section 2.0 of this document provides a broad summary of quality objectives for the different survey techniques and data to be collected in the interim capping and post-cap monitoring. Section 3.0 presents basic QA/QC requirements that are generally applicable to the interim and post-cap field and laboratory operations. Each of the different monitoring techniques then is addressed in an individual section, where only the QA/QC topics applicable to the technique are addressed. This organizational structure was deemed appropriate due to the significant number and variety of sampling techniques/measurement types included in the interim and post-cap monitoring program; all of the QA/QC procedures, requirements, processes, etc., applicable to a given measurement type can be found easily in one place. The overall objective of this QAPP is to document the procedures that will be followed to ensure that data are of known and acceptable quality and sufficiently complete, comparable, representative, accurate, and precise to fulfill their intended use. The QA/QC program and procedures presented in this QAPP are based upon and consistent with those developed and utilized in the baseline phase of the monitoring program, as documented in the baseline PWP (SAIC 2000).

1.2 Types of Sampling

The baseline (i.e., pre-capping) phase of the monitoring program consisted of four integrated sampling techniques: sediment coring and subsequent chemical and geotechnical analysis of core subsamples; sediment profile imaging; side-scan sonar surveying; and subbottom profiling. The objectives of these sampling tasks were to characterize pre-capping conditions at specific cells within the effluent-affected (EA) footprint considered for capping. The four baseline sampling techniques will continue to be utilized in the capping and post-cap phases of the monitoring program, as described elsewhere in the PWP. The following monitoring activities also will be included during the capping and post-cap phases: collection and chemical analysis of seawater samples, bottom current measurements, vessel-based turbidity plume tracking and current profiling, video documentation of seafloor conditions, and acquisition of hopper dredge operational data. Each of the sampling tasks requires a specific approach to data collection, analysis and associated QA/QC, as described herein and in the accompanying PWP documents.

Quality assurance reviews of data generated from the field surveys and laboratory analyses (e.g., relative to measurement quality objectives, as well as basic error and format checks) will be performed. Reviewed data will be input to the Disposal Analysis Network - Los Angeles (DAN-LA) geographic information system (GIS) being developed for the project.

1.3 Organization of the QA Program

The SAIC team organization for the interim and post-cap phases of the monitoring program is illustrated in the organizational chart presented in the Overview Section of this PWP. Mr. Ray Valente will serve as the SAIC QA/QC Officer (QAO). As QAO, Mr. Valente will prepare and update, as necessary, the QAPP, monitor adherence to the QA requirements and procedures, conduct technical audits as necessary, organize and oversee reviews of program deliverables, and interact with the Project Manager and Team Leaders to ensure quality. Mr. Valente is familiar with all of the QA/QC requirements entailed in the program, and will not be directly involved in data collection and analysis for the monitoring program.

SAIC's project organization identifies Team Leaders for each of the major logistical/technical areas (see organizational chart in Overview Section of PWP). Team Leaders are responsible for assisting, coordinating, tracking, reporting, and corrective actions for the various monitoring task areas. Each individual working on the monitoring project is responsible for maintaining a high level of technical performance and associated data quality, through awareness of and adherence to the requirements and procedures identified in this QAPP and the associated documents. Additional quality assurance oversight, including document review and approval, external audits of contractors, and reviews and assessments of project data and data quality, will be performed by USACE. USACE does not plan to conduct formal audits of monitoring or sample analysis tasks; however, the USACE expects to perform sampling oversight on one or more dates during the period of August 10 through September 2.

2.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

USEPA specifies five major characteristics of data quality that must be addressed in environmental sampling and analytical projects: accuracy, precision, completeness, representativeness, and comparability. Accuracy, precision and completeness objectives can be expressed quantitatively, while representativeness and comparability are qualitative parameters. Table 2-1 provides a summary of the accuracy, precision, and completeness objectives for the various measurement data to be obtained in the interim capping and post-cap monitoring program.

Accuracy is the degree of agreement of a measurement (or measurement average) with an accepted reference or true value. It is an indicator of measurement or system bias. It is usually expressed as the difference between the "measured" and the "true" or accepted value, or as a percentage of this difference. For the analysis of p,p'-DDE in PV Shelf sediment and seawater samples, accuracy will be assessed through the analysis of the following types of quality control samples: spiked method blanks, matrix spike and matrix spike duplicates (MS/MSD), and a Regional Reference Material (RRM) consisting of PV Shelf sediment that has been accurately characterized with respect to p,p'-DDE concentration (Table 2-1). It is not possible to establish accuracy objectives for the various geotechnical analyses (e.g., grain size, Atterberg Limits, vane shear, bulk density) due to the lack of appropriate accuracy-based "standards" or "reference materials" for these parameters. Accuracy-based "standards" likewise do not exist for remote sensing techniques like sediment profile imaging, side-scan sonar and sub-bottom profiling. Accuracy for these techniques will be evaluated on a relative basis by examining the degree of agreement among them.

Precision is a measure of agreement among individual measurements of the same property under similar conditions. It is expressed in terms of percent difference or the standard deviation of replicate values. As a measure of sampling precision, some replicate field samples will be collected and analyzed and replicate field measurements performed. These samples will yield information regarding the precision of the field sampling effort and the degree of spatial heterogeneity. Analytical precision (i.e., for sediment chemical and geotechnical analyses) will be determined by replicate analyses of selected field and laboratory QC samples. Precision of some of the remote sensing techniques (i.e., side-scan sonar and sub-bottom profiling) will be evaluated by comparing duplicate results obtained at the survey lane points of intersection (Table 2-1).

Completeness is the measure of the total number of usable data points (i.e., total data points minus unusable [i.e., rejected] data points) divided by the total number of data points collected; completeness is always expressed as a percentage. Usable data points are those that meet the project quality objectives for accuracy, precision, comparability, and representativeness. Completeness is applicable to all of the data collection activities that will occur as part of the interim capping and post-cap monitoring program. Normally, completeness goals are established following a rigorous statistical evaluation of a given project's sampling design (e.g., statistical

Table 2-1. Summary of measurement quality objectives for data to be collected in the interim and post-cap monitoring program

Measurement	Accuracy Objective	Precision Objective	Completeness Objective
Sediment p,p'-DDE	75% to 125% recovery for spiked method blanks and matrix spike/matrix spike duplicate (MS/MSD); within acceptance range for Regional Reference Material (RRM)	Relative percent difference (RPD) < 30 for field duplicates and MS/MSD; control chart maintained for RRM	100%
Seawater p,p'-DDE	75% to 125% recovery for spiked method blanks and MS/MSD	RPD < 30 for field duplicates and MS/MSD	100%
Total suspended solids	80% to 120% recovery for Laboratory Control Standard (LCS)	RPD ≤20 for field and laboratory duplicates; control chart maintained for LCS	100%
Sediment bulk density	NA[1]	RPD < 30	100%
Sediment grain size	NA[1]	RPD < 30	100%
Sediment Atterberg Limits	NA[1]	NA[2]	100%
Sediment vane shear	NA[1]	NA	100%
Hopper dredge position	Verify dGPS accuracy of ± 1 to 3 m	Verify dGPS repeatability of ± 1 to 3 m	100%
Hopper dredge draft	Verify ADISS pressure sensor and hopper dredge sensor readings agree within 6 inches	Verify consistency of pressure sensor readings	100%
Sediment profile imaging (SPI) and plan view photography	SPI grain size results and coring grain size results should agree at 90% or more of the stations where both are obtained	NA	100%
Side-scan sonar	Side-scan sonar characterization of sediment types should agree visually with coring and sediment profile imaging results	"Duplicate" results should agree with respect to type and location of seafloor features	100%
Current Velocity	NA	RPD < 20% for side-by-side readings from different current meters	100%
Turbidity	Meter reading within 10% of true value	RPD < 20% for side-by-side readings from different current meters	100%
Sub-bottom profiling	Sub-bottom profiling results should agree with coring and/or sediment-profile imaging results within ±20 cm	"Duplicate" results should agree within ±20 cm	100%

[1] NA = not applicable because accuracy-based standards are not available for these measurement types
[2] NA = not applicable because insufficient sediment volume available from cores for duplicates analyses.

power analysis) that determines the minimum number of data points necessary to address specific null hypotheses. Because the overarching goal of the PV Shelf Pilot Capping monitoring program is to provide measurement data for use in a semi-quantitative evaluation of capping feasibility under different operational scenarios, a rigorous statistical approach has not been employed. To maximize data acquisition, a completeness goal of 100% has been established for all of the measurement techniques.

Representativeness is defined as the degree to which the data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter relating to the proper design of a sampling program, and is ensured by collecting sufficient samples of a population medium, properly distributed with respect to location and time. Representativeness is ensured in the laboratory by proper sample storage, analyses, and extraction within the project-required holding time, and acceptable instrument calibration and operation. The methods and protocols used to select samples that are representative of a particular test cell are described in the Field Sampling Plan (FSP).

Comparability is the degree to which data from one study can be compared with data from other studies, reference materials, or reference values. Comparability can be maximized by analyses of common reference materials and calibration standards, using standardized protocols or approaches, and/or intercalibration exercises.

Quality assurance objectives for the different survey/data types are discussed in greater detail in the individual sections devoted to each.

3.0 FIELD AND LABORATORY OPERATIONS

3.1 Field Operations

A complete set of Standard Operating Procedures (SOPs) for field operations is provided in Volume II of the PWP.

3.1.1 Field Sampling Documentation

All information pertinent to field activities will be recorded in a field sampling logbook. Entries will be made in water-resistant ink and will include the items listed below:

- Field sampling personnel
- Date and time
- Survey number and station, sampling depth (where appropriate)
- Descriptions of all problems encountered that may affect the samples and field measurements
- Other pertinent observations (e.g., floating particulates, surface sheens, plankton blooms)

The following logs are maintained separately from the field logs described above:

- Station coordinate log sheet: records station coordinates and depth initially at the start of sampling.
- Gravity core tracking sheet: records information about the disposition (i.e., acceptable or unacceptable quality) of each core sample.
- Sampling status data sheet: records sampling dates, numbers of cores, and comments that initiate the sample tracking process.

These logs also will be filled out in water-resistant ink and signed by the SAIC Team Leader. Corrections will be lined-out and initialed.

3.1.2 Sample Custody in the Field

A critical aspect of sound sample collection and analysis protocols is maintenance of strict chain-of-custody (COC) procedures. Sample custody procedures include inventorying and documenting each sample during collection, shipment, and laboratory processing. A sample is considered to be in an individual's custody if the sample is (1) in the physical possession or view of the responsible party, (2) secured to prevent tampering, or (3) placed in a restricted area by the responsible party.

Sample custody in the field is initiated through detailed record keeping by the field sampling personnel. COC establishes the documentation and control necessary to identify and trace a sample from collection to final analysis. It includes sample labeling to prevent mix-up and secure custody, and provides the recorded support information for potential litigation.

COC forms are used to document the integrity of all samples and to maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory (Figure 3-1). The COC form will contain the following information:

- Sample number (for each sample in shipment)
- Collection date (for each sample shipment)
- Time sample was obtained/or collected
- Number of containers of each sample
- Sample description (environmental matrix)
- Analyses required for each sample
- Shipment number
- Shipping address of the laboratory
- Date, time, and method of shipment
- Spaces to be signed as custody is transferred.

The individual in charge of shipping samples to the laboratory is responsible for completing the COC form. This individual will also inspect the form for completeness and accuracy. Any changes made to the COC form shall be initialed by the person making the change.

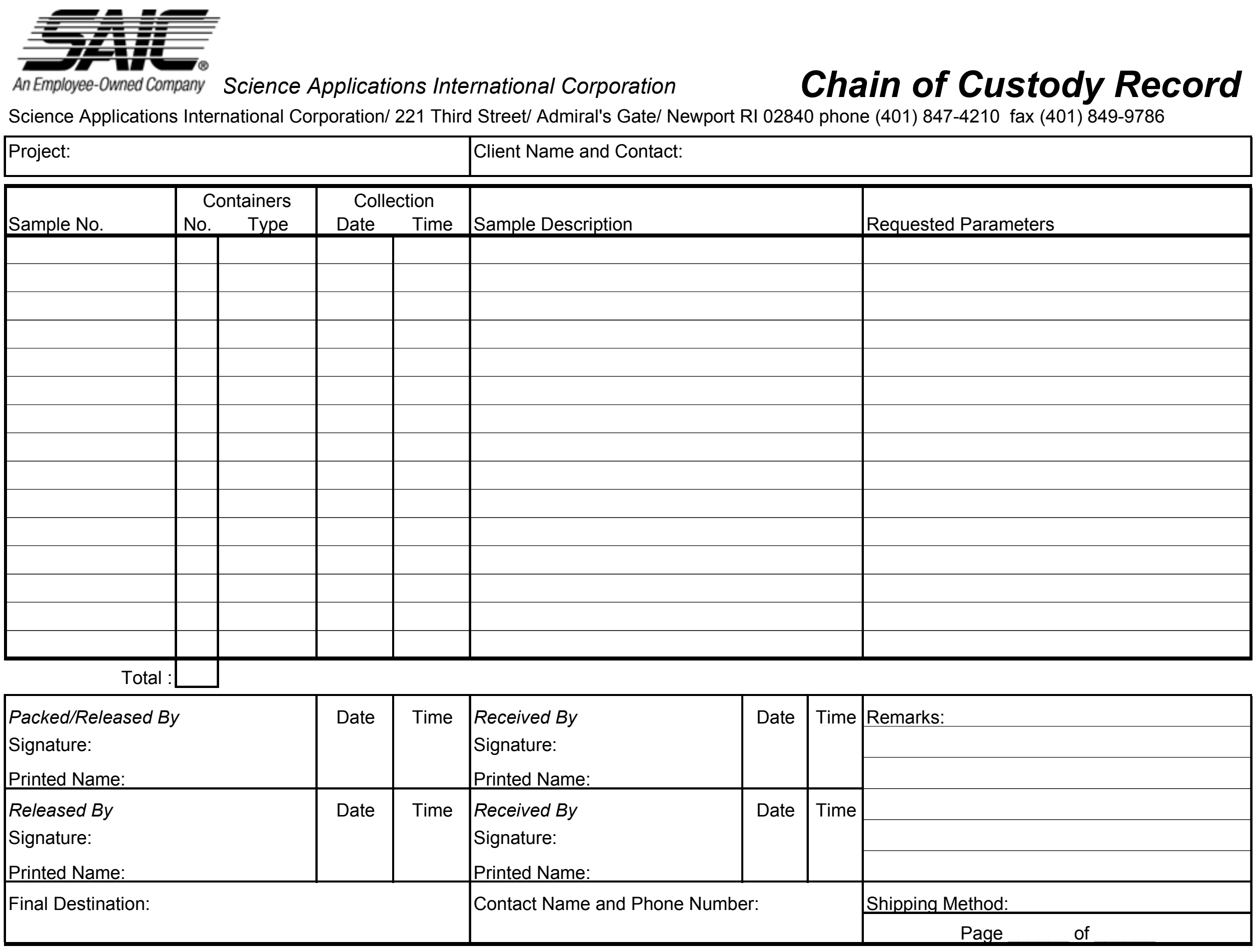
An approved COC record shall accompany sample transfers. When the possession of samples is transferred, the individual relinquishing the samples signs and records the date and time on the COC document. The individual receiving the samples repeats the procedure. This record represents the official documentation for all sample custody transfers until the samples have arrived at the laboratory.

The following is a description of the procedure followed when transporting environmental samples from the sampling site to the laboratory:

- Log book entries, sample tags, COC forms, and field record sheets with sample identification, date, time, and names or initials of all persons handling the sample in the field are completed.

- After the cooler is filled, the appropriate COC form is placed inside the cooler for shipment to the laboratory.

Glass sample containers are wrapped or placed with plastic material to prevent contact with other sample containers or the inner walls of the cooler. Section 3.2.2 below discusses custody procedures upon receipt of samples at an analytical laboratory.



SAIC An Employee-Owned Company Science Applications International Corporation

Chain of Custody Record

Science Applications International Corporation/ 221 Third Street/ Admiral's Gate/ Newport RI 02840 phone (401) 847-4210 fax (401) 849-9786

Project:	Client Name and Contact:

Sample No.	Containers No.	Containers Type	Collection Date	Collection Time	Sample Description	Requested Parameters
Total :						

Packed/Released By Signature: Printed Name:	Date	Time	*Received By* Signature: Printed Name:	Date	Time	Remarks:
Released By Signature: Printed Name:	Date	Time	*Received By* Signature: Printed Name:	Date	Time	
Final Destination:			Contact Name and Phone Number:			Shipping Method: Page ____ of ____

Figure 3-1. Example of the SAIC Chain-of-Custody Record to be employed on the interim and post-cap monitoring program.

3.2 Laboratory Operations

This section addresses only general laboratory operations, while the sections on each survey/data type present specific QA/QC requirements and procedures associated with the processing of specific samples. In the PV Shelf pilot interim and post-cap monitoring program, laboratory processing of samples is only applicable to sediment coring activities (p,p'-DDE and various geotechnical analyses) and water column sampling (p,p'-DDE and total suspended solids analyses).

All laboratories providing analytical support to the monitoring program will have the appropriate facilities to store and prepare samples, and appropriate instrumentation and staff to provide data of the required quality in the time periods dictated by the project. Laboratories are expected to conduct operations using good laboratory practices, including:

- A program of scheduled maintenance of analytical balances, microscopes, laboratory equipment and instrumentation.

- Routine checking of analytical balances using a set of standard reference weights (ASTM Class 3, NIST Class S-1, or equivalents).

- Checking and recording the composition of fresh calibration standards against the previous lot. Acceptable comparisons are ±2 percent of the previous value.

- Recording all analytical data in bound logbooks in ink.

- Daily monitoring and documenting the temperatures of cold storage areas and freezer units.

- Verifying the efficiency of fume hoods.

- Having a source of reagent water meeting American Society of Testing and Materials (ASTM) Type I specifications (ASTM 1984) available in sufficient quantity to support analytical operations. The conductivity of the reagent water should not exceed 1 µS/cm at 25° C.

- Labeling all containers used in the laboratory with date prepared, contents, and initials of the individual who prepared the contents.

- Dating and storing all chemicals safely upon receipt. Chemical are disposed of properly when the expiration date has expired.

- Using a laboratory information management system to track the location and status of any sample received for analysis.

Laboratories should be able to provide information documenting their ability to conduct the analyses with the required level of data quality. Such information might include results from interlaboratory comparison studies, control charts and summary data of internal QA/QC checks. Laboratories should be able to provide analytical data and associated QA/QC information in specified formats and time frames.

3.2.1 Laboratory Personnel, Training and Safety

Each analytical laboratory will identify a single individual to serve as the point-of-contact. This individual will be responsible for helping to identify and resolve issues related to data quality. Laboratories may be required to demonstrate acceptable performance before analysis of samples can proceed, as described for various measurement types in subsequent sections. Laboratory operations may be evaluated, as deemed necessary by the USACE Program Manager, through on-site audits, performance evaluation studies, and/or required participation in interlaboratory comparison exercises.

Laboratory personnel will be well versed in good laboratory practices, including standard safety procedures. It is the responsibility of the laboratory manager and/or supervisor to ensure that safety training is mandatory for all laboratory personnel. The laboratory will maintain a current safety manual in compliance with the Occupational Safety and Health Administration (OSHA), or equivalent state or local regulations. The safety manual will be readily available to laboratory personnel. Proper procedures for safe storage, handling and disposal of chemicals will be followed at all times; each chemical should be treated as a potential health hazard and good laboratory practices should be implemented accordingly.

3.2.2 Sample Custody in the Laboratory

This section describes general laboratory custody procedures associated with sample receipt, storage, preparation, analysis, and security. Samples submitted to the laboratory are logged in as soon as possible. Any sample that is suspected of being contaminated, improperly stored or preserved, or improperly prepared, is reported immediately to the Laboratory Manager and SAIC Project Manager.

The sample receiving process includes the following steps:

- Sample containers are inspected for condition (damage).
- Sample documentation is checked (i.e., COCs, number of samples, receipt date, etc.).
- Each sample received is given a unique internal identifier. Labels are made and applied to the original sample containers.
- Samples remain in appropriate sample storage until removal for sample preparation or analysis.
- If requested, transfers of samples into and out of the storage area(s) can be documented on an internal chain-of-custody record. The sample custodian will control the internal custody of samples.
- After a sample has been removed from storage for analysis, the analyst is responsible for returning the sample to the storage area.

Sample Receipt

A designated Sample Custodian receives samples at the laboratory. The Sample Custodian removes the samples from the cooler and compares the sample labels with the information provided on the COC form. The sample containers are also inspected for damage that may have occurred during transportation. The COC is also inspected for any comments or notes to the laboratory.

The paperwork accompanying the samples is checked for consistency and transcription accuracy. The water samples are assigned a unique laboratory identification number that is physically affixed to the sample container(s).

This unique laboratory number is the mechanism to track samples throughout the laboratory. Any discrepancies in the information are noted and reported to the Laboratory Manager and SAIC's Project Manager for corrective action. The resolution of discrepancies will be noted on the COC form, the log-in sheet, and/or an individual phone log. In general, samples will not be logged in until all discrepancies are resolved.

Sample Security

Samples will be kept in locked storage areas except during analysis. All laboratory personnel who receive samples are responsible for the care and custody of samples from the time each sample is received until samples (or empty containers) are returned to the Sample Custodian. All subsets (extraction, digestates, etc.) of the samples shall be kept in storage which is controlled by the appropriate laboratory section head.

The following security measures will be employed:

- Doors to the laboratory will be closed and secured at all times.
- Only authorized personnel and visitors under escort shall have access to the laboratory.
- Outside exit doors will be closed and locked at all times.
- All laboratory personnel should question and determine legitimacy of a stranger's presence in the laboratory.
- Deliveries will be escorted to the laboratory from the main reception area or from the loading dock.

Sample Storage and Disposal

The Sample Custodian shall be responsible for the following:

Sample Storage

- Samples and extracts shall be stored in a secure area.
- Samples shall be removed from the shipping container and stored in their original containers unless damaged.
- Damaged samples are documented and the Laboratory Manager is contacted immediately about the damaged samples.
- Storage area is kept secured at all times. Sample Custodian will control access to the storage area. (Duplicate keys for locked storage areas should be maintained only by authorized personnel.)
- Samples removed from storage will be documented. All sample transfers are documented in the internal COC.
- Standards are not stored with samples.

Sample Disposal

- Upon completion of the analysis, any remaining sample will be placed into long-term storage until sample disposition instructions are received.
- When sample analysis and all QC checks have been completed and a final report has been issued, the unused sample portion, extract, digestate, etc., shall be stored under proper conditions until release and/or disposal is authorized.

SAIC will notify the USACE and request transfer of archived samples and residue materials to the USACE's custody. SAIC will prepare the necessary COC forms for transfer of these samples.

3.2.3 Quality Assurance Documentation

All laboratories must have the latest revision of the QAPP (this document). In addition, the following documents and information must be current, and they must be available to all laboratory personnel participating in the processing of samples:

- Laboratory QA Plan: Clearly defined policies and protocols specific to a particular laboratory including personnel responsibilities, laboratory acceptance criteria for release of data, and procedures for determining the acceptability of results.

- Laboratory Standard Operating Procedures (SOPs) - Detailed instructions for performing routine laboratory procedures. SOPs offer step-by-step instructions describing exactly how a particular method is implemented in the laboratory, specific for the particular equipment or instruments on hand.

- Instrument performance study information - Information on instrument baseline noise, calibration standard response, analytical precision and bias data, detection limits, etc. This information usually is recorded in logbooks or laboratory notebooks.

- Control charts - Control charts must be developed and maintained throughout the project for all appropriate analyses and measurements (see Section 3.2.9).

For the chemical analysis of sediment and seawater samples for p,p'-DDE, the analytical laboratory will provide the following documentation to SAIC for review and approval prior to commencing with sample analysis:

- Laboratory Standard Operating Procedures
- Laboratory Quality Assurance Plan
- Results of initial performance evaluation
- Results of method detection limit studies
- Examples of Past Performance

3.2.4 Laboratory Standards

<u>Traceability of Standards</u>

Organic analytical standards utilized for instrument/methodological calibration and preparation of quality control samples shall be traceable to a recognized authority for the preparation of such materials (e.g., National Institute of Standards and Technology (NIST)). Primary standards must be obtained from reliable, certifiable sources and be of the highest possible purity. Any commercial standards prepared must be verified against appropriate Standard Reference Materials (SRMs).

Expiration or Holding Time Criteria

All standards obtained or purchased from commercial vendors, as well as reference materials, solvents and reagents, are dated when opened. The expiration date is also noted and, if not available, will be obtained from the supplier or manufacturer. If no information is available from the supplier, the laboratory holding time or shelf-life for the materials shall be half the normal shelf-life (i.e., assuming 1 year for most compounds, then it would be a 6-month shelf-life).

Standards are protected from degradation, deterioration, and contamination based on storage requirements (e.g., polyethylene containers for alkaline solution, glass containers for organic solutions, and brown glass for light-sensitive solutions; temperature storage and segregation of standards based on reactivity).

Stock and working standard solutions are prepared fresh as required by their stability, and they are checked regularly for signs of deterioration (i.e., discoloration, formation of precipitates, and changes in concentration). Standards prepared as stock or working standards are properly labeled as to name of compound mixture, concentration, solvent/medium, date and preparer, and expiration date. This information is also recorded in a laboratory notebook. Information required to trace the standard back to the vendor and lot number should also be kept in a laboratory logbook.

Guidelines for Standard Preparation

Guidelines for preparation of analytical standards used as spiking solutions and/or calibration standards are as follows:

- Laboratory analysts experienced in calibration and use of analytical measurement tools are assigned standard preparation tasks.
- Analytical reagent grade materials are utilized in the preparation of analytical/control sample standards. Whenever possible, guaranteed assay materials with supporting chromatograms are requested from the manufacturers.
- Solvents used for dilution of standards are checked for background contamination.
- Analytical measuring tools such as balance, volumetric glassware, syringe, etc., are calibrated to obtain accurate measurements.
- All data generated (e.g., weights of standard used, volume aliquot taken, lot number, solvent used, date of preparation, concentration of the solution, etc.) are documented immediately in a standard preparation logbook.

- A sequential standard log number (SL #) is assigned to the prepared standard solution. This standard identification code is noted in the standard log, on all run logs associated with the instrument analysis of the solution for traceability evaluation, and on any storage vessels which are used to contain the original solution or any aliquots of the prepared solution.

- Standards are analyzed prior to use for any analytical measurement by use of the instrumentation system for which it was intended.

- When a standard of the same material is available from a second source (e.g., NIST), it will be used as a quality control traceability reference standard.

- Both the new standard solution and the reference standard are analyzed on the same instrument and within the same time frame to maximize analytical precision. The new standard solution is quantified against the reference standard as an unknown to determine its acceptability.

- Once the standard solution has passed QC evaluation for traceability, it is aliquoted appropriately, sealed, and stored appropriately to maintain its integrity until required.

Labware

Class A volumetric glassware is used by the laboratory for measuring trace constituents for organic analysis.

The glassware and labware cleaning SOP is implemented to minimize potentials for laboratory contamination. The SOP is followed to ensure the removal of all traces of parameter(s) of interest and contaminants that could interfere with analysis.

3.2.5 Equipment Calibration

Laboratory equipment requiring calibration, but not operational calibration, is checked for accuracy on a routine basis. These include the following:

- Balances
- Ovens
- Refrigerator/Freezer
- Pipettes
- Thermometers

Balances

Balances are checked routinely using a set of standard reference weights (ASTM Class 3, NIST Class S-1 or equivalent) to within the specifications established by the laboratory. Balances that fail the calibration check are not used until they have been serviced. Balances are calibrated annually by a licensed specialist across the full weight range of the balance. In addition, calibration weights are re-calibrated and certified (on a bi-annual frequency) by a licensed specialist.

Ovens

Oven temperatures will be recorded each working day in oven logs and maintained at the required temperature $\pm 5^{o}C$ at the operating range of 60-300 degrees Celsius. If the temperature is out-of-control during analysis, the results of that analysis will not be reported. The analysis will be repeated after the oven has stabilized for 8 hours, and those results reported.

Refrigerators/Freezers

The temperature in all the refrigerators shall be recorded each working day in the refrigerator logs and maintained at $4^{o}C \pm 2^{o}C$ degrees. Freezers will be maintained at $-10^{o}C$. In cases where temperatures are out of these limits, the thermostat will be adjusted accordingly with the laboratory section supervisor's approval.

Pipettes

Pipette volume accuracy is evaluated quarterly by weighing a known volume of water that equates to a specific mass on a calibrated balance. Pipette adjustments are made accordingly to ensure delivery of a desired volume.

Thermometers

Every thermometer must be checked annually against a second thermometer of equal or greater precision (i.e., one calibrated against an NIST certified thermometer). The procedures of ASTM E77-92 for calibration at ice point and other fixed points are followed. Errors in temperature indications of the thermometer being verified should not exceed the "scale errors" as expressed in Table 1 of ASTM E1-83. Thermometers will be calibrated across the anticipated range of operation.

3.2.6 Preventive Maintenance

Preventive maintenance is defined as an orderly program of positive actions for preventing failure of equipment and ensuring that the equipment is operating with the reliability required for quality results. The actions include specification checks, calibrating, cleaning, lubricating, reconditioning, adjusting, and checking.

A preventive maintenance program for instrumentation ensures fewer interruptions of analyses, personnel efficiency, and lower repair costs. It eliminates premature replacement of parts, and reduces discrepancy among test results. It increases reliability of results.

The following preventive maintenance program will be established:

- Each type of equipment/instrument has a written SOP that describes the methods for routine inspection, cleaning, maintenance, testing, calibration, and/or standardization of the equipment. Instrument operating manuals are kept near the instrument or where analysts have easy access.

- Analysts using the instruments are properly trained and have developed troubleshooting skills that will enable them to recognize problems, their causes and appropriate corrective actions, quickly and accurately to reduce equipment failure and reduce dependence upon outside servicing agencies. In complicated cases, the servicing agency or supplier is called to solve the problem.

- Written instrumentation and equipment records are kept to document all inspection, maintenance, troubleshooting, calibration, or modifications. Whenever maintenance is performed on an instrument, it is properly documented in a preventive maintenance logbook, which is kept near the equipment to monitor the adequacy of maintenance schedules. The records contain the date (month, day, year), description of the maintenance done, and the actual findings, the name of the person doing the maintenance, and a statement of whether the maintenance operations were routine and if those operations followed the written SOP and/or the operating manual.

- Performance criteria are established for judging when data from instrument performance checks indicate the need to make adjustments in the instrument operating conditions.

Preventive maintenance schedules should be available in the Laboratory's SOP manual or the maintenance logbooks.

3.2.7 Backup Equipment

The analytical chemistry laboratory is responsible for obtaining and maintaining backup instrumentation. Backup equipment is available so that, in the event of failure of the primary instrumentation, the analyses can be completed without jeopardizing the sample holding times. SAIC is responsible for obtaining and maintaining backup equipment for field surveys to ensure efficient and complete field data collection.

3.2.8 Equipment Maintenance

The following maintenance and calibration is performed on laboratory equipment:

- Analytical balances are calibrated before use and serviced annually.
- Pipettes are calibrated quarterly.
- Thermometers are calibrated annually.

Other equipment and instrumentation particular to each laboratory are also routinely maintained. Records, service, maintenance, and calibration of equipment are detailed in equipment maintenance logbooks.

3.2.9 Control Charts

Control charts are a graphical tool to demonstrate and monitor statistical control of a measurement process. A control chart basically is a sequential plot of some sample attribute (measured value or statistic). The type of control chart used primarily by laboratory analysts is a "property" chart of individual measurements (termed an X chart). Measured values are plotted in their sequence of measurement. Three sets of limits are superimposed on the chart: 1.) the "central line" is the mean value calculated from at least 7 initial measurements and represents an estimate of the true value of the sample being measured, 2.) upper and lower "warning limits" representing the 95 percent confidence limits around the mean value, within which most (95 percent) of the measured values should lie when the measurement process is in a state of statistical control, and 3.) upper and lower "control limits" representing the 99 percent confidence limits around the mean, within which nearly all (99 percent) of the measured values should lie when the measurement process is in a state of statistical control.

Laboratory personnel should update control charts as soon as a control sample measurement is completed. Based on the result of an individual control sample measurement, the following course of action should be taken (Taylor 1987):

- If the measured value of the control sample is within the warning limits, all routine sample data since the last acceptable control sample measurement are accepted, and routine sample analyses are continued.

- If the measured value of the control sample is outside of the control limits, the analysis is assumed to no longer be in a state of statistical control. All routine sample data analyzed since the last acceptable control sample measurement are suspect. Routine sample analyses are suspended until corrective action is taken. After corrective action, statistical control must be reestablished and demonstrated before sample analyses continue. The reestablishment of statistical control is demonstrated by the results of three consecutive sets of control sample measurements that are in control (Taylor 1987). Once statistical control has been demonstrated, all routine samples since the last acceptable control sample measurement are reanalyzed.

- If the measured value of a control sample is outside the warning limits, but within the control limits, a second control sample is analyzed. If the second control sample measurement is within the warning limits, the analysis is assumed to be in a state of statistical control, and all routine sample data since the last acceptable control sample measurement are accepted, and routine sample analyses are continued. If the second sample measurement is outside the warning limits, it is assumed the analysis is no longer in a state of statistical control. All routine sample data analyzed since the last acceptable control sample measurement are suspect. Routine sample analyses are suspended until corrective action is taken. After corrective action, statistical control must be reestablished and demonstrated before sample analyses continue. The reestablishment of statistical control is demonstrated by the results of three consecutive sets of control sample measurements that are in control (Taylor 1987). Once statistical control has been demonstrated, all routine samples since the last acceptable control sample measurement are reanalyzed.

Taylor (1987) also provides additional criteria for evaluating control chart data to determine if a measurement system is no longer in a state of statistical control. For X charts, these criteria include:

- Four successive points outside a range equal to plus or minus one-half the warning limits.
- Seven successive points on one side of the central line, even if all are within the warning limits.
- More than 5 percent of the points outside the warning limits.

Central line, warning limits, and control limits will be evaluated periodically by the on-site QA coordinator. Central lines, warning limits, and control limits for each analyte and sample type will be redefined based on the results of quality control and quality assessment sample measurements. Current control charts must be available for review during laboratory audits. Copies of charts will be furnished to SAIC or USACE upon request. Such charts should contain both the points and their associated values.

3.2.10 Record Keeping

The objective of records management is to assure that all documents for a given program are accountable and traceable. It includes COC records, all logbooks, graphs, remote sensing images and data displays, and other miscellaneous items. Any correction to the data is documented by the originator of the correction, and the change is communicated to all involved project staff.

Laboratory Data

Documentation in the laboratory is initiated by the Sample Custodian (SC) who receives samples, assigns laboratory numbers, and generates COC forms that document sample movement in the laboratory. Each shipment of samples received is given a unique batch number (project number). A batch consists of a number of samples carried through the entire analytical procedure, along with samples and standards. All work performed on a sample batch is documented in bound laboratory logbooks which are described as follows:

- Sample Receiving Logbook is used to record computer-generated sample summary forms which were entered into the laboratory sample database on a sample receipt basis. It is compiled on a monthly basis to document sample receipt information.

- Instrument Maintenance Logbook is used to record the maintenance performed on the analytical instruments.

