WATER RECLAMATION
SOLID WASTE MANAGEMENT

COUNTY SANITATION DISTRICTS
OF LOS ANGELES COUNTY

1955 Workman Mill Road, Whittier, CA 90601-1400
Mailing Address: P.O. Box 4998, Whittier, CA 90607-4998
Telephone: (562) 699-7411, FAX: (562) 699-5422
www.lacsd.org

GRACE ROBINSON CHAN
Chief Engineer and General Manager

November 13, 2013
File No: 31-300.25

Mr. Sam Unger, Executive Officer
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th St., Suite 200
Los Angeles, CA 90013

Attn: Information Technology Unit

Joint Water Pollution Control Plant
CI No. 1758; Resolution R09-008; NPDES No. CA0053813
Special Study Progress Report, Third Quarter 2013 – Final Report Submission

As required under Resolution R09-008, please find enclosed the final report for the following special study:

1) Palos Verdes shelf baseline sediment coring and hotspot chemical contamination characterization (JWSS-09-001).

Unless otherwise instructed by the Regional Board or Regional Board staff, this submission will be the final quarterly progress report for this Special Study. However, any other reports or peer-reviewed publications resulting from these studies will also be provided to Regional Board staff as they become available.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Very truly yours,
Grace Robinson Chan

Joseph R Gully

Joseph R. Gully
Supervising Environmental Scientist
Technical Services Department

JRG:AH:cv
Enclosure

Revised Final Data Report for the Fall 2009 Sediment Sampling Program

Palos Verdes Shelf
(OU 5 of the Montrose Chemical Corporation Superfund Site)
Los Angeles County, California

EPA Contract No. EP-S9-08-03
Task Order No. 0029

Prepared for:

United States Environmental Protection Agency, Region IX
79 Hawthorne Street
San Francisco, California 94105

Prepared by:

ITSI Gilbane Company
2730 Shadelands Drive
Walnut Creek, California 94598

and

CDM Smith
100 Pringle Avenue, Suite 300
Walnut Creek, California 94596

In association with:

Calscience Environmental Laboratories, Inc.
7440 Lincoln Way
Garden Grove, California 92841

GMU Geotechnical, Inc.
23241 Arroyo Vista
Rancho Santa Margarita, California 92688

Sanitation Districts of Los Angeles County
1995 Workman Mill Road
Whittier, California 90607

United States Geological Survey
384 Woods Hole Road
Woods Hole, Massachusetts 02543

November 2013

REVISED FINAL DATA REPORT FOR THE FALL 2009 SEDIMENT SAMPLING PROGRAM

PALOS VERDES SHELF (OU 5 OF THE MONTROSE CHEMICAL CORPORATION SUPERFUND SITE)
LOS ANGELES COUNTY, CALIFORNIA

EPA Contract No. EP-S9-08-03
Task Order 0029

Prepared for:

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and

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Whittier, California 90607

United States Geological Survey
384 Woods Hole Road
Woods Hole, Massachusetts 02543

November 2013

Note: This report was revised to incorporate comments received from California DTSC via e-mail on 18 September 2013.

EXECUTIVE SUMMARY

In September 2009, the United States Environmental Protection Agency (EPA) initiated a sediment sampling program at Palos Verdes Shelf (PV Shelf), Los Angeles County, California. PV Shelf is Operable Unit (OU) 5 of the Montrose Chemical Corporation Superfund Site (Montrose). The program was conducted in support of the interim remedy promulgated in the Interim Record of Decision (IROD) for Montrose OU 5 (EPA, 2009). DDTs and PCBs are the chemicals of concern (COCs) at PV Shelf.

Components of the interim remedy for Montrose OU 5 are as follows:

- Continue the existing institutional controls (ICs) program.
- Place an *in situ* isolation cap (layer of clean sand) over the most contaminated and erosive area of sediment. Successful cap placement will achieve the following:
  - Reduce the mean DDT concentration in surface sediment on the shelf from 150 milligrams per kilogram normalized for organic carbon (mg/kg OC) to 78 mg/kg OC.
  - Reduce the mean PCB concentration in shelf surface sediment to the cleanup level of 7 mg/kg OC.
- Monitoring the natural recovery in sediment to achieve the following:
  - Reduce the mean DDT concentration in surface sediment to 23 mg/kg OC.
  - Maintain the mean PCB concentration in surface sediment at 7 mg/kg OC.

The overall objectives of the fall 2009 sediment sampling program were to: (1) gather data to establish the baseline condition of the sediment bed; and (2) support the possible remedial design (RD) of the interim isolation cap.

For the 2009 sampling event, EPA designed an array of sediment core locations to cover an area of PV Shelf approximately 20 kilometers (km) in alongshore length and 1.5 km in shore-normal width. This area is known to encompass the most contaminated portions of the effluent-affected (EA) sediment bed. The EA bed is the deposition of sediment that is affected by wastewater effluent from the Joint Water Pollution Control Plant (JWPCP), owned and operated by the Sanitation Districts of Los Angeles County [LACSD]. The JWPCP and the corresponding White Point outfalls are the recognized historical sources of DDTs and one of several possible historical sources of PCBs at PV Shelf.