- Standards Logbook is used to record the preparation and use of all standards in the laboratory. It notes date of preparation and by whom, concentration, as well as date of expiration of the standards or reagents.

- Chemist's Notebook and/or Worksheets are used to record the raw data and final data of every batch. It is used to document all activities associated with the analytical process. Laboratory notebooks of each staff represent functional records and are pre-numbered.

- Instrument Benchsheet Logbook is used to record sample run sequence or injections done in a day's or shift's run.

Rules Governing the Use of Logbooks

- Bound logbooks with pre-numbered pages are the preferred record-keeping forms. Loose sheets are not used unless permanently affixed to the logbooks.
- Field logbooks should contain waterproof paper.
- Only assigned laboratory notebooks or logbooks are used for record keeping (e.g., Instrument Run logbook, Maintenance logbook, Standards logbook, etc.).
- All writing must be legible and shall be completed in water-resistant ink. All numbers must be clear. Corrections should be made by drawing one line through the incorrect entry, entering the correct information, initialing, and dating the change.
- Complete information should be entered so that in an examination, it can be determined what was done, when, and what the results were.
- If any data are determined to be invalid, reasons are indicated.
- All relevant information is included (e.g., the manufacturer and lot number of a chemical, the specific procedure used for sample preparation and analysis, instrumental conditions, etc.).
- When work is continued in another notebook or logbook, the number of the first notebook is written in the first page of the second notebook and vice-versa.

3.2.11 Document Control

Document control is accomplished through the use of a centralized repository of document inventories and all documents generated in conjunction with the project or contract. All project files, analytical data files, and documentation related to sample analysis are maintained by designated personnel. SOPs and copies of the QA manual will be controlled by the Laboratory QAO through numbered distribution listings. Revisions are subject to SAIC QAO approvals. Revisions will be noted on header pagination used for these controlled documents. In accordance with the memorandum of understanding (MOU) between EPA Region IX and USACE, all records will be retained for 30 years. All records applicable to the Palos Verdes Shelf Superfund Site Pilot Capping Project will be provided to the project manager by SAIC with the Final Report.

Document Handling

Designated laboratory personnel are responsible for the collection, organization, maintenance, and security of all documents, and will establish a client/contract file for all documentation regarding a project or a contract.

Active files shall be maintained in locking metal file cabinets. Only authorized personnel shall have access to the files. The file drawers shall be kept locked when not in use. Archived files must also be secured and access shall be limited to authorized personnel.

The following records will be maintained by the laboratory:

- Logbooks (Field, COC, Bench, Analytical Run, Temperature, and Oven)
- Instrument Calibration Data
- Instrument Maintenance Logs
- Computer Software Verification
- Performance Evaluation Records
- Certification Program Records
- QC Sample Analysis
- Control Charts
- Corrective Action Forms
- Purchased Material Certificates
- QC Coordinator Reports
- QC Audit Reports
- Standard Operating Procedures
- Equipment Manuals
- Personnel Qualifications and Training
- In-House Forms

Consistency of Documentation

Before releasing analytical results, the laboratory assembles and cross checks the information in field logs, sample tags, custody records, laboratory bench sheets, personal and instrument logs, and other relevant data to ensure that data pertaining to each particular sample or case is consistent throughout the record.

Document Inventory

Document tracking and control are facilitated through the use of an inventory checklist for document tracking.

Document/Data Package Shipping

The delivery schedule of the data package is defined by the USACE. The date of shipping is documented and a list of data/documents shipped is retained for the record. A copy of the data package sent is kept by the laboratory to be filed for future reference in case of future requests for information.

3.2.12 Standard Operating Procedures

SOPs are maintained for each laboratory section and describe standard procedures for use of logbooks, benchsheets, traceability of standards, instrumentation, samples, and environmental data. In addition to the detailed instructions for performing each test or analysis, laboratory procedures shall address all applicable quality control techniques and activities necessary to maintain the required accuracy and precision of results. These quality control factors include calibration of instruments and equipment, specifications for reagents and supplies, labeling and logging of samples, preservation and storage of samples, standardization of instruments and methods, replicate and blind check samples, and blank and spiked samples. Additional control factors include control of environmental conditions, tolerance of measurements, recordkeeping requirements, statistical quality control methods and charts, performing and checking calculations and results, and interlaboratory quality control tests or analyses. Methods for handling incorrect or defective samples shall be specified. Results shall be traceable to the sample.

Responsibilities for Document Preparation and Approval

The Laboratory QAO shall be responsible for the format and content of the Laboratory Quality Assurance Manual. Prior to initial issuance and any subsequent major revisions, it shall be reviewed and approved by the Laboratory Manager. The Laboratory QAO shall compile, issue, distribute, and maintain the QA Manual, record the distribution, and review the contents on an annual basis.

Each Laboratory Section Manager shall create or approve all internally generated procedures and forms for his/her assigned area of work. The Section Manager shall be responsible for initially verifying the technical accuracy and adequacy of internal procedures and forms based on approved external methods and his/her technical expertise.

All SOPs and their subsequent revisions shall be reviewed and approved by the Section Manager and the QAO. Each reviewer is responsible for assuring that the procedure or form is accurate and adequate based on his/her area of expertise. In-house data forms shall be reviewed and approved by the Section Manager and the Laboratory QAO. Project-specific manuals shall be reviewed and approved by the USACE, the Lab QAO, and the SAIC Project Manager.

Document Revision

Documents are updated for any revision made to reflect the actual procedures being followed. Before any revision is made, such documents shall be submitted to the Laboratory QAO for approval of the proposed revisions.

Changes to documents, other than those defined as minor changes, shall be considered as major changes and shall be reviewed and approved by the same organizations that performed the original review and approval unless other organizations are specifically designated. The reviewing organization shall have access to pertinent background data or information upon which to base their approval.

Minor changes shall be defined as those changes that do not affect the content or quality of the action being prescribed in the document, such as punctuation or grammatical changes, aesthetic changes or, in the case of data forms, small changes made strictly for the convenience of the user that do not affect the accuracy or integrity of the document.

An addendum, subject to all review and approval criteria as defined above, may be attached to a document to reflect policy and procedural changes that become effective between revisions. These changes will then be incorporated into the body of the document at the time of the next revision.

If the revision is justified for the changes to be done, the Project Manager submits the proposed revision of a section of a document or SOP to the QAO for approval.

Document revision shall also include policy changes that could substantially impact the QA/QC plan as follows:

- Personnel changes relating to QA/QC responsibilities
- Method changes
- Procedural changes in establishing control limits and/or the preparation and use of control charts.

4.0 MONITORING OF HOPPER DREDGE OPERATIONS

4.1 Overview

Monitoring of hopper dredge operations consists of making continuous recordings of the hopper dredge's position, draft, orientation and pump-out status while it is being loaded with cap material, during transit to each placement location, and during each placement event. SAIC will install two different, but closely related, systems on the hopper dredge to allow continuous, automatic recording of vessel position, draft, orientation and pump-out status: 1) the Automated Disposal Surveillance System (ADISS), and 2) the Automated Disposal Surveillance System Display (ADISSPlay).

The ADISS consists of a small box which automatically records: 1) the dredge's horizontal position (i.e., latitude and longitude) by receiving signals from a Differential Global Positioning System (DGPS), and 2) the dredge's vertical position relative to the waterline (draft) by receiving signals from a pressure sensor installed in one of the vessel's storage wells (i.e., "hopper"). In addition, the ADISS will keep a record of the "on/off" status of the dredge's pump used for discharge of the capping material. When the pump is on and capping material is being discharged, the SAIC marine technician present on the dredge will manually activate a switch on the ADISS box to allow the data to be recorded.

The ADISSPlay system resides on a lap-top computer to facilitate both display of information and user interaction. This system generally is installed in a vessel's wheelhouse and is used by the operator both for real-time navigation (through a helmsman display of the vessel's position plotted on a chart on the computer's monitor) and for recording standard "disposal log" information about each dredged material placement operation (by keyboard entry using a customized user interface).

4.2 Summary of Procedures

ADISS will be installed on the hopper dredge, *Sugar Island*, and maintained throughout the project to acquire vessel position, draft, and pump information during the loading, transit and placement operations. During both the hopper dredge loading process and transit to the target cell, the ADISS system will record position and draft information automatically at ten-minute intervals. The rate of data acquisition will automatically increase to six-second intervals whenever the dredge nears to within 0.5 miles of the target placement location. The ADISS receives the differential correction signals for GPS provided by the U.S. Coast Guard and uses these to record highly accurate position coordinates. In addition, the ADISS will automatically record changes in vessel draft based on input from a pressure sensor installed in the aft ram well. Furthermore, ADISS will make a record to indicate when the dredge's pump is being used for discharge of capping material. This recording function will be activated by a switch controlled by the

SAIC marine technician present on the dredge during each cap material placement event. Together, the continuous position records, draft measurements and the pump on/off information will be used during data processing to produce plots depicting time and vessel position during loading or discharge of cap material.

The ADISSPlay will be installed on the *Sugar Island* to display the vessel position (track line) and draft. ADISSPlay will receive and record the position and draft information from ADISS, and provide the real-time display of the vessel's location relative to the target cell over a chart of the area. In addition, ADISSPlay will receive and record information about the orientation of the dredge during placement activities (note: orientation is defined as the azimuth of the vessel's lubberline); this information will be received by ADISSPlay from the vessel's gyro compass. During the transit to the target, ADISSPlay will allow the user to display either the vessel track line or draft, as desired. ADISS data will be automatically stored within the ADISSPlay database, which will be exported to DAN-LA for display and analysis. Other information entered via keyboard by SAIC's on-board marine technician and stored in the ADISSPlay database include:

- Project, vessel and target identifications (ADISSPlay user interface pull-down entries)
- Volume of material loaded in the hopper (ADISSPlay direct key-board entry)
- Type of placement operation, either drag-arm (i.e., pump out) or split-hull (ADISSPlay interface pull-down entry)

4.3 Quality Assurance Objectives for Measurement Data

Measurement quality objectives for the hopper dredge operation monitoring are summarized in Table 4-1. The accuracy of the position data recorded by ADISS, based on the differential correction signals for GPS provided by the U.S. Coast Guard, is anticipated to be ±1 to 3 m. Verification of the DGPS accuracy and precision will be made prior to installation of ADISS aboard the hopper dredge, *Sugar Island*. The verification check will consist of placing the GPS antennae at a control point located on land near the PV Shelf study location (e.g., a U.S. Geological Survey geodetic marker or equivalent control point having known horizontal coordinates) and allowing the system to record position data at 6 second intervals continuously for a period of 1 hour. Accuracy will be verified by comparing the mean position given by the DGPS system with the known position. It is anticipated that the mean DGPS position will be within ±3 m of the known position. Precision (i.e., repeatability) will be verified by preparing a scatter plot of the individual DGPS readings relative to the control point. It is anticipated that 95% of the readings obtained during the 1-hour period will fall within a circle having a radius of 3 m around the control point.

Table 4-1. Summary of quality control checks and measurement quality objectives for monitoring the operation of the hopper dredge

System/parameter	QC Check	Frequency	Accuracy criteria	Precision criteria
DGPS System	Initial verification of accuracy and precision	Once prior to hopper dredge operation monitoring	Average system value should be within 3 m radius of control point	95% of replicate system values should be within 3 m radius of control point
Pressure sensor	Compare draft values with those obtained by hopper dredge's system	Prior to each placement event	NA	Readings should agree within 6 inches
ADISSPlay time-of-disposal data	Compare with values obtained by hopper dredge's Silent Inspector system	Each placement event	NA	Values should agree within 1 minute

When the ADISSPlay laptop computer is connected to the ADISS box on the hopper dredge, an identical set of vessel positions and time will be recorded in its database. The ADISSPlay computer will also receive and record vessel orientation information received from the dredge's gyro compass. An initial check will be made to ensure that the compass reading being displayed by ADISSPlay matches the direct read-out from the gyro compass.

Draft and pump-out information will be acquired in both ADISS and the ADISSPlay database to identify where sediment collection and placement occurs. The resolution of the pressure sensor used to record changes in vessel draft during loading and placement operations is ±3 inches. Accuracy of the draft measurements depends on the proper placement of the sensor in the aft ram well of the hopper dredge. The accuracy of the vessel draft data recorded by ADISS will be verified by comparing the ADISS readings with those recorded using the hopper dredge's existing system (which utilizes a hull-mounted pressure sensor). The two sets of readings should agree within ±6 inches. Accuracy of the pump-out information will depend on the correct operation of the ADISS equipment. A trained SAIC individual (the Marine Technician) present on the hopper dredge during cap placement operations will be responsible for manually operating the switch to coincide with pump-out of the material.

When the hopper dredge approaches to within 0.5 mile of the target cell, measurements of position, orientation, draft and pump operation will be recorded once every six seconds. "Outlier" readings, indicative of receiver or sensor stability problems, will be obvious upon examination of the records and will trigger appropriate corrective action (e.g., receiver or sensor repair or replacement). In addition, the processed ADISSPlay data will be compared with the data acquired by the hopper dredge's existing Silent Inspector system, which records the time of disposal. Lack of agreement between the two sets of readings will trigger corrective action in the form of troubleshooting until the source of the discrepancy is identified. The completeness objective for the hopper dredge operation monitoring is a full, validated data set for incorporation in the DAN-LA system. The database will contain the position, orientation, draft and pump information for each loading, transit and placement event during the project.

4.4 Calibration Procedures and Frequencies

4.4.1 GPS and DGPS Receivers

Both the GPS and DGPS components receive signals transmitted from satellites and base stations, respectively. The initial comparison of position at a known location (control point) with ADISS values will verify the accuracy of the system. The comparison will be made prior to installation on the hopper dredge at a known location in proximity to the PV Shelf study site.

4.4.2 Pressure Sensor

The factory calibration of the pressure sensor and spare sensor will be checked prior to installation on the hopper dredge. In a laboratory test tank, pressure values will be noted against depth of sensor submersion at 1-foot intervals over a 0 to 12-foot range. The data for depth of submersion and pressure will be correlated and used to convert raw pressure values recorded on the dredge to its draft. The conversion coefficient will be stored within the ADISS processing software, ADISSPro, and within the ADISSPlay database to convert pressure counts to engineering units (feet).

Prior to each loading operation, the ADISS technician will compare the ADISS draft measurement to the draft measurement obtained by the vessel's Silent Inspector system. If the measurements do not agree within ±6 inches, the ADISS technician will troubleshoot the system to identify and correct the cause of the discrepancy.

4.5 Analytical Procedures

Data analysis takes place during the processing of the ADISS and ADISSPlay data using the processing software ADISSPro. The beginning and ending position of each disposal event is selected in a time-vs.-draft plot by the ADISS Technician according to changes in draft and pump activity. Once the database is updated with the selection of the placement points, the track line is plotted over the background of the target cell. The ADISSPlay points are checked with those from ADISS before the images of the plots are transferred to the SAIC Database Manager for incorporation into DAN-LA.

4.6 Sample Custody

There are three individuals who will have custody of the ADISS and ADISSPlay data: the on-site Marine Technician, the ADISS Technician at SAIC's Newport, RI office, and the on-site Database Manager (Figure 4-1). Initially, at the end of each day's operation, the Marine Technician will download the data files from both ADISS and ADISSPlay for e-mail transfer to the ADISS Technician for processing and quality assurance review. Once the processing becomes routine, it will be conducted on-site by the Marine Technician with oversight from the ADISS Technician. Ensuring the proper initiation of the COC will be the responsibility of the Marine Technician for each day of ADISS operations. COC forms will accompany the electronic records that are transferred to shore at the end of the day's field operations. A duplicate copy of the completed COC form will be submitted to the SAIC Project Manager for entry to the project archive. The COC form will contain the following information:

- Date and time of ADISS and ADISSPlay downloads
- Name of Marine Technician performing download (signature space provided)
- Date and time of data e-mail transfer to ADISS Technician
- Name of ADISS Technician performing data processing (signature space provided)
- Date and time of data product transfer to Data Manager
- Name of Data Manager importing data to DAN-LA (signature space provided)

4.7 Data Reduction, Validation and Reporting

Position, draft and pump information will be stored in the ADISS portable flash memory card. Pressure and pump data are appended to the position data acquired by the GPS and DGPS receivers and stored in ASCI-II file format. Each line of data is time and date-stamped and stored as it is received. Data is recorded for load events, and transits/placements to/at the target cells are stored in separate files. Load and transit/placement files are composed of Latitude-Longitude position, pressure values and pump on-off information. Information indicating the quality of the position fix is also included in each line (i.e., the number of satellites detected and the reception of the Differential GPS signal). The load data will be gathered at ten-minute intervals. The transit data will be acquired at ten-minute intervals until the dredge is within one half mile of the target cell boundary, when the interval will increase to six seconds. The placement event will be recorded for 20 to 120 minutes, depending on the mode of disposal. A single point, split hull placement will require less time than the motile dispersion of sediments employing the pump out method through the drag arm. By exercising a variety ADISS firmware options, sampling parameters can be changed as required.

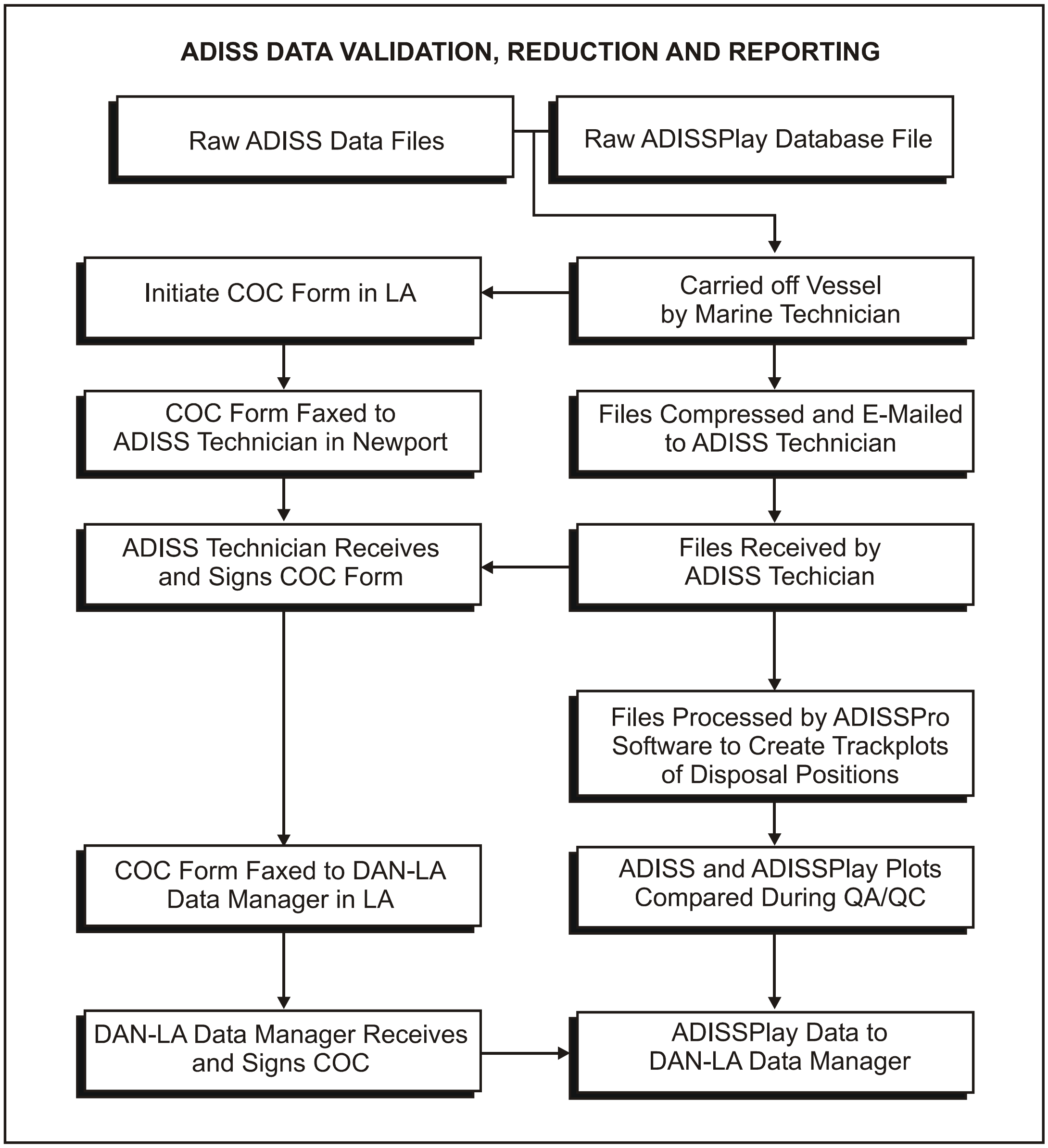


Figure 4-1. Flow chart depicting ADISS data validation, reduction, reporting, and chain of custody.

Data reduction, validation and reporting will include data transfer following each placement event (Figure 4-1). The ADISS Marine Technician will download the ADISSPlay database and the ADISS data files, compress them and e-mail them to the ADISS Technician in Newport, RI. The ADISSPlay data will be processed using the ADISSPro software, and compared with the information in the ADISS data files before submittal to DAN-LA for reporting. Validation will include the determination of the quality of the Differential and GPS satellite position fixes, using the information recorded in the data strings, as well as the raw pressure counts of vessel draft and the compass bearing information. Observations will be noted in the posting of the data plots of position, should the quality of the data be compromised or in question. Database contents will include the time and date of each vessel position and orientation, pump activity, vessel draft, load volume, and the identities for the target, vessel and project. Draft-time series and vessel track lines will be plotted and reported on the project web site.

Internal quality control checks will be performed during the processing of the ADISS and ADISSPlay data once both are recovered from the hopper dredge. An ADISS Engineer located in Newport, RI will check the quality of the data when the Newport ADISS Technician performs the processing, or the ADISS Technician will conduct the internal quality checks when the on-site Marine Technician processes the data.

4.8 Performance and Systems Audits and Frequency

The ADISS Engineer, the ADISS Technician or the Marine Technician will conduct performance audits of the ADISS system (including ADISSPlay) prior to loading operations for each placement. The audit will consist of proper system responses to set up commands and good reception from the sensors and receivers, including:

- Checks for proper logging sequences and proof of file storage
- Checks of pressure sensor function and correlation with visual draft measurement values
- Checks of pump switch function and proper recording
- Checks of correct compass readout with vessel gyro compass readout
- Checks of Differential GPS reception
- Checks of GPS signal reception

4.9 Preventive Maintenance

The Marine Technician operating the ADISS and ADISSPlay system will be trained in its operation by the ADISS Engineer and ADISS Technician. Preventive maintenance of the equipment and modification to the software will be the responsibility of the ADISS Engineer and ADISS Technician, either of whom will make semi-weekly service visits to the hopper dredge. The Marine Technician will be capable of operating the equipment and recovering the data from both ADISS and ADISSPlay memories. The ADISS Engineer will direct the Marine Technician’s efforts to trouble shoot the ADISS equipment and firmware, should the need arise, while the ADISS Technician will guide the Marine Technician through potential problems with the ADISSPlay software.

4.10 Corrective Action

Both GPS and DGPS signals are received by antennas installed atop the hopper dredge wheelhouse. Only the GPS antenna must have an unobstructed view of the sky to receive signals from available satellites. Since the GPS antenna is small and portable, it can be easily relocated about the flying bridge of the dredge to meet the needs for an unobstructed signal. The DGPS antenna receives it signal from the local U.S. Coast Guard facility and does not depend on an unobstructed pathway for operation. However, if the signal transmission from the primary station is interrupted, then the ADISS receiver will automatically switch frequencies to the next available station.

Trouble shooting the ADISS equipment will be the responsibility of the Marine Technician with guidance provided by either the ADISS Engineer or Technician. Most problems can be remedied by re-setting ADISS. Trouble shooting the ADISSPlay software and hardware will also be the responsibility of the Marine Technician with guidance provided by the ADISS Technician. The Marine Technician will be trained to diagnose common data acquisition and processing problems, and solve them with assistance from the ADISS Technician.

Should the pressure transducer, GPS antenna, DGPS antenna, ADISS unit or ADISSPlay laptop computer malfunction, they will be replaced with the spare units and tested by either the ADISS Engineer or Technician.

5.0 COLLECTION AND CHEMICAL ANALYSIS OF SEDIMENT AND SEAWATER SAMPLES

5.1 Sample Collection

5.1.1 Seawater Sample Collection

Seawater samples collected from within sediment plumes generated during the capping operations will be analyzed for p,p'-DDE and total suspended solids. The sampling will occur during six cap placement events (including the flex survey) and three upper water column monitoring surveys. Background samples will be collected in all monitoring areas prior to cap placement. Details regarding field sampling procedures are presented in the FSP and in SOPs (Volume II of the PWP). A summary of sample collection procedures follows.

Objectives

The objectives of water sampling are to assess the total suspended solids (TSS) and p,p'-DDE plume concentrations, location and extent for two hours following hopper placement of capping materials and to determine and map the extent and concentration of plume TSS in the upper water column (upper 30 meters) during expected on-shore transport events.

Sampling Collection Method

Water sample collection will be conducted using a rosette water sampler interfaced with a CTD (see Major Sampling Equipment below). Samples will be collected at the discretion of the Field Leader and Corps Project Manager as described below. The rosette-CTD package is deployed and retrieved by either a crane or winch with an A-Frame. After deployment the unit will be towed to station submerged. Water samples are collected by "triggering" each of the 12 10-Liter Niskin bottles via the CTD deck box when on station. After the water sample bottles have been filled, the package is retrieved and the 10-Liter water samples are sub-sampled for subsequent analysis of TSS and p,p'-DDE.

Niskin bottles used for the collection of seawater samples are made of high-density polyethylene (HDPE). Each Niskin bottle is deployed in the open position and is therefore extremely well flushed with seawater prior to being closed to obtain the sample. Because HDPE is relatively inert and the bottles will be well flushed between samples, chemical decontamination of the inside surface of the Niskin bottles is considered unnecessary. Additionally, water samples for DDE analyses will be removed from the Niskin bottles as soon as the rosette sampler is retrieved to the deck of the survey vessel, thus minimizing potentials for significant phthalate leaching from the bottle walls into the samples. Niskin rinsate samples (see Section 5.1.3 below) will be used to verify that the inside surface of the sampler is not a source of sample contamination for DDE or phthalates which could potentially interfere with DDE quantitation. The Niskin rinsate sample water would be subjected to approximately the same contact time as the field samples

Major Sampling Equipment

The major sampling equipment associated with the water sampling survey includes a General Oceanics Model 1016 Intelligent Rosette Water Sampler interfaced with a SeaBird Electronics 911 *plus* Conductivity, Temperature and Depth (CTD) water column profiler. The rosette is fitted with 12 10-Liter Niskin water sampling bottles for water collection.

In addition to the conductivity, temperature and depth sensors, a C Star 25-cm pathlength Transmissometer and a Datasonics PSA-900 Sonar Altimeter is integrated with the CTD system to provide real-time water column turbidity measurements and the instrument package's altitude above the seafloor.

The water sampling field operations will use research vessels equipped with a hydraulic A-frame and winch, at least 2,500 feet of hydrographic wire or line, and complete electronic instrumentation (radar, depth finder, dGPS, radio). Vessels will meet all Coast Guard regulations.

Sampling Frequency and Locations

The TSS and p,p'-DDE samples will be collected throughout a two-hour period following specific cap placement events (Table 5-1). Samples will be collected at the discretion of the SAIC Project Manager, based on plume identification (via transmissometer) and changing environmental monitoring conditions. A total of six samples for p,p'-DDE and TSS analysis will be collected during each event, at prescribed times of 5, 20, 40, 60, 90 and 120 minutes after cap placement. These samples will be taken in the centroid of the plume within two meters of the bottom, where concentrations are expected to be greatest. Up to 21 additional TSS samples will be taken during each two-hour period (at the discretion of the SAIC Project Manager) for the purpose of plume tracking.

Identifying and tracking a sediment plume, and subsequently collecting discrete water samples from within it, require that the field-sampling plan remain flexible. Collection locations are dependent upon a number of variable oceanographic conditions (e.g., currents, stratification etc.). Therefore, the sampling locations for the majority of the water samples collected for this project will be at the discretion of the SAIC Project Manager during field operations.

5.1.2 Seawater Sample Labeling, Preservation and Holding

Individual TSS and p,p'-DDE water samples will be subsampled from the 10-Liter Niskin bottles and placed in the appropriate sample containers (Table 5-2). A sample label is immediately attached to each sample container at the time of collection. Labels are self-adhering and covered with clear tape to further prevent the label from washing

Table 5-1. Seawater Sample Locations, Frequencies, and Sampling Intervals by Parameter

Parameter	Matrix	Frequency	Sampling Stations	Sampling Interval
TSS	Seawater	One two-hour sample collection interval for each of six placement events.	At discretion of Field Leader based on plume identification.	5, 20, 40, 60, 90 and 120 minutes after placement
		One two-hour sample collection interval for each of three separate plume transport surveys.	At discretion of Field Leader and Corps Project Manager based on plume identification and oceanographic conditions.	Within upper 30 meters of water column plume.
p,p'-DDE	Seawater	6 samples for each of four events	Centroid of plume and within 2 meters of the bottom.	5, 20, 40, 60, 90 and 120 minutes after placement

Table 5-2. Seawater Sample Collection and Preservation Procedures by Parameter

Parameter	Sampling Method	Sample Volume	Preservation	Container	Holding Time
TSS	Rosette/Niskin Bottle	500 ml	4ºC	500-mL plastic bottle or glass jar	7 days in dark
p,p'-DDE	Rosette/Niskin Bottle	2 liters	4ºC	1-L amber glass jar with Teflon-lined lid.	7 days for extraction; 40 days for sample extract analysis

off or dissolving. Each pre-printed, laboratory-supplied label identifies the project title, cruise number, sample type, station number, and sample number. Specific sample information is written in indelible ink for the following:

Survey number

- Station identification
- Date and time collected
- Sample replicate number
- Collector's name or initials
- Analysis to be performed

Immediately following collection and labeling, the seawater samples will be placed on ice. At the end of each day of survey operations, samples will be transferred to the person responsible for shore-based water sample processing. The water samples are shipped on ice to the laboratory by overnight courier within 24 hours of collection.

5.1.3 Types and Numbers of Seawater Samples Generated in the Field

The various types of seawater samples to be generated in the field include the following: performance evaluation sample, background sample, field sample, field duplicate sample, field blank, Niskin rinsate sample, and matrix spike/matrix spike duplicate sample (Table 5-3). These samples are defined as follows:

Performance Evaluation Sample: Prior to any of the scheduled plume sampling activities, a near-bottom water sample will be obtained from a random location within one of the pilot cells. The sample will be sent to the laboratory (Woods Hole Group, Inc.) for analysis as a performance evaluation sample prior to the analysis of any field samples (see Section 5.2.3 for further discussion of the initial performance evaluation).

Background Sample: A near-bottom seawater sample obtained immediately prior to cap placement operations in a given cell and used to document "background" (i.e., pre-capping) conditions.

Field Sample: Regular seawater samples obtained for the purpose of addressing the study objectives. The seawater captured within each Niskin bottle on the Rosette sampler, representing a discrete sampling point in space/time, is considered a single "sample". This "sample" is then transferred to various containers for the purpose of storage, shipping and analysis, as indicated in Table 5-3.

Field Duplicate Sample: Seawater from a given Niskin bottle is poured into four 1-Liter containers. The first two 1-Liter containers represent the field sample and the second two 1-Liter containers represent the field duplicate sample. The field duplicate samples will be sent to the laboratory as "blind" duplicates. Analysis of the field duplicate samples will provide a measure of the homogeneity of seawater within the Niskin bottle, as well as an assessment of laboratory analytical precision.

Field Blank: A 1-Liter sample container filled with distilled water from the laboratory is carried into the field and handled in the same manner as all the other 1-Liter seawater containers. While another container is being filled from the Niskin bottle to create a field sample, the field blank bottle is opened and exposed to air in the same location and for the same period of time. The container is then sealed and sent to the laboratory for analysis of p,p'-DDE. The purpose of the field blank is to determine the potential for any sample contamination due to container handling or exposing the inside of the containers briefly to air while filling.

Niskin Rinsate Sample: One of the Niskin bottles on the sampling Rosette is filled with distilled water and left in the closed position for approximately 2 hours (i.e., the same period of time that a seawater field sample would remain in

Table 5-3. Types and numbers of seawater samples to be generated in the field

Type of Sample	Frequency	Collection Volume	Total Number of Samples
Performance Evaluation Sample	p,p'-DDE: Once, prior to the plume sampling activities	Six 1-L containers per sample	1
Background Sample	TSS: 3 samples for each of 3 events and 6 samples for 1 event p,p'-DDE: 3 samples for each of 3 events and 6 samples for 1 event	1 500-ml container per sample Two 1-L containers per sample	15 15
Field Sample	TSS: up to 27 samples for each of 8 events and up to 25 samples for 1 event p,p'-DDE: 6 samples for each of 5 events and up to 5 samples for 1 event	1 500-ml container per sample Two 1-L containers per sample	241 35
Field Duplicate Sample	TSS: 3 for each of 9 events p,p'-DDE: 1 for each of 5 events	1 500-ml container per sample Two 1-L containers per sample	27 5
Field Blank	p,p'-DDE: 1 for each of 5 events	Two 1-L containers per sample	5
Niskin Rinsate Sample	p,p'-DDE: 1 for each of 5 events	Two 1-L containers per sample	5
MS/MSD	p,p'-DDE: 1 for each of 5 events	Six 1-L containers per sample	5

contact with the inside of the sampler during a typical plume tracking sampling event). The distilled water is then collected in two 1-Liter containers and sent to the laboratory for analysis of p,p'-DDE. The purpose of this sample is to evaluate the potential of sample contamination from the Niskin bottles.

MS/MSD: Seawater from a single Niskin bottle is poured into six 1-Liter containers. Two of the containers are sent to the laboratory for analysis as the "field sample" from the Niskin bottle. A known amount of p,p'-DDE is spiked into the other four containers (two containers are the matrix spike and two are the matrix spike duplicate). The purpose of the MS/MSD is to evaluate laboratory analytical accuracy and precision (see Section 5.3.4).

In general, EPA recommends that field duplicate samples and samples for MS/MSD analyses be collected at locations/times of known or suspected moderate contamination. The field duplicates and MS/MSD samples identified above will be obtained, to the extent possible, during the early stages of each plume tracking/sampling event, when total suspended solids concentrations (and associated p,p'-DDE concentrations) are likely to be highest.

5.1.4 Sediment Sample Collection

Subsamples of sediment taken from each core will be analyzed to determine the concentration of p,p'-DDE. Core subsamples also will be analyzed for the following geotechnical parameters: bulk density, grain size, water content, specific gravity, Atterberg Limits, and vane shear measurements (see Section 6.0 for field and laboratory QA/QC associated with these geotechnical parameters). Details regarding field sampling procedures for sediment coring are presented in the FSP and in an SOP (PWP, Volume II). A summary of sample collection procedures follows.

Objectives

The objective of the sediment coring is to collect cores with a minimum length of 20 cm without contaminating the sample or distorting the existing layering. This sampling is being performed to examine the vertical distribution of p,p'-DDE and selected geotechnical parameters during and following the cap placement operations.