The sediment coring array included 34 baseline locations and an additional 25 locations near the outfall diffusers. Cores were collected in October 2009 using a gravity coring device dropped from LACSD's ocean monitoring vessel, the *Ocean Sentinel*. Nominal ocean depths at the core collection locations ranged from about 40 to 150 meters (m).

More than 1,000 sediment samples were generated and analyzed for physical and chemical properties. For each sample, COC chemistry results were organized into groupings as follows:

- <u>Total DDTs</u> – the summation of the *o,p*'- and *p,p*'- isomers of DDD, DDE, and DDT. These forms of DDT have established toxicological criteria in EPA's Integrated Risk Information System (IRIS)
- <u>Total DDT Compounds</u> – the summation of Total DDTs plus *p,p*'-DDMU and *p,p*'-DDNU.
- <u>Total PCBs</u> – the summation of 28 individual PCB congeners.

The summation values of these three COC groupings were normalized for OC due to the widely accepted view that for nonionic compounds (such as DDTs and PCBs), toxic impacts to organisms correlate well to concentrations of contaminants in the sediment OC fraction, but do not correlate well with the overall dry weight concentrations of contaminants in sediment, i.e., the bioavailability of contaminants is dependent on sediment OC content.

Results of the physical and chemical tests were used to develop vertical profiles of the sediment bed at each core, depicting bulk density values and COC concentrations versus bed depth. In most cases, the profiles indicated a distinction between the EA bed and the underlying native sediment.

Select data parameters were entered into ARC-GIS and Mining Visualization System (MVS) software to produce two- and three-dimensional renderings of overall patterns of contamination, and conduct geostatistical analyses, including calculations of average COC concentrations and COC mass in the EA bed. Output from the geostatistical models indicated a widespread pattern of DDT contamination, with areas of high concentrations at the LACSD outfalls, similar to the patterns reported by previous investigators. The model output also indicated a widespread pattern of PCB contamination, with areas of high concentrations at the LACSD outfalls and southeast of the outfalls.

For the 0-8-cm sediment bed depth interval (recognized as the biologically active zone in PV Shelf sediment), model output calculated the average (mean) concentration of Total DDTs normalized for OC to be 56 mg/kg OC, and the average concentration of Total PCBs to be 0.23 mg/kg OC. The model also calculated the overall mass of Total DDT Compounds in the (modeled) sediment bed to be 20 metric tons (MT), and the overall mass of Total PCBs to be 0.1 MT.

Main conclusions of the sediment sampling program are:

- Although patterns of COCs in the sediment bed at PV Shelf appear to have not changed appreciably over time, COC concentrations detected in sediment samples (and corresponding estimates of COC mass at PV Shelf) have dropped significantly. This phenomenon appears to be related to several factors of monitored natural recovery (MNR) including dechlorination, sediment erosion, and sediment resuspension coupled with desorption of COCs from sediment into seawater.
- Output of the MVS model indicated that the average OC-normalized concentrations of DDTs and PCBs (56 mg/kg OC and 0.23 mg/kg OC, respectively) are less than the cleanup levels for surface sediment identified in the IROD specific to the interim isolation cap (78 mg/kg OC and 7 mg/kg OC, respectively). If data from future sampling events continue to indicate that concentrations of COCs are below cleanup goals, then an interim cap likely will be rendered unnecessary.
- Data gaps exist at PV Shelf. To fully understand the fate and transport of the COCs, additional sediment studies should be conducted. In future studies, the coring locations used for this 2009 study should be reoccupied, and the procedures for collecting and handling cores should be duplicated, to allow for meaningful comparison of data with respect to temporal trends, especially in assessing the effectiveness of MNR and determining whether COC concentrations have reached applicable cleanup levels.

* * * *

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ACRONYMS AND ABBREVIATIONS

AWQC	Ambient Water Quality Criteria
^{o}C	degrees Celsius
Cal-EPA	California Environmental Protection Agency
Calscience	Calscience Environmental Laboratories, Inc.
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
cm	centimeters
COC	chain of custody, chemical of concern
CSM	conceptual site model
DGPS	differential global positioning system
DPH	California Department of Health
DQOs	data quality objectives
EA	effluent-affected
eDMS	environmental data management system
ELAP	Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
FS	Feasibility Study
FSP	Field Sampling Plan
FYR	5-year review
g	gram(s)
g/cm^3	grams per cubic centimeter
GCS	Geographic Coordinate System
GC/MS	gas chromatography/mass spectrometry
GIS	geographic information system
GMU	GMU Geotechnical, Inc.
GS	galvanized steel
ICs	institutional controls
ID	identification
IRIS	Integrated Risk Information System
IROD	Interim Record of Decision
ITSI Gilbane	ITSI Gilbane Company
JWPCP	Joint Water Pollution Control Plant
kg	kilograms
km	kilometers
km^2	square kilometers
LACSD	Sanitation Districts of Los Angeles County
m	meter(s)
m^3	cubic meters
MDL	method detection limit
µg/kg	micrograms per kilogram (parts per billion)
µm	microns
mg/kg	milligrams per kilogram (parts per million)
mgd	million gallons per day
MIV	mass inventory volume