Sample Collection Method

The aft deck of the survey vessel will be washed periodically with filtered seawater to keep the sampling area clean of debris. The gravity corer used to collect sediment chemistry samples will be rinsed thoroughly with filtered seawater between samples. Coring and core processing procedures have been refined to minimize the amount of excess sediment to be washed overboard. New core tubes or butyrate core liners will be used for each coring attempt. Therefore, decontamination of core liners is not necessary.

Once on station, the gravity core will be assembled by adjusting the weight and attaching the core barrel. Generally, one or two test cores are required to fine-tune the weight requirements for a project site. The weight stand is designed to accommodate a maximum of 800 to 900 lb., but this weight will not be needed for the relatively shallow penetration required for the baseline sampling program. The core barrel is inserted into a collar using clamps on the lower side of the weight stand. A supply of core barrels will be pre-cut to accommodate 2.5-ft cores, as this will be sufficient to achieve the required minimum penetration depth of 20 cm and will allow better control of the sediment core during deployment and recovery.

The whole device is manipulated by either a crane or winch and A-Frame via a lifting bail on top of the weight stand. The corer will be lowered by controlled descent until contact with the bottom. Contact with the bottom is determined by slack cable and a change in the sound of the winch. When the corer is brought aboard following collection of a bottom sample, the corer is held in a horizontal position, the core cutter and catcher are then removed from the lower end of the core barrel, a core cap is placed on the end of the liner and taped in place, then the core liner is removed from the barrel. Next, the core liner is held vertically and a small hole is drilled into the core liner about 1 cm above the sediment-water interface to allow any water that may be trapped above the sediment sample to be removed. (If this interface is not immediately visible, then the core liner is held vertically until all suspended sediment has settled and the interface is apparent.) Then, any excess length of core liner above the sediment top will be cut off while the core liner is held vertically; this is done with significant care to ensure that the core sample is not disturbed in the process. Lastly, a core cap is taped in place on the top of the corer liner, and the liner is labeled according to station number, core replicate (if multiple cores were acquired at the same station), and core top/bottom are indicated. The cores will be stored in a dark container at 4° C until brought ashore at the end of the sampling day.

At a shore-based laboratory, the core can be subsampled with a minimal amount of disturbance within 24 hours of collection. The core will be split in half longitudinally, visually inspected for sampling artifacts, and photographed. A detailed description of each core (core log) will be recorded by hand using an ink pen in a laboratory notebook. The core description will include the following information:

- Core length
- Log of intervals that were photographed
- Description (lithology, grain size, texture, odor, presence/thickness of hair mats, number/type of organisms, color, apparent water content)

Only undisturbed cores will be retained for subsampling. Disturbed cores will be discarded. The core length will then be measured and the core will be sectioned into discrete, specified intervals (see section below on sampling frequency and locations). Subsamples of sediment will be collected in each interval using decontaminated stainless steel scoops. The sediment subsample for chemical analyses will be removed from portions of the core that have not contacted the surface of the core liner. Each sediment subsample for p,p'-DDE analysis will consist of approximately 100 g of sediment placed in a certified-clean, 250-mL glass container with a Teflon-lined lid. Sediment chemistry samples will be held at 4° C (on ice or in a refrigerated storage unit) prior to shipping.

<u>Major Sampling Equipment</u>

Sediment cores will be acquired using a conventional gravity corer. This device consists of a 4 to 8-ft long aluminum or steel core barrel, having an outside diameter of 4-in, attached to a weight stand (core head). The weight stand is constructed of heavy-gauge steel and is designed to accommodate varying amounts of weight. The individual lead weights are donut-shaped, weighing approximately 50 lb each. Additionally, the weight stand is equipped with a check valve, at the top of the spindle and in line with the core barrel, to allow water to pass freely through the aperture on descent through the water column. Further, there are four “fins” at the top of the weight stand to minimize rotation on descent.

A supply of core barrels will be pre-cut to accommodate 2.5-ft (76 cm) cores, as this will be sufficient to achieve the required minimum penetration depth of 20 cm while preventing severe over-penetration and allow better control of the sediment core during deployment and recovery. For each coring station, a 3.5-in inside diameter butyrate core liner will be inserted into the core barrel and retained mechanically by a steel core cutter that is attached at the end of the core barrel to facilitate impact with the seafloor. The core cutter/catcher assembly is attached to the core barrel using rivets or other mechanical fasteners.

Phthalate contamination or interferences from the core liners are avoided using the prescribed core subsampling method (i.e., removal of sediment from the exact center of the core, well away from any contact with the inside of the liner), as demonstrated by the baseline monitoring results. Regardless, core liner rinsate blanks will be collected and analyzed with the field samples. The core liner rinsate water will be subjected to approximately the same contact time as the field samples.

Sampling Frequency and Locations

A total of 42 sediment samples will be analyzed for p,p'-DDE for the Pilot Project (Table 5-4). Six of these samples will be collected from the hopper dredge prior to placement of capping material taken from each of 2 borrow pits, 12 sediment samples will be sub-samples from cores taken during the Post Cap Monitoring survey of Cell LU and the remaining 24 samples will be sub-samples taken from cores that are obtained as part of the Flex Surveys of the project.

The six individual samples taken from the hopper dredge prior to placement will be sediment samples from the first three loads of capping material taken from each of two borrow areas (designated as borrow areas A2 and A3). Each of these samples will be a composite sample of cap material sub-samples taken from the dredge at three different points: the bow, center and stern of the hopper. The three sub-samples from each load will be homogenized into one representative sample for p,p'-DDE analysis. This sampling method will be repeated for each of the six sample collection events.

The twelve core sediment samples will be sub-samples taken from four of nine cores that will be collected during the Post Cap Survey of Cell LU. The four cores will be selected at random from the nine total cores collected within the cell. Three sediment sub-samples will be extracted from each of the four cores for p,p'-DDE analyses at specified intervals. The sampling intervals are 0 cm (sediment/water interface), 3 cm above the sediment/water interface and 4 cm below the sediment/water interface.

Table 5-4. Sediment Chemistry (p,p'-DDE) Locations, Frequencies and Sampling Intervals.

Parameter	Matrix	Monitoring Type	Frequency	Sampling Stations	Sampling Interval	Total Number of p,p'-DDE Samples
p,p'-DDE	Sediment	In-Hopper Sediment Data	First 3 loads from each of 2 borrow areas	Hopper dredge	One composite sample of sediment (cap material) taken from the bow, center and stern of the hopper dredge for each of 3 loads from each of 2 borrow areas	6 (composite samples)
p,p'-DDE	Sediment	Flex Surveys	As needed to supplement other surveys	Based on discretion of Corps Project Manager	Same as below	24 (8 additional cores sampled at 3 intervals each for a total of 24 samples for analysis)
p,p'-DDE	Sediment	Post Cap	Once in Cell LU and once in Cell SU following completion of cap placement activities.	4 randomly selected cores from 9 total core stations within each of Cells LU and SU	Sediment/water interface (0 cm) 3 cm *above* sediment/mixed layer interface 4 cm *below* sediment/mixed layer interface	24 (8 cores sampled at 3 intervals each for a total of 24 samples for analysis)

In addition to the above analyses, eight additional cores may be collected as part of the Flex Surveys. Each of these cores would be sub-sampled at the intervals described above for a total of 24 sub-samples for analyses. The collection of these additional samples will be at the direction of the Corps Project Manager (or other designee) based on recommendations of the SAIC Project Manager.

5.1.5 Sediment Sample Labeling, Preservation and Holding

Core liners containing sediment cores will be labeled immediately following sediment collection. The core tube itself will be labeled on the outside using indelible ink. The label includes the following specific sample information:

- Project number and title
- Survey number
- Station identification
- Date and time collected
- Sample replicate number
- Top/bottom core indicators
- Collector's name or initials
- Sample depth (if appropriate)

At the end of each day of survey operations, cores will be transferred to the person responsible for shore-based core processing.

As previously indicated, each 100 g subsample of sediment from the core to be analyzed for p,p'-DDE will be placed in a certified-clean, 250-mL glass container with a chemically-inert lid liner. Sample preservation and holding information is summarized in Table 5-5. A label is attached to each sample jar prior to filling. The pre-printed label identifies the date/time of sample collection, project title (site ID), sample number (to be recorded under site ID), preservative (if any), requested analysis and the name of the individual who collected/prepared the sample in the field (Figure 5-1).

5.1.6 Types and Numbers of Sediment p,p'-DDE Samples Generated in the Field

For the p,p'-DDE analysis of the sediment subsamples obtained from each core, the following types of samples will be generated in the field: field sample, field duplicate, field blank, core liner rinsate sample, and core tool rinsate sample. These samples are summarized in Table 5-6 and defined as follows:

<u>Field Sample</u>: A composite sample collected from the hopper dredge or a single aliquot of sediment taken from specific intervals within the cores. The purpose of the hopper dredge samples is to document the concentration of p,p'-DDE in any cap material taken borrow areas A2 or A3. The purpose of the core subsample is to evaluate the vertical distribution of p,p'-DDE relative to the interface between cap material and existing surface sediments within the pilot capping cells.

Table 5-5. Sample Containers, Preservation, Volumes, and Holding Times for Sediment p,p'-DDE Analysis

Parameter	Container	Preservative	Min. Sample Mass	Holding Time
p,p’-DDE	250-mL wide-mouth glass jar, certified clean, with lids lined with chemically-inert material	4° C, freeze upon receipt at laboratory	100 g wet weight (includes primary analysis [20 g] and QC analyses and archival material)	14 days if not frozen; up to 1 year if frozen; 40 days for extracts

Table 5-6. Types and numbers of sediment samples to be generated in the field for p,p'-DDE analysis

Type of sample	Number to be generated in the field
Field sample (in-hopper)	6 (see Table 5-4)
Field sample (core sample)	48 (see Table 5-4)
Field duplicate	5 (10% of field samples)
Field blank	1
Core liner rinsate sample	1
Core tool rinsate sample	3 (1 for every 20 field samples)

SAIC 221 Third Street Newport, RI 02840
1-800-729-4210
PALOS VERDES PROJECT
Collected by: Pam Walter 8/8/00
ATTN: WHG; Helder Costa
Analysis: p,p' DDE
Survey: LU Cap
Sample ID: LU-C-57-A-1

Figure 5-1. Example label for sediment chemistry samples removed from cores. The sample ID shown in this example is based on the following naming convention: LU = placement cell; C = cap survey; 57 = core number; A = core replicate; 1 = horizon in core (1 = 0-3 cm below surface, 2 = 7 cm above cap/EA sediment interface, 3 = 3 cm above cap/EA sediment interface, 4 = 4 cm below cap/EA sediment interface, 5 = 8 cm below cap/EA sediment interface).

Field Duplicate: A second (duplicate) aliquot of sediment collected from the same core interval as the field sample within selected cores and analyzed for p,p-DDE. The field duplicate will be sent to the laboratory as a "blind" duplicate, to provide a check on laboratory analytical precision.

Field Blank: Two 1-Liter containers of distilled water are opened on the table where the cores are being processed and left open for the same period of time that the core section is exposed to air during the core subsampling procedure. The field blank is then sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-Liter containers is required for analysis - the second represents a back-up sample). The purpose of the field blank is to verify that there is no significant contamination of the sediment in the core from the core processing facility/core processing operation.

Core Liner Rinsate Sample: Distilled water is poured over the internal surface of a core liner (chosen at random from among those used in the field), collected in two 1-Liter containers, and sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-liter containers is required for analysis - the second represents a back-up sample). The core liner rinsate sample serves to verify that there is no significant contamination of the collected sediment resulting from contact with the inside of the core liner.

Core Tool Rinsate Sample: The implements used for removing sediment from each core interval (i.e., stainless steel spoon/spatula) will be decontaminated between each sampling event (i.e., prior to sampling of each core interval). At regular intervals (e.g., every 20 samples), the spoon/spatula will be rinsed with distilled water at the end of the decontamination procedure but before the sediment sample is taken. The rinsate will be collected in two 1-Liter containers and sent to the laboratory for analysis of p,p-DDE (note: only one of the 1-Liter containers is required for analysis - the second represents a back-up sample). The tool rinsate sample provides a check on the adequacy of the decontamination procedure to remove residual p,p-DDE from the sampling implements between samples.

5.2 Laboratory Analysis of Sediment Samples for p,p'-DDE

Overall, the laboratory QA/QC program associated with the sediment p,p'-DDE analysis consists of the following elements:

- Documentation of analytical protocols
- Initial documentation of method detection limits
- Initial performance evaluation
- Routine analysis of specified QC samples along with each batch of field samples
- Confirmation of GC-ECD results using GC/MS

5.2.1 Documentation of Analytical Protocols

Woods Hole Group Environmental Laboratories (WHG) of Raynham, Massachusetts will analyze the sediment samples to determine the concentration of p,p'-DDE. The analytical protocol to be followed by WHG is based on the following published methods:

- Method 8081A and Method 8000B, *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, Final Update III, December 1996 (USEPA Office of Solid Waste and Emergency Response, Washington, D.C.)

A complete set of WHG Standard Operating Procedures for sediment analysis of p,p'-DDE is provided in Volume II of the PWP. The following is a summary of these SOPs and any modifications therein to be used by WHG for analyzing the sediment samples from the PV Shelf for p,p'-DDE:

<u>Sample Receipt</u>
Samples received by WHG will be inspected and logged for analysis after measurement of cooler temperature. Samples will be transferred to a freezer at -10° to -20° C for frozen storage as soon as practically possible following receipt. Samples should be aliquoted for determination of percent solids and for screening prior to freezer storage. Procedures are described in WHG *Sample Management Standard Operating Procedure (Revision 4)*.

<u>Sample Screening</u>

1. Aliquot 1 g of each sample into a 40-mL glass vial. Add approximately 1 g of a drying agent (diatomaceous earth) and 10 mL hexane. Mix the sample in hexane by shaking for 5 min.

2. Allow sample/solvent mix to settle for 30 min and aliquot 1 mL of the hexane extract into a GC vial.
3. Analyze by GC/MS using procedures in WHG SOP for EPA Method 8270C, modified as follows: a) calibrate with two calibration standards for 4,4'-DDE using a selected ion monitoring acquisition method that includes the base peak and at least two other ions for 4,4'-DDE, b) screen extracts using the same SIM method developed for the calibration, c) run screens without applicable tuning or CCV procedures.
4. Report screening measurements to the GC supervisor, who will indicate surrogate spike amounts for extraction of each sample assuming 10 g extracted. The GC supervisor will also estimate the approximate extract final volume necessary for a 10-g extract of each sample to provide 4,4'-DDE response within the GC-ECD calibration range (1 ng/mL to 200 ng/mL calibration solution concentrations).

Sample Analysis

1. Aliquot approximately 10 g wet weight of each sample, spike with the amount of surrogate compounds tetrachloro-meta-xylene (TCMX) and decachlorobiphenyl (DCB) indicated by the GC supervisor following the screening analysis.
2. Extract samples following procedures for sonication (EPA Method 3550B) described in Section 7.4 of WHG SOP *Method 8081A Organochlorine Pesticides by Gas Chromatography/ Electron Capture Detection (Revision 0)*.
3. Extract up to 20 field samples with the following batch QC samples: 1 method blank, 1 spiked method blank, 1 matrix spike/matrix spike duplicate pair, and 1 regional reference material (RRM PV7C provided to WHG by SAIC).
4. Exchange methylene chloride extracts into hexane and clean with activated copper following procedures in WHG SOP *Method 3660B Sulfur Cleanup (Revision 1.0)*.
5. Adjust "neat extracts" to a measured volume of 10.0 mL in hexane. **Note:** At a nominal extract volume of 10 mL, which when coupled with a 10-g sample wet weight provides a nominal wet-weight reporting limit of 1 ug/Kg, further extract cleanups will not likely be necessary. Use the first extraction batch as an indication of whether cleanups may be necessary.
6. If further extract cleanup appears necessary, an aliquot of the extract in hexane may be cleaned through amino-propyl gel following procedures in WHG SOP *Amino-Propyl Cleanup of Tissues and Sediments (Revision 0)*. If further cleanup appears necessary, gel permeation chromatography may be employed on methylene chloride extracts following automated high-performance liquid chromatography procedures in WHG SOP *Gel Permeation Chromatography (Revision 0)*.
7. Submit 1 mL of extracts to GC laboratory for any dilutions and analysis by GC-ECD following procedures in WHG SOP *Determination of Polychlorinated Biphenyls (PCBs) as Congeners and Organochlorine Pesticides by Gas Chromatography/Electron Capture Detection (Revision 1.1)*.

8. Implement the following modifications to the SOP cited in step 7:
   - Use only Rtx-5 and Rtx-1701 columns for the dual-column analysis
   - Evaluate all initial calibrations using the linear calibration criterion and use average relative response factors for analyte quantification (calibrate for 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, TCmX and DCB)
   - Use a 15% D acceptance criterion for CCVs
   - Evaluate and report MS/MSD recoveries for 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT; quantify all three only in the native sample associated with the MS/MSD
   - Report recoveries for both surrogates, but DO NOT adjust 4,4'-DDE measurements for surrogate recovery

9. Any initial dilutions of the 10.0-mL "neat extracts" will be performed using a gas-tight syringe by the GC analyst setting up the analysis run. Sample chromatograms with 4,4'-DDE response falling outside the calibration response range for either the primary or confirmatory column will require reanalysis at an adjusted dilution.
10. Report any batch or matrix QC noncompliance to the Laboratory Project Manager prior to implementing corrective action. Instrument QC noncompliance should be addressed by the analyst in consultation with the GC supervisor and corrective action implemented without need for notification of the Laboratory Project Manager.

Confirmatory Analysis

1. The Laboratory Project Manager, in consultation with SAIC, will select 10% of the samples to be confirmed for identification and quantification of 4,4'-DDE by GC/MS-SIM following instrumental procedures in WHG SOP *Analysis of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Spectrometry with Selected Ion Monitoring (Revision 1.0)*.
2. The GC/MS-SIM SOP will be modified to target 4,4'-DDE and the surrogate compounds TCMX and DCB, and the internal standard from the GC-ECD analysis. Each compound will be represented in the SIM acquisition by no fewer than two and no more than three ions. SOP criteria for initial calibration will follow SOP limits for linear calibration with average relative response factors and %D $\leq$ 15% for CCVs. DDT breakdown will not be monitored for the confirmatory analysis.
3. Analyze the associated batch QC samples (method blank and spiked blank) for each sample set. Matrix batch QC (MS/MSD, RRM, SRM) will not be confirmed.
4. Confirmation analyses from multiple (approximately five) extraction batches will be combined into each GC/MS analysis run; these will be reported in a single data package.
5. Confirmatory analysis results will be reported to SAIC to support data validation. Corrective actions will be limited to GC/MS corrective actions specified for QC noncompliance in the SOP. GC/MS results will not be used to trigger corrective actions for GC-ECD analyses.

5.2.2 Initial Documentation of Method Detection Limits

Method detection limit (MDL) studies have been conducted by WHG in accordance with the approved EPA protocol (CFR 40, Part 136) to determine the minimum quantity of p,p'-DDE that can be reliably measured by the analytical methods used for this project. The MDLs for the primary and secondary columns are 0.048 ug/kg and 0.0958 ug/kg, respectively. The practical quantitation limit for sediment samples from this project is 1 ug/kg dry weight.

5.2.3 Initial Performance Evaluation

The initial performance evaluation consisted of determining the concentration of p,p'-DDE in three replicate aliquots of RRM PV7C and two aliquots of SRM 1944 (New York/New Jersey Waterway Sediment; Table 5-7). RRM PV7C is Palos Verdes Shelf sediment that has been well-characterized (in terms of p,p'-DDE concentration) as part of a laboratory intercomparison exercise conducted by the Southern California Bight 1998 (Bight '98) regional monitoring program. The "true" value shown in Table 5-7 represents a consensus value based on analysis of the material by multiple reputable laboratories. This material represents an ideal PE sample because it is a matrix identical to the samples being analyzed, and it is accuracy-based (i.e., the concentration of p,p'-DDE is known with a high degree of confidence). For these same reasons, it will also be used as a laboratory control material to be analyzed with each batch of field samples.

In the case of SRM 1944, the "true" value for p,p'-DDE is a reference value based on repeated analysis of the material by the certifying agency (NIST) using a single technique (GC-ECD). The concentration of p,p'-DDE in SRM 1941 is significantly lower than in RRM PV7C, and the New York/New Jersey harbor sediment comprising the SRM represents a more complex matrix containing numerous contaminants. It was used as a PE sample to verify the laboratory's accuracy in quantifying p,p'-DDE at lower levels and to corroborate the RRM PV7C results. Both reference materials were analyzed at the same time using the same analytical techniques.

Table 5-7. Summary of laboratory results for the initial performance evaluation. All concentrations = ug/kg dry weight (ppb).

PE Sample	"True" Value	Acceptance Range	WHG Results	Avg. % Deviation
RRM PV7C	10,127	6,556 to 15,297	rep 1 = 13,000 rep 2 = 14,000 rep 3 = 14,000 avg = 13,667	34.9%
SRM 1944	86	NA	rep 1 = 60 rep 2 = 67 avg = 63.5	26.2%

The average value reported by WHG for n = 3 replicate analyses of the RRM (13,667 ug/kg) is within 35% of the true value and within the acceptance range . The average value reported for n = 2 analyses of SRM 1944 (63.5) also is within 35% of the true value. These results are considered indicative of the laboratory's ability to meet the program's measurement quality objectives documented in this QAPP.

5.2.4 Routine Analysis of Quality Control Samples

Table 5-8 provides a summary of all of the QC samples that will be analyzed in the laboratory (including field-generated samples) for the sediment p,p'-DDE analysis, including frequency of analysis and target accuracy and precision limits.

Accuracy of sediment p,p'-DDE analyses will be assessed by analyzing RRM PV7C. The RRM PV7C will be analyzed along with each sample batch. Matrix spikes and matrix spike duplicate samples also will be prepared and analyzed with each sample batch. The recoveries of spiked compounds in the MS/MSD will provide a further check on the accuracy achieved by the laboratory. Analytical accuracy is also addressed by acceptable calibration, surrogate recoveries, and method blank results.

The precision of the sediment p,p’-DDE analyses will be evaluated from results of analyses of RRM PV7C, as well as the field-generated field duplicate and the laboratory-generated matrix spike/matrix spike duplicate (MS/MSD) that will be analyzed with each sample batch.

The completeness objective for the sediment p,p'-DDE analysis, which will be calculated on those samples collected and analyzed (as opposed to those collected and archived), is 100%. Data from samples will be considered complete if the samples have been properly collected, preserved, stored, prepared, and analyzed within holding times, and all of the associated quality control criteria have been met.

The representativeness of the sediment chemistry results will be determined by documenting the collection location and conditions to describe fully each sample's origin and handling history. Representativeness of the sediment chemistry data also will be verified by evaluating method and clean-up blank interference, field and equipment interference, and matrix spike/matrix spike duplicate results. Comparability will be evaluated from results of the RRM analyses, as well as comparisons with historical site data.

The laboratory must continuously track and evaluate performance using control charts for recoveries of: surrogate compounds, matrix spike compounds, and p,p'-DDE in RRM PV7C. The results for various QC samples will be reviewed by laboratory personnel immediately following the analysis of each sample batch. The results will be used to determine whether control limits have been exceeded and, if so, corrective actions needed before analyses proceed. The relative accuracy of the RRM analyses will be determined by comparing the laboratory's value for p,p'-DDE against the RRM consensus value of 10,127 ug/kg and the RRM acceptance range of 6,556 to 15,297 ug/kg. On average, the laboratory's value should be within 35% of the consensus value, as well as within the laboratory's own control chart limits.

Table 5-8. Summary of QC Samples and Performance Criteria for Laboratory Analysis of p,p'-DDE in Sediment Samples. NA = not applicable; RPD = relative percent difference; MDL = method detection limit; MS/MSD = matrix spike/matrix spike duplicate; RRM = regional reference material.

QC Sample	Number (Frequency)	Accuracy Criteria	Precision Criteria	Blank Contribution
Initial Calibration Verification (ICV)	2 (1 per batch of 20 field samples)	85% to 115% recovery	NA	NA
Continuing Calibration Verification (CCV)	2 (1 per batch of 20 field samples)	80% to 120% recovery	NA	NA
Field Duplicate	4 (10% of field samples)	NA	RPD ≤30	NA
Field Blank	1	NA	NA	< 3x MDL
Core liner rinsate sample	1	NA	NA	< 3x MDL
Core tool rinsate sample	2 (1 rinsate for every 20 field samples)	NA	NA	< 3x MDL
Method Blank	2 (1 per batch of 20 field samples)	NA	NA	< 3x MDL
Spike Method Blank	2 (1 per batch of 20 field samples)	80% to 120% recovery	NA	NA
MS/MSD	2 (1 per batch of 20 field samples)	75% to 125% recovery	RPD ≤30	NA
RRM PV7C	2 (1 per batch of 20 field samples)	Within acceptance range of 6,556 to 15,297 ug/kg p,p'-DDE	Within laboratory control chart limits	NA

For the analysis of p,p'-DDE in sediment samples obtained from the PV shelf cores during the program, the following objectives are established for calibration checks: 15% relative standard deviation (RSD) for initial calibration verification (ICV) and 20% RSD for continuing calibration verification (CCV).

Final sample concentrations for p,p'-DDE will be reported on a dry weight basis. Sample results will not be corrected for either surrogate compound recovery or blank contributions. The concentrations of individual analytes in method blanks must be less than 3 times the corresponding method detection limit.

5.2.5 Confirmation of GC-ECD Results Using GC/MS

The Laboratory Project Manager, in consultation with SAIC, will select 10% of the samples to be confirmed for identification and quantification of 4,4'-DDE by GC/MS following instrumental procedures in WHG SOP *Analysis of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Spectrometry with Selected Ion Monitoring (Revision 1.0)*. This is EPA Method 8270C modified to acquire data based on selected ions rather than full-scan acquisition mode. Agreement between GC/MS and GC-ECD measurements should be 50%. Lack of 50% agreement triggers a review for possible corrective action. Assuming no apparent quantification errors or biases, the GC-ECD result would be qualified to indicate that GC/MS confirmation exceeded the target for agreement. Corrective actions will be limited to GC/MS corrective actions specified for QC noncompliance in the SOP. The GC-ECD measurement is the reported measurement.

DDT breakdown will not be monitored for the confirmatory analysis. Matrix batch QC (MS/MSD, RRM, SRM) will not be confirmed. Confirmation analyses from multiple (approximately five) extraction batches will be combined into each GC/MS analysis run; these will be reported in a single data package. Confirmatory analysis results will be reported to SAIC to support data validation.

5.3 Laboratory Analysis of Seawater Samples for p,p'-DDE

Overall, the QA/QC program associated with the seawater p,p'-DDE analysis is similar to the sediment program and consists of the following elements:

- Documentation of analytical protocols
- Initial documentation of method detection limits
- Initial performance evaluation
- Routine analysis of specified QC samples along with each batch of field samples
- Confirmation of GC-ECD results using GC/MS

5.3.1 Documentation of Analytical Protocols

WHG of Raynham, Massachusetts will analyze the seawater samples to determine the concentration of "total recoverable" p,p'-DDE (i.e., the whole water sample, which includes both the dissolved and particulate fraction, will be extracted). The analytical protocol to be followed by WHG is based on the following published methods:

- Method 8081A and Method 8000B, *Test Methods for Evaluating Solid Waste*, SW-846, Third Edition, Final Update III, December 1996 (USEPA Office of Solid Waste and Emergency Response, Washington, D.C.)

A complete set of WHG Standard Operating Procedures for seawater analysis of p,p'-DDE is provided in Volume II of the PWP. The following is a summary of these SOPs and any modifications therein to be used by WHG for analyzing the seawater samples from the PV Shelf for p,p'-DDE:

Sample Receipt

Samples received by WHG will be inspected and logged for analysis after measurement of cooler temperature. Samples will be transferred to a refrigerator at 2° to 6° C for storage as soon as practically possible following receipt. Procedures are described in WHG *Sample Management Standard Operating Procedure (Revision 4)*.

Sample Screening

1. Because 4,4'-DDE concentrations in seawater are expected to fall within the calibration range for Method 8081A as applied to this project, samples will not be screened.

Sample Analysis

1. Transfer the contents of the sample container (1-L or 2-L amber glass bottle) to a separatory funnel and spike the sample with the surrogate compounds tetrachloro-meta-xylene (TCMX) and decachlorobiphenyl (DCB).
2. Extract samples following procedures described in WHG SOP *Method 3510C Extraction of Water Samples by Separatory Funnel (Revision 1.0)*.
3. Extract up to 20 field samples with the following batch quality control QC samples: 1 method blank, 1 spiked method blank, and matrix spike/matrix spike duplicate pair.
4. Exchange extracts into hexane and adjust "neat extracts" to a measured volume of 0.500 mL for "plume" samples, and 0.250 mL for "background" or "reference" station samples. **Note:** A nominal extract volume of 0.500 mL coupled with a 1-L sample volume provides a nominal reporting limit of 0.50 ng/L for 4,4'-DDE.
5. If extract cleanup appears necessary, an aliquot of the extract in hexane may be cleaned through amino-propyl gel following procedures in WHG SOP *Amino-Propyl Cleanup of Tissues and Sediments (Revision 0)*.
6. Submit extracts to GC laboratory for analysis by GC-ECD following procedures in WHG SOP *Determination of Polychlorinated Biphenyls (PCBs) as Congeners and Organochlorine Pesticides by Gas Chromatography/Electron Capture Detection (Revision 1.1)*.
7. Implement the following modifications to the SOP cited in step 7:
   - Use only Rtx-5 and Restek CLPesticide II columns for the dual-column analysis. Initial evaluation of the CLPesticide II column versus Rtx-1701 indicated fewer potential co-elutions of DDT pesticides

and PCB congeners on the CLPesticide II column than the Rtx- 1701 under our GC operating conditions.

- Evaluate all initial calibrations using the linear calibration criterion and use average relative response factors for analyte quantification (calibrate for 4,4'-DDE, 4,4'-DDD, 4,4'-DDT, TCMX and DCB)
- Use a 15% D acceptance criterion for CCVs
- Evaluate and report MS/MSD recoveries for 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT; quantify all three only in the native sample associated with the MS/MSD
- Report recoveries for both surrogates, but DO NOT adjust 4,4'-DDE measurements for surrogate recovery

8. Any initial dilutions of the "neat extracts" will be performed using a gas-tight syringe by the GC analyst setting up the analysis run. Sample chromatograms with 4,4'-DDE response falling outside the calibration response range for either the primary or confirmatory column will require reanalysis at an adjusted dilution.
9. Report any batch or matrix QC noncompliance to the Laboratory Project Manager prior to implementing corrective action. Instrument QC noncompliance should be addressed by the analyst in consultation with the GC supervisor and corrective action implemented without need for notification of the Laboratory Project Manager.

Confirmatory Analysis

1. The Laboratory Project Manager, in consultation with SAIC, will select 10% of the samples to be confirmed for identification and quantification of 4,4'-DDE by GC/MS-SIM following instrumental procedures in SOP *Analysis of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Spectrometry with Selected Ion Monitoring (Revision 1.0)*. If possible, samples with GC-ECD measured concentrations of 100 ng/L or greater will be selected for GC/MS confirmation to assure adequate instrument sensitivity.
2. The GC/MS-SIM SOP will be modified to target 4,4'-DDE and the surrogate compounds TCMX and DCB, and the internal standard from the GC-ECD analysis. Each compound will be represented in the SIM acquisition by no fewer than two and no more than three ions. SOP criteria for initial calibration will follow SOP limits for linear calibration with average relative response factors and %D $\leq$ 15% for CCVs. DDT breakdown will not be monitored for the confirmatory analysis.
3. Analyze the associated batch QC samples (method blank and spiked blank) for each sample set. Matrix batch QC (MS/MSD, RRM, SRM) will not be confirmed.
4. Confirmation analyses from multiple (approximately five) extraction batches will be combined into each GC/MS analysis run; these will be reported in a single data package.
5. The goal for GC/MS confirmation is a positive identification and $\leq$50%D between the GC-ECD and GC/MS quantifications. Failure to meet this target goal will trigger review of the GC-ECD and GC/MS

analyses for possible measurement bias. Confirmatory analysis results will be reported to SAIC to support data validation; GC/MS quantifications that do not meet the 50%D goal will be flagged with a qualifier. Other than described herein, corrective actions will be limited to GC/MS corrective actions specified for QC noncompliance in the SOP. GC/MS results will not be used to trigger corrective actions for GC-ECD analyses.

5.3.2 Initial Documentation of Method Detection Limits

MDL studies have been conducted by WHG in accordance with the approved EPA protocol (CFR 40, Part 136) to determine the minimum quantity of p,p'-DDE that can be reliably measured by the analytical methods used for this project. The MDL is 0.8 ng/L, based on extracting one liter of seawater and a final extract volume of 1.0 ml. Additional concentration of the extract volume will enable the laboratory to achieve the required detection limit of 0.25 ng/L for total recoverable p,p'-DDE in the PV Shelf seawater samples.

5.3.3 Initial Performance Evaluation

As previously indicated, the initial performance evaluation will consist of analyzing seawater collected near the bottom on the PV Shelf. Six one-liter containers of seawater will be provided to the laboratory for analysis as a matrix spike/matrix spike duplicate sample. The results will be used to verify the following: 1) the volume of seawater being collected and the laboratory's analytical protocol are both sufficient to provide a detection limit of at least 0.25 ng/L total recoverable p,p'-DDE, 2) the laboratory's reported results are comparable to values reported previously for p,p'-DDE concentrations in near-bottom seawater from the PV Shelf (Zeng et al. 1999), and 3) the laboratory is capable of meeting the required accuracy and precision goals for the MS/MSD seawater samples (see Table 5-9).

If it is found that an insufficient volume of seawater is being collected, the volume will be adjusted in all subsequent sampling to enable a detection limit of 0.25 ng/L to be attained.

5.3.4 Routine Analysis of Quality Control Samples

Table 5-9 provides a summary of all of the QC samples that will be analyzed in the laboratory (including field-generated samples) for the seawater p,p'-DDE analysis, including frequency of analysis and target accuracy and precision limits.

Table 5-9. Summary of QC Samples and Performance Criteria for Laboratory Analysis of p,p'-DDE in Seawater Samples. NA = not applicable; RPD = relative percent difference; MDL = method detection limit; MS/MSD = matrix spike/matrix spike duplicate.

QC Sample	Number (Frequency)	Accuracy Criteria	Precision Criteria	Blank Contribution
Initial Calibration Verification (ICV)	2 (1 per batch of 20 field samples)	85% to 115% recovery	NA	NA
Continuing Calibration Verification (CCV)	2 (1 per batch of 20 field samples)	80% to 120% recovery	NA	NA
Field Duplicate	5 (1 for each of 5 events)	NA	RPD ≤30	NA
Field Blank	5 (1 for each of 5 events)	NA	NA	< 3x MDL
Niskin Rinsate Sample	5 (1 for each of 5 events)	NA	NA	< 3x MDL
Method Blank	2 (1 per batch of 20 field samples)	NA	NA	< 3x MDL
Spike Method Blank	2 (1 per batch of 20 field samples)	80% to 120% recovery	NA	NA
MS/MSD	5 (1 for each of 5 events)	75% to 125% recovery	RPD ≤30	NA

Accuracy of sediment p,p'-DDE analyses will be assessed by analyzing matrix spikes and matrix spike duplicate samples along with each sample batch. The recoveries of spiked compounds in the MS/MSD will provide a check on the accuracy achieved by the laboratory. Analytical accuracy is also addressed by acceptable calibration, surrogate recoveries, and method blank results.