mm	millimeters
MNR	monitored natural recovery
Montrose	Montrose Chemical Corporation
msl	mean sea level
MT	metric ton(s)
MVS	Mining Visualization System
NAD 83	North American Datum of 1983
NELAP	National Environmental Laboratory Accreditation Program
ng/L	nanograms per liter
NIST	National Institute of Technology and Standards
NPDES	National Pollutant Discharge Elimination System
NRDA	National Resource Damage Assessment
NWLON	National Water Level Observation Network
OC	organic carbon
OU	Operable Unit
PBL	Portuguese Bend Landslide
PCBs	polychlorinated biphenyls
POLA	Port of Los Angeles
ppm	parts per million
PV Shelf	Palos Verdes Shelf
QAPP	Quality Assurance Project Plan
QATS	Quality Assurance Technical Services
QCSR	Quality Control Summary Report
RA	Remedial Action
RAC	Remedial Action Contract II
RAOs	remedial action objectives
RD	Remedial Design
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SCCWRP	Southern California Coastal Water Research Project
SOP	standard operating procedure
SPI	sediment profile imaging
SRM	standard reference material
SSRC	Superfund Sediment Resource Center
SSRM	site-specific reference material
SWAC	surface (area) weighted average concentration
Synectics	Synectics, Inc.
TO	Task Order
TOC	total organic carbon
USGS	United States Geological Survey
Water Board	California Regional Water Quality Control Board
WQL	Water Quality Laboratory
2D	two-dimensional
3D	three-dimensional

1.0 INTRODUCTION

The United States Environmental Protection Agency (EPA) Region IX, conducted a sediment sampling program at Palos Verdes Shelf (PV Shelf), Los Angeles County, California. PV Shelf is Operable Unit (OU) 5 of the Montrose Chemical Corporation (Montrose) Superfund Site. The Montrose Superfund Site is located at 20201 Normandie Avenue, Los Angeles, California.

An Interim Record of Decision (IROD) for PV Shelf was signed in September 2009 (EPA, 2009b). The purpose of this sediment sampling program was to support the interim remedy by gathering data to establish the baseline condition of sediment, and to support the possible remedial design (RD) of an interim isolation cap. ITSI Gilbane, Walnut Creek, California, was EPA's prime contractor responsible for the project; the work was conducted under EPA Remedial Action Contract II (RAC) Number EP-S9-08-03, Task Order (TO) 0029.

1.1 HISTORY OF MONTROSE OU 5

Since 1937, the Joint Water Pollution Control Plant (JWPCP) in Carson, California, operated by the Sanitation Districts of Los Angeles County (LACSD), has sent treated wastewater (effluent) to ocean outfalls at White Point on the Palos Verdes Peninsula (Figure 1). From the 1950s to 1971, the Montrose plant on Normandie Avenue discharged wastewater containing DDTs into the local municipal sewer system. The wastewater was treated at JWPCP then discharged to the Pacific Ocean via the White Point outfalls. Until polychlorinated biphenyls (PCBs) were banned in 1976, PCBs from local industries also formed part of the wastewater stream discharged to the sewer system and, after treatment at JWPCP, to PV Shelf by way of the ocean outfalls. In 1971, annual mass emissions from JWPCP were 167,000 metric tons [MT] of effluent solids, containing 21.1 MT of DDT and 5.2 MT of PCBs (SAIC, 2004). Montrose stopped discharging DDT to the sewer system in 1971, but damage to the natural environment, most notably the collapse of the California brown pelican population due to DDT-related egg-shell thinning, already had occurred.

In 1985, the State of California issued an interim health advisory discouraging consumption of white croaker fish. In 1990, the California Department of Fish and Game (CDFG; now the

California Department of Fish and Wildlife [CDFW]) closed the area at PV Shelf to commercial fishing for white croaker.

In 1994, five state and federal Natural Resource Trustees, or "Trustees", issued a Natural Resource Damage Assessment (NRDA) documenting the ecological impacts caused by DDT- and PCB-contaminated sediment in the PV Shelf area.

Major conclusions of the 1994 NRDA are summarized below.

- The effluent-affected (EA) sediment formed a shallow deposit varying in thickness from 5 centimeters (cm) to 1 meter (m) and covering 44 square kilometers (km^2).
- Concentrations of chemicals of concern (COCs; i.e., DDT compounds and PCBs) varied with depth in the deposit, with the highest concentrations buried under cleaner, but still contaminated, sediment.
- An estimated 110 MT of DDT compounds and 10 MT of PCBs were mixed within the EA sediment (Lee *et al*., 1994).

The NRDA findings were used as the basis for EPA's conceptual site model (CSM) for PV Shelf as presented in the Remedial Investigation (RI) report (EPA, 2007b) and in the IROD (EPA, 2009b).

Since 1994, through their technical studies, organizations including the Southern California Coastal Water Research Project (SCCWRP) and LACSD have contributed to EPA's understanding of PV Shelf. Concurrent with this 2009 sediment study, EPA has also performed field studies focused on modeling sediment transport and assessing degradation of COCs at PV Shelf. In terms of numbers of cores and sediment samples, this baseline assessment is the most comprehensive sediment sampling event since the 1992 sediment sampling event performed for the 1994 NRDA.

Since the 1970s, loading rates of contaminated suspended solids emitted through LACSD's White Point outfalls have diminished due to several factors including: (1) industrial pre-treatment programs related to the Clean Water Act of 1972; (2) the closures of several local industrial facilities, including the 1982 closure of the Montrose Normandie Avenue plant (now the Montrose Superfund Site); and (3) LACSD's secondary treatment of wastewater at JWPCP, which was initiated in November 1983 and fully online in November 2002. DDTs have not been detected in JWPCP effluent since 2002, and PCBs have not been detected in JWPCP effluent since 1985 (LACSD, 2012). LACSD continues to operate JWPCP and the White Point outfalls, serving 2.5 million southern California residents and 2,300 industries, treating an average of 273 million gallons per day (mgd) of wastewater (LACSD, 2012).

1.2 SITE DESCRIPTION

The PV Shelf Study Area is an area of the continental shelf and near-shore continental slope in the Pacific Ocean off the Palos Verdes Peninsula (Figure 1). The area extends in the alongshore direction between Point Fermin and Redondo Canyon, and in the seaward direction from the shore to the 200-m isobath. The study area footprint is about 102 km^2 and encompasses the vast majority of the EA deposit.

Historical sediment sampling efforts at PV Shelf indicate that parallel to shore, the bulk of the EA bed extends roughly from Palos Verdes Point on the northwest to Point Fermin on the southeast. In the shore-normal direction, the EA deposit extends from about the 35-m isobath out past the shelf break at the 70-m isobath. Samples of contaminated sediment have been retrieved in waters as deep as 700 m on the continental slope (Lee, 1994).

Previous researchers have surmised that material from the Portuguese Bend Landslide (PBL; Figure 1) and other landslides on the Palos Verdes Peninsula has mixed with the contaminated solids discharged from the White Point outfalls, resulting in a general enlargement of the EA deposit (Kayen *et al*., 2002).

The EA bed at PV Shelf generally is distinguishable from the underlying native sediment bed due to differing physical and chemical properties, e.g., higher organic carbon (OC), higher moisture content, lower mean grain size, lower bulk density, and higher COC concentrations (Lee *et al*., 2002). Previous investigators have described a three-layer characterization of the vertical sediment profile at PV Shelf, as follows (EPA, 2009b):

- Surficial sediment–Shallow sediment in the 0-20-cm bed-depth interval (though this interval can vary widely) has relatively low to moderate DDT concentrations. Characteristics of this layer conform to deposition of relatively less contaminated material and physical reworking by waves, currents, and benthic invertebrates.
- Heavily contaminated sediment–Below the shallow sediment, a layer with lower dry bulk densities and high DDT concentrations is encountered. The thickness of this layer varies widely along PV Shelf but appears to be greatest near the diffuser (discharge) sections of the LACSD outfalls.

- Native sediment–Beneath the heavily contaminated sediment lies the native sediment bed; the bed generally is sandy and is less cohesive and is coarser then the layers above. It also is further characterized by higher bulk densities and lower concentrations of COCs and OC.

Investigations have shown that DDT at PV Shelf has undergone significant degradation via reductive dechlorination to form several breakdown products, including *p,p'*-DDE and *p,p'*-DDMU, while PCBs have not exhibited biodegradation at PV Shelf (Eganhouse *et al.*, 2008). Figure 2 illustrates potential microbial degradation pathways for DDT at PV Shelf, and indicates that *p,p'*-DDMU and *p,p'*-DDNU have been detected historically in samples of PV Shelf sediment (Eganhouse *et al*., 2007).

In 2002, the following characteristics of the EA deposit were reported (Lee *et al*., 2002):

- The maximum thickness of the EA deposit was about 70 cm.
- The approximate volume of the EA bed was 10 million cubic meters (m^3).
- About 70 percent of the volume was present in water depths less than 100 m.
- The EA bed exhibited strong spatial continuity, notably in the alongshore direction.
- The dominant direction for transport of sediment was to the northwest.

Estimates of the mass of DDT compounds at PV Shelf by previous researchers have varied greatly, ranging from about 60 MT to 120 MT (Lee, H.J., 1994; Murray *et al.*, 2002; see Section 4.4.3 of this report). The median concentration of DDTs in surface sediment at the shelf has been reported as 1.9 parts per million (ppm); the median concentration of PCBs has been reported as 0.2 ppm (EPA, 2009b).