The precision of the seawater p,p'-DDE analyses will be evaluated from results of analyses of the field-generated duplicates and the laboratory-generated MS/MSD that will be analyzed with each sample batch.

The completeness objective for the seawater p,p'-DDE analysis, which will be calculated on those samples collected and analyzed (as opposed to those collected and archived), is 100%. Data from samples will be considered complete if the samples have been properly collected, preserved, stored, prepared, and analyzed within holding times, and all of the associated quality control criteria have been met.

The representativeness of the seawater chemistry results will be determined by documenting the collection location and conditions to describe fully each sample's origin and handling history. Representativeness of the seawater chemistry data also will be verified by evaluating method and clean-up blank interference, field and equipment interference, and matrix spike/matrix spike duplicate results. Comparability will be evaluated through comparisons with historical site data.

The laboratory must continuously track and evaluate performance using control charts for recoveries of surrogate compounds and matrix spike compounds. The results for various QC samples will be reviewed by laboratory personnel immediately following the analysis of each sample batch. The results will be used to determine whether control limits have been exceeded and, if so, corrective actions needed before analyses proceed.

For the analysis of p,p'-DDE in seawater samples obtained from the PV shelf cores during the program, the following objectives are established for calibration checks: 15% relative standard deviation (RSD) for initial calibration verification (ICV) and 20% RSD for continuing calibration verification (CCV).

Sample results will not be corrected for either surrogate compound recovery or blank contributions. The concentrations of individual analytes in method blanks must be less than 3 times the corresponding method detection limit.

5.3.5 Confirmation of GC-ECD results using GC/MS

The Laboratory Project Manager, in consultation with SAIC, will select 10% of the samples to be confirmed for identification and quantification of 4,4'-DDE by GC/MS following instrumental procedures in WHG SOP *Analysis of Polynuclear Aromatic Hydrocarbons by Gas Chromatography/Mass Spectrometry with Selected Ion Monitoring (Revision 1.0)*. This is EPA Method 8270C modified to acquire data based on selected ions rather than full-scan acquisition mode. Agreement between GC/MS and GC-ECD measurements should be 50%. Lack of 50% agreement triggers a review for possible corrective action. Assuming no apparent quantification errors or biases, the GC-ECD result would be qualified to indicate that GC/MS confirmation exceed the target for agreement. Corrective actions will be limited to GC/MS corrective actions specified for QC noncompliance in the SOP. The GC-ECD measurement is the reported measurement.

DDT breakdown will not be monitored for the confirmatory analysis. Matrix batch QC (MS/MSD, RRM, SRM) will not be confirmed. Confirmation analyses from multiple (approximately five) extraction batches will be combined into each GC/MS analysis run; these will be reported in a single data package. Confirmatory analysis results will be reported to SAIC to support data validation.

5.4 Laboratory Analysis of Total Suspended Solids

Overall, the QA/QC program associated with the seawater TSS analysis consists of the following elements:

- Documentation of analytical protocols
- Routine analysis of specified QC samples along with each batch of field samples

5.4.1 Documentation of Analytical Protocols

WHG of Raynham, Massachusetts will analyze the seawater samples to determine the concentration of TSS. The analytical protocol to be followed by WHG is based on the following published methods:

- Method 160.2, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, March 1983 (USEPA, Washington, D.C.)
- Total Suspended Solids Method 2540D, *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, 18th Edition, 1992 (APHA, Washington, D.C.)

The WHG Standard Operating Procedures applicable to the TSS analysis are provided in Volume II of the PWP. The following is a summary of these SOPs and any modifications therein to be used by WHG for analyzing the sediment samples from the PV Shelf for total suspended solids:

Sample Receipt

1. Samples received by WHG will be inspected and logged for analysis after measurement of cooler temperature. Samples will be transferred to a refrigerator at 2° to 6° C for storage as soon as practically possible following receipt. Procedures are described in WHG *Sample Management Standard Operating Procedure (Revision 4)*.

Sample Analysis Summary

Procedures for sample analysis are described in the WHG *Total Suspended Solids Standard Operating Procedure (Revision 4.1)* and summarized as follows:

1. A well-mixed sample is filtered through a glass fiber filter.
2. The residue retained on the filter is dried to a constant weight at 103-105°C.
3. Calculate TSS results in mg/L, report result to two significant figures. The practical range of the determination is 2 mg/L to 20,000 mg/L.
4. QC samples include a method blank, sample duplicate (laboratory duplicate), and laboratory control standard.

5.4.2 Initial Documentation of Method Detection Limits

Method detection limit (MDL) studies have been conducted by WHG in accordance with the approved EPA protocol (CFR 40, Part 136) to determine the minimum quantity of TSS that can be reliably measured by the analytical methods used for this project. The MDL for TSS in seawater reported by WHG is 0.78 mg/L. As previously indicated in the Data Quality Objectives section of this PWP, an objective of the water column TSS measurements is to determine the extent to which cap placement causes increases above background conditions in concentrations of suspended solids. Because background TSS concentrations are expected to range from approximately 1-5 mg/L within the project area (based on recent analyses of two “background” water samples, each containing 2 mg/L TSS), the MDL for TSS measurements (0.78 mg/L) will be sufficient to allow evaluations of the changes in TSS levels following cap placement events.

5.4.3 Routine Analysis of Quality Control Samples

For laboratory analysis of TSS, the following types of quality control samples will be analyzed: field duplicate, method blank, laboratory duplicate, and laboratory control standard (LCS). The field duplicates will be generated in the field along with the regular field samples and sent to the laboratory as "blind" duplicates (see Table 5-3). The field duplicate will consist of a second sample container filled from the Niskin bottle immediately after the primary (i.e., field sample) container is filled. One field duplicate will be generated for each of 8 sampling events.

The method blank, laboratory duplicate, and laboratory control standard are QC samples that will be generated in the laboratory and analyzed along with each batch of 20 field samples. These samples are defined as follows:

Method blank: 300 ml of laboratory distilled water for which TSS concentration is determined.

Laboratory duplicate: A field sample which is selected at random, homogenized and split in the laboratory to create two samples for analysis (duplicates).

Laboratory control standard (LCS): A solution having a known TSS concentration and used to evaluate analytical accuracy. The LCS is prepared by adding a known amount of dried infusorial earth (IE) to distilled water in a 1 liter volumetric flask.

Table 5-10 provides a summary of all the QC samples that will be analyzed in the laboratory for the seawater TSS analysis, including frequency of analysis and target accuracy and precision limits.

Table 5-10. Summary of QC Samples and Performance Criteria for Laboratory Analysis of TSS in Seawater Samples. NA = not applicable; RPD = relative percent difference.

QC Sample	Number (Frequency)	Accuracy Criteria	Precision Criteria	Blank Contribution
Field Duplicate	8 (1 per sampling event)	NA	RPD $\leq$20	NA
Method Blank	1 per batch of 20 field samples	NA	NA	Residual weight cannot exceed 0.5 mg
Laboratory Duplicate	1 per batch of 20 field samples	NA	RPD $\leq$20	NA
Laboratory Control Standard	1 per batch of 20 field samples	80% to 120% recovery	Within control chart limits	NA

5.5 Laboratory Corrective Action

An out-of-control event is defined as any occurrence failing to meet pre-established criteria. A nonconformance is a deficiency in characteristic, documentation, or procedure sufficient to make the quality indeterminate or unacceptable. An out-of-control event is a subcategory of nonconformance.

Factors that affect data quality (failure to meet calibration criteria, inadequate record keeping, improper storage, or preservation of samples) require investigation and corrective actions. Some factors can be easily assessed through the use of control charts. Control charts can reveal shifts, trends, biases, and conditions where parts of the analytical system are out-of-control. The detection of one of these conditions is an indication that the analytical system is out-of-control. The out-of-control value(s) are placed on the control chart, circled, and documented in a corrective action form. The Laboratory QAO is notified and both the analyst and QAO investigate and determine whether the condition indicates a procedure that is truly out-of-control, or a possible random error. The QAO shall document corrective actions taken (i.e., whether the sample run was repeated or whether the data was received and released for reporting to the client) on the corrective action form. Section 3.2.9 of this QAPP describes the use of control charts and rules for deciding when the laboratory process is out of statistical control.

The need for corrective action comes from several sources: equipment malfunction, failure of internal QA/QC checks, failure to follow-up on performance or system audit findings, and noncompliance with QA requirements. When measurement equipment or analytical methods fail QA/QC requirements, the problems will immediately be brought to the attention of the Laboratory Manager and Laboratory QAO. Corrective measures to be taken will depend entirely on the type of analysis, the extent of the error, and whether the error is determinant or not. The corrective action to be taken is determined by either the Laboratory Section Manager , the analyst, the USACE Project Manager, and the Laboratory QAO, or by all of them in conference, if necessary. Final approval, however, is the responsibility of the USACE's Project QAO and/or Project Manager.

If the problem is instrumental or specific only to preparation of a sample batch, samples prepared after the out-of-control event are reprocessed after the instrument is repaired and recalibrated, provided holding times are not exceeded. The analytical chemistry laboratory will ensure that backup equipment/instruments are available so that holding times are not jeopardized by instrument problems. If a sample batch is still out-of-control after reanalysis, all method-related activities shall stop immediately. A detailed laboratory-wide investigation shall be conducted to isolate and correct faulty operations. Sample security, integrity of standards, reagents, glassware, laboratory notebooks, instrument performance, and adherence to the methods shall be included in the investigation.

5.6 Laboratory Data Review, Reduction, Validation, and Reporting

The procedures described below will be used, as applicable, for review, reduction, validation and reporting of the following: 1) analysis of sediment samples for p,p'-DDE, 2) analysis of seawater samples for p,p'-DDE, and 3) analysis of seawater samples for total suspended solids (TSS).

5.6.1 Data Review

Data review is the systematic procedure of reviewing a body of data against a set of criteria to provide assurance of its validity prior to its intended use. The process of data quality review is accomplished through routine audits of the data collection and flow procedures and by monitoring QC sample results. Review of data from the chemistry laboratories involves several levels of evaluation. This process includes the following: dated and signed entries by analyst and section managers on the worksheets and logbooks used for all samples; use of sample tracking and numbering systems to track the progress of samples through the laboratory; and use of quality control criteria to reject or accept specific data. Laboratory data and flow audits for sediment chemistry data include the following:

- Review by the analyst(s) of sample documents for completeness at each step of analysis.
- Review of data relative to instrument calibration, standard preparation, method blanks, raw data, calculations, and transcriptions by analysts, the Laboratory QAO and/or Laboratory Manager.
- Review of instrument logs, and analyst performance by the Laboratory QAO and/or Manager.
- Review of performance indicators such as blanks, surrogate recoveries, MS/MSD, RRM, etc., by analysts, the Laboratory QAO and/or Laboratory Manager.
- Random calculation checks.
- Review of all reports prior to and subsequent to data entry.
- Review and approval of the final data package by the Laboratory Manager.

The data quality indicators (such as method blanks, replicate analyses, and spike recovery determinations) should be compared to the acceptance criteria described in the analytical procedures. The emphasis is on the data acceptability relative to the data quality indicators and on the accuracy of the final data summaries. All analytical problems encountered during sample analysis are properly addressed to provide explanations for data users. The technical documentation is checked against the following criteria during the internal laboratory review:

- Stated QA objectives of the QAPP
- Analysis date versus the applicable holding times
- Percentage of QA analyses conducted
- Field and laboratory blank contamination
- Laboratory accuracy (percent recovery versus control limits)
- Laboratory and field precision (RPD versus control limits).

Data sets are reviewed for completeness and accuracy by the Laboratory QAO or Manager. The data review is documented, and then the data are delivered to the SAIC database management personnel for loading into the database. After data from the laboratory are loaded into the database and formatted, the data are reviewed by SAIC to verify correct values, correct sample information, and correct formats. One hundred percent (100%) of the data values are checked against the hard-copy data reports to verify that the original data have not been altered during the conversion and formatting step. Additionally, sample record information (station, replicate number, instrument code, wet weight, and percent dry weight) in the database is checked against the data sheets. Computer programs are run to match the sample record information with the sample (chemical) data sets to check for missing data.

Review of QC Sample Data

When analyses of a sample set are completed, the results will be reviewed and evaluated to assess the validity of the data set. General principles for all parameters and methods apply as follows:

- Blank Evaluations - Method blank results are evaluated for high readings characteristic of background contamination. If high blank values are observed, laboratory glassware, air, and reagents will be checked for contamination, and the analysis halted until the system is brought under control. A high background is defined as greater than the method detection limit.

- Matrix Spike Pair Evaluation - If the observed accuracy and/or precision values exceed the acceptance criteria for the given parameters, the Laboratory and Project Managers are notified. The sample set may be reanalyzed for the parameter in question.

- Calibration Standard Evaluation - The calibration curve is evaluated to determine linearity through its full range and to verify that sample values are within the range defined by the low and high standards. If the curve is nonlinear, an appropriate algorithm can be used to fit a nonlinear curve to the standards.

- RRM Evaluation - The laboratory's values for RRM PVC7 are compared with the consensus value and acceptance range. Values outside the acceptance range require corrective action to determine the source of error. All sample analyses should be halted pending this evaluation. Following correction of the problem, the RRM should be reanalyzed.

5.6.2 Data Reduction and Validation

This section applies to the laboratory results for both sediment and seawater samples.

<u>Data Reduction</u>

All bench chemists document sample preparation activities in bound laboratory notebooks or benchsheets. These serve as the primary record for subsequent data reduction. The data for GC analyses are generated by stand-alone computers and integrators. Results of each analysis are transferred onto analytical results forms (or electronic spread sheets) specific to the particular analysis. Concentrations of the analytes are expressed according to the required units, depending on the sample matrix. The validity of instrument-generated data shall be supported by maintenance and inspection of the following records:

- Description of the calibration performed
- Description of routine instrument checks (noise levels, drift, linearity, etc.)
- Documentation of the traceability of instrument standards, samples, and data
- Documentation of analytical and QC methodology
- Description of the controls taken to determine and minimize interference from contaminants in analytical methods
- Description of routine maintenance performed.

Steps and checks used to validate precision and accuracy of the measured parameters, and support representativeness, comparability, and completeness, include:

- Correlation coefficient >0.995 (coefficient of determination ≥ 0.990) or other predetermined calibration acceptance criteria
- Predetermined accuracy and precision objectives
- Documentation of the traceability of instrument standards
- Documentation of analytical methodology and QC methodology from the analyses SOP
- Routine maintenance performed and documented in instrument logs
- Documentation of sample preservation, transport, and storage.

<u>Data Validation</u>

In general, laboratory analytical data are to be delivered to SAIC on 3.5 inch floppy disks in a Microsoft Excel®, Microsoft Access®, or equivalent spreadsheet/database file format for incorporation into the DAN-LA database.

Independent data validation is not required for this project. However, for the sediment chemistry analysis data (i.e., p,p'-DDE data), SAIC will perform 100% validation of the data packages from WHG. Complete validation will be conducted on one data package containing seawater chemistry (p,p’-DDE) results. One data package is approximately equal to 30 percent of the total seawater p,p’-DDE data set. Complete validation of the marine sediment p-p’-DDE data will not be conducted due to the limited number of sediment samples to be collected and the level of validation conducted on the marine sediment data packages collected during the baseline monitoring project. Complete validation on all samples will be conducted only in the event that systematic laboratory failures (e.g., using incorrect calculation or peak identification programs at the instrument level) are discovered. A QC summary validation will be conducted on the remainder of the marine sediment and water samples collected, as described in the following sections:

Laboratory Data Package Verification

Data package verification shall be performed by the specific analytical section leader, the laboratory section QC coordinator, and the laboratory QC Manager. Verification will be accomplished through routine audits of the data collection and flow procedures and monitoring of QC sample results. Data collection and flow audits shall include the following checks:

- Review of sample documents for completeness by the analyst at each step of the analysis scheme
- Daily review of instrument logs, performance test results, and analyst performance by the analytical task manager
- Unannounced audits of report forms, notebooks, an other data sheets by the laboratory QC manager
- Daily review of performance indicators, such as blanks, surrogate recoveries, duplicate analyses, and matrix spike analyses, by the analytical task manager
- Checks on a random selection of calculations by the laboratory QC manager
- Review by the laboratory manager of all reports before and after computerized data entry
- Review and approval of final report by the laboratory QC manager.

All laboratory data are validated and approved for incorporation into DAN-LA by the Project Quality Assurance Officer. The following are the basic activities that will be conducted as part of the laboratory data approval process:

- Validation of all laboratory data using relevant and applicable criteria described in the USEPA *National Functional Guidelines for Organic Data Review* (EPA540/R-99/008, October 1999), *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* (SW-846, May 1996), and this QAPP. QC summary validation will be limited to reviewing the information contained in the QC summary forms and comparing the results to the QAPP requirements. Complete validation will include the QC summary form review in addition to the validation procedures described in the above referenced EPA guideline document (i.e., raw data review for system performance indicators, target compound identification, and compound quantification and project-required reporting and method detection limits).

- Reconciliation of all data received with that proposed in the PWP and the analyses requested on the chain-of-custody forms. Compilation of all missing data points and notification of the USACE Project Manager or her designated technical point-of-contact, and the laboratory QC manager.

- Review of laboratory QC check data applicable to all samples in one analytical batch for all sample shipments received. Compilation of all check points outside method control ranges. Assessment of the impact of laboratory QC data on data quality.

- Review of field QC check data applicable to all samples in one sample shipment and for all shipments from the Palos Verdes Study Site to the laboratory. Calculation of RPD values from concentrations of p,p' DDE in the field duplicates, as well as compilation of all blank contamination. Assessment of the impact of field data on data quality.

5.6.3 Laboratory Data Reporting

Data will be submitted to the USACE in both hard copy and electronic format. Final results of the laboratory analyses of environmental samples will be presented and described in the summary report for the pilot capping program. To facilitate data validation and data usability assessment, the minimum laboratory reporting requirements are listed below:

<u>General Analytical Reporting Requirements</u>

- Laboratory sample identification number
- SAIC identification number
- Sample collection and laboratory receipt dates
- Volume or mass of sample purged or extracted
- Percent moisture for each sediment sample
- Upper and lower control limits of percent recovery and RPD calculations for all applicable QC check analyses

<u>General Laboratory Data Package Requirements</u>

- Case narrative specific to the data package submitted
- Copies of all signed chain-of-custody forms specific to the data package submitted
- Analytical results reported as received and in the same order listed on the applicable chain-of-custody form. Each analytical data group shall be reported with all applicable laboratory QC data.
- All analytical results report to one significant figure for values less than 10 and two significant figures for values greater than 10.
- All analytical results reported with correct analytical units (e.g., ng/L, mg/Kg)

<u>GC/MS Confirmation Analyses</u>

- Sample results with method detection limits and laboratory reporting limits
- Surrogate recoveries with control limits
- Method blank results
- Method blank spikes/laboratory control sample results with control limits
- GC/MS tuning results

- Initial calibration results with control limits
- Continuing calibration results with control limits
- Internal standard area and retention time results

GC Analyses

- Sample results with method detection limits and laboratory reporting limits
- Method blank spikes/LCS results reported with control limits
- Surrogate recoveries with control limits
- MS/MSD results with control limits
- Method blank results
- Initial calibration results with control limits for primary and confirmation columns
- Continuing calibration results with control limits for primary and confirmation columns
- SRM/RRM results
- Instrument performance check results
- Clean up check sample results

6.0 GEOTECHNICAL ANALYSIS OF SEDIMENT SAMPLES

6.1 Sample Collection

6.1.1 Sampling Procedures

Sub-samples of sediment taken from each core will be analyzed for the following geotechnical parameters: grain size, bulk density, water content, specific gravity, Atterberg limits and vane shear strength. Details regarding field sampling procedures for sediment coring are presented in the FSP and in the coring SOP (PWP, Volume II). A summary of sample collection procedures follows.

Objectives
The objective of the sediment coring is to collect representative samples of the cap material and the interface of cap and effluent affected (EA) material without contaminating the sample or distorting any existing layering. This sampling is being performed to examine the vertical distribution of selected geotechnical parameters and p,p'-DDE during and following the cap placement operations.

Sample Collection Method
The cores collected for p,p'DDE sub-sampling will be the same cores utilized for geotechnical analysis. Sample collection methods are summarized in Section 5.1.2 of this document and described more fully in the FSP and in an SOP (PWP, Volume II).

At the shore-based laboratory, the cores will be sub-sampled with a minimal amount of disturbance within 24 hours of collection. The cores will be split in half longitudinally, visually inspected for sampling artifacts, and photographed. A detailed description of each core will be recorded. The core description will include the following information:

- Core length
- Log of intervals that were photographed
- Descriptions, including but not limited to: lithology, grain size, texture, odor, presence/thickness of hair mats, number/type of organisms, color, apparent water content

The core length will be measured and the core will be sectioned into discrete, specified intervals (see section below on sampling frequency and locations). Before any sub-sampling occurs vane shear testing of the undisturbed sediment will be conducted at each sample interval. It should be noted that sandy sediments cannot be tested for shear strength. Each sample interval will be attempted, however, very sandy intervals will not yield viable data.

Sub-samples of sediments will be collected in each interval using decontaminated stainless steel scoops. Bulk density samples will be collected using 10 cc plastic tubes. The tubes will be placed in resealable plastic bags that limit the sediments ability to slide out. The sediment in each tube will also be analyzed for water content. Grain size and specific gravity analysis will be conducted using approximately 500g of material from the same sample interval as the bulk density and water content sample. This material is scooped into a resealable plastic bag and labeled with core and sample identifiers. Bulk density, grain size, water content, specific gravity, vane shear and p,p'-DDE samples will be collected from the same core at the designated sample interval. Atterberg limits require more material than can be provided by one core sub-sampled for all of the above analyses, therefore, additional cores will be used for sampling Atterberg limits. Bulk density samples will also be collected from material used for Atterberg limits. The sample interval used for Atterberg limit analysis will be chosen by the laboratory technician based on any observed layering and/or mixing of cap and EA material. As with vane shear, sandy samples do not yield viable data for Atterberg limits. All sediment sub-samples for geotechnical analyses will be held at 4° C (on ice or in a refrigerated storage unit) prior to shipping.

Major Sampling Equipment

Sediment cores will be acquired using a conventional gravity corer; this device is described in detail in Section 5.0 under Major Sampling Equipment.

Vane shear measurements will be made manually during core processing using a motorized laboratory vane apparatus. The vane is lowered into the sediment to be tested and the motorized unit is turned on. When the soil shears, the arrow on the inner scale of the device stops rotating. Using a series of calculations, the vane shear or shear strength can be calculated from the degrees of deflection and rotation given by the sampling device. Further detail on the operation of the motorized laboratory vane can be found in the SOP provided in Volume II of this PWP.

6.1.2 Sampling Frequency and Locations

Table 6-1 provides a summary of the total number of geotechnical samples to be collected. Additional information pertaining to each survey is listed below.

Sediment collected as part of the in-hopper surveys will not be obtained from cores as in the other tasks, however, the samples will be analyzed for geotechnical properties and p,p'DDE in the same manner as the core sub-samples. A single composite sample from each of the first three loads of cap material will be analyzed for grain size, bulk density, specific gravity, water content, and Atterberg limits (providing sufficient fines are present). A single composite sample also will be collected from each of the first three loads of material from each of two borrow areas

Table 6-1. Total Numbers of Geotechnical Samples to be Collected during Different Sampling Events

	In-Hopper Survey	Single Hopper Placement Survey Cells LD, LU & SU	Interim Survey Cell LU	Post Cap Surveys Cells LU & SU	Total # Samples
Grain Size	34	3	1	40	78
Bulk Density	34	3	1	48*	86
Water Content	34	0	0	40	74
Specific Gravity	34	0	0	40	74
Atterberg Limits	34	0	0	8*	42
Vane Shear	0	0	0	40*	40

*maximum number of samples dependent on sampling fine-grained sediments

and sampled for the above geotechnical parameters. An additional 25 composite samples from the hopper dredge will be collected throughout the capping operation; this sampling will occur at the direction of the USACE Project Manager. Overall, a total of 34 in-hopper samples will be collected for geotechnical analysis (Table 6-1).

There will be no geotechnical samples generated during any of the flex surveys. One geotechnical sample for grain size and bulk density will be collected from either one core or a composite of cap material from the four cores collected in the single hopper surveys in Cells LD, LU and SU. Therefore, a total of three grain size and bulk density samples will be collected for the single hopper placement surveys (one for each of the three cells).

One geotechnical sample for grain size and bulk density will be collected in the Interim placement survey after a predicted cap accumulation of 10 cm in Cell LU. The other Interim placement surveys in Cells LU, LD and SU will not be sampled for geotechnical analysis.

Nine cores will be collected during the Post Cap Survey of Cells LU and SU. Four cores from each cell will be selected at random for geotechnical and p,p'-DDE sub-sampling. Three sediment sub-samples will be extracted from each of the four cores at specified intervals for grain size, bulk density, water content, specific gravity and vane shear. The sampling intervals are 0 cm (sediment/water interface), 3 cm above the cap/EA interface and 4 cm below the cap/EA interface. Additional samples for grain size, bulk density, water content, specific gravity and vane shear will be collected at 7 cm above and 8 cm below the cap/EA interface; all of these samples except vane shear will be archived at 4 degrees Celsius at the laboratory performing the geotechnical analyses (Applied Marine Science, Inc.). Therefore, a total of 40 samples for grain size, water content, specific gravity and vane shear will be collected for the Post Cap surveys in Cells LU and SU (24 samples for immediate analysis and 16 samples to be archived at the laboratory).

Atterberg limits require a volume of material dependent upon the amount of fines. To supply the laboratory conducting the analysis with sufficient volume, four of the five remaining cores from Cells LU and SU will be sub-sampled for Atterberg limits. The core interval being analyzed will be selected based upon the amount of mixing of cap and EA material. An additional bulk density sample will be collected at the interval sampled for Atterberg limits. Therefore, a total of 8 Atterberg limits and 48 bulk density samples will be analyzed as part of the Post Cap Survey (Table 6-1).

6.1.3 Sediment Sample Labeling, Preservation and Holding

Core liners containing sediment cores will be labeled immediately following sediment collection. The core tube itself will be labeled on the outside using indelible ink. The label includes the following specific sample information:

- Project number and title
- Survey number
- Station identification
- Date and time collected
- Sample replicate number
- Top/ bottom core indicators
- Collector's name or initials

At the end of each day of survey operations, the collected cores will be transferred to the person responsible for shore-based core processing.

As previously indicated, each grain size, bulk density, water content, specific gravity and Atterberg limit sub-sample from the core will be placed in a resealable plastic bag. The bag is labeled utilizing the naming convention from the original core which includes the date/time of sample collection, project title (site ID), sample number (to be recorded under site ID), requested analysis, and the name of the individual who prepared the sample in the core processing facility. Each interval sampled is noted in the Laboratory Log book and on the COC. Table 6-2 summarizes geotechnical sample containers, preservation, amounts, and holding times.

6.1.4 Types of Geotechnical Samples Generated in the Field

For the grain size, bulk density, water content, specific gravity and Atterberg limits analyses of the sediment subsamples obtained from each core, both field samples and field duplicates will be generated.

Field Sample: A composite sample collected from the hopper dredge or a single aliquot of sediment taken from specific intervals within the cores. The purpose of the hopper dredge samples is to document the grain size and bulk density of the dredged cap material prior to placement. The purpose of the core sub-sample is to evaluate the vertical distribution of geotechnical properties relative to the interface between cap material and existing surface sediments within the pilot capping cells.

Table 6-2. Sample Preservation and Holding Times

Parameter	Container	Preservation	Minimum Sample Mass	Holding Time
Grain Size	Quart size resealable plastic bag	4° C; wet ice or refrigerated	500 grams	Refrigerated, no more than 6 months
Bulk Density	10 cc plastic tube	4° C; wet ice or refrigerated	10 grams	Refrigerated, no more than 6 months
Water Content	10 cc plastic tube (same tube as bulk density)	4° C; wet ice or refrigerated	10 grams	Test as soon as practical after sampling
Specific Gravity	Quart size resealable plastic bag (same bag as grain size)	4° C; wet ice or refrigerated	10 grams	Refrigerated, no more than 6 months
Atterberg Limits	Quart size resealable plastic bag	4° C; wet ice or refrigerated	Dependent on % fines	Refrigerated, no more than 6 months
Vane Shear	NA	NA	NA	Must be tested on site when core is split

Field Duplicate: A second (duplicate) aliquot of sediment collected from the same core interval as the field sample within selected cores and analyzed. The field duplicate will be sent to the laboratory as a "blind" duplicate, to provide a check on laboratory analytical precision. Duplicate vane shear measurements also will be made at a frequency of 10%. Due to the high variability of sediments, duplicate vane shear measurements are often difficult to make. Likewise, it is difficult to obtain shear strength measurements in sediment that is sandy or otherwise lacking a substantial fine-grained fraction.

6.2 Laboratory Analysis of Sediment Samples for Geotechnical Properties

Overall, the QA/QC program associated with the sediment geotechnical analysis consists of the following elements:

- Documentation of analytical protocols
- Routine analysis of QC samples along with each batch of field samples

6.2.1 Documentation of Analytical Protocols

Applied Marine Science, Inc. (AMS) of League City, Texas will analyze the sediment samples to determine the grain size, bulk density, specific gravity, water content and Atterberg limits. A complete set of AMS Standard Operating Procedures for sediment analysis of these parameters is provided in Volume II of the PWP. The following is a summary of these SOPs and any modifications therein to be used by AMS for analyzing the sediment samples from the PV Shelf for geotechnical parameters:

- Determination of Particle Size Distribution (Phi Size Classification) in Sediment Samples. SOP: AMS-PGS93. Reference Method: Plumb 1981. Method to determine disaggragated particle size distribution in marine sediments, adapted from Plumb (1981), characterizes marine sediments in terms of phi size for particle size distribution (full phi distribution). With the phi size distribution values, mean grain size, silt-clay fraction, coarse fraction, skewness, sorting, and kurtosis are calculated.

- Determining the Bulk Density of Soil Samples. SOP: AMS-9504. Reference Method: USACE EM 1110-2-1906. The determination of bulk density of soil is expressed as its weight per unit volume.

- Determination of Atterberg Limits: Liquid Limit, Plastic Limit, and Plasticity Index of Soils. SOP: AMS-D4318. Reference Method: ASTM-D4318 wet multi-point procedure. For marine sediments the liquid limit of the soils is determined by the multi-point procedure described in the SOP. Atterberg limit test method is used as an integral part of several engineering classification systems to characterize the fine-fraction of soils. The Liquid limit: the water content, in percent, of a soil at the arbitrarily defined boundary between the liquid and plastic states. Plastic limit: the water content, in percent, of a soil at the boundary between the plastic and brittle states. Plastic soil: a soil which has a range of water content over which it exhibits plasticity and which will retain its shape on drying. Plasticity Index: the range of water content over which a soil behaves plastically. Numerically, plastic index is the difference between the liquid limit and the plastic limit.

- Determination of Moisture (Water) Content. SOP: AMS-D2216. Reference Method: ASTM D2216. The determination of the moisture content of soils. The moisture content of a material is defined as the ratio, expressed as a percentage, of the mass of 'pore' or 'free' water in a given mass of material to the mass of the solid particles.

- Determination of Specific Gravity of Soil Samples. SOP: AMS-D854. Reference Method: ASTM D854-83 (1984). The determination of the specific gravity of soil by means of a pycnometer. Specific gravity is the ratio of the mass of a unit volume of a material at a stated temperature to the mass in air of gas-free distilled water at a stated temperature. Thus, the results of the specific gravity analyses are reported as a ratio and have no units.

Sample Receipt

Samples received by AMS will be inspected for breakage or loss of water content and checked against the COC accompanying the shipment. Samples will be transferred to a refrigerator and stored at 4° C until analyzed.

Sample Analysis

Bulk density samples will be transferred to a stainless steel volumetric plugger and the corresponding mass recorded. The mass of sediment divided by the volume yields bulk density. Bulk density is reported as a wet unit weight (g/cm3), and after drying, as a dry weight (g/cm3). Potential errors associated with void spaces and foreign matter will be noted and avoided when possible.

Grain size samples analyzed with the Plumb 1981 method combine sieve and pipette analysis of sediments, and classifies samples according to the Wentworth Classification. Under this classification, gravel-sized particles are those retained on a No. 10 sieve (>2.00 mm), sand-size particles are those that pass the No. 10 sieve and are retained on the No. 230 (0.0625 mm) sieve. The distribution of silt and clay-sized particles is measured by pipette withdrawals at prescribed depths and time intervals. Silt particles range from <0.0625 mm to 0.0039 mm. Clay particles are those <0.0039 mm. In the laboratory, sediment samples will be homogenized using stainless steel spatulas creating a 25-50 gram aliquot.

Atterberg limits will be determined using the standard wet preparation, multi-point method. All particles greater then 0.425 mm will be removed and the analysis performed on the remaining sample. The water content of each sample is adjusted using distilled water or a low wattage air dryer. The liquid limit is determined using a standard liquid limit device. The height of the drop for the cup is calibrated with a height gauge to minimize error. The plastic limit of each sample is determined by reducing the water content to the point where the soil can no longer be rolled into 3.2 mm threads. The Plasticity Index is equal to the liquid limit minus the plastic limit

Water/Moisture Content will be determined by weighing the container used for drying with and without the sediment, drying the sample, determining the mass of the sample and container after drying and calculating the percent water content through the differences in mass.

Specific Gravity will be reported as a ratio of mass of a unit volume at a stated temperature to the mass of air or gas-free distilled water at the same temperature. Because specific gravity is a ratio it has no set units.

6.2.2 Routine Analysis of Quality Control Samples

For laboratory analysis of geotechnical parameters, the following types of quality control samples will be analyzed: field duplicates and laboratory duplicates. Table 6-3 provides a summary of QC samples and performance criteria. Quality control limits for the duplicate analyses is ≤25% relative percent difference (RPD). Quality control sample results will be provided in the data report from AMS. The field duplicates will be generated in the field along with the regular field samples and sent to the laboratory as "blind" duplicates (see Section 6.1.4). The field duplicate will consist of a second sample container filled from the same sample interval as the primary (i.e., field sample) container is filled. One field duplicate will be generated at a frequency of 10% of the total number of field samples collected under each parameter (see Table 6-1 for total number of samples for each parameter).

Table 6-3. Summary of QC Samples and Performance Criteria for Laboratory Analysis of Geotechnical Sub-samples. NA = not applicable; RPD = relative percent difference.

QC Sample	Number (Frequency)	Accuracy Criteria	Precision Criteria
Field Duplicate	8 Grain Size 9 Bulk Density 7 Water Content 7 Specific Gravity Atterberg Limits 4 Vane Shear	NA NA NA NA NA NA	RPD ≤25% RPD ≤25% RPD ≤25% RPD ≤25% NA NA
Laboratory Duplicate	1 per batch of 20 field samples, except for Atterberg Limits (1 per batch of 10)	NA	RPD ≤25%

The laboratory duplicate is a QC sample that will be generated in the laboratory and analyzed along with each batch or every 20 field samples, whichever is more frequent. The laboratory duplicate is defined as a field sample that is homogenized and split in the laboratory to create two samples for analysis (duplicates).