More details on PV Shelf and the origin and fate and transport of COCs found at the site are available in several sources, including those listed below.

- *The Distribution and Character of Contaminated Effluent-Affected Sediment, Palos Verdes Margin, Southern California, Expert Report* (Lee, H.J., 1994)
- *Final Palos Verdes Shelf Superfund Site Remedial Investigation Report* (CH2M Hill, 2007)
- *Feasibility Study* (FS)*, May 2009, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corp. Superfund Site* (EPA, 2009a)
- *Interim Record of Decision, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corporation Superfund Site, Los Angeles County, California* (EPA, 2009b)

1.3 DESCRIPTION OF INTERIM REMEDY

The interim remedy as described in the IROD has the following components (EPA, 2009b):

- Continue the existing institutional controls (ICs) program.
- Monitoring the natural recovery to achieve specific Remedial Action Objectives (RAOs).
- Place an in situ isolation cap (layer of clean sand) over the most contaminated and erosive area of sediment. The objectives of the cap were to:
    - Immediately reduce mean PCB concentrations in surface sediment to the interim cleanup level of 7 mg/kg OC; and
    - Reduce DDT concentrations in surface sediment to an interim cleanup level of 46 mg/kg OC (half the cleanup level of 23 mg/kg OC) by the first post-cap 5-year review (FYR).
- Currently, natural recovery alone (i.e., without the interim cap), is estimated to reduce the remaining DDT in surface sediment to 46 mg/kg OC by the first FYR (due in September 2014).

Specific RAOs promulgated in the IROD include the following (EPA, 2009b):

- Reduce risk to human health from eating fish contaminated with DDTs and PCBs by the following:
    - Achieve the goal of 400 micrograms per kilogram (μg/kg) DDTs and 70 μg/kg PCBs in white croaker, an indicator fish species.
    - Maintain the ICs program consisting of public outreach and education; enforcement; and monitoring.
    - As an interim goal, attain a median concentration of 46 mg/kg OC Total DDTs in surface sediment (double the cleanup level of 23 mg/kg OC).
    - As an interim goal, attain a median concentration of 7 mg/kg OC Total PCBs in surface sediment by the first FYR.
- Reduce risks from DDTs and PCBs to ecological receptors by the following:
    - Support the Trustees' strategies to sustain wildlife recovery.
- Reduce DDTs and PCBs in surface water to meet EPA's Ambient Water Quality Criteria (AWQC; EPA, 2013) by the following:
    - Achieve human health AWQC for DDTs of 0.22 nanograms per liter (ng/L) within 30 years.
    - As an interim goal, collect and assess PCB data to determine the timeline to meet human health AWQC for PCBs of 0.064 ng/L.
- Minimize impacts to sensitive habitats and biota during cap placement by the following:
    - Develop a monitoring program to protect kelp beds.

  - During cap placement, use low-impact techniques and monitor current speeds and sediment resuspension. Stop work if site-specific standards are exceeded.

1.4 OBJECTIVES OF THE SEDIMENT SAMPLING PROGRAM

The area studied during the 2009 sediment sampling program focused on the portion of the PV Shelf Study Area from Palos Verdes Point on the northwest to Point Fermin on the southeast, i.e., the main part of the EA sediment unit. LACSD sampling stations for benthic infauna and sediment chemistry were used as a basis of locating cores, so that sediment characteristics could be compared to past and future measurements.

The *Final Sampling and Analysis Plan for Sediment Sampling, Part 2- Field Sampling Plan* (FSP; ITSI Gilbane, 2013) provides a detailed description of the sampling program. The objectives of the sampling program conducted in October 2009 are summarized below.

- A baseline sampling program was conducted to collect and analyze sediment samples along 10 shore-normal transects (Figure 3). The data, along with additional samples collected around the outfalls, are to be used to map the distribution of COCs along the shelf and to estimate the mass of COCs. This baseline program is also intended to establish protocols and procedures that can be duplicated during future sampling events, e.g., at FYR cycles. This will allow a meaningful comparison of data sets so that the effectiveness of the interim remedy can be assessed.
- A more intensive evaluation of the White Point outfall area was conducted to collect and analyze sediment samples at more than 30 locations in the vicinity of the diffuser sections of the LACSD outfalls (Figure 4). Data gathered from sediment sample testing are to be used during the RD phase, to support the calculation of the mass of COCs (and related risks to human health and the environment) and the selection of areas of PV Shelf that could undergo capping.

To meet these objectives, the sediment samples were tested for the following characteristics:

- Physical parameters pertinent to evaluating (modeling) sediment transport and the design of the interim isolation cap - these include grain size (particle size); sediment bulk density; specific gravity; and moisture content. Values of bulk density and moisture content are also used in calculating concentrations of COCs and contaminant mass.
- Chemical parameters pertinent to evaluating progress of MNR and for selecting areas where an isolation cap will be placed; these include concentrations of the prevalent DDT forms encountered at PV Shelf; individual PCB isomers; and total organic carbon (TOC).