6.3 Laboratory Data Reporting

Data will be submitted by AMS to SAIC in both hard copy and electronic format. The results will be accompanied by a case narrative discussing any problems or QA/QC issues related to the analyses. To facilitate data validation and data usability assessment, the minimum laboratory reporting requirements are listed below:

General Analytical Reporting Requirements

- Laboratory sample identification number
- SAIC identification number
- Sample collection and laboratory receipt dates

General Laboratory Data Package Requirements

- Case narrative specific to the data package submitted
- Copies of all signed chain-of-custody forms specific to the data package submitted
- Analytical results reported as received and in the same order listed on the applicable chain-of-custody form. Each analytical data group shall be reported with all applicable laboratory QC data.
- All analytical results report to two significant figures.
- All analytical results reported with correct analytical units

Laboratory Data

Documentation in the laboratory is initiated by the Sample Custodian (SC) who receives samples, assigns laboratory numbers, and generates COC forms which document sample movement in the laboratory. Each shipment of samples received is given a unique batch number (project number). A batch consists of a number of samples carried through the entire analytical procedure, along with samples and standards. All work performed on a sample batch is documented in bound laboratory logbooks which are described as follows:

1. Sample Receiving Logbook is used to record computer-generated sample summary forms which were entered into the laboratory sample data base on a sample receipt basis. It is compiled on a monthly basis to document sample receipt information.

2. Instrument Maintenance Logbook is used to record the maintenance performed on the analytical instruments.

6.4 Document Control

Document control is accomplished through the use of a centralized repository of document inventories and all documents generated in conjunction with the project or contract. All project files, analytical data files, and documentation related to sample analysis are maintained by designated personnel. SOPs and copies of the QA manual will be controlled by the Laboratory QAO through numbered distribution listings. Revisions are subject to SAIC QAO approvals. Revisions will be noted on header pagination used for these controlled documents. SAIC will retain all data records and documents for a period of one year following submittal of the final program deliverables, unless instruction is received from project sponsors (U.S. Army Corps of Engineers or U.S. EPA) specifying a different required record retention time.

Document Handling

Designated laboratory personnel are responsible for the collection, organization, maintenance, and security of all documents, and will establish a client/contract file for all documentation regarding a project or a contract. Active files shall be maintained in locking metal file cabinets. Only authorized personnel shall have access to the files.

The following records will be maintained by the laboratory:

- Logbooks (Field, COC, Bench, Analytical Run, Temperature, and Oven)
- Instrument Calibration Data
- Instrument Maintenance Logs
- Computer Software Verification
- Performance Evaluation Records
- Certification Program Records
- QC Sample Analysis
- Control Charts
- Corrective Action Forms
- Purchased Material Certificates
- QC Coordinator Reports
- QC Audit Reports
- Standard Operating Procedures
- Equipment Manuals
- Personnel Qualifications and Training
- In-House Forms.

Consistency of Documentation

Before releasing analytical results, the laboratory assembles and cross checks the information in field logs, sample tags, custody records, laboratory bench sheets, personal and instrument logs, and other relevant data to ensure that data pertaining to each particular sample or case is consistent throughout the record.

Document Inventory

Document tracking and control are facilitated through the use of an inventory checklist for document tracking.

Document/Data Package Shipping

The delivery schedule of the geotechnical data package from AMS is defined by SAIC. The date of shipping is documented and a list of data/documents shipped is retained for the record. A copy of the data package sent is kept by the laboratory to be filed for future reference in case of future requests for information.

6.5 Data Review and Validation

For the sediment grain size analysis, the weight of each sediment fraction should be reported to the nearest 0.0001 gram dry weight. For all of the geotechnical parameters being analyzed in the laboratory (i.e., sediment grain size, bulk density, water content, specific gravity, and Atterberg Limits), the laboratory should report the results for all samples analyzed (including QC duplicates) both in hard copy and in a computer-readable format (Microsoft Excel® or equivalent spreadsheet). In addition, both the paper and electronic data packages should include a cover letter with a summary of all quality control checks performed and a narrative explanation of any problems that may have influenced data quality.

It is the responsibility of SAIC's DAN-LA database manager (Ms. Chris Seidel) to acknowledge initial receipt of the data package(s), verify that the four data evaluation steps identified in the following paragraph are completed, notify the laboratory of any additional information or corrective actions deemed necessary as a result of the SAIC's data evaluation and, following satisfactory resolution of all "corrective action" issues, take final action by notifying the laboratory in writing that the submitted results have been officially accepted as a completed deliverable in fulfillment of contract requirements. It is the responsibility of the SAIC's QA Officer to closely monitor and formally document each step in the data evaluation process as it is completed. This documentation should be in the form of a data evaluation tracking form or checklist that is filled in as each step is completed. This checklist should be supplemented with detailed memos to the electronic and paper project files outlining the concerns with data omissions, analysis problems, or descriptions of questionable data identified by the laboratory.

Evaluation of the data package should commence as soon as possible following its receipt, since delays increase the chance that information may be misplaced or forgotten and (if holding times have been exceeded) can sometimes limit options for reanalysis. The first part of data evaluation is to verify that all required information has been provided in the data package. On the PV Shelf interim and post-cap monitoring program, this should include the following specific steps:

- SAIC's Database Manager will verify that the package contains a cover letter signed by the laboratory manager, hard copies of all results (including QA/QC results), and accompanying computer diskettes.

- The electronic data file(s) will be parsed and entered into the DAN-LA database to verify that the correct format has been supplied.

- Once the data have been transferred to the DAN-LA database, checks will be performed to verify that results have been reported for all expected samples and all analytes.

SAIC's Project Manager or his designee will contact the laboratory and request any missing information as soon as possible after receipt of the data package. If information was omitted because required analyses were not completed, the laboratory should provide and implement a plan to correct the deficiency. This plan may include submittal of a revised data package and possible reanalysis of samples.

Data validation, or the process of assessing data quality, will begin after SAIC has determined that the data package is complete. Data validation for grain size data will consist of the following: 1.) a check to verify that all reporting units and numbers of significant figures are correct; 2.) a check to verify that the cumulative percentage of each particle size fraction never exceeds 100% (i.e., a failed range check); 3.) a check to verify that the precision goal of RPD $\leq$25% for the field duplicate and laboratory duplicate samples has been met.

For the other geotechnical parameters (bulk density, water content, specific gravity, and Atterberg Limits), data validation will consist of the following: 1.) a check to verify that all reporting units and numbers of significant figures are correct; 2.) a check to verify that the precision goal of RPD $\leq$25% for the field duplicate and laboratory duplicate samples has been met.

Upon completion of all data evaluation steps, a memo summarizing the QA review of the data package will be prepared, samples will be properly stored or disposed of, and laboratory data will be archived both in a storage file and in the DAN-LA database. Memos summarizing the results of the QA review of the data package will summarize all conclusions concerning data acceptability and should note significant quality assurance problems that were found. These memos are useful in providing data users with a written record of data concerns and a documented rationale for why certain data were accepted as estimates or were rejected. The following specific items should be addressed in the data evaluation memo:

- Summary of overall data quality, including a description of data that were qualified.
- Brief descriptions of sample collection and analysis methods.
- Description of data reporting, including any corrections made for transcription or other reporting errors, and description of data completeness relative to objectives stated in the QA plan.

7.0 SEDIMENT PROFILE IMAGING AND SEDIMENT PLAN VIEW PHOTOGRAPHY

7.1 Quality Assurance Objectives for Measurement Data

Sediment profile imaging (SPI) and sediment plan view photography are both semi-quantitative sampling techniques, and no specific reference materials or standards exist that can be used to evaluate directly the accuracy of the collected data. Comparability for the SPI/plan view monitoring component will be addressed by adherence to SAIC Standard Operating Procedures for these seafloor imaging techniques. Use of standard procedures for image acquisition, analysis and reporting will ensure comparability among multiple surveys to be performed throughout the course of the PV Pilot Capping monitoring program. Representativeness will be ensured through the use of a survey design which includes obtaining images at multiple stations distributed in and around each pilot capping cell. During selected sampling events, three replicate SPI and corresponding plan view photographs will be obtained at each station. The sampling design should provide an evaluation of both small-scale (i.e., within station) and larger-scale (i.e., among station) variability and thus accurately represent sediment physical and biological conditions within each cell. Representativeness of the SPI/plan view data also will be evaluated by comparisons with data from coring, side-scan, and subbottom profiling.

For those monitoring surveys where three replicate SPI images are to be obtained and analyzed at each station, an average value will be calculated for each of the measured parameters (e.g., redox potential discontinuity depth, penetration depth, Organism-Sediment Index) and used for mapping and interpretative purposes. For parameters which are not expressed on a continuous number scale (e.g., successional stage designation; grain size major mode), all of the replicate values will be displayed in maps and used for interpretative purposes. For those monitoring surveys where only a single image (out of three replicates) is to be analyzed, the image will be selected based on the best professional judgement of SAIC scientists. Typically, the image selected will be the one which best exemplifies the characteristics of the station and which is of the highest quality for subsequent analysis (e.g., optimal penetration of the camera prism into the sediment, sediment-water interface clearly observed, sediment features clearly visible, lack of artifacts such as streaking or smearing). It is not possible to specify acceptance criteria for precision or agreement among the values measured for the three replicate images; these values will reflect the small-scale (i.e., on the order of meters) spatial heterogeneity or homogeneity which is naturally present at a given station.

The completeness objective for SPI/plan view photography is 100%. The field procedures and associated QA/QC are designed to ensure that the 100% completeness goal is met. These procedures are described in detail in the FSP. Briefly, back-up camera systems and a complete inventory of spare parts will be available to avoid loss of data due to mechanical or electronic equipment malfunction. The film will be developed and reviewed immediately following the completion of each day's field work. Images can be missed due to over- or under-penetration of the

SPI camera prism at a given station. The SPI camera penetration can be adjusted by adding weights, lowering the "stops" or adding "snow shoes" to allow successful image acquisition. Same-day developing and review of the images will allow stations to be re-occupied on the following field day and any missed images obtained.

7.2 Sampling Objectives, Locations and Frequency

The objective of the SPI/plan view sampling is to support characterizations of the physical and geotechnical properties of bottom sediments within and around the pilot capping cells, particularly with respect to the presence and thickness of cap material layers within and around the various pilot cells during and following the cap placement operations.

The SPI/plan view sampling stations will be located both within and outside the boundaries of the pilot capping cells. Schematic diagrams which illustrate the locations of the SPI/plan view stations are provided in the Field Sampling Plan. Pre-capping (i.e., baseline) SPI/plan view surveys will be performed; these are documented in the PWP prepared for the baseline phase of the monitoring program. For the interim and post-cap phases of the monitoring program (this PWP), the number of SPI/plan view stations per cell and the sampling frequency are summarized in Table 7-1. Four sampling surveys will occur at Cell LU: one survey after a single hopper load of material has been placed, two interim placement surveys and a post-capping survey (Table 7-1). The first interim survey will occur after the predicted number of loads to create a 10 cm cap have been placed within the disposal cell. The second interim survey will occur two thirds of the way through the 15 cm cap placement. Two surveys will occur at Cell LD: one after a single hopper load of material has been placed and one post-capping (Table 7-1). Three sampling surveys will occur at Cell SU: one survey after a single hopper load of material has been placed, one interim placement survey, and a post capping operations survey (Table 7-1). The interim survey will occur two thirds of the way through the 15 cm cap placement.

7.3 Major Sampling Equipment

Field sampling operations will use research vessels equipped with a hydraulic A-frame and winches, at least 2,500 feet of hydrographic wire or line, and complete electronic instrumentation (radar, depth finder, dGPS, radio). Vessels will meet all Coast Guard regulations.

SPI images will be acquired using a Benthos Model 3731 sediment profile camera. The camera consists of a wedge-shaped prism with a Plexiglas face plate; light is provided by an internal strobe. The back of the prism has a mirror mounted at a 45-degree angle to reflect the profile of the sediment-water interface toward the camera which is mounted horizontally on the top of the prism. The prism is filled with distilled water, through which the photographs are obtained. Because the object (sediment) to be photographed is directly against the face plate, turbidity of the ambient seawater is not a limiting factor. The camera prism is mounted on an assembly that can be moved up and down by allowing tension or slack on the hydrowire. The rate of prism penetration into the bottom sediment is controlled by an adjustable, "passive" hydraulic piston.

Table 7-1. Summary of the SPI/plan-view sampling effort for the interim and post-cap monitoring program

Survey Type	Capping Cell(s)	Number of Stations	Sampling Frequency	Total No. of Images to be Analyzed (includes all cells)	Level of Analysis
Single Hopper Placement	LU, LD, SU	37 stations per cell (15 stations within the cell and 22 stations surrounding the cell)	1 replicate image at each station, at 4 randomly selected stations 3 replicates will be analyzed	(4 stations x 3 replicates + 33 stations x 1 replicate) x 3 cells = **135 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments
Interim Placement	LU (x2), SU	14 stations per cell (all stations within the cell)	1 replicate image at each station, at 2 randomly selected stations 3 replicates will be analyzed	(2 stations x 3 replicates + 12 stations x 1 replicate) x 3 surveys = **54 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments
Post Cap	LU, LD, SU	37 stations per cell (15 stations within the cell and 22 stations surrounding the cell)	1 replicate image at each station, at 4 randomly selected stations 3 replicates will be analyzed	(4 stations x 3 replicates + 33 stations x 1 replicate) x 3 cells = **135 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments
Flex Survey(s)	As needed	Up to 60 stations in total	1 replicate image at each station	60 stations x 1 replicate = **60 images**	Thickness of cap material and evidence of mixing or erosion of EA sediments

mounted at a 45-degree angle to reflect the profile of the sediment-water interface toward the camera which is mounted horizontally on the top of the prism. The prism is filled with distilled water, through which the photographs are obtained. Because the object (sediment) to be photographed is directly against the face plate, turbidity of the ambient seawater is not a limiting factor. The camera prism is mounted on an assembly that can be moved up and down by allowing tension or slack on the hydrowire. The rate of prism penetration into the bottom sediment is controlled by an adjustable, "passive" hydraulic piston.

The equipment and expendable supplies associated with the SPI sampling operations are listed below:

- Benthos Model 3731 Sediment Profile Camera
- 25 lb lead weights (2 sets of 5)
- 7.2 volt rechargeable battery packs

- Benthos pinger and hydrophone
- ASA 100 color slide film (36 exposures per roll)
- "Mud" doors to prevent over penetration into soft sediment
- Glass cleaner and paper towels
- Distilled water
- Winch and hydrowire
- Swivel for hydrowire
- Field notebook and sampling logs
- DGPS navigation system and sampling stations
- SPI tool kit with stainless hardware spares

Plan view photographs of the seafloor will be acquired using a downward-looking Photosea underwater 35 mm camera and strobe which are mounted on the sediment profile camera chassis. Primary plan view camera components that will be mobilized for the plan view sampling include:

- Photosea Underwater 35 mm Camera and Strobe
- Synchronized Camera and Strobe Trigger Assembly
- ASA 200 Color Slide Film (250 exposures per bulk roll)

7.4 Field Sampling Procedures

All methods are standardized to maintain consistent and high quality data collection. Detailed descriptions of field survey methods are provided both in the FSP and in the following SOPs (PWP Volume II):

- *Standard Operating Procedure for the Collection and Analysis of Sediment Profile Images*
- *Standard Operating Procedure for Sediment Plan view Photography and Analysis*

7.5 Sample Labeling

During sample acquisition, date, time, station, replicate number, and coordinates are recorded in the field log by the field technician for each image acquired. The field technician is also responsible for processing the film at the end of each day and for storing the film data until it is relinquished to the image analyst. The coordinates of each sampling point (i.e., individual camera drop) also are electronically logged on the navigation system. The SPI camera is equipped with a data-back which displays the current time when the photograph is taken. The digital time stamp recorded on each image and the numerical order of the images are used to identify the correct station and replicate number. The plan view camera has a digital display which records the time, a survey identifier and the frame count on each image. This information is used to identify the correct station and replicate number for each plan view photograph. The project name, date, time, station number, and replicate number are then recorded on each slide by the image analyst. All slides from a survey are inserted into clear plastic slide-holder sheets and maintained in a three-ring binder as one data set. The project binder containing original sediment-profile images and plan view photographs, edited REMOTS® Data Sheets, the edited hardcopy of the plan view data spreadsheet, survey navigation diskettes, and other related information is labeled with the project name and date, and stored in a secure Data Archive Room located at the SAIC facility in Newport, RI.

7.6 Equipment Calibration

Calibration is the comparison of a measurement standard or instrument with another standard or instrument to report or eliminate by adjusting any variation (deviation) in the accuracy of the item being compared. This section describes preparation of calibration standards, and calibration procedures used for instrumentation and equipment.

<u>Sediment Profile Imaging</u>
At the beginning of each survey day, the camera data back time setting is synchronized to the navigation computer time. The data back records a digital time stamp on each image that matches the navigational fix time. After the film has been processed, the correct station and replicate identification for each image is determined using this time stamp.

A real-time verification of successful image acquisition is provided by the Benthos pinger, which is attached to the camera frame and doubles its ping rate when the camera fires successfully. A test shot is taken at the beginning of each new roll of film. This shot records the film roll number and date. This is done to verify that the Benthos pinger and frame counter are working properly, and also provides a unique identifier for each roll of film. At regular intervals during each survey day, the frame counter is checked to make sure that the desired number of replicates have been taken. If images have been missed or the penetration depth is insufficient, then proper adjustments are made (e.g., weight is added to the frame) and additional replicates are taken. Two weight packs, each capable of holding 125 pounds of lead (in 25 lb increments), can be loaded to increase penetration (e.g., for work in sandy or high shear strength, compacted sediments). If penetration is too great, adjustable stops can be lowered to control the distance the prism can descend. In addition, "mud" doors can be attached to each side of the frame to increase the bearing strength of the entire unit.

A computer image analysis system is used to make linear measurements of the images, such as prism penetration depth, and is also used to detect differences in optical reflectance used to determine the apparent RPD depth. The image analysis system is calibrated at the beginning of each analysis day. A digital image is taken of a calibration slide that is marked in ten 1 cm increments. The image is measured using the image analysis system and the calibration data are stored. The system is recalibrated whenever focus or zoom adjustments are made on the video camera.

Sediment Plan view Photography

At the beginning of each survey day, the plan view camera display time setting is synchronized to the navigation computer time. The display records a digital time stamp on each image that matches the navigational fix time. After the film has been processed, the correct station and replicate identification for each image is determined using this time stamp.

7.7 Analytical Procedures

Sediment Profile Imaging

The SPI images will be analyzed with a full-color image analysis system. This is a PC-based system integrated with a Javelin video camera and frame grabber. Color slides are digitally recorded as color images on computer disk. The image analysis software is a menu-driven program that incorporates user commands. The system displays each color slide on the color monitor while measurements of physical and biological parameters are obtained. Software allows the measurement and storage of data on up to 21 different variables for each image obtained. Automatic disk storage of all measured parameters allows data from any variables of interest to be compiled, sorted, displayed graphically, contoured, or compared statistically. All measurements are printed out on data sheets for a quality assurance check by an SAIC senior scientist before being approved for final data synthesis, statistical analyses, and interpretation.

SPI images will be analyzed for the following parameters:

- Sediment type: major mode and sorting
- Boundary roughness
- Optical prism penetration depth
- Mud clasts
- Apparent RPD
- Layering
- Methane
- Infaunal successional stage
- Organism-sediment index
- Habitat Characterization

A complete description of image analysis techniques for each of these parameters is provided in the SAIC *Standard Operation Procedure for the Collection and Analysis of Sediment Profile Images* (PWP Volume II).

Sediment Plan View Photography

The purpose of the plan view photograph analysis is to supplement the more detailed and comprehensive SPI characterization of the seafloor. The plan view analysis consists of qualitative descriptions of key sediment characteristics (e.g., sediment type, bedforms and biological features) based on careful scrutiny of projected 35 mm slides. Since the surface sediment descriptions are based on visual observations and therefore are somewhat subjective, only the obvious presence of rock, gravel, sand and/or fines can be noted. Likewise, the presence of shell debris and any evidence of epifaunal or infaunal organisms (e.g., tubes, burrow openings, etc.) can be recorded. Recent dredged material can be evidenced from black, grey or rust-colored deposits of poorly sorted or overconsolidated sediments. The presence of dredged material from past disposal can sometimes be indicated by angular rocks and/or anthropogenic materials. An estimation of wave energy can be determined by the presence of ripples in sand and/or deposits of fine-grained material. Fine-grained sediments tend to be winnowed away in higher energy environments. Higher energy environments can also cause ripples in sandy substrates. A scale bar is not present in the photographs; however, each photograph covers an area of seafloor measuring roughly 0.48 m x 0.71 m (roughly 0.34 m^2).

7.8 Data Review, Reduction, Validation, and Reporting

Data reduction, validation, and reporting are on-going processes that involve the field personnel, analysts, QA personnel, and the Project Manager. The following section describes the data handling process and outlines responsibilities of the various personnel. Collected data shall not be reported or released outside of the program organization without the written authorization of USACE and/or USEPA.

Documentation associated with SPI and sediment plan view photography consists of field logs and data files and associated hard copy (data sheets) generated during image analysis.

<u>Sediment Profile Imaging</u>

At the end of each survey day the film of the acquired images is processed. When the film is dry the images are reviewed and stations requiring re-sampling are noted. After the survey is complete and the slides are mounted and labeled, the images are analyzed (Figure 7-1).

An SAIC technician operates the image analysis system and generates a series of measurements for each sediment-profile image. The data for each image are stored in an individual REMOTS® Data Sheet (RDS) file. Upon completion of analyses, all RDS files are printed out and reviewed for accuracy and completeness by an SAIC senior scientist. Edits are noted on the hard copy RDS printouts and then entered by the technician into the electronic file. Re-measurement of parameters using the image analysis system is done at this time. When all edits and re-measurements are complete, the data from all RDS files are exported into bulk data spreadsheet format. The bulk data spreadsheet is compared to the edited RDS hard copies to eliminate transcription errors or omissions. The sediment-profile images are scanned to create electronic files in .TIF format. An archive CD is created to store all the image

DATA REDUCTION, VALIDATION AND REPORTING

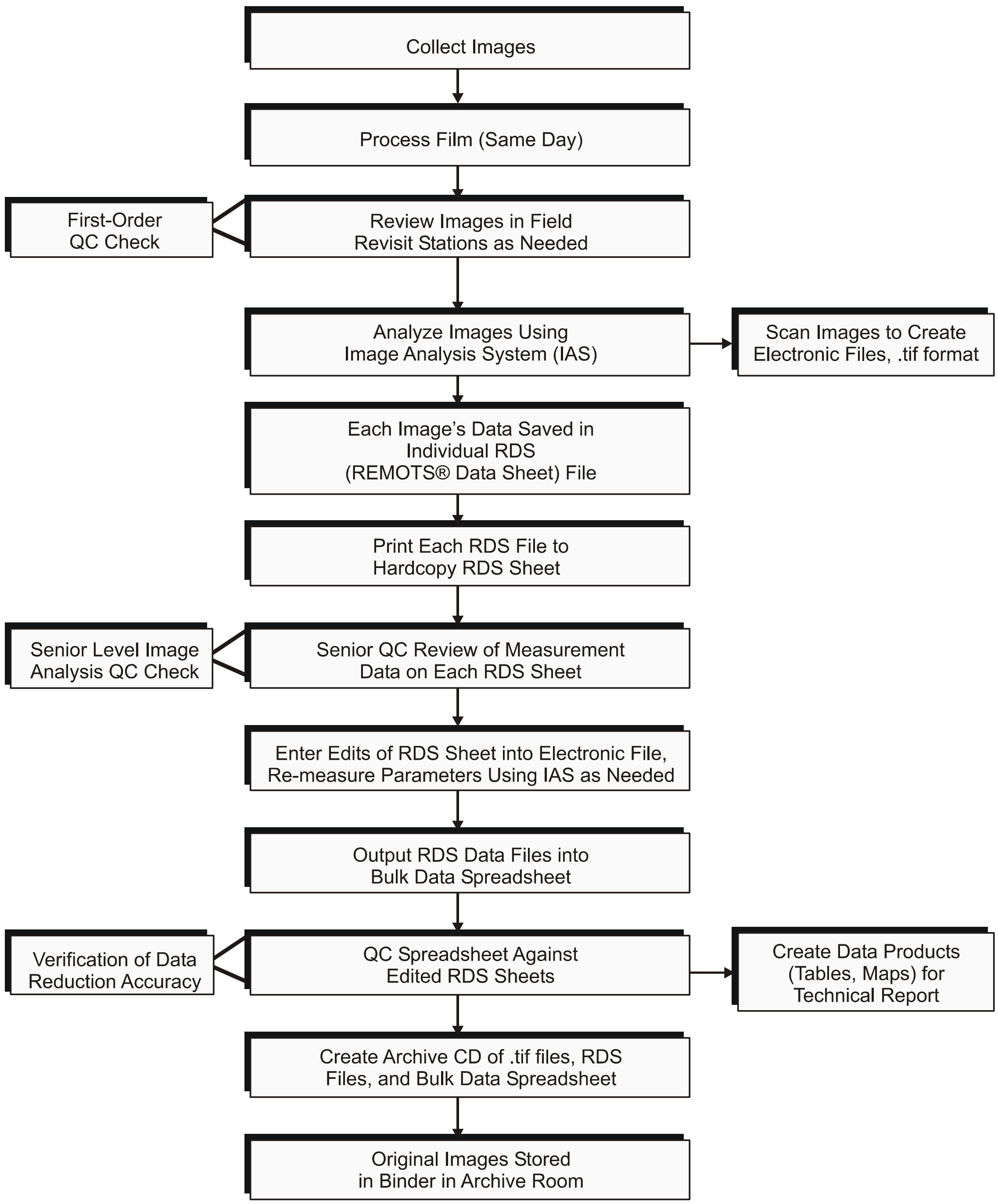


Figure 7-1. Flow chart of data reduction, validation and reporting for sediment-profile imaging.

files, RDS files, and the spreadsheet of the exported bulk data. Data products (tables and maps) are created from the bulk data spreadsheet. The original images and edited RDS sheets are stored in a binder in an archive room at the SAIC facility in Newport, RI.

Sediment Plan View Photography

At the end of each survey day the film of the acquired images is processed. When the film is dry the images are reviewed and stations requiring re-sampling are noted. After the survey is complete and the slides are mounted and labeled, the images are analyzed.

During image analysis, the various parameters are measured by an SAIC technician, and the data for each image are stored as a line item within a spreadsheet file. Upon completion of analyses, the spreadsheet is printed out and reviewed with the slides by an SAIC senior scientist. Edits are noted on the hard copy and then entered into the electronic file. The plan view photographs are scanned to create electronic files in .TIF format. An archive CD is created to store all the image files and the plan view data spreadsheet file. Data products (tables and maps) are created from the data spreadsheet. The original images and edited hard copy spreadsheet are stored in a binder in an archive room.

7.9 Internal Quality Control Checks

7.9.1 Field QA/QC

SPI Image Field QA/QC

A first-order QC review of sediment-profile images will be performed by the SAIC field team leader to ensure that a sufficient number of images of acceptable quality were obtained. Unacceptable images include:

- Underpenetration/No penetration. Check the number of weights and, if more can be added, revisit the site. If the site is too rocky, penetration may not be possible. Check the other replicate images obtained at the station and estimate whether penetration is possible.
- Overpenetration. Check and reduce the number of weights, possibly use the mud doors, and revisit the site. Some material may be too soft to support the weight of the camera.
- Pull out. The camera prism has started to pull away and is not flush with the sediment when the image is taken; revisit the site.
- Mud Smears. The wiper blade may not be near enough to the prism glass or material may be very sticky. Revisit the site after checking the wiper blade.
- Black image. No illumination of the sediment via the strobe light; check the strobe and revisit the site.
- Water shot. Revisit the site.

Plan view photograph Field QA/QC

A first-order QC review of plan view photographs will be performed by the SAIC field team leader to ensure that a sufficient number of images of acceptable quality were obtained. Unacceptable images include:

- Obscured. Due to vegetation or suspended sediment. If the site has abundant vegetation an unobscured image may not be possible. Check the other replicates and make a best estimate whether a good image can be collected.
- Black image. No illumination; check the strobe and revisit the site.
- Water shot. Revisit the site.

7.9.2 Laboratory QA/QC

SPI Image Laboratory QA/QC

Upon completion of the image analysis, an SAIC senior scientist will conduct a QC review of the measurement data for each image using the RDS hard copy. The QC check following image analysis will flag any potential errors from the image analysis. Some variables that can be incorrectly measured include the maximum grain size, successional stage, or RPD depth. Corrections are noted on the RDS hard copy and edits are made to the electronic files.

Once the RDS hard copies have been corrected and re-measurements made using the image analysis system, the corrected data will be exported into a summary spreadsheet. The values in the summary spreadsheet are checked against the hard copy RDS sheets to verify 100% transcription accuracy.

Plan view photograph laboratory QA/QC

Upon completion of the image analysis, a senior scientist will conduct a QC review of the data for each image using the spreadsheet hard copy. The QC check following image analysis will flag any potential errors from the image analysis. Corrections are noted on the hard copy and edits are made to the electronic file.

7.10 Preventive Maintenance

As part of survey mobilization, all SPI and plan view field equipment is "bench tested" to ensure everything is working properly before departure. The equipment includes, but is not limited to, the electronic components of the SPI camera, the Benthos pinger, plan view camera, and plan view strobe. Upon return from the survey, demobilization of all field equipment includes a fresh water rinse and servicing such as checking o-rings and batteries. The equipment will be re-checked and, if it is not functioning properly, repairs made (i.e., replace electronic boards within the camera). Routine maintenance is also accomplished at this time (i.e., replace prism window and/or mirror).

7.11 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The SAIC Field Team Leader is responsible for verifying that all QC procedures are followed. This requires that the Field Team Leader assess the correctness of the field methods and the impact of any deviations upon the sampling objectives and subsequent data quality. In addition, the Field Team Leader is responsible for ensuring that the QA objectives are met. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective to not be met, or impact data quality, the Field Team Leader will immediately notify the SAIC Project Manager. Corrective action measures are then decided upon and implemented. The Field Team Leader documents the situation, the field objective affected, the corrective action taken, and the results of that action. Copies of the documentation are provided to the Project Manager and the Project QAO.

During field survey operations it is apparent immediately if there is a problem with the SPI camera, the pinger, or the plan view system. During the SPI test shot, performed on the sampling vessel immediately prior to the initial deployment of the camera and following each change of film, the motor winder is audible, the strobe flash is visible, the pinger doubling is audible, and the film counter is checked. If any one of these actions fails, trouble-shooting begins until the problem is resolved. Similarly, during the plan view test shot the motor winder is audible, the strobe flash is visible, and the film counter is checked. If any one of these actions fails, trouble-shooting begins until the problem is resolved. If the data record is interrupted or distorted, sampling will cease until the problem is identified and corrected.

8.0 TURBIDITY PLUME TRACKING USING A BROADBAND ADCP

8.1 Quality Assurance Objectives for Measurement Data

No specific reference materials or standards exist that can be used to evaluate directly the accuracy of the Broadband Acoustic Doppler Current Profiler (BBADCP). The scattering of acoustic energy by sediment particles suspended in the water column produces acoustic signals that can be measured by the BBADCP. The successful use of the method requires that the acoustic signals from the suspended sediment associated with the placement operation be clearly distinguishable from signals produced by other acoustic scatterers. Other acoustic scatterers include suspended sediment unrelated to the placement operation, plankton, and air bubbles. Therefore, this method is not suitable for areas where the acoustic signals from other scatterers result in spatial and temporal distributions that are similar to those produced by the suspended sediment from the placement operation.

In addition to determining the distribution of suspended sediment from a dredged material placement operation, a BBADCP survey can acoustically measure current speed and direction for calculations related to the transport of suspended material. The BBADCP measures water motion relative to its own acoustic sensors, and can track its motion relative to the seafloor. Thus the relative water motion from the BBADCP's movement can be determined and subtracted from the measured water motion to produce measurements of current speed and direction. When the BBADCP can track bottom, a survey is useful for measuring currents over a wide area, and measuring current variations with depth. The BBADCP can track bottom when the bottom is hard and the instrument is located less than 60 m off the bottom. Accurate measurements of current made while the instrument is tracking bottom require that the survey be conducted at a speed of less than 2 m/s, and that it be conducted along straight survey lines. When the BBADCP cannot track bottom, single point measurements of current speed and direction with depth down to less than 60 m can be made. This requires that the instrument be kept at a single position for at least 1 min, and position data from a Differential Global Positioning System (DGPS) capable of at least +/-1 m accuracy be recorded with the BBADCP data. The DGPS data are used to correct for the inaccuracy of not being able to keep the instrument at a fixed position. For both bottom-tracking and non-bottom-tracking data acquisition, the BBADCP records quality data only when its sensors are pointing straight down toward the seafloor within +/-20^{o} from the vertical. It is not suitable for measuring current speed and direction when waves or other motions cause frequent variations in sensor orientation outside the 20^{o} specification.

Comparability for the BBADCP will be addressed through adherence to the Standard Operating Procedure (SOP) for Broadband Acoustic Doppler Current Profiler (BBADCP) Surveys of Dredged Material Placement Operations provided in Volume II of this Project Work Plan (PWP). This will ensure comparability among the multiple BBADCP surveys that will be performed throughout the course of the PV Pilot Capping Monitoring Program.

8.1.1 Sampling Objectives

The objective of the BBADCP surveys is to assess the extent of sediment plume surge during placement operations. In this capacity, the BBADCP system will be used to help map the location and extent of the plume created by the placement of cap materials and to facilitate the collection of seawater samples for subsequent chemical analysis. The BBADCP will be used to identify and track the plume for sample collection for a 2-hour period following material placement.

8.1.2 Sampling Frequency

BBADCP monitoring surveys for the Pilot Capping Monitoring Program will occur during several stages: initial disposal at cell LU and SU and during two other events to be determined in coordination with the Corps Project Manager. The surveys will be carried out simultaneously with the seawater chemistry sample collection and the video documentation of placement surge tasks of this PWP.

8.1.3 Sampling Locations

Identifying and documenting the location and extent of the plume created by the placement of cap materials for two hours using the BBADCP system requires that the survey plan remain flexible. Documentation locations are dependent upon a number of oceanographic conditions (e.g., currents, stratification etc.). To this end, BBADCP sampling locations for this project will be at the discretion of the BBADCP Survey Field Leader and the SAIC and Corps Project Managers.

8.2 Major Sampling Equipment

The BBADCP is a 5-beam, 600-kHz , Broad Band Acoustic Doppler Current Profiler manufactured by RD Instruments (RDI) in San Diego, CA. Four of the beams are mounted at a 20-degree angle from the vertical, and are used to measure current speed and direction. The fifth beam points straight down and is used solely for measuring acoustic signals from the suspended sediment resulting from the dredged material placement operation.

The BBADCP system consists of the following:

1. BBADCP
2. side-mount or tow body
3. tow cable and winch (when towed)
4. deck cable
5. control unit
6. data acquisition and analysis computers

7. DGPS
8. pressure sensor (when towed)
9. BBADCP data acquisition and acoustic processing software

8.3 Field Sampling Procedures

The BBADCP is either mounted rigidly to the side of a survey vessel or in a hydrodynamically-stable tow body. When surveying using the tow body, the BBADCP is towed behind the survey vessel below the vessel's wake on an electro-mechanical cable along straight survey lines that start and end outside the area of interest. The BBADCP measures a vertical profile of acoustic signals from depths less than 60 m below it. The profile is composed of measurements representing 0.5-m depth cells. The maximum depth to which these signals are useful depends on site-specific conditions related to the turbidity, temperature, and salinity of the water.

Immediately before a placement operation, repeated transects are made across the placement area to determine the magnitude and variation of the naturally occurring acoustic background. If the depth of the area is greater than the depth at which the BBADCP can track bottom, the instrument is mounted in a tow body and the background survey is conducted with the instrument towed at multiple depths so that a complete vertical profile (i.e., near-surface to bottom) can be surveyed. Current speed and direction in a layer extending to less than 60 m above the bottom are surveyed along the transects as the instrument tracks bottom. Several point measurements of current speed and direction are made in the area for any additional layers of depth that are above the depth at which the BBADCP can track bottom.

During and after the release of dredged material, transects are made to measure the extent of suspended sediments that result from the placement operation. Current shear normally causes the near-surface suspended sediments to be transported at a faster rate than the near-bottom sediments. Therefore, to successfully track the movement of suspended sediments over time, it is normally necessary to concentrate on a single layer where the transport does not vary greatly with depth. The background acoustic measurements are subtracted from the measurements made during and after the placement operation, and the differences are divided by the standard deviations of the background variations as determined from the repeated transects made prior to the placement operation. This results in values of acoustic backscatter above background (ABAB) which are used to map the extent of the suspended sediments resulting from the placement operation.

During the survey, a log book will be kept to record the designation of each survey line, the start and end data record for each line, the data file name, and the start and end times of each line. Additional notes will include information about the placement operation, the presence of boat wakes in the area, and any other information related to the data. If single-point current measurements are made, the log should give the tow body depth, and the start and end locations and times for the measurements. The navigation data, and the instrument operating parameters, are automatically recorded with the BBADCP data.

8.4 Field Sampling Documentation

Documentation associated with BBADCP operations consists of field logs, notes and narratives associated with data processing, review, and interpretation, and sections of the capping and post-cap monitoring program addressing these sampling tasks.

8.5 Equipment Calibration

Prior to the survey operations, SAIC and the USACE field personnel will install all necessary navigational and positioning equipment on the survey vessel. The BBADCP system will be installed and data communication interfaces will be tested for proper operation. Offset distances between the tow point and the GPS positioning antenna will be determined to facilitate accurate calculation of the BBADCP towfish position during survey operations.

8.6 Analytical Procedures

Data from the BBADCP is transmitted by cable to a computer and recorded during the survey. The magnitude of the acoustic signals, and the current speed and direction, are displayed during the survey, but only raw data is recorded, and must be processed to produce final data products. Data are recorded on the computer’s hard drive, and displayed during the survey using software supplied with the system by RDI. The procedures for data processing can be found in the SOP relating to this survey method.

8.7 Data Review, Reduction, Validation, and Reporting

BBADCP data that are collected on board the survey vessel will be processed at the SCMI shore office facility. Preliminary data products will be provided within two days of survey completion. All processed BBADCP results will be input to the project GIS (DAN-LA) within two weeks of collection (PWP Volume II).

BBADCP data will be processed and analyzed using software developed by the Coastal and Hydraulics Laboratory (CHL) at the U.S. Army Engineer Research and Development Center (ERDC). A detailed description of this process can be found in the BBADCP SOP.

8.8 Internal Quality Control Checks

At the beginning of each survey day, a test program supplied by the manufacturer (RDI) is run to check for proper operation of the BBADCP system. During the survey the status of the DGPS is checked frequently to assure that differential signals are being received and that there are sufficient number of satellites in view to achieve the desired accuracy. During each step of the data processing, qualitative checks of the results are made to verify their reasonableness.

8.9 Preventive Maintenance

As part of survey mobilization, BBADCP equipment will be tested to ensure everything is working properly before departure. Following the survey, demobilization of the equipment will include rinsing and servicing. Repairs are made at this time if the equipment is not functioning properly. Routine maintenance is also accomplished at this time.

8.10 Field Corrective Action

During field survey operations it is apparent immediately if there is a problem with the BBADCP. BBADCP data are collected and evaluated in real-time on the survey vessel. If the data record is interrupted or distorted, sampling will cease until the problem is identified and corrected.

The BBADCP manual, provided by the manufacturer (RDI), contains a section on trouble shooting. In addition, the BBADCP's firmware contains self-tests that can be run which will define certain problems with the system, if any should be present.

9.0 CURRENT MEASUREMENTS USING BOTTOM-MOORED ARRAYS

9.1 Overview

Current meters will be deployed during the capping operations to characterize how currents and turbidity levels in the vicinity of the pilot cells are affected by the placement of cap material. Toward this goal, time series of horizontal current velocities will be measured and recorded at locations and sites described in the FSP. Time series measurements of water turbidity also will be made and recorded concurrent with the current velocity measurements. The goal of the program is to obtain an accurate and precise set of observations that resolve the high frequency spatial patterns of currents and turbidity prior to, during and following placement of cap material on the bottom. Because multiple sensors will be used, the degree of comparability among different instruments will be assessed as part of the quality assurance review of the data.

9.2 Instrumentation

SAIC will make environmental measurements (near-bottom current velocity and turbidity) that can be used to help determine if near bottom currents and suspended sediments can be related directly to the active placement of cap material at specific locations. Details on sampling procedures are provided in the FSP and in an SAIC SOP presented in Volume II of the PWP.

Three types of instruments will be used to measure current velocity in this program: 1) the "Workhorse" Acoustic Doppler Current Profiler (ADCP) instrument manufactured by RD Instruments (RDI), 2) the Automated Resuspension Surveillance System (ARESS) developed by SAIC, and 3) the Aquadopp instrument manufactured by Nortek. In addition, two types of instruments will be used to measure turbidity: 1) the "OBS-1" Optical Backscatter Sensor (OBS) turbidity meter manufactured by D&A Instrument Company, and 2) the Seapoint Turbidity Meter (which also is based on measuring OBS) manufactured by Seapoint Sensors, Inc.

All of the various instruments and sensors to be used for the current and turbidity measurements are off-the-shelf and have specified levels of accuracy and resolution (Table 9-1). The sensors have all been tested and verified by their manufacturers and used successfully in other studies. Redundant observations will be made during the interim and post-cap monitoring program to help assure data set completeness. The quality control checks and equipment maintenance procedures described below will be applied prior to, during and following field measurements to verify instrument performance and ensure the acquisition of high quality data.

Table 9-1. Manufacturer's specifications for instruments used to measure water velocity (i.e., currents) and turbidity

Instrument/measurement	Accuracy	Resolution
RD Instruments ADCP current sensor	±0.5% of measured velocity	±0.5 cm/s
Aanderaa Model 3500 current sensor (ARESS)	±0.15 cm/s	0.5 cm/s
Nortek AquaDopp current meter	±1% of measured velocity	±0.5 cm/s
D&A Instrument Company OBS turbidity meter	NA	0.5 NTU
Seapoint OBS turbidity meter	NA	200 mV/FTU

The RDI ADCP will collect data through the whole water column to characterize the vertical profile of horizontal velocity. This device will be placed on the seafloor within a specially-designed instrument mount. It will provide velocity measurements in approximately 1 m vertical intervals ("bins") from approximately 2-3 m above the transducer heads to within approximately 3 meters of the water surface.

Each ARESS unit consists of a bottom-mounted instrument platform containing two Aanderaa Model 3500 acoustic current meters placed, respectively, approximately 0.5 and 1.25 m above the seafloor. One ARESS unit will be placed at each of three sites during each monitoring event.

There will also be two Nortek Aquadopp current meters deployed during each monitoring event; these instruments will be placed approximately 1 m above the seafloor. During the first few monitoring events, one of the Aquadopp meters will be mounted on one of the three ARESS platforms to obtain a side-by-side comparison between the ARESS and Aquadopp current measurements. The second Aquadopp will be deployed at a separate (fourth) monitoring site to obtain independent current measurements at that location during each monitoring event. Once the intercomparison of the Aquadopp and ARESS current measurements has been completed, the Aquadopp will be removed from the ARESS unit and deployed at a separate (fifth) site during each monitoring event for the duration of the project.

It is important to point out that although the ARESS and Aquadopp current sensors have different physical configurations, measurement physics, and volumes over which point measurements of horizontal currents are derived, both technologies represent state-of-the-art electronic sensors and thus, the results are believed to be comparable within the measurement accuracy and resolution stated by the individual manufacturers. Furthermore, to assure comparability among the data obtained from the two instrument types, the internal time base of each instrument will be synchronized to a standard project time base. With the intercomparison data obtained from the simultaneous and co-located measurements on a single measurement platform, it will be possible to quantitatively determine whether there are any significant differences in current velocity data between the two sensor types that could be associated with the measurement technologies. Also, it will be possible to determine whether this potential measurement (instrument) error is much smaller that the magnitude of the currents to be measured (which we suspect so, based upon review of historic current data from the project site)."

Note that when the *in situ* intercomparison of the ARESS and Aquadopp current sensors is being conducted, simultaneous and co-located measurements of turbidity also will be acquired for intercomparison of the two commercially available Optical Backscatter Sensor (OBS) turbidity meters that are being used on this project. These instruments rely on measuring the amount of emitted light reflected back to the sensor. The greater the reflection, the greater the quantity of solid material suspended in the water parcel being measured. A time series of measured OBS values provides a temporal record of local total suspended solids in the water column. OBS measurements will be made as follows:

- One Seapoint OBS will be deployed at each of two levels on each of the three ARESS platforms.
- One D&A Instruments OBS will be deployed alongside each of the two Aquadopp current meters.
- No OBS measurements will be made in conjunction with the ADCP observations.

All OBS measurements will be recorded on the data logger used for the associated current measurements. By this method, current and OBS observations will be coincident for each instrument. Each of the data logging instruments (ARESS, Nortek Aquadopp and RDI Workhorse ADCP) records, in internal memory, data arriving from the various sensors to which it is linked. Data sampling rates and the start-sampling time are programmed into the instrument prior to deployment. ARESS data are collected at 3.6 Hz and Nortek Aquadopp data are collected at 33 Hz. These higher frequency data samples will be averaged to at least one second intervals to enhance the confidence intervals and the observational stability. RDI ADCP data are averaged from 30 minute ensembles or more frequently. Actual ADCP sampling rates, horizons and a servicing schedule will be finalized and coordinated with the Project Manager.

Operationally, it is important that the cap placement activities and field current and turbidity measurements be precisely related/synchronized in time. It is expected that all time measurements on instruments will be precisely related to Greenwich Mean Time (GMT) using signals from GPS satellites as the method of coordination. Similarly, all cap placement activities will be related via ADISS to the same time setting. Given the relatively short overall measurement duration, internal instrument clocks should be sufficiently stable and constant to provide overall synchronization to within several seconds. The expected rate at which measurement averages will be made is approximately 1 observation per second (1 Hz). This frequency will help assure that even relatively short-lived processes can be resolved and documented.

9.3 Equipment Calibration

All three of the current measuring instruments to be used in this program measure current velocity based on the speed of sound in water. The Aanderaa 3500R sensor operates with an assumed speed of sound in water of 1500 m/s. The Nortek Aquadopp can be programmed for a particular speed of sound or it can calculate a speed of sound based on a programmed salinity and the measured temperature at the instrument. The RDI Workhorse ADCP calculates a speed of sound based on a programmed salinity and the temperature measured by the instrument. The resulting speed measurements on all three instruments can be corrected for the actual speed of sound in water if temperature and salinity data are available. Salinity data from CTD casts made in the vicinity of the instrument along with temperature data collected by the instrument are adequate to make the appropriate correction.

The Seapoint Turbidity meter and the D&A OBS sensor are factory calibrated for specific FTU ranges based on the formazin standard for measuring water turbidity. A calibration check (see below) will be performed prior to instrument deployment using prepared standard solutions having a known concentration of total suspended solids (TSS).

Proper functioning of each of the data logging instruments (ARESS, Nortek Aquadopp/OBS and RDI Workhorse ADCP) is ensured through periodic servicing by the manufacturer. Before the initial use, each instrument will be checked for proper function (see below), and data will be reviewed immediately following each deployment to verify proper instrument performance.

9.4 Quality Control Checks

Quality control checks associated with each instrument/sensor are summarized in Table 9-2. For each of the current meters, there are system checks that are performed prior to deployment, while the instrument is in the shoreside facility or on-board the research vessel and connected to a laptop computer. Predeployment checks include verification of battery connection and power, internal system electronic checks, a check on the delayed start function, and verification of instrument signal (ping) at the specified delayed start time. All predeployment QC checks are recorded on a standardized deployment/retrieval log specific to each instrument (examples of logs are provided in the SAIC current measurement SOP included in PWP Volume II). If the instrument fails any of the predeployment QC checks, corrective action will involve troubleshooting until the problem is resolved or replacement of the instrument.

During the first few monitoring events, simultaneous (i.e., side-by-side) measurements of current velocity will be obtained with the ARESS Aanderaa Model 3500 current sensors and the Nortek Aquadopp. Following each event, the data will be processed to determine the level of agreement between the two sets of readings. It is expected that the relative percent difference between the simultaneous readings should be less than 20%. Failure of the instruments to demonstrate agreement will result in corrective action. The source(s) of the discrepancy will be identified and eliminated and the side-by-side deployment repeated to verify agreement between the instruments.

Table 9-2. Summary of quality control checks for current and turbidity meters

Instrument/measurement	QC Check(s)	Frequency	Goal	Corrective Action
RD Instruments ADCP current sensor	Electronic system check following manufacturer's operation manual	Prior to each deployment	System fully operational	Troubleshoot until problem corrected
Aanderaa Model 3500 current sensor (ARESS)	Electronic system check following manufacturer's operation manual	Prior to each deployment	System fully operational	Troubleshoot until problem corrected
	Side-by-side comparison with Aquadopp current meter	First several monitoring events	<20% relative percent difference (RPD) between readings	Identify source(s) of discrepancy and eliminate
Nortek AquaDopp current meter	Electronic system check following manufacturer's operation manual	Prior to each deployment	System fully operational	Troubleshoot until problem corrected
	Side-by-side comparison with ARESS current meter	First several monitoring events	<20% RPD	Identify source(s) of discrepancy and eliminate
D&A Instrument Company OBS turbidity meter	Calibration check using formazin standard	Prior to each deployment	Meter reading within 90% to 110% of known value	Identify source(s) of discrepancy and eliminate
Seapoint OBS turbidity meter	Calibration check using formazin standard	Prior to each deployment	Meter reading within 90% of known value	Identify source(s) of discrepancy and eliminate

For the turbidity measurements using the OBS sensors, the quality control check will consist of an initial calibration check of each instrument prior to each deployment. Each sensor will be immersed in a formazin standard solution having a known turbidity (expressed in Nephelometric turbidity units or NTUs). The standard will be prepared such that its turbidity level will be roughly in the mid-range of values expected at the deployment locations on the PV Shelf. The instrument reading will be compared with the calibration standard true value. If the meter reading is not within 90% to 110% of the true value, the calibration of the OBS will be checked, adjusted as necessary, and the calibration check performed again prior to instrument deployment.

9.5 Data Review, Reduction, Validation and Reporting

9.5.1 Current Meter and Turbidity Sensor Data

Following each deployment, recorded data is recovered and stored as described in the SOP included in Volume II of the PWP. Using appropriate, and, where possible, manufacturer-developed software, the instrument data are converted to engineering units. The engineering units will be presented as preliminary summary tables and/or graphs. Generally, a hardcopy of these data products will be made in the field within several days of each instrument recovery.

9.5.2 Data Review

The preliminary field-generated data products will be used for quasi-real time evaluation of the quality of observations from each sensor. This first-order evaluation can involve a review of the values of variables in engineering units, as well as initial examination of the individual and joint patterns of both currents and turbidity. An SAIC senior physical oceanographer experienced with these types of data will review data quality by: (1) examining actual observed values, in particular the background level of current velocity and turbidity, (2) evaluating the consistency of values and patterns of change between proximate sensors, and (3) evaluating how well the observations conform to the levels and variability expected to exist for the measurement sites. Additional experienced physical oceanographers will be available to support the field personnel should unresolved questions arise concerning the quality of the observations. As the number of deployments increases, the observational data base available for use in evaluating data quality will correspondingly increase.

If observations are suspect, the instrument of concern will be examined and evaluated. If adjustments/repairs can be made, these will be done prior to redeployment. However, given the mode by which currents are measured, if an instrument does not appear to be working properly, it will generally need to be returned to the manufacturer for a more formal electronic evaluation and possible repair. If satisfactory adjustments can not be made, that sensor will not be relied on to provide environmental information. If necessary some changes in equipment placement and siting may be made to optimize data return relative to the data needs of the program.

9.5.3 Data Reduction and Validation

On completion of the field measurements of currents and turbidity, all data time series will be returned to the SAIC physical oceanographic data processing center for formal and final data reduction, processing and management. Prior to being entered into the database, all records will be in engineering units. The conversion from instrument data to engineering units relies on manufacturer-supplied software. As data are entered into the database, all records will be quality controlled and properly formatted for incorporation in the SAIC Physical Oceanographic Database Management System (DBMS). SAIC has routines for converting the output from the manufacturer-provided software to the formats used within the SAIC DBMS.

The SAIC database management system utilizes a consistent identifier format whereby each data record is assigned a unique identifier or name. When this name is assigned, the associated metadata for the record is incorporated in the database. The name assigned to the time series (either vector or scalar) is the link that ties linked time series together across the various relations in this relational data base system (e.g., raw data and filtered data records). Once in SAIC's database, each time series record (file) for each deployment is analyzed for proper instrument performance, missing or erroneous data, calibration errors or trends in the data. Proper start/stop times are evaluated with a determination that the expected number of observations occurred between the two end points. An interactive, SAIC-developed, graphically based program allows searching and editing for possibly spurious data values and corresponding editing of data values. Short records or missing or erroneous data (several observations in duration) may be bridged by interpolation. Once the raw time series files have been quality controlled, they can be analyzed further (e.g., filtered) and presented graphically, using an extensive and comprehensive set of analysis and graphics routines that are interactively linked to the SAIC DBMS. Once data that has been reviewed and accepted populates the database, they can be exported in several different standard formats for transfer to others who may need to have access to the data.

All QC procedures to be applied have been used extensively for many years. Data managers/analysts/ oceanographers responsible for the data processing have extensive experience with all the data types to be taken during this program. SAIC has used all proposed software to support a large number of prior oceanographic programs. SAIC experience with observations and conditions in comparable water depths on the shelf just south (15 km) of the present measurement sites will further facilitate QA/QC procedures.

All deployments of field instruments will be documented by instrument and field logs as described in the SOP. These provide the information that is required for the data to be properly calibrated and entered into the DBMS.

9.6 Preventive Maintenance

Instrument performance and data quality will be examined routinely by maintaining the SOPs for the equipment and a consistent and regular evaluation of data being produced by the current meters and OBS sensors. Quality control for each of the data logging instruments (ARESS, Nortek Aquadopp/OBS and RDI Workhorse ADCP) consists of periodic servicing by the manufacturer (prior to this field program), proper handling and use, and by performing the various system tests outlined in the various manufacturer's operation manuals. Where the ARESS system is deployed, current measurements are collected at more than one near-bottom levels and turbidity measurements at up to two near-bottom levels. Adjacent measurements provide a basis for comparative checks of the various current and turbidity events that occur. Though not expected to be identical, typical responses are likely to exhibit similar trends in speed, direction and turbidity as various events are recorded.

10.0 SUBBOTTOM PROFILING

10.1 Quality Assurance Objectives for Measurement Data

No specific reference materials or standards exist that can be used to evaluate directly the accuracy of subbottom profiling data. Precision will be evaluated by comparing data for the "duplicate" subbottom profile records that will be obtained at the intersections of perpendicular transects. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method. The resolution of the subbottom technique in the study area (water depths ranging from 40 to 70 m) is expected to be on the order of ±20 cm. The degree of agreement between "replicate" measurements cannot be expected to be any better than this minimum resolution (i.e., the acceptance criteria for precision is that the replicates should agree within ±20 cm). As a secondary quality control check, the results of the subbottom surveys will be compared against both the SPI and coring results.

To meet the objective of characterizing sediment conditions (including the degree of spatial variability) within and around each placement cell, it is important that complete subbottom records are obtained along each of the planned survey transects. The procedures for ensuring that the 100% completeness goal is met are described in detail in the FSP. Comparability for subbottom profiling will be addressed by adherence to SAIC SOPs for this monitoring technique, to ensure comparability among multiple surveys to be performed throughout the course of the PV Pilot Capping monitoring program. Representativeness will be ensured through the use of a survey design which includes obtaining continuos records along survey lanes throughout each pilot capping cell.

10.2 Sampling Objectives, Frequency and locations

The objective of subbottom profiling is to support characterizations of the physical and geotechnical properties of bottom sediments within and around the pilot capping cells during and following the capping operations. Sampling frequency and locations (survey lanes) are described in the FSP.

10.3 Major Sampling Equipment

High-resolution subbottom profile data will be acquired using an Datasonics Model Chirp II CAP-6600 Acoustic Profiling System. The acoustic transducers of the ChirpII system are mounted in a towfish and lowered using the winch aboard the survey vessel. The electronic signal cable from the towfish is mated to a mechanical tow cable with brass clips. The amplified return signal of the ChirpII transducers are sent through an A/D converter to an on-board data acquisition system for data storage to magnetic optical disk, real-time color data display, and hard-copy printouts of profile data.

10.4 Field Sampling Procedures

The Chirp II system generates a frequency-modulated pulse that sweeps over an acoustic range of 2-10 kHz The vertical (thickness of sediment) resolution for each of the sweep ranges is 6 cm respectively. The pulse rate will be set to 8 pulses per second for optimum performance of the output devices. At 8 pulses per second, traveling at an average vessel speed of 4 to 5 knots, a subbottom measurement will be acquired every 34 to 43 cm along the vessel track. Each subbottom return signal will be recorded digitally and stored with a geodetic positional fix.

The Chirp II profiler generates a relatively narrow (13°) acoustic beam which translates to a 12-m wide swath on the seafloor along each survey lane for an average water depth of 55 m, as encountered in the pilot study area. Swath width will vary proportionally with water depth and the depth at which the fish is towed. For the baseline survey, the towing depth will be approximately 10 m. With a lane spacing of 100 meters, approximately 12% bottom coverage will be obtained over the survey area.

10.5 Field Sampling Documentation

Documentation associated subbottom profiling consists of field logs, notes and narratives associated with data processing, review, and interpretation, and sections of the interim capping and post-cap monitoring program addressing these sampling tasks. The subbottom profiling data are stored on board the survey vessel as electronic files and as hard-copy printouts of profile data. Sampling information and documentation are included in the data files.

10.6 Equipment Calibration

Prior to the survey operations, the subbottom profile system will be installed and data communication interfaces will be tested for proper operation. The subbottom signal cable will be mated to a mechanical tow cable mounted on the vessel's winch. Offset distances between the tow point and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

10.7 Analytical Procedures

Subbottom profile data stored on magnetic optical disk will be reviewed and analyzed to identify any subbottom horizons or features that may be used as benchmarks to evaluate cap thickness from subsequent surveys. The subbottom data will be displayed on the PC monitor as both a continuous profile, duplicating the shipboard display, as well as individual pulses. The processed digitized data are stored in data files containing the geodetic position and the vertical distance (depth) from the first return (sediment-water interface) to the subsurface layer for each sonar ping. A relational database of survey lanes and screen images of subbottom profiles will be compiled and incorporated into the project GIS.

10.8 Data Review, Reduction, Validation, and Reporting

Subbottom profiling data are collected and processed on board the survey vessel. Preliminary data products including a survey trackline map and subbottom profile images for individual lanes will be provided upon survey completion. Within two weeks, all processed subbottom results will be input to the project GIS. Final results will be presented and described in the summary report for the summer Program. This report will contain graphical data products including subbottom profiles for selected lanes of the pilot study area.

Subbottom profile data stored on magnetic optical disk will be reviewed and analyzed to identify any subbottom horizons or features that may be used as benchmarks to evaluate cap thickness from subsequent surveys. The processed digitized data are stored in data files. A relational database of survey lanes and screen images of subbottom profiles will be compiled and incorporated into the project GIS.

10.9 Internal Quality Control Checks

Duplicate subbottom profile records, obtained at the points of intersection of survey lanes, will be reviewed to determine whether measurements of subbottom layer thickness from the two records agree within ±20 cm and whether the two records show the same number and pattern of subbottom reflectors. Sediment coring and sediment profile imaging data obtained at the subbottom points of intersection will be compared to determine whether there are any discrete depositional layers on or near the sediment surface with thickness less than about 20 cm as a means to independently ground-truth the subbottom results.

10.10 Preventive Maintenance

As part of survey mobilization, subbottom profiling equipment will be tested to ensure everything is working properly before departure. Following the survey, demobilization of the equipment will include rinsing and servicing. Repairs are made at this time if the equipment is not functioning properly. Routine maintenance is also accomplished at this time.

10.11 Field Corrective Action

During field survey operations it is apparent immediately if there is a problem with the subbottom profiling equipment. Subbottom profiling data are collected and evaluated in real-time on the survey vessel. If the data record is interrupted or distorted, sampling will cease until the problem is identified and corrected.

11.0 SIDE-SCAN SONAR SURVEYING

11.1 Quality Assurance Objectives for Measurement Data

No specific reference materials or standards exist that can be used to evaluate directly the accuracy of side-scan sonar data. Precision will be evaluated by comparing the "duplicate" side-scan sonar records that will be obtained over relatively broad areas. This duplication provides a means to check on the precision (repeatability) and degree of resolution of the survey method. Duplicate records should agree closely in terms of both the type(s) of surface features present and the location of these features. Data on surface sediment type (i.e., grain size) at the side-scan sonar lane points of intersection will be obtained from both the sediment coring and SPI surveys. These data can be used as an independent check or ground truth of the side-scan sonar interpretation. The sediment type determinations for the side-scan sonar survey will be compared against both the SPI and coring results.

To meet the objective of characterizing sediment conditions (including the degree of spatial variability) within and around each placement cell, it is important that a complete side-scan sonar record is obtained along each of the 8 survey transects. Procedures for meeting the 100% completeness goal are described in the FSP. Comparability for side-scan sonar will be addressed by adherence to SAIC SOPs for this monitoring technique, to ensure comparability among multiple surveys to be performed throughout the course of the PV Pilot Capping monitoring program. Representativeness will be ensured through the use of a survey design which includes obtaining continuos records along survey lanes throughout each pilot capping cell.

11.2 Sampling Frequency and Locations

The objective of side-scan sonar surveying is to support characterizations of the physical and geotechnical properties of bottom sediments within and around the pilot capping cells during and following the capping operations. Sampling frequency and locations (survey lanes) are described in the FSP.

11.3 Major Sampling Equipment

For the interim and post-cap monitoring surveys, a state-of-the-art side-scan sonar system will be used for acquisition of two-dimensional seafloor data in the vicinity of the pilot cells. The system will consist of an Edgetech DF1000 digital side-scan towfish interfaced to a Triton-Elics ISIS® top-side sonar data acquisition system. The DF1000 is a dual-frequency system capable of simultaneously emitting and receiving sound waves at both 100 and 500 kHz frequencies. All sonar returns are digitized to 12-bit high-resolution data within the towfish, merged with vessel heading information from the built-in compass, and transmitted to the top-side data acquisition unit via a high-speed digital uplink. Aboard the survey vessel, the DF1000 interfaces to the Triton-Elics ISIS® sonar acquisition system for archiving and display of the digital side-scan data. The ISIS® integrates the raw sonar image data with towfish position information provided by the onboard, DGPS-based HYPACK vessel navigation system. The merged data are stored on Magneto-Optical disks for playback and post-processing. In addition to data storage, ISIS® displays the high-resolution sonar imagery in real-time on a computer monitor. Vessel speed over the ground and slant range corrections are applied in real-time to the data so that images are displayed with the correct aspect ratio. In this manner, the geodetic position of targets and other seafloor features can be determined in near real time.

11.4 Field Sampling Procedures

The side-scan sonar data acquisition system will be configured to collect seafloor imagery data 100 m to either side of the towfish, resulting in a total swath coverage of 200 m along each survey lane. With the 100-m lane spacing, side-scan data coverage within and around each cell will be approximately 200%. During survey operations along each lane, the survey vessel will maintain a constant course and speed of approximately 4 knots to achieve clear seafloor images. Towfish position will be determined continuously, and to an accuracy of approximately 5 to 10 m, using the HYPACK DGPS navigation system, based on the vessel position, speed, heading, and length of cable behind the vessel.

Four channels of data (port and starboard channels from both the 100 kHz and 500 kHz frequencies) will be both archived on disk and displayed in real time aboard the survey vessel. During survey operations, the towfish will be maintained at an altitude above the seafloor equivalent to 8 to 20% of the range scale selected (e.g., 8 to 20 m above the seafloor for the 100 m range scale) to achieve optimum surveying resolution.

11.6 Field Sampling Documentation

Documentation associated side-scan sonar consists of field logs, notes and narratives associated with data processing, review, and interpretation, and sections of the interim capping and post-cap monitoring PWP addressing these sampling tasks. The side-scan data are stored on board the survey vessel as electronic files and as hard-copy printouts. Sampling information and documentation are included in the data files.

11.6 Equipment Calibration

Prior to the survey operations, SAIC field personnel will install all necessary navigational and positioning equipment on the survey vessel. The sonar acquisition system will be installed and data communication interfaces will be tested for proper operation. Offset distances between the tow point and the GPS positioning antenna will be determined to facilitate accurate calculation of towfish position during survey operations.

11.7 Analytical Procedures

Following the survey, side-scan data will be processed with Triton-Elics Delph Map software. Data from each survey lane will be analyzed for surficial sediment texture and identification/location of objects or features on the seafloor. Screen grabs of the individual targets will be generated and stored in the project GIS (DAN-LA) so the location and the image can be accessible for future analyses.

The side-scan data from each survey lane will be mapped and composited using the position data. This process results in a geo-referenced, raster image called a "mosaic" that is compatible with a variety of software programs for analysis and mapping of spatial datasets with GIS-based systems.

11.8 Data Review, Reduction, Validation, and Reporting

Side-scan data are collected on board the survey vessel and processed at the SCMI shore office facility. Preliminary data products including a side-scan coverage map and high-resolution screen grabs for selected features or objects will be provided within two days of survey completion. Graphical data products include side-scan mosaics of the seafloor in and around each pilot cell, a tabular listing of targets observed on the seafloor and their location, as well as example images of targets and seafloor substrates presented at full resolution. All processed side-scan results will be input to DAN-LA within two weeks of collection.

11.9 Internal Quality Control Checks

Duplicate side-scan sonar records will be compared. There should be 100% agreement between the two records in the sediment type determination and the identification of surface features. The two records should agree within ±10 m with respect to the location (coordinates) of specific targets or features.

Data on surface sediment type (i.e., grain size) at the side-scan sonar lane points of intersection, obtained from both the sediment coring and sediment profile imaging surveys, will be used as an independent check or ground truth of the side-scan sonar interpretation. At 90% of the stations, there should be agreement between the sediment-profile imaging and coring grain size results versus the sediment type determination obtained through side-scan sonar interpretation.

11.10 Preventive Maintenance

As part of survey mobilization, the side-scan sonar equipment will be tested to ensure everything is working properly before departure. Following the survey, demobilization of the equipment will include rinsing and servicing. Repairs are made at this time if the equipment is not functioning properly. Routine maintenance is also accomplished at this time.

11.11 Field Corrective Action

During field survey operations it is apparent immediately if there is a problem with the side-scan sonar. Side-scan sonar data are collected and evaluated in real-time on the survey vessel. If the data record is interrupted or distorted, sampling will cease until the problem is identified and corrected.

12.0 PLACEMENT SURGE VIDEO DOCUMENTATION

12.1 Quality Assurance Objectives for Measurement Data

Placement surge video documentation is primarily a qualitative sampling technique, and no specific reference materials or standards exist that can be used to evaluate the accuracy of the data directly. Comparability for the video documentation surveys will be addressed by adherence to SAIC SOPs for this monitoring technique.

The QA objectives for completeness of the video documentation efforts include successfully documenting bottom surge in each of four surveys during the course of the pilot cap placement operations. The goal is to acquire sufficient video footage during these events to create at least six video clips (30 to 60 second duration per clip) showing bottom surges created as a result of cap placement. Completeness for these surveys also is defined by successfully collecting data to compliment the data acquired by the quantitative monitoring instruments that will be used simultaneously during the video documentation surveys.

12.2 Sampling Objectives, Frequency and Locations

The objective for this monitoring element is to provide video documentation of the bottom surge that occurs during placement of cap material during conventional placement operations.

Video documentation for the Pilot Capping Monitoring Program will occur during several stages: initial cap placement at Cells LU and SU and during two other events to be determined by SAIC in consultation with the USACE Project Manager.

Identifying and documenting bottom surge requires that the survey plan remain flexible. Documentation locations are dependent upon a number of oceanographic conditions (e.g., currents, stratification etc.). For each of the four video surveys, the video footage will be obtained at varying distances from the point of sediment release (e.g., 50 to 100 m intervals). The video camera is mounted within a conical, stainless steel frame (for support and stability) and suspended by cable from the vessel. To obtain video footage of the placement surge as it moves along the bottom and through the water column, the frame/video camera will be both rested on the bottom and suspended above the bottom. The intent is to illustrate the characteristics (e.g., speed and thickness) of the surge with increasing distance from the point of release out to the point where the surge is minimal or not present. The sampling locations will be determined by the Video Survey Field Leader, in consultation with the SAIC and Corps Project Managers. The locations in part will be dependent upon the data being collected by other sediment plume tracking instruments including the integrated CTD system and bottom moored instrument arrays that measure current speed, suspended sediment and other surge characteristics.

12.3 Major Sampling Equipment

The video documentation of bottom surge will be accomplished using an Outland Technology Model UWS-6010 complete underwater video system. The system consists of a UWC-560 Color CCD Camera, two UWL-200 150 watt lights, a CON-3000 video processing console, a S-VHS video recorder and a 500 ft video deployment cable. The video camera and underwater lights will be mounted inside a conical, stainless steel frame that provides both stability and protection for the camera. An underwater compass and a depth gauge also will be mounted on the frame within the camera's field of view. This array will allow the camera to operate either when resting on the seafloor or suspended above it. During all video-surveying operations, the camera will be in a downward looking position and will be adjusted vertically to document the lateral spread of the bottom surge during placement events. The camera apparatus is deployed via a mechanical winch aboard the survey vessel. In addition to the winch cable used to lower and raise the camera/frame, a separate video cable connected the camera is used for electrical supply and two-way transmission of signals.

12.4 Field Sampling Procedures

The video system will be deployed using the SOP for *Bottom Surge Documentation Using a Sub-Surface Video Camera* (Volume II of the PWP). The camera will be lowered to the desired depth and adjusted (e.g., focus and light intensity) accordingly based on the environmental conditions of the seawater. Video data from the camera is then transmitted to the surface via a video cable that is connected to the operating and data collection console. The video data is routed directly to the VCR where it is recorded. Real-time audio is overlaid onto the video noting time "markers", significant events and any additional information that is relevant to the video data collection. A field logbook is kept to document all survey activities.