2.0 METHODS

This section provides a synopsis of activities that were conducted during the sediment sampling program.

2.1 COLLECTION OF SEDIMENT CORES

In October 2009, LACSD conducted cruises to collect sediment cores from PV Shelf using the monitoring vessel, *Ocean Sentinel*. Operations for collecting cores are described below.

2.1.1 Locations for Baseline Cores

As described in the FSP (ITSI Gilbane, 2013), 34 locations for baseline cores were selected generally based on LACSD's standard "benthic" stations; these stations are typically used by LACSD to meet requirements in the State of California National Pollutant Discharge Elimination System (NPDES) permit (California Regional Water Quality Control Board [Water Board], 2011) regarding monitoring the conditions of benthic infauna and sediment chemistry related to JWPCP outfall discharges. Figure 3 shows the core locations for the baseline sampling program.

Parallel to the shore, LACSD's benthic stations are situated along four main isobaths. Designated isobath names and associated nominal depths are as follows: A (300-m depth); B (150-m depth); C (60-m depth); and D (30-m depth). Perpendicular to the shore, the stations are organized along 11 transects sequentially numbered north-to-south along the Palos Verdes Peninsula, from Transect 0 located north of Palos Verdes Point near Redondo Canyon, to Transect 10 located near Point Fermin at San Pedro (Figure 3). Transect 8 is aligned along the White Point outfalls.

Baseline sediment cores were collected along the 40-m, 60-m, and 150-m isobaths at LACSD Transects 1 through 10. Additional cores were collected along the 100-m isobath at LACSD Transects 6 through 9. Single replicate cores were collected at LACSD stations 2B, 4C, and 5B.

2.1.2 Locations for Outfall Area Cores

As described in the FSP (ITSI Gilbane, 2013), 25 locations were selected for coring at a relatively higher spatial frequency near the LACSD outfall diffusers; seven of these locations were selected for single replicates (Figure 4). Approximate spacings between adjacent core locations ranged from 0.1 km to 1.2 km. Core locations were selected based on historical data, including concentrations of COCs; erodibility of the sediment; penetration depths of sediment profile imaging (SPI) cameras; and reported thickness of the EA bed.

2.1.3 Mapping, Bathymetry, and Vessel Positioning

For this sediment sampling event, ArcView by ESRI, Redlands, California, was used as the software platform for mapping. The mapping coordinate system was the Geographic Coordinate System (GCS) of 1983, based on the Greenwich Meridian and the 1983 North American Datum (NAD 83), as provided by ESRI. Coordinates were reported in degrees-decimal minutes, in conformance to previous work at PV Shelf.

Seabed bathymetry at PV Shelf was based on the low-resolution bathymetric data from multi-beam sonar surveys of the Los Angeles Margin (Point Dume [Malibu] to Dana Point [Orange County]) that were conducted by the United States Geological Survey (USGS) from 1996 to 1999 (Figure 1).

To navigate and position the survey vessel, HypackMAX® (Coastal Oceanographic, Inc.) software was used with a differential global positioning system (DGPS). Horizontal accuracy was +/-3 m. A fathometer was used to measure ocean depths at the time of core collection.

The core location was based both on the desired ocean depth, i.e., along a certain isobath, and on the planned latitude and longitude coordinates. During each coring operation, the vessel position was logged, i.e., a navigation fix was recorded, at the exact time that the sampling equipment (coring device) reached the seabed. For replicate samples, collected in the same location as the initial (primary) sample, the vessel was repositioned to the original planned coordinates for the primary sample. To avoid damage to LACSD infrastructure during coring operations near the LACSD outfalls, the *Ocean Sentinel* ship captain used sonar to monitor the locations of the outfall pipes and their associated ballast (support).

The captain operated a DGPS and manually recorded in a daily navigation log all significant events and any problems encountered. Tables 1 and 2 present the nominal coordinates and water depths for the baseline and outfall area sediment cores, respectively. A total of 69 cores were collected from 59 stations.

2.1.4 Coring Procedure

For the fall 2009 sediment sampling program, LACSD's standard gravity core cylinder was used to collect sediment cores. Figure 5 is a schematic of the gravity coring device used for this program. The coring device with cutting head is 94 cm in length and has an effective sampling length of about 90 cm. For coring, the corer was attached to a winch cable; the winch was supported by a small crane mounted on the stern of the *Ocean Sentinel*. Lead weights attached to the top of the cylinder provided the driving force for penetration; for the ocean depths at PV Shelf, a 23-kg top assembly was used with 11-kg rings to give the corer a total weight of about 135 kg. The total length of the coring device with cutting head and weighted top assembly was 134 cm.