12.5 Field Sampling Documentation

Documentation for the video survey will include the field sampling logbook and the recorded video on VHS videotape. The entries made in the logbook will be made in water-resistant ink and will include the items listed below:

- Survey personnel
- Date and time of survey and all significant visual events
- Event identification (e.g., location in latitude and longitude) and sampling depth.
- Descriptions of all problems encountered that may affect survey measurements.
- Other pertinent observations (e.g., floating particulates, surface sheen, plankton blooms).

In addition to the field-sampling logbook, real-time audio will be overlaid onto the videotapes denoting any significant observations and/or time and location information to ensure that the video documentation can be correlated to other simultaneous survey activities (i.e., ADCP, CTD and transmissometer plume monitoring and water sample collection).

Each videotape will be labeled clearly in indelible ink with the following information: project, videotape number, sampling event, date, camera operator, and identifiers for each discrete surge event documented on the tape. The videotape number is a key sample identifier because it will be used to cross-reference the contents of the tape with the notes recorded in the field logbook.

12.6 Equipment Calibration

The video system requires no instrument calibration. The only pre-survey checks that need to be completed are checks to ensure that all of the features of the camera (e.g., focus and lights) are in proper working order prior to deployment. The complete system is also bench tested on deck prior to deployment.

12.7 Analytical Procedures

Following the video surveys, the VCR tapes will be reviewed and correlated with information obtained by the CTD system and the bottom instrument arrays. Informational clips of the video will be incorporated into the DAN-LA database.

12.8 Data Review, Reduction, Validation, and Reporting

Video data are stored on VCR tapes, which will be removed from the survey vessel at the completion of each day's sampling under the custody of the Field Team Leader. The primary tape from the vessel will be recorded onto a second tape as soon as practicable following each sampling event to provide an archival back-up copy. The back-up will occur on land at the project sample processing facility (Southern California Marine Institute, or SCMI).

Once the back-up copy is made, each videotape will be reviewed to identify changes in surge characteristics including speed and thickness. During review, the data will be displayed on the console monitor. The video results will be correlated with the compass readings and depth sensor readings that are mounted to the video camera array and with the information obtained by the bottom instrument arrays and the CTD system. Following the technical review of the videotapes, selected footage showing placement surges will be digitized to create video clips in digital format. The conversion from the analog tapes to digital files will be accomplished by connecting the VCR to a personal computer equipped with a video digitizer card. The digitized footage will be edited to create at least six annotated files (.AVI format) for subsequent delivery to the Corps Project Manager for use in PC-based presentations.

The SAIC Database Manager based at the SCMI shoreside processing facility during the project will be responsible for the on-site security of the field logbooks and videotapes acquired during the field survey operations. Ultimately, the original field logbooks and videotapes will be transferred and maintained in a secure storage facility at SAIC's Newport, Rhode Island office. Processed digital data will be maintained in the DAN-LA system. Daily backups of the DAN-LA data archive will be part of the routine maintenance procedures for this system.

Video documentation data will be submitted to the USACE in the form of one or more edited, annotated videotapes accompanied with a narrative report. In addition, at least 6 video clips of 30-60 second duration each will be provided in digital format for use in presentations or other media.

12.9 Internal Quality Control Checks

One of the internal quality control checks performed for video documentation is the real-time adjustment of the camera position immediately prior to, and during, each survey. Based on real-time environmental conditions (e.g., currents and background turbidity), field trials will be conducted prior to each cap placement event to assess optical conditions (i.e., visibility, clarity and focus). These field trials will help delineate the optimum camera settings and deployment strategy for the video documentation, as well as any possible limitations. In addition to the field trials, the camera will be adjusted as necessary during surveying operations based on the visibility and thickness of the surge along the bottom.

12.10 Preventive Maintenance

The preventive maintenance program for the video system will ensure fewer interruptions of video collection, personnel efficiency, and lower repair costs. Preventive maintenance eliminates premature replacement of parts, and reduces discrepancy among test results. Additionally, preventive maintenance increases reliability of results. Backup equipment for video documentation will be available to ensure efficient and complete field data collection.

As part of the video survey mobilization, the video equipment will be bench tested to ensure it is working properly before shipment to the field site. Following each survey, demobilization of the system will include rinsing and servicing. Routine maintenance and any needed repairs are undertaken at this time.

During field operations, the images obtained by the video system are viewed by the operators in real-time. Any problems with image quality related to operation of the equipment will be identified immediately and corrected before the system is deployed again. Corrective actions include field troubleshooting of the video camera electronics/connections, sending the system back to the manufacturer for troubleshooting and repair, and/or use of a back-up system.

13.0 QA REPORTS TO MANAGEMENT

The Project QAO is responsible for preparing monthly summary reports to project management indicating effectiveness of the QA Program. The Project QAO will review current quality-related activities, and provide regular updates to the SAIC Project Manager for incorporation into any progress reports to the USACE. The quality assurance report shall include the following topics, as appropriate:

- Findings of any internal or external audits
- Nonconformances, data affected, and effectiveness of corrective action taken
- QC summary data
- SOPs implemented
- Personnel and instrumentation changes
- QA Project Plans written/reviewed/revised or amended

Project specific audits, nonconformances, or changes which may affect quality will be reported, verbally and in writing. The USACE and SAIC Project Managers will determine, with the Project QAO, appropriate corrective actions.

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SAIC. 2000. Project Work Plan for the Baseline Portion of the Pilot Cap Monitoring Program

Project Work Plan
for the
Palos Verdes Pilot Capping Project:
Interim and Post-Cap Monitoring

HEALTH AND SAFETY PLAN

Prepared for:

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U.S. Environmental Protection Agency
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April 2003

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SAIC Report Number 505

Site Specific Health and Safety Plan Approvals

______________________________	______________
Dr. Scott McDowell, SAIC Project Manager	Date
______________________________	______________
John Nakayama, SAIC Project Health and Safety Officer	Date
______________________________	______________
Ms. Eleanor Nevarez, USACE Project Manager	Date
______________________________	______________
TBD, USACE Project Health and Safety Officer	Date

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1.0 INTRODUCTION

1.1 Scope and Applicability

The information provided in this Health and Safety Plan (HSP) was developed for use by Science Applications International Corporation (SAIC) and its subcontractors in support of the field pilot study of in-situ capping of Palos Verdes Shelf contaminated sediments. This HSP was prepared in accordance with the requirements contained in SAIC's Corporate Environmental Compliance & Health and Safety Manual (Procedure 20, Hazardous Waste Operations) and assigns responsibilities, establishes personal protection standards and mandatory safety procedures, and provides for contingencies that may arise while SAIC operations are conducted. SAIC disclaims responsibility for any other use of this information other than the express purpose for which it is intended and assumes no liability for the use of this information for any other purpose. The evaluation of potential hazards and their controls reflect professional judgements subject to the accuracy and completeness of information available when this plan was prepared.

All subcontractors for the Palos Verdes interim and post-cap monitoring program must comply with this plan. This HSP does not relieve any subcontractor of the responsibility to provide a safe workplace for its employees. This HSP does not cover all hazards that may be associated with the work of SAIC subcontractors. Subcontractors must supplement the requirements of this HSP with standard procedures or other means, as necessary, to ensure the safety of their employees and prevent exposure of SAIC employees to health or safety hazards. Failure to comply with the requirements of the plan is grounds for immediate dismissal from the program.

1.2 Project Description

In-situ capping is being considered for DDT and PCB contaminated sediment restoration on the Palos Verdes Shelf off the coast of Los Angeles, CA. The overall objective of the field pilot study is to demonstrate that a cap can be placed on the shelf as intended by the design, and to obtain field data on the short-term processes and behavior of the cap as placed. The shelf area under consideration for capping lies between the 40- and 70-meter depth contours. Three pilot capping cells are proposed for the Field Pilot Study, with each cell having dimensions of 300 meters by 600 meters. Details of the project are provided in the Overview Section of the Project Work Plan.

1.3 Project Work Scope Overview

Table 1-1 describes the objectives for the interim and post-cap monitoring activities. Additional details on the field methods for each monitoring activity are described in the Field Sampling Plan of the Project Work Plan. Evaluation of hazards associated with each activity is provided in the following sections.

Table 1-1. Interim and Post-Cap Monitoring Objectives.

Field Task	Monitoring Applications	Period over which task will be performed*
Sediment profile imaging (SPI)	Sediment layer thickness, lateral extent, layer mixing, grain size, biological condition	12 surveys during project. Baseline, initial placement, interim placement, and post-capping SPI sampling for each of 3 cells.
Moored current meters	Plume tracking, current speed and direction, suspended sediment, surge characteristics	4 deployments during project. Deployment and recovery of meter arrays around hopper disposal events at each cell.
Hopper sediment sampling	Chemical and physical profile of hopper sediment	First 3 loads transported to each of 3 cells, up to 30 loads during capping, and first 3 loads from each borrow area.
Hopper disposal monitoring	Tracking placement location and volume/rate for each hopper load	Monitoring hopper disposal throughout project.
ADCP plume tracking	Map plume location and extent, current speed and direction, surge characteristics	4 surveys during project. Survey for 2 hours following hopper placement events.
CTD/water sampling	Suspended solids, p,p'DDE resuspension, plume tracking	4 sample events during project. Samples collected following hopper placement events.
Video imagery of plume passage	Video documentation, plume tracking, surge characteristics (speed, thickness), suspended sediment	4 surveys during project.
Sediment coring	Sediment cap layer thickness, layer mixing, grain size, chemical profile	8 coring surveys during project.
Side-scan sonar survey	Cap distribution, bottom disturbance features, bottom topography	6 surveys during project**
Sub-bottom profile survey	Cap thickness, stratigraphy	2 surveys during project**

* All field activities will be performed during daylight hours.
** Both systems can be operated simultaneously during cap monitoring surveys.

1.4 Project Organization and Responsibilities

Table 1-2 identifies the individuals who have key responsibilities for site health and safety. The responsibilities of these key personnel, as well as the responsibilities of the field team members, are described below.

Table 1-2. Individuals Responsible for Site Health and Safety for the Palos Verdes Baseline Monitoring Program.

Position Title	Name	Phone Number
Project Manager	Dr. Scott McDowell	(401) 848-4772 (office) (401) 261-4108 (cell) (310) 548-1704 (SCMI field office)
Project Health and Safety Officer	John Nakayama	(425) 482-3313 (office)
Field Team Manager	John Evans	(858) 826-7476 (office) (310) 548-1704 (SCMI field office)
Site Health and Safety Officer	Vicki Frank	(858) 826-9553 (office) (310) 548-1704 (SCMI field office)

Responsibilities

Project Manager

- Designates qualified Site Health and Safety Officer(s)
- Ensures HSP is prepared and approved before field work commences.
- Reviews and approves the HSP.
- Authorizes the performance of all field work.
- Enforces the requirements in the HSP.
- Serves as central point of contact with the USACE Project Manager.
- Identifies to the Project Health and Safety Officer the names of all individuals assigned to perform field work covered under this HSP.

Project Health and Safety Officer

- Obtains a qualified technical review of the HSP.
- Ensures that all personal protective equipment specified in the HSP is available for use at the site.
- Ensures that subcontractors are provided a copy of the HSP and complete and return the acknowledgement form (Appendix A, Form 1)
- Ensures that all field personnel have completed the required training (Section 4.1) and medical surveillance (Section 4.3).
- Completes the Project Debriefing Questionnaire (Form 5) in Appendix A upon completion of the field work.

Field Team Manager

- Ensures that the HSP is implemented during the performance of all field work.
- Enforces the safety requirements contained in this plan.

Site Health and Safety Officer(s)

- Documents the implementation of the HSP.
- Conducts site specific health and safety training.
- Conducts daily inspections (Form 4, Appendix A) to verify compliance with the HSP and notifies the Project Safety Officer and Field Team Manager of violations or hazardous conditions.
- Initiates corrective action(s) for identified violations or hazardous conditions.

- Suspends field operations if site conditions are unsafe, until the problem is corrected.
- Ensures that personnel (SAIC employees, subcontractors, and visitors) allowed access inside exclusion zones or other controlled areas have completed the required training and received medical clearance.
- Ensures that monitoring equipment is properly calibrated and used.
- Ensures daily work schedules are appropriate for the specific work, levels of effort, and outside temperature and weather conditions.
- Ensures a copy of the HSP is available on-site and that emergency medical care and procedures are posted.

Field Team Members

- Comply with the HSP and all other required health and safety guidelines
- Take all precautions necessary to prevent injury to themselves and to their fellow employees
- Immediately inform the Site Health and Safety Officer of any hazardous conditions
- Perform only tasks that they are qualified to do and believe they can do safely
- Notify the Site Health and Safety Officer of any special medical conditions (i.e., allergies, contact lenses, diabetes) which could affect their ability to safely perform site operations
- Prevent spillage and splashing of materials
- Practice good housekeeping by keeping the work area neat, clean and orderly
- Immediately report all injuries, no matter how minor to the Site Health and Safety Officer
- Maintain site equipment in good working order and report defective equipment to the Site Health and Safety Officer
- Properly inspect and use the personal protective equipment (PPE) as directed by the Site Health and Safety Officer and Field Team Manager

2.0 SITE DESCRIPTION

The Palos Verdes Shelf and slope are located off the Palos Verdes peninsula that separates Santa Monica and San Pedro Bays. Since the first outfall diffusers became operational in 1937, particulate matter discharged through the outfalls has settled and built up an effluent-affected (EA) sediment deposit on the shelf and slope. The volume of the entire mapped EA layer has been estimated at approximately 9 million cubic meters, and the mapped layer covers a surface area of approximately 40 square kilometers. A detailed site description is provided in the Overview Section of the Project Work Plan.

Field operations will generally take place on the survey vessel(s), described in Section 3.2.1. Sediment processing will occur onshore at the Southern California Marine Institute (SCMI) in Terminal Island, California.

3.0 SITE SPECIFIC HAZARD EVALUATION

Hazards encountered during sampling programs of this kind are generally classified as chemical, physical, or environmental. Chemical hazards are twofold: (1) contaminants or hazardous materials potentially present within the sediments sampled, and (2) chemicals used to decontaminate sampling gear. Physical hazards are associated with sampling gear, vessel, and process area hazards and work conditions over water. Environmental hazards are associated with physical exposure. Exposure to harmful microbiological organisms or other organisms in the sediments is not expected during this program. Therefore, biological hazards will not be discussed further.

3.1 Chemical Hazards

Chemicals found in EA sediments during previous investigations at Palos Verdes include DDT and PCBs. The maximum detected concentration of each of these chemicals is presented in Table 3-1. These chemicals can pose contact, inhalation, and ingestion hazards. These chemicals are relatively nonvolatile and do not pose a vapor hazard. Control measures to prevent skin contact and inhalation of dusts or mists during sample collection and processing are presented in the Hazard Monitoring and Control Section (Section 4.0). In addition to routes of exposure noted below, any of these compounds can be harmful if accidentally ingested as a result of inadequate decontamination procedures or personal hygiene practices. Material Safety Data Sheets (MSDS) for these chemicals can be found in Appendix B. Chemicals used in the decontamination of sampling equipment are described below.

Hexane, Hydrochloric acid, and Methanol: These chemicals are used to decontaminate sampling equipment. They are clear, colorless liquids with strong odors. Methanol and hexane are volatile solvents and are flammable. Hydrochloric acid will burn exposed skin on contact. Personnel are required to wear protective gloves and eyewear whenever handling these decontaminating agents. These liquids are used in the open air or under a hood. Personnel are to ensure that others are not down wind, and that methanol and hexane are stored and used in areas free of any potential sources of ignition. Smoking is prohibited within 50 feet of areas where methanol/hexane are used or stored.

Table 3-1. Summary of Chemicals of Concern in EA Sediment at Palos Verdes Reported in WES Technical Report EL-99-2 (Palermo et al. 1999)

Compound	Concentration Range (ppm)	Average Concentration (ppm)	Station Maximum
Total DDT	0.014 – 253.000	7.70	556
Total PCBs	0.009 – 20.600	0.773	564

Table 3-2 provides an evaluation of the hazards associated with the chemicals that may be encountered during the monitoring program at Palos Verdes, including chemicals used in decontamination procedures.

Table 3-2. Chemical Hazard Evaluation [Values taken from OSHA (29 CFR 1910.1000) and ACGIH (1999 TLVs and BEIs), with the more conservative value reported.]

Chemical	**TWA[1] (mg/m^3)**	**STEL[2] (mg/m^3)**	**Ceiling[3] (mg/m^3)**	**Exposure Routes**	**Symptoms**
Total DDT*	1		---	Skin absorption and contact Ingestion Inhalation	Coughing, irritation, dizziness, convulsions
Total PCBs* **(Assumes 54% chlorine)**	0.5	---	---	Skin absorption and contact Ingestion Inhalation	May damage adult reproductive system, nervous system, liver damage, skin rash, chloracne
Hydrogen Sulfide	7 (5 ppm)[4]	---	21 (15 ppm)	Inhalation	Convulsions, eye and respiratory irritation, headaches, dizziness
Methanol	262 (200 ppm)	328 (250 ppm)	---	Skin absorption and contact Ingestion Inhalation	Headache, drowsiness, coughing, skin and eye irritation or burning, blindness, ingestion of 2 ounces can cause death
Hexane	176 (50 ppm)	---		Skin absorption and contact Ingestion Inhalation	Nasal and respiratory irritation, skin and eye irritation, lightheadedness, nausea, headache, numbness of the extremities, muscle weakness, dermatitis, giddiness
Hydrochloric Acid	---	---	7 (5 ppm)	Skin Contact Ingestion Inhalation	Severe burns to eye or skin, breathing difficulties, irritation

* Identified by NIOSH as a carcinogen

3.2 Physical Hazards

General physical hazards and their controls which are associated with the field work to be performed are listed below:

- Slips, trips, and falls will be minimized by keeping work areas dry and clear of equipment and debris.
- Electrical/mechanical equipment. All personnel will be instructed in the proper use of electrical and mechanical equipment prior to using the equipment. All electrical equipment will be properly grounded (i.e., use of three prong connector and GFCI). All equipment used in the field is cord and plug connected.

[1] TWA – Time weighted average concentration not to be exceeded for an 8-hour workday.
[2] STEL – Short term exposure limit averaged over a 15-minute time period which is not to be exceeded.
[3] Ceiling – Concentration not to be exceeded at any time.
[4] ppm = parts per million

Personnel will not attempt to lift heavy equipment and samples without assistance. When two or more people are required to handle an object, it is important to ensure that the load is lifted uniformly, weight equally distributed between individuals, and that each person, if possible is facing the direction in which the object is being moved. Back braces are recommended when moving or lifting heavy objects. In addition, the buddy system will be in place at all times during sampling and processing operations. This system will be implemented to reduce the risk of injury and minimize the response time should an injury occur. More detailed physical hazards and their controls associated with specific field activities are described in the following sections.

3.2.1 Research Vessel Operations

Field sampling in Palos Verdes will be conducted in mid to late summer, aboard research vessels ranging from 40 feet to 70 feet long. These vessels are equipped with hydraulic A-frames and include the R/V SEA WATCH, R/V YELLOWFIN, and M/V Tuna. Both vessels are approximately 70 feet long with a hydraulic A-frame. Sampling operations will consist of gravity coring, sediment profile camera work, side-scan sonar and sub-bottom profiling surveys, underwater video surveys, hopper sediment sampling and disposal monitoring, ADCP plume tracking, and CTD surveys and water sampling. In addition, moored current meter arrays will be deployed from the sampling vessels. The physical hazards associated with each of these field sampling tasks are discussed in further detail in the following sections.

The physical hazards associated with the deployment and retrieval of large pieces of sampling equipment (such as the sediment profile camera and gravity corer) are due to their weight and the method of deployment. The sediment profile camera weighs 1000 pounds (including the stainless steel frame assembly). During deployment and retrieval in rough waters or strong winds, this equipment may shift on deck or swing (if at the end of the winch wire). Therefore, the camera and all other large sampling equipment will always be handled by two persons. During deployment and retrieval of samplers in rough waters or high winds, safety lines may be used to stabilize and control the load. The safety lines will be left in place until the sampler or camera clears the transom. During retrieval of the equipment, a person watching over the stern of the vessel will notify the winch operator when the equipment first comes in sight and again when it breaks the water surface. Only persons whose presence is required will be allowed on the deck during deployment and retrieval of the samplers.

The side-scan sonar, sub-bottom profiling and broadband Acoustic Doppler Current Profiler (ADCP) equipment are encased in weighted and deployable towfish. The physical hazards associated with deployment and retrieval of these sampling equipment are due to their weight and method of deployment. Care will be taken when deploying the equipment to ensure the equipment does not impact the bottom. The towfish unit should be deployed and recovered with at least two personnel so that excessive weight strain does not cause injury to the handlers. The position of the towfish will be monitored, such that one person is assigned the responsibility of following its position at all times. That individual will also be responsible for following the motion of the vessel (taking into account the turning radius of the vessel while towing equipment), mobility depending on obstructions on the vessel, and actual or potential fouling of the sampling gear. Hands and feet must never be placed underneath sampling gear.

The possibility exists that mid-water sediment trap moorings will be deployed in the field pilot study area by Montrose and their contractor, Geosyntec Consultants. These moorings are potential fouling hazards to towed geophysical gear such as the side-scan sonar, sub-bottom profiler, or ADCP towfish. Fouling with these moorings can lead to extreme physical hazards, including snapping cables, failing blocks, winches or A-frame, and erratic and sudden vessel motion. Use of towed instrumentation near these moorings should be avoided, if possible. If necessary, wide berths and extreme caution should be observed when towing instrumentation around the moorings. All towfish handlers will stand well clear of all cables, winches, blocks, and A-frame until the towfish is clear of these moorings. Locations of the moorings, including geographic coordinates, water depth, height above bottom, and array design should be obtained from Montrose prior to conducting towed survey operations in these areas.

Sample handling equipment, containers, deck lines, and water hoses not in immediate use will be kept clear of walkways and work areas until needed. Each time operations at a given station have been completed, the deck will be washed to prevent slipping. All deck personnel will have Coast Guard-approved life vests or life jackets available for use. Under circumstances of potentially dangerous waves or winds, the vessel pilot and Field Team Manager will employ best professional judgment to ensure safe field operations. Emergency procedures for a person-overboard situation are discussed in Section 3.8. A hand-held radio or cellular phone will be onboard to allow for direct communication to shore. Emergencies will be handled via marine radio channel 16. Operations will require various notices to mariners notifications. The phone numbers of all related Harbor Patrol and USCG facilities will be posted on the survey vessel, as well as onshore at the Southern California Marine Institute (SCMI), and in the vehicles of field members.

3.2.2 Small Vessel Operations

A small boat (20-foot Whaler) may be used to transport personnel and/or equipment to the survey vessel. Conditions that may require the use of such a boat would be to send out replacement equipment or parts to the survey vessel, enabling the survey vessel to remain on-site. Some small boats can be unstable in the water; therefore, Coast Guard-approved life vests or life jackets will always be worn by field personnel. Prior to coming on-site, all persons will be trained on the operation of the vessel including boat safety, navigation rules, how to start/stop the motor, forward/reverse, fuel requirements, etc. Personnel shall be aware of, and not exceed, the limits for weight capacity and number of persons on the boat. A hand-held radio or cellular phone will be onboard to allow for direct communication to shore or the survey vessel. Under circumstances of potentially dangerous waves or winds, the Field Team Manager will employ best professional judgment to ensure safe field operations.

3.2.3 Sediment Profile Imaging

Sediment profile imaging will be used to determine sediment layer thickness, lateral extent, layer mixing, grain size and biological condition of the Palos Verdes sediments. As described in Section 3.2.1, the sediment profile camera is a heavy piece of sampling equipment. The operator must use caution when deploying and retrieving this gear, especially under adverse weather conditions. Proper safety equipment (hard hat, safety vest, and steel-toed boots) will be worn by all personnel operating the camera. Under adverse weather conditions, tag lines will be used to secure the camera during deployment and retrieval.

3.2.4 Moored Current Meters

Five bottom-moored arrays consisting of a recording current meter and a self-recording Optical Back Scatter (OBS) gage will be deployed in order to obtain information on disposal plumes, current speed and direction, suspended sediment, and surge characteristics during placement events. The instruments will be retrieved following the placement events. As with other large pieces of sampling equipment, the operator must use caution when deploying and retrieving this gear, especially under adverse weather conditions. Proper safety equipment (hard hat, safety vest, and steel-toed boots) will be worn by all personnel involved in deployment and retrieval of the gear. In addition, the alkaline and lithium battery packs should be handled and disposed of properly. Any sediments adhering to the instrument anchor or mounting frame will be retained to the extent possible and stored as hazardous wastes.

3.2.5 Hopper Sediment Sampling

Data on the physical and chemical characteristics of the sediment in the placement vessels will be collected as part of the evaluation of how well actual field results compare to the expected spread and thickness of sediments at the capping cells. SAIC will only be responsible for providing sample containers and instructions to the dredging contractors for sample collection, sample custody, and laboratory analysis of geotechnical properties of the sediment samples. Sediment samples will be collected by the dredge vessel operators, so SAIC personnel will not be exposed to physical hazards.

3.2.6 Hopper Disposal Monitoring

Hopper dredge position data will be acquired during the transit and placement operations at test sites. The Automated Disposal Surveillance System (ADISS) will be installed in the wheelhouse of the hopper dredge. The hardware for ADISS and ADISSPlay (the helmsman display of ADISS positions and draft information) are electronic components, which reside in a small water- and tamper-resistant enclosure, and a laptop computer, respectively. ADISS and ADISSPlay equipment require 12-volt power converted from the 110-volt ship supply, and though no high voltages are present, due caution must be exercised when working around the electronics.

3.2.7 ADCP Plume Tracking

A broadband acoustic Doppler current profiler (ADCP) and optical back scatter (OBS) equipment will be used to map the location and extent of disposal plumes, as well as to obtain information on current speed and direction and surge characteristics. The ADCP will be mounted in a hydrodynamically-stable tow body. Hardhats, life jackets, and steel-toed boots are required when working on the deck to deploy and recover the ADCP. An A-frame and a hydraulic winch are required to lift the instrument in and out of the water. The deployment and retrieval of this sampling equipment will follow the same general precautions as those outlined in Section 3.2.1.

3.2.8 CTD/Water Sampling

Near-bottom water sampling coupled with conductivity, temperature and depth (CTD) water column profiling will be used to assess the concentrations of total suspended solids (TSS) and p,p'-DDE following the placement of dredged material. The Rosette/CTD underwater unit is a heavy piece of sampling equipment that is supported by a thin-edged aluminum mount stand. The operator must use caution when deploying and retrieving this gear, especially under adverse weather conditions. Proper safety equipment (hard hat, safety vest, steel-toed boots) will be worn by all personnel operating this equipment. Under adverse weather conditions, tag lines will be used to secure the unit during deployment and retrieval.

3.2.9 Video Imagery of Plume Passage

Real-time video photography will be used to visually document the lateral spread of the bottom surge during placement events. The video camera array will be equipped with lights. Although this piece of equipment is not very large, the operator must use caution when deploying and retrieving the video camera, especially under adverse weather conditions. In addition, life-threatening voltages are present in the camera system and care should be taken to avoid injury. Power will be disconnected before servicing the video camera in order to prevent electrical shock.

3.2.10 Sediment Coring

Sediment coring with a gravity corer will be used to obtain information on the sediment cap layer thickness, layer mixing, grain size, and a chemical profile of the sediments. Sediment corers are potentially dangerous pieces of equipment. All personnel should wear hard hats, steel-toed boots, and life vests when working on the vessel with the gravity corer. Personnel should avoid standing directly beneath the winch wire or in the bight of any taut cable or ropes. The operators must be careful not to place hands or fingers in a position where they could be injured. The corer is a heavy piece of equipment (especially when full). The operators must take care when deploying or retrieving this gear under adverse weather conditions. Safety lines are recommended during adverse weather conditions. Residual sediments will be retained to the extent possible and stored on the survey vessel as hazardous wastes.

The sediment cores will be transported to the SCMI laboratory for processing. Site control measures to be used at the SCMI laboratory are described in Section 4.5. The core tube liners containing sediment are split using a motorized cutting unit and knives. When using the motorized unit, hearing protection and leather gloves, or other comparable protection should be worn in addition to the recommended PPE for intrusive sampling, described in Section 4.2. As with the operation of any motorized cutting device, hands, fingers, hair and other body parts should be kept away from moving parts. When using knives to split the remainder of the core liner, personnel must wear leather gloves, or other comparable protection and keep hands away from the blades. Personnel will use extreme caution when using knives. Personnel should avoid pulling the knife towards the body, and hands should be kept above and away from the area being cut.

3.2.11 Side-scan Sonar Survey

A side-scan sonar survey will be performed to provide information on cap distribution, bottom disturbance features, and bottom topography. The side-scan sonar is encased in a weighted and deployable towfish unit. Precautions related to the deployment and recovery of the equipment are described in Section 3.2.1. In addition, the side-scan sonar is an electronically-powered instrument and should be treated with common safety awareness related to general electrical usage.

3.2.12 Sub-bottom Profile Survey

Sub-bottom seismic profiling will be used to determine cap thickness and stratigraphy. The sub-bottom profiling system is also deployed with a towfish unit and will be operated simultaneously with the side-scan sonar equipment during post-cap surveys. The same general physical hazards of the side-scan sonar equipment described in Section 3.2.11 also apply to the sub-bottom profiling equipment, and the same precautions will be followed.

3.2.13 Environmental Exposure

Exposure to the elements and fatigue are two major causes of accidents onboard vessels. The sampling shifts may cover 10 hours or more and, in the marine environment, the weather can often be unpredictable. Working in rough waters can lead to seasickness, fatigue, and exposure. The combination of rough waters and fatigue increases the chances for a person-overboard situation. To prevent fatigue and overexposure in adverse weather conditions, field personnel will rotate tasks so that each person is periodically working inside the vessel's cabin. The frequency of the shift changes will be determined by the SHSO. Proper clothing will be brought to accommodate changes in weather.

Field work will be conducted during the summer months when site personnel may be subject to the sun and high air temperatures. In these conditions, field teams must be prepared to wear proper protective clothing and to recognize symptoms of heat stress. Heat-related illnesses can occur at any time when protective clothing is worn. Workers wearing semi-permeable or impermeable encapsulating clothing (e.g., Tyvek) should be monitored for heat stress through regular checks of heart rate and by more comprehensive monitoring when the temperature in the work area is above 21°C (70°F). A pulse rate in excess of 150 beats per minute may indicate heat exhaustion, although this rate will vary among workers. All personnel should know what their baseline pulse rate is before working in elevated temperatures, so as to monitor themselves. The SHSO will be trained in monitoring, treating, and recognizing the signs of heat stress. Heat stress can be manifested as both heat stroke and heat exhaustion:

- In **heat stroke**, the person's temperature control system that causes sweating stops working correctly. The body temperature rises so high that brain damage and death will result if the person is not cooled quickly. The main signs and symptoms of heat stroke are red or flushed, hot, dry skin, although the person may have been sweating earlier; and extremely high body temperature, often to 41°C (106°F). There may be dizziness, nausea, headache, rapid respiratory and pulse rates, and unconsciousness or coma.

  Treatment: Cool a victim of heat stroke quickly. If the body temperature is not brought down fast, permanent brain damage or death will result. Soak the person in cool but not cold water, sponge the body with rubbing alcohol or cool water, or pour water on the body to reduce temperature to a safe level - below 39°C (102°F). Then stop cooling and observe the victim for 10 minutes. If the temperature starts to rise again, cool the victim again. Do not give coffee, tea, or alcoholic beverages. When the victim's temperature remains at a safe level, get medical help immediately.

- **Heat exhaustion** is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. This condition is much less dangerous than heat stroke, but it none the less must be treated. The major signs of heat exhaustion are pale, clammy skin, profuse perspiration, and extreme tiredness or weakness. The body temperature is approximately normal, pulse is weak and rapid, and breathing is shallow. The person may have a headache, dizziness, and may vomit.

  Treatment: Remove the person to a cool place, loosen clothing, place in a head low position and provide bed rest. Give a salt solution (1/2 teaspoon salt in 1/2 glass of water) every 15 minutes for three or four doses. Medical care is needed for severe heat exhaustion.

Heat Stress Monitoring and Work Cycle Management. For field activities that are part of ongoing site work activities in hot weather, the following procedures should be used to monitor the body's physiological response to heat, and to manage the work cycle, even if workers are not wearing impervious clothing. These procedures are to be instituted when the temperature exceeds 21°C (70°F).

1) Site workers will be briefed on the recognition and treatment of heat related illnesses. This training will include the signs, symptoms, and treatment of heat related illnesses.

2) Workers will be encouraged to drink a minimum of 16 ounces of liquids (water or electrolyte) prior to start of work in the morning, after lunch, and at end of work shift. Liquids containing caffeine should be avoided.

3) A shelter or shaded area will be provided where workers may be protected from sunlight during rest periods.

4) Monitoring of physiological heat stress will be performed using one of the two methods below to prevent and/or provide for early detection of heat induced stress:

5) Measure Heart Rate. Heart rate should be measured by the radial pulse for 30 seconds before beginning work and as early as possible in the resting period. The heart rate at the beginning of the rest period should not exceed 100 beats/minute. If the heart rate is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute

at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 110 beats/minute.

6) Measure Body Temperature. Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 37.4°C (99.40°F); if it does, the worker will be prohibited from continuing work until the oral temperature is maintained below 37.4°C (99.4°F).

7) Manage Work/Rest Schedule. The following work/rest schedule shall be used as a guideline. Level D protection gear is anticipated. Therefore, this guideline should be considered conservative.

Adjusted Temperature (°F)	Active Work Time (min/hr) Using Level B/C Protective Gear
75 or less	50
80	40
85	30
90	20
95	10
100	0

Calculate the adjusted temperature:
T (adjusted) = T (actual) + (13 x fraction sunshine)

Measure the air temperature with a standard thermometer. Estimate fraction of sunshine by judging what percent the sun is out:

- 100-percent sunshine = no cloud cover = 1.0;
- 50-percent sunshine = 50 percent cloud cover = 0.5;
- 0-percent sunshine = full cloud cover = 0.0

Reduce or increase the work cycle according to the guidelines under heart rate and body temperature.

4.0 HAZARD MONITORING AND CONTROL

4.1 Training

All SAIC and subcontractor personnel and visitors who enter contamination reduction or exclusion zones (as described below in Section 4.5) at the Palos Verdes site must have the required training and/or documented equivalent experience. This includes any intrusive sampling activities, which consist of the sediment coring and processing. The SPI camera work will not be considered intrusive sampling, so long as any sediment adhering to the camera frame is rinsed off prior to bringing the camera on the vessel deck. Any personnel involved in any intrusive sampling activities for this program must have completed the 40-hour hazardous waste site training, annual 8-hour refresher courses as applicable and appropriate medical monitoring in accordance with CFR 1910.120. At a minimum, one SAIC personnel having completed the 8-hour supervisor training course will be on-site during intrusive sampling and processing operations. All personnel requiring this training will have documented on-site supervision for a period of three days or will work under direct supervision by a qualified individual for the first three days of the field effort. The barge/dredge vessel will not be considered a contamination reduction or exclusion zone as no hazardous material will be encountered. Therefore, any personnel or visitors onboard the barge/dredge vessel will not require the above training.

All SAIC and subcontractor personnel and visitors will be briefed on site-specific conditions during a one-time safety meeting to be conducted before commencement of each field program effort at the Palos Verdes site. It is anticipated that the interim and post-cap monitoring program will require the rotation of personnel due to the logistics of placing survey personnel on-site for extended periods of time. Additionally, at least two personnel with first aid and CPR certifications will be on-site during sampling and processing operations. Training certifications will be kept on file on-site and at the employee's home SAIC office. The Project Safety Officer and Site Safety Officers will be responsible for ensuring any new (rotated) personnel receive the initial one-time safety meeting before beginning work on-site. The following checklist will be used by the Project Safety Officer and Site Safety Officers for these safety meetings.

Site Review and Work Plan

- Area maps
- Pertinent site history
- Work description

General Field Safety Techniques

- Responsibilities
- Medical program
- Site control zones
- Potential hazardous contaminants present at the project site, chemical hazards at specific sites, and chemicals brought on-site (toxicity and symptomatology)

- Occupational exposure limits and action levels
- Use of field equipment and supplies
  - Coring equipment
  - Work tools
  - Survey equipment
  - Monitoring equipment
- Site control and security
- Buddy system
- Work limitations
  - Hours of work
  - Light conditions
  - Weather (including heat stress and cold stress)

Personal Protective Equipment and Clothing

- General
  - Work clothing
  - Eye protection
  - Foot protection
  - Head protection
  - Hearing protection
- Decontamination of clothing and equipment
- Disposal of contaminated clothing and equipment

Emergency Procedures

- Availability of emergency services and location of telephone numbers
- Transportation of emergency cases
- First aid/cardiopulmonary resuscitation
- On-site emergency assistance and review of hand signals
- Fire/explosion prevention and control

4.2 Personal Protective Clothing and Equipment

All scientific members are required to wear rain gear or Tyvek, rubber steel-toed boots, safety glasses, and nitrile gloves (modified Level D) when performing intrusive activities (sediment sampling and processing), and while using hydrochloric acid, hexane, or methanol for decontaminating equipment. For personnel involved with sediment core processing, Tyvek aprons or lab coats may be used in place of Tyvek coveralls. These requirements will also apply to all scientific members working in the core processing area. At a minimum, rubber steel-toed boots are required for performing all other non-intrusive activities. A hard hat is required when an overhead hazard exists (e.g., deploying and retrieving sampling equipment). All field members performing sample handling and equipment decontamination activities must have available a half-mask or full-face respirator equipped with organic vapor cartridges and P-95 filters. The use of respirators during sediment sampling and processing is not expected to be required unless instructed by the SHSO. Coast Guard-approved flotation vests must be available for all crew while on the sampling vessel. Use of flotation vests will be directed by the SHSO, under circumstances of potentially dangerous waves or winds.

Visiting personnel will not require the PPE specified for scientific members (modified Level D) unless entering the exclusion zone or contamination reduction zone (CRZ) described in Section 4.5. Visiting personnel may wish to have available rain gear, rubber steel-toed boots, safety glasses, protective gloves, and a hard hat, depending on the anticipated hazards for the specific areas that they will be visiting.

Each field member is expected to bring clothing appropriate to the weather and task to minimize the hazards of exposure and heat or cold stress. Boots and rain gear or other waterproof clothing are required (or will be available), while sampling on the vessel.

Each field member is required to inspect his or her PPE for proper functioning (e.g., for leaks, tears, holes, missing fasteners, etc.) on a daily basis and to report any malfunctions to the SHSO. The SHSO shall maintain a record of any such malfunctions in order to monitor the effectiveness of the PPE program.

Additional safety supplies to be placed in the vehicles onshore, and on the vessels include: first-aid kit, eye wash, blanket, clean water, and ABC type fire extinguisher (minimum 20 pounds charged weight). Safety equipment and operating procedures required by the U.S. Coast Guard will be followed on the vessel.

4.3 Medical Surveillance

All scientific crew involved with intrusive sampling will have the appropriate medical monitoring, performed by or under the supervision of a certified occupational medical physician, in accordance with CFR 1910.120 for this program. No site-specific medical monitoring is required.

4.4 Monitoring Equipment and Procedures

It is not anticipated that any monitoring for volatile organic compounds will be required for the post-cap monitoring program. Monitoring of organic vapors was conducted using an H-Nu photoionization detector during baseline study. Measurements of organic vapors were compared to background readings taken before sediments were processed. The organic vapor action level for field activities was 10 ppm above background in the breathing zone for 5 minutes or longer. There was no indication of the presence of organic vapors based on this initial monitoring, so no further monitoring for organic vapors will be required. Hydrogen sulfide was also monitored during the baseline study using a direct reading hydrogen sulfide meter. The action level for hydrogen sulfide was 5 ppm. There was no indication of the presence of elevated hydrogen sulfide based on this initial monitoring, so no further monitoring for hydrogen sulfide will be required. Good air circulation is recommended when processing marine sediments. Adding fans to the processing area can reduce and eliminate hazardous levels as well as aid in keeping the area cooler for technicians. Exposure to chemicals used during decontamination will be minimized, as decontamination activities will be performed outdoors where fresh air is being exchanged over the work area.

4.5 Site Control Measures

Three work areas—an exclusion zone, a contamination reduction zone (CRZ), and a support zone—will be established at each activity site. This procedure will help minimize the number of personnel in the work area, ensure that personnel are properly protected against the hazards present where they are working, and ensure that work activities and contamination are appropriately confined.

Exclusion Zone

The exclusion zone is the area where contamination does or could occur. The seafloor of Palos Verdes defines the exclusion zone for this project. During intrusive sampling, the exclusion zone also includes the area of the vessel in which sediments collected from the seafloor are handled. This part of the vessel is designated as the exclusion zone only when sediment is being handled on the vessel. When no sediment is onboard, the entire vessel is considered the support zone. An area of the SCMI laboratory where sediment processing is performed onshore will be designated as the exclusion zone. Only authorized field personnel will be allowed in the exclusion zone. The initial level of protection required may be adjusted by the SHSO as conditions change. The barge/dredge vessel will not be considered an exclusion zone, as no hazardous materials will be encountered.

Contamination Reduction Zone

The contamination reduction zone (CRZ) is the transition area between the contaminated area and the clean area. The CRZ during sediment sampling is the vessel deck, except as noted in the preceding paragraph. The CRZ during processing will be determined. Decontamination of both personnel and equipment will occur in this zone to prevent the transfer of chemicals of concern to the support zone.

Support Zone

The support zone is where all personnel will suit-up in specified PPE before entering the exclusion zone. The support zone will be located onshore in an area outside the CRZ, or in the cabin or holds of the vessel, or on the vessel deck when contaminated sediment is not on deck. The support zone includes storage areas for "clean" equipment and resting and eating facilities for personnel.

4.6 Decontamination Plan

Personnel

Personnel will be required to decontaminate any known or suspected contamination before food or drink breaks, and before leaving the exclusion zone on the vessel. Full decontamination includes the following:

- Equipment drop
- Tape removal
- Outer glove wash with laboratory detergent and water rinse; removal and placement in plastic bag (processing operations only)
- Safety boot washdown, using scrub brushes, with laboratory detergent and water
- Tyvek removal and disposal, or rain-slick washdown with laboratory detergent and water (for breaks, Tyvek or rain slicks may be removed to the waist)
- Inner glove removal and disposal
- Hand and face wash
- Thorough wash and shower at end of day

The SHSO will monitor the decontamination methods to determine their effectiveness. A potable water supply, toilet facilities, and washing facilities will be available both at the shoreside facility (SCMI) and on the research vessel.

In case of an emergency, gross decontamination procedures will be speedily implemented if possible. If a life-threatening injury occurs and the injured person cannot undergo decontamination procedures without incurring additional injuries or risk, he or she will be transported, wrapped in plastic sheeting if time allows and if consistent with the injury. The medics and medical facility will be informed that the injured person has not been decontaminated, and will be provided information regarding the most probable chemicals of concern.

Sampling Equipment

Intrusive sampling equipment will be decontaminated prior to initiation of sampling and between sampling locations. Decontamination methods described in the Field Sampling Plan will be used by field personnel prior to initialization of sampling and between sampling locations. Decontamination of intrusive sampling equipment (pans, utensils, etc.) and samplers used in this investigation may involve a combination of laboratory detergent, tap water, methanol, hexane, and hydrochloric acid.

4.7 Communication

A hand-held radio and/or cellular telephone will be on-board any vessels used, and on-site at a designated area onshore, to allow for direct communication to shore or to a vessel. Pertinent telephone numbers will be provided to all site and project personnel prior to initiation of field work.

4.8 Investigation-Derived Waste Management Plan

The control of investigation-derived wastes will be performed in accordance with the measures outlined in Section 5.0 of the Field Sampling Plan. It is expected that only unused site materials and decontamination reagents will be generated as waste. Excess sediments and other site-derived material not needed for analysis will be collected and retained in sealed and labeled containers. Spent decontamination reagents (hexane, methanol, and hydrochloric acid) will be collected and retained in sealed and labeled containers. These chemicals will be stored onsite at the SCMI facility. Hexane and methanol may be stored in the same container, and hydrochloric acid will be stored separately. It is anticipated that the hexane and methanol waste will be combined with appropriate waste streams at the SCMI facility and disposed of accordingly. The hydrochloric acid waste will be diluted and neutralized before disposing of at the SCMI facility.

4.9 Other Hazard Control Measures

Personnel will only work during daylight hours, and no field activities will be scheduled during the period of thirty minutes before dusk to thirty minutes before dawn. Additional site- and situation-specific hazard control measures shall be identified and incorporated as revisions or addenda to this HSP, as required.

4.10 Enforcement of the Health and Safety Plan

To protect all personnel visiting SAIC site activities from any adverse health effects that may result from those site activities, all employees, contractors, and visitors to the SAIC work site are required to follow the requirements of this plan. All visitors to the site must be granted admission to the site by the USACE and SAIC project representatives. All personnel involved with the investigation will check in with the Field Manager prior to site entry. All personnel must provide their own necessary PPE as specified in this HSP or by the Project Safety Officer. All personnel visiting the investigation area will be briefed on this HSP, as described in Section 4.1. Visiting personnel will not require the PPE specified in Section 4.2 (modified Level D) unless they will be entering the exclusion zone or contamination reduction zone (CRZ) as described in Section 4.5. If visiting personnel enter the exclusion zone or CRZ, whether on a research vessel or onshore, the training and medical monitoring requirements outlined in Sections 4.1 and 4.3 will apply. All SAIC and subcontractor field personnel are required to sign their acknowledgment of the requirements herein. A copy of this health and safety plan shall be maintained in designated areas both on the sampling vessels and at the onshore worksite at all times.

4.10.1 Safety Rules

All personnel working in the field will follow the rules and procedures listed below:

1) Before any field operations take place, all project personnel must review this site Health and Safety Plan (HSP) and become familiar with the required safety procedures. The Site Safety Officer will review safety procedures with the field team at the initiation of field operations. Measures to ensure that the HSP is being followed will include workday safety meetings and inspections that include checklists and documentation procedures.

2) The Site Safety Officer will contact key emergency services prior to the start of sampling activities to establish final procedures to be used in case of an onboard emergency and to inform them of the activities being performed on-site and the associated potential problems. The U.S. Coast Guard will be kept informed of the research vessel(s) operations/locations.

3) Copies of this Health and Safety Plan will be available on board the vessels and in each field vehicle. A waterproof copy of the completed Emergency Contacts sections will be posted near the ship-to-shore radio or cellular telephone. In addition, a waterproof map of the site including waterways and associated piers will be posted in the same location.

4) The Site Safety Officer, in conjunction with the vessel operator, will continually monitor weather conditions (e.g., storm fronts, lightning, or high winds). A radio capable of receiving the National Weather Service frequency for the Palos Verdes area will be onboard or onshore and monitored periodically. The Site Safety Officer will have the responsibility and the authority to halt operations if conditions are deemed to be unsafe.

4.10.2 Safety Briefings

All personnel will be given a health and safety briefing prior to performing any on-site task. This initial briefing will include a rehearsal of the Emergency Response Plan that will consist of a verbal walk-through of an emergency situation (e.g., a physical injury), emergency response actions (e.g., administration of first aid), notification of emergency services (e.g., 9-1-1 system), and transport to medical facility. In addition, periodic health and safety briefings will be conducted to remind personnel of the potential on-site hazards or as conditions change.

5.0 SPILL CONTAINMENT PLAN

It is anticipated that all chemicals brought onsite will be stored in plastic bottles placed in plastic bags or glass bottles in shipping (cardboard) boxes. These bottles will be stored in labeled, spillproof containers with a lid, such as a 5-gallon bucket or a cooler. Site- and situation-specific spill containment measures shall be identified and incorporated as revisions or addenda to this HSP as required.

6.0 RECORDKEEPING

All revisions or addenda to this HSP will be documented in the project file and copies of all modifications will be maintained on the job site at all times. Appendix A contains the following Health and Safety forms relevant to this project:

- Form 1: Signature Page
- Form 2: Modification to the Health and Safety Plan
- Form 3: Employee Exposure/Injury Incident Report
- Form 4: Daily Safety Inspection
- Form 5: Hazardous Waste Site Task/Project Debriefing Questionnaire

The Site Health and Safety Officer will be responsible for completing these forms as necessary, and for forwarding all health and safety information pertinent to the project to the project manager and project safety officer. Form 5 will be completed by the Project Health and Safety Officer (or individual designated by the Project Manager) and reviewed by the Project Manager or other cognizant management within 30 days of the date of last activity at a site. Copies of all forms completed will be kept in the project file.

7.0 EMERGENCY RESPONSE PLAN

For all Health and Medical Emergencies, Notify the On-site SAIC Health and Safety Officer and Field Manager or Vessel Operator. Following an emergency, the SHSO will report incidents to Local, State, and other authorities, as appropriate. The SHSO will also provide an evaluation and critique the emergency response actions to the SAIC field and project managers.

SAIC PROJECT MANAGER:	Dr. Scott McDowell
Phone numbers:	(401) 847-4210 (office) (401) 683-7998 (home) (401) 261-4108 (cell)
SAIC FIELD TEAM MANAGER:	John Evans
SAIC PROJECT HEALTH AND SAFETY OFFICER:	John Nakayama
CLIENT CONTACT:	Ms. Eleanor Nevarez
CLIENT PHONE NUMBER:	(626) 401-4045 (office) (601) 278-0326 (cell)
SITE PHONE NUMBERS:	(310) 519-3172 (SCMI General Number) (310) 548-1704 (SAIC Field Office at SCMI)
DREDGING CONTRACTOR (NATCO):	Bill Murchison (630-574-2992) Lynn Nietfeld (630-258-3909) Pier 400 Project Office (562-983-5666)
Personal Injury or Illness:	Administer First Aid Call Ambulance If necessary, transport to hospital See Emergency Medical Care and Procedures

Fire or Explosion: Turn off all motorized equipment; evacuate the work area; meet at designated upwind assembly area.

Hazardous Material Spill or Release: Turn off all motorized equipment; evacuate the work area in a direction upwind of the spill or release; meet at designated upwind assembly area; contact appropriate response personnel as necessary.

Person Overboard: Stop the vessel immediately. Turn off all motorized equipment, and cease all non-rescue activities. Flotation devices attached to lines will be thrown to the victim from the vessel. Keep the victim in sight as long as possible. No other person(s) shall enter the water except if the victim is unconscious or seriously injured. Rescuers must wear life preservers and be tethered to the research vessel. The victim will then be brought aboard the vessel; wet clothes will be removed and replaced with dry clothing. In the event the victim is injured or unconscious, activate the emergency medical alert system (911) and/or notify the U.S. Coast Guard.

Equipment Failure: If any other equipment on-site fails to operate properly, the Field Manager and SHSO shall be notified and they shall determine the effect of this failure on continuing operations on-site. If the failure affects the safety of personnel or prevents the proper completion of the tasks described in the work plan, all operations will be secured and all personnel shall cease activities until the situation has been evaluated and appropriate actions taken.

8.0 EMERGENCY MEDICAL CARE AND PROCEDURES

For all Health and Medical Emergencies, Notify the On-site SAIC Health and Safety Officer, Field Manager, or Vessel Operator

SAIC PROJECT MANAGER:	Dr. Scott McDowell
FIELD TEAM MANAGER:	John Evans
SAIC PROJECT HEALTH AND SAFETY OFFICER:	John Nakayama
CLIENT CONTACT:	Ms. Eleanor Navarez
CLIENT PHONE NUMBER:	(626) 401-4045 (office) or (601) 278-0326 (cell)
SITE PHONE NUMBER:	(310) 548-1704 (SAIC Field Office at SCMI)

Nearest Emergency Medical Facility:
Local urgent care and emergency medical services are located within 15 miles of the Southern California Marine Institute. Four facilities capable of taking personnel for job-related injuries (two urgent care and two after hours/emergency room) are identified below. Additionally, these facilities have been approved for University and foundation employees.

Urgent Care Facilities

Mulliken Medical Center	**Long Beach Memorial Occupational Medical Services**
5000 Airport Plaza Drive	450 East Spring Street
Lakewood, CA	Long Beach, CA
562.497.4759	562.933.0085
8:00 am through 5:00 pm	8:00 am through 11:00 pm
Distance from SCMI: 13.50 miles	Distance from SCMI: 8.91 miles

After Hours/Emergency Room

Long Beach Community Medical Center	**Long Beach Memorial Medical Center**
1720 Termino Ave.	2801 Atlantic Ave.
Long Beach, CA	Long Beach, CA
562.498.1000	562.933.2000
All Hours	All Hours
Distance from SCMI: 10.09 miles	Distance from SCMI: 8.75 miles

Driving directions to the above facilities are on the following pages.

Emergency Phone Numbers:

Police Department, Emergency	911
Fire Department, Medical Emergency	911
U.S. Coast Guard	TBD

Emergency First Aid Procedures for Substances Present:
See attached data sheets for specific symptoms and treatments.

If a blood spill occurs:

- Clean up the spill immediately or as soon as possible after the spill occurs.
- Use disposable gloves and other PPE when cleaning spills.
- Wipe up the spill with paper towels or other absorbent material.
- After the area has been wiped up, flood the area with a solution of ¼ cup of liquid chlorine bleach to 1 gallon of fresh water (approximately a 10% solution), and allow it to stand for at least 20 minutes.
- Dispose of the contaminated material used to clean up the spill in a labeled biohazard container.

First Aid Equipment On-Site: (Placed in accessible area outside of the Work Zone)
First Aid Kit, Cellular Telephone, Fire Extinguishers (minimum of two), a portable eye wash capable of providing 15-minutes of uninterrupted water flow, Cool water/fluids (2 gallons/person/day)

Mulliken Medical Center

From:	SCMI 820 S Seaside Ave Terminal Island, CA	To:	Mulliken Medical Center 5000 Airport Plaza Dr Lakewood, CA 90731-7330 562.497.4759

Your trip's estimated travel time is 32 minutes for 15.3 miles of travel, total of 19 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

Directions:

1. Start out going Northwest on S SEASIDE AVE towards WHARF ST. Drive 0.4 miles.
2. Turn RIGHT onto TERMINAL WAY. Drive 0.8 miles.
3. Turn RIGHT at the intersection of FERRY ST to stay on TERMINAL WAY. Drive 0.9 miles.
4. Turn LEFT onto NAVY WAY. Drive 0.2 miles.
5. Turn RIGHT onto N SEASIDE AVE. Drive 0.2 miles.
6. N SEASIDE AVE becomes W OCEAN BLVD. Drive 2.2 miles.
7. Take the ramp towards PORT OF LONG BEACH/DOWNTOWN. Drive 0.7 miles.
8. Merge onto I-710 N. Drive 3.5 miles.
9. Take the I-405/SAN DIEGO FWY exit on the RIGHT towards SANTA MONICA/SAN DIEGO. Drive 0.2 miles.
10. Take the I-405 SOUTH exit on the RIGHT towards SAN DIEGO. Drive 0.3 miles.
11. Take the I-405/SAN DIEGO FWY exit on the LEFT towards SAN DIEGO. Drive 0.3 miles.
12. Merge onto I-405 S. Drive 3.2 miles.
13. Take the CA-19 NORTH/LAKEWOOD BLVD NORTH/CA-19 SOUTH/LAKEWOOD BLVD SOUTH exit on the RIGHT towards LONG BEACH AIRPORT.
14. Keep RIGHT at the fork in the ramp. Drive 0.5 miles.
15. Merge onto N LAKEWOOD BLVD. Drive a short distance.
16. Turn RIGHT onto E WILLOW ST. Drive 0.5 miles.
17. Turn RIGHT onto REDONDO AVE. Drive 0.4 miles.

18. Turn RIGHT onto E SPRING ST. Drive 0.9 miles.

19. Turn RIGHT onto AIRPORT PLAZA DR. Drive 0.1 miles to your destination at 5000 AIRPORT PLAZA DR.

Figure 8-1. Location of Mulliken Medical Center.

Long Beach Memorial Occupational Medical Services

From:	SCMI 820 S Seaside Ave Terminal Island, CA	To:	Long Beach Memorial Occupational Medical Services 450 E Spring St Long Beach, CA 90731-7330 562.933.0085

Your trip's estimated travel time is 21 minutes for 9.3 miles of travel, total of 13 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

Directions:

1. Start out going Northwest on S SEASIDE AVE towards WHARF ST. Drive 0.4 miles.
2. Turn RIGHT onto TERMINAL WAY. Drive 0.8 miles.
3. Turn RIGHT at the intersection of FERRY ST to stay on TERMINAL WAY. Drive 0.9 miles.
4. Turn LEFT onto NAVY WAY. Drive 0.2 miles.
5. Turn RIGHT onto N SEASIDE AVE. Drive 0.2 miles.
6. N SEASIDE AVE becomes W OCEAN BLVD. Drive 0.6 miles.
7. Turn LEFT onto CA-47 N. Drive 1.0 miles.
8. CA-47 N becomes CA-103 N. Drive 2.6 miles.
9. Take the exit on the LEFT towards CARSON/LONG BEACH. Drive a short distance.
10. Turn RIGHT onto W WILLOW ST. Drive 1.6 miles.
11. W WILLOW ST becomes E WILLOW ST. Drive 0.2 miles.
12. Turn LEFT onto N LONG BEACH BLVD. Drive 0.5 miles.
13. Turn RIGHT onto E SPRING ST. Drive 0.1 miles to your destination at 450 E SPRING ST.

Figure 8-2. Location of Long Beach Memorial Occupational Medical Services.

Long Beach Community Medical Center

From:	SCMI 820 S Seaside Ave Terminal Island, CA	To:	Long Beach Community Medical Center 1720 Termino Ave Long Beach, CA 90804-2104 562.498.1000

Your trip's estimated travel time is 25 minutes for 10.3 miles of travel, total of 12 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

Directions:

1. Start out going Northwest on S SEASIDE AVE towards WHARF ST. Drive 0.4 miles.
2. Turn RIGHT onto TERMINAL WAY. Drive 0.8 miles.
3. Turn RIGHT at the intersection of FERRY ST to stay on TERMINAL WAY. Drive 0.9 miles.
4. Turn LEFT onto NAVY WAY. Drive 0.2 miles.
5. Turn RIGHT onto N SEASIDE AVE. Drive 0.2 miles.
6. N SEASIDE AVE becomes W OCEAN BLVD. Drive 2.2 miles.
7. Take the ramp towards PORT OF LONG BEACH/DOWNTOWN. Drive 0.7 miles.
8. Merge onto I-710 N. Drive 1.1 miles.
9. Take the CA-1 SOUTH/PACIFIC COAST HWY SOUTH exit on the RIGHT. Drive 0.2 miles.
10. Merge onto W PACIFIC COAST HWY. Drive 0.8 miles.
11. W PACIFIC COAST HWY becomes E PACIFIC COAST HWY. Drive 2.7 miles.
12. Turn RIGHT onto TERMINO AVE. Drive 0.1 miles to your destination at 1720 TERMINO AVE.

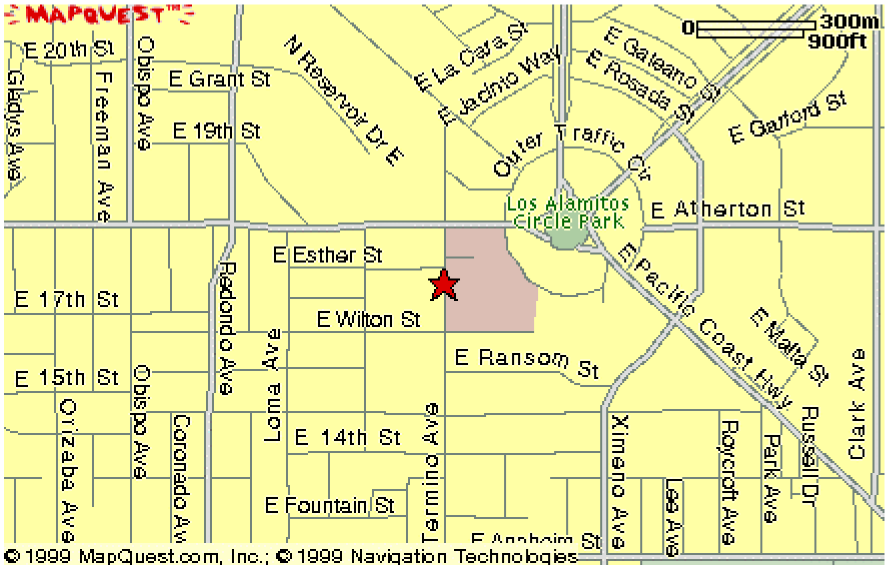

Figure 8-3. Location of Long Beach Community Medical Center.

Long Beach Memorial Medical Center

From:	SCMI 820 S Seaside Ave Terminal Island, CA	To:	Long Beach Memorial Medical Center 2801 Atlantic Ave Long Beach, CA 90806-1737 562.933.2000

Your trip's estimated travel time is 21 minutes for 9.2 miles of travel, total of 13 steps.

These driving directions are provided only as a rough guideline. Please be sure to call ahead to verify the location and directions.

Directions:

1. Start out going Northwest on S SEASIDE AVE towards WHARF ST. Drive 0.4 miles.
2. Turn RIGHT onto TERMINAL WAY. Drive 0.8 miles.
3. Turn RIGHT at the intersection of FERRY ST to stay on TERMINAL WAY. Drive 0.9 miles.
4. Turn LEFT onto NAVY WAY. Drive 0.2 miles.
5. Turn RIGHT onto N SEASIDE AVE. Drive 0.2 miles.
6. N SEASIDE AVE becomes W OCEAN BLVD. Drive 0.6 miles.
7. Turn LEFT onto CA-47 N. Drive 1.0 miles.
8. CA-47 N becomes CA-103 N. Drive 2.6 miles.
9. Take the exit on the LEFT towards CARSON/LONG BEACH. Drive a short distance.
10. Turn RIGHT onto W WILLOW ST. Drive 1.6 miles.
11. W WILLOW ST becomes E WILLOW ST. Drive 0.2 miles.
12. Turn LEFT onto N LONG BEACH BLVD. Drive 0.2 miles.
13. You will come to an intersection from N LONG BEACH BLVD. Turn RIGHT to go onto next road. Drive 0.3 miles to your destination at 2801 ATLANTIC AVE.

Figure 8-4. Location of Long Beach Memorial Medical Center.

9.0 PLAN APPROVALS

This site-specific health and safety plan has been written for the use of SAIC and its subcontractor(s)' project personnel. The project team claims no responsibility for its use by others. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

PLAN PREPARED BY:	Mary K. S. Hubbard SAIC Marine Chemist
DATE:	June 30, 2000
PLAN APPROVED BY:	
DATE:	

10.0 REFERENCES

Palermo, M., P. Schroeder, Y. Rivera, C. Ruiz, D. Clarke, J. Gailani, J. Clausner, M. Hynes, T. Fredette, B. Tardy, L. Peyman-Dove, and A. Risko. 1999. Options for *In-Situ* Capping of Palos Verdes Shelf Contaminated Sediments. Technical Report EL-99-2. U.S. Army Corps of Engineers Waterways Experiment Station. 60 p. + figures and appendices.

APPENDIX A

HEALTH AND SAFETY FORMS

FORM 1

SIGNATURE PAGE

THIS HEALTH AND SAFETY PLAN APPLIES TO THE EMPLOYEES OF SAIC AND ITS SUBCONTRACTORS WHILE WORKING ABOARD THE RESEARCH VESSEL, PERFORMING MONITORING ACTIVITIES, AND WHILE PROCESSING SEDIMENTS. THE SAIC SITE SAFETY OFFICERS, SAIC PROJECT MANAGER, AND EVERY MEMBER OF THE FIELD INVESTIGATION TEAM ARE RESPONSIBLE FOR THE IMPLEMENTATION OF THIS HEALTH AND SAFETY PLAN. SAIC WILL PROVIDE A COPY OF THE HEALTH AND SAFETY PLAN TO ALL SAIC PERSONNEL AND ITS SUBCONTRACTORS, AND REQUIRES ALL PERSONNEL TO FOLLOW THESE PROTOCOLS.

Prepared by:

____________________	____________________	____________________	__________
Name (Print)	**Signature**	**Title**	**Date**

Approved by:

____________________	____________________	____________________	__________
Name (Print)	**Signature**	**Title**	**Date**

We, the undersigned, have read this Site Health and Safety Plan and will institute the provisions and abide by the requirements contained herein for the duration of this program. Failure to comply with these requirements may lead to disciplinary action and/or dismissal from the work site.

Name (Print)	**Signature**	**Title**	**Date**

FORM 2

MODIFICATION TO HEALTH & SAFETY PLAN
PALOS VERDES BASELINE MONITORING
DATE ___/___/___

Modification:____

____

____

____

Reason for Modification:____

____

____

____

Site Personnel Briefed:

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Name:____ Date:_______________

Approvals

Site Safety Officer:____

Project Safety Officer:____

Project Manager:____

Others:____

FORM 3

EMPLOYEE EXPOSURE/INJURY INCIDENT REPORT

(Use additional page if necessary)

Date:______________________________ Time:______________

Name:______________________________ Employer:______________________

Site Name and Location:____

Site Weather (clear, rain, snow, etc.):______________________________________

____

Nature of Illness/Injury:____

Symptoms:____

Actions Taken: Rest:______________ First Aid:______________ Medical:______________

Transported By:____

Witnessed By:____

Hospital's Name:____

Treatment:____

Comments:____

What was the person doing at the time of the accident/incident?______________________

____

Personal Protective Equipment Worn:_______________________________________

____

Cause of Accident/Incident:____

____

What immediate action was taken to prevent recurrence?_________________________

____

Additional Comments:____

____

Employee's Signature:

____

Date

Supervisor's Signature:

____

Date

Site Safety Representative's Signature

____

Date

FORM 4

DAILY SAFETY INSPECTION

DAILY SAFETY INSPECTION	YES	NO	N/A
1. Access logs for the previous day were reviewed and the safety briefing acknowledgement form was signed by each new employee and visitor.			
2. Training documents and evidence of medical exams are in file for each new employee and/or visitor, where required.			
3. Workers in the exclusion zone are wearing the respiratory protective clothing specified in the HSP for the task they are performing.			
4. Workers in the exclusion zone are wearing the type of protective clothing specified in the HSP for the task they are performing.			
5. Protective clothing in use is free of visible contamination or defects.			
6. In hot weather, heat stress is monitored as specified in the "Physical Hazards" section of the HSP and appropriate work/rest schedules are followed.			
7. An adequately stocked first aid kit is available at each work location.			
8. A full-charged 20 lb.-ABC fire extinguisher is available at each work location.			
9. Radio and/or cellular telephone communication equipment is functioning properly.			
10. Deficiencies observed in previous inspection have been corrected.			
11.			
12.			
Use the space below to list any deficiencies and corrective actions taken:			
Inspection performed by:__________________________Date:			

FORM 5

HAZARDOUS WASTE SITE TASK/PROJECT DEBRIEFING QUESTIONNAIRE

The purpose of this questionnaire is to serve as a checklist for documenting a formal review of environmental compliance and health and safety (EC&HS) status upon completion of a field effort at a hazardous waste site. This form is to be prepared by the Project Safety Officer (or individual designated by the Project Manager) and reviewed by the Project Manager or other cognizant management within 30 days of the date of last activity at a site.

1. Site Name:____

2. Applicable SSHSP (title, date):____________________________________
____

3. Duration of site work covered by this debriefing:
   Start Date:__________________ Completion Date:________________________

4. List SAIC Employees who worked at this site:

Name	Employee No.	Name	Employee No.
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	
Attach additional list on reverse of this page.			

5. List of subcontractors to SAIC who worked at this site:

Subcontractor Name	Address	Task

6. Were there any accidents or injuries involving SAIC or SAIC subcontractor personnel that required medical treatment? (Yes/No)

   If yes, give names of individual(s), date(s) of injury, and attach a copy of the supervisor's accident investigation report:

Name	Date	Employer

7. Did the subcontractors comply with applicable health and safety requirements? (Yes/No)

   If no, give details:____

   ____

   ____

8. Were there any unplanned releases of contaminated material to the environment (spills to navigable water, non-compliant discharges to a POTW)? (Yes/No)

   If yes, what notifications were made (e.g. National Response Center, client, EPA, or State Agency)? Attach relevant correspondence.

   ____

   ____

9. Were employee exposures to chemical hazards monitored? (Yes/No)

   If yes, complete the following:

   A. Monitoring using OVA or H-Nu Instrument:

   Action level stated in the SSHSP:____________________________________

   Was action level ever exceeded? (Yes/No)

If yes, indicate date(s) and action taken:

Date	Action

B. Monitoring using chemical-specific devices (such as Draeger tubes, H_sS monitor, samples collected for laboratory analysis):

Substance Measured	PEL	BZ or Area	Lowest Measured Exposure	Highest Measured Exposure	Respiratory Protection Used (Yes/No)

Comments:____

____

____

10. A. Were employee exposures to noise measured at this site? (Yes/No)

If yes, attach applicable reports.

B. List significant sources of noise (indicate type of drill rig, compressors, pumps, and other noise generating equipment)

1. ____

2. ____

3. ____

4. ____

C. Was hearing protection required? (Yes/No)

If hearing protection was required, was it provided? (Yes/No)

D. Was the use of hearing protection in high noise areas enforced? (Yes/No)

11. Were radiation hazards monitored at the site?

If yes, complete the following:

Types of radiation:__________alpha__________beta___________gamma

Isotopes:____

____

Airborne radioactive contamination____

Non-airborne radioactivity (fixed contamination, sealed sources, etc.)___________________________

____

Cumulative radiation doses for site workers by job category (i.e., rig geologist, supervisor, field technician, visitors, subcontractors, other):

Job Category	**Cumulative Dose (millirem)**	**Number of Employees per Category**

12. Were any unusual conditions encountered at the site? (Yes/No)

If yes, please explain:____

____

____

____

____

____

13. Describe any lessons learned at this site, regarding hazard identification and control that should be communicated to other SAIC personnel working at hazardous waste sites_________________________

Prepared By:______________________________ **Reviewed By:**______________________________

Date:______________________________ **Date:**______________________________

APPENDIX B

MATERIAL SAFETY DATA SHEETS

APPENDIX C

OCCUPATIONAL HEALTH GUIDELINES