A clean acetate liner was placed into the core barrel prior to each drop. To initiate a coring event, the research vessel was piloted to the selected sample location. The crew then used a high-speed winch to drop the corer into the ocean. As the corer travelled downward through the water column, the hinged cap at the top remained open. When the coring device hit the bottom, a trigger mechanism (weighted bar) closed the hinged cap, providing a suction seal that helped retain the sediment core in the metal tube. When the boat crew noted slack in the winch cable, the winch was reversed to pull the corer to the surface. The cutting head at the bottom of the corer had a passive retainer (an array of sheet metal "fingers") designed to maintain core integrity during retrieval upward through the water column.

After the corer was placed on the deck, the core was inspected for acceptance or rejection. Criteria used in evaluating whether cores should be rejected included:

- Heavy disturbance of surface sediment, indicated by muddy water at the top of the core liner;
- Water leakage out of the sides of the corer, causing the core to slump;
- Formation of a "heel" on the bottom of the core;
- Unusually short cores in comparison to historical data;
- Rocky conditions at the ocean floor; or
- Damage to the coring device (possibly due to a rocky ocean floor).

Details of core acceptance and rejection are included in Section 3.1. Each accepted core was retrieved from the corer with the acetate liner intact. The liner ends were sealed and strapping tape was applied as necessary to maintain core integrity. The core length was measured and recorded and the core was placed into a galvanized steel (GS) sleeve. The core liner was marked with indelible ink to record the core location name, core length (measured in cm), and sampling date.

Retrieved cores were immediately stored vertically in one of two shipboard wooden cold boxes. Each cold box had been previously stocked with dry ice and equipped with supports to hold nine cores. Approximately 1 liter of liquid nitrogen was applied to the ends of the GS sleeve to provide quick freezing. All cores were transported to JWPCP for storage in a deep freezer, sometimes on a daily basis, if capacity in the cold boxes was full or near-full.

2.2 CORE CUTTING AND PREPARATION OF SEDIMENT SAMPLES

Cores were cut into slices at JWPCP during two separate events, one event occurring from 16-20 November 2009, and another event conducted from 08-10 February 2010. Core cutting was conducted by LACSD staff at the Water Quality Laboratory (WQL) at JWPCP. Cutting techniques conformed to WQL's *Sediment Core Cutting Procedure, Method 500C* (see FSP – ITSI Gilbane, 2013). Each slice had an approximate thickness of 2 cm. Cuts were made until the bottom remaining material was less than 2-cm thick, and this remainder was discarded. A total of 1,704 sediment slices was generated from the sediment cores collected during the 2009 sampling event.

To create samples after the cores were cut, the outer ring of each frozen core slice initially was trimmed using a ring punch to remove potentially smeared material generated during bed penetration. The remaining slice then was broken into chunks while still frozen and partitioned into four portions of approximately equal volume. The weight of the portions ranged from approximately 60 grams (g) to 120 g, with an average of 90 g. The portions of each slice were distributed into three containers (4-ounce amber glass jars with Teflon-lined caps) as follows: one portion for chemical testing; two portions for geotechnical testing; and one portion for archiving (deep-freeze). As agreed between EPA and LACSD, archived samples were sent to the LACSD sediment archive for storage.

2.3 TESTING OF SAMPLES

Sediment samples generated from the core cutting events were transported from JWPCP under chain-of-custody (COC) protocol to GMU Geotechnical, Inc. (GMU), Rancho Santa Margarita, California, for geotechnical testing and to Calscience Environmental Laboratories, Inc. (Calscience), Garden Grove, California, for testing of chemistry parameters and for moisture content. A separate set of COC forms was generated for each destination.

The 0-to-8-cm layer of the sediment bed at PV Shelf has been recognized as the biologically active zone where a majority of the benthic biological activity occurs (SAIC, 2005a). At both laboratories, the four 2-cm-thick slices of each core, representing the bed depth interval of 0 to 8 cm, were tested separately. For the portions of each core representing the bed interval greater than 8 cm, two-way composite samples were prepared by combining slices representing two successive sample intervals (e.g., the slices corresponding to bed depth intervals of 8-10 cm and 10-to-12 cm). For cores with an odd number of slices, the slice remaining after two-way compositing, i.e., the deepest slice, was analyzed separately.

2.3.1 Geotechnical Tests

At GMU, samples were stored in a freezer until they were prepared for analysis. Sample preparation steps included opening the sample containers and examining the frozen chunks. Where no compositing was required, samples were thawed and analyzed by test methods listed below. For testing the two-way sample composites for bulk density, the two individual samples were first examined independently while still frozen; the largest single chunk was selected as being representative of the composite and, while still frozen, tested for bulk density. For the other geotechnical tests (i.e., grain size and specific gravity) where sample compositing was required, laboratory staff removed thawed aliquots of equal weight from each of the two individual sample containers and placed them into a clean glass beaker. The aliquots then were mixed using a stainless steel spoon or spatula to create a visually homogeneous mixture. The mixture was then tested for grain size and specific gravity as listed below.

After compositing, a total of 1,005 samples was generated. Sample counts were as follows: 495 samples were generated for the baseline cores; 42 samples were generated for the baseline replicate cores; 357 samples were generated for the outfall area cores; and 109 samples were generated for the outfall area replicate cores. Bottom-core samples BA9DC01200949 (bed-depth interval 48-50 cm) and OA1101200973 (bed-depth interval 72-74 cm) were never in GMU's custody and were not analyzed for geotechnical parameters. These two samples were presumed lost in transit.

GMU conducted the following tests on the sediment samples:

- For testing grain size, GMU used ASTM D422-63: *Standard Test Method for Particle-Size Analysis of Soils*. Following this standard, GMU used sieves to determine the grain size distribution for particles 75 microns (µm; #200 sieve) and larger, and a hydrometer to measure the distribution of particle sizes smaller than 75 µm.
- For testing bulk density, GMU used ASTM D7263-09: *Standard Test Method for Laboratory Determination of Density (Unit Weight) of Soil Specimens*, Method A (direct measurement).
- For testing specific gravity (the ratio of the weight of a sample to the weight of an equal volume of water), GMU used techniques for moist soil as described in ASTM D854-98, *Standard Test Method for Specific Gravity of Soil*.

2.3.2 Chemistry Tests

At Calscience, samples were stored in a freezer until they were prepared for analysis. Calscience tested sediment samples for moisture content, TOC, and COCs. Calscience is certified as an environmental testing laboratory under the Environmental Laboratory Accreditation Program (ELAP) administered by the California Department of Public Health (DPH). (As of July 1999, the National Environmental Laboratory Accreditation Program [NELAP] recognized ELAP to be the NELAP-accrediting authority for California.) Calscience was selected for this sampling event as a result of a rigorous laboratory evaluation; this evaluation involved three candidate laboratories and included analyses of a standard reference material (SRM) obtained from the National Institute of Standards and Technology (NIST).

At Calscience, samples were accepted from the courier and stored in a freezer until they were prepared for analysis. Sample preparation steps included thawing the frozen samples and mixing them in the original sample containers using a stainless steel utensil. When two samples were composited, laboratory staff removed aliquots of equal weight from each of the two sample containers and placed them into a certified-clean container. The aliquots then were mixed using a stainless steel spoon or spatula to create a visually homogenous mixture.

After compositing, a total of 1,005 samples was generated. Sample counts were as follows: 496 samples were generated for the baseline primary cores; 42 samples were generated for the baseline replicate cores; 358 samples were generated for the outfall area primary cores; and 109 samples were generated for the outfall area replicate cores.

Tests of the sediment samples were conducted in accordance with the requirements specified in the following guidance documents:

- *Test Methods for Evaluating Solid Waste, SW-846 Physical/Chemical Methods* (EPA, 2007a)
- ASTM Standard D2216-05, 2005, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*
- *Final Sampling and Analysis Plan for Sediment Sampling, Part 1 - Quality Assurance Project Plan* (QAPP; ITSI Gilbane, 2013)

The specific analytical methods used for this project are listed below:

- TOC using EPA Method 9060, a water method modified for sediment. This method includes an acidification step.
- Percent moisture (moisture content) using Calscience standard operating procedure (SOP) M700, based on ASTM D2216-05, (EPA Method 160.3/SM 2540 B), *Determination of Moisture or Solids Content*
- DDTs and PCBS using EPA Method 8270SIM

Table 3 lists the individual chemistry analytes, including eight DDT compounds and 28 PCB congeners, along with the associated reporting limits used for the chemistry tests. For *p,p'*-DDMU and *p,p'*-DDNU, Calscience performed method detection limit (MDL) studies.

2.4 DATA MANAGEMENT SYSTEM

A web-based environmental data management system (eDMS) was used to manage the data received from the geotechnical and chemistry laboratories. The eDMS provided access to the chemistry data for the data validation step (Section 2.5) and, combined with Access software, allowed for quick transfer and tabulation of data.

2.5 DATA VALIDATION

Analytical data were reviewed and validated by Synectics, Inc. (Synectics), Sacramento, California, following procedures specified in the QAPP (ITSI Gilbane, 2013). Ninety percent of the data were subjected to a “routine” data validation approach; 10 percent of the data were subjected to full data validation. Synectics used an automated data validation system augmented by manual review.

2.6 MVS GEOSTATISTICAL MODEL

Mining Visualization System (MVS) software (C Tech Development Corporation, Bellingham, Washington) was used as the geostatistical modeling platform to provide crucial calculations including average COC concentrations. The MVS model was set up using a rectilinear three-dimensional (3D) grid aligned roughly parallel to the shore, in the general direction of the recognized dominant transport pathway at PV Shelf (Sherwood *et al*., 2006). The initial model extent was the area surrounding the sediment cores, with a buffer of 10 percent across the entire domain. That area was trimmed on the seaward side at the 150-m isobath (the “A” stations were included) and on the inshore side along the 30-m isobath, due to fact that data were not available to map past those boundaries. As such, the total modeled area was 29.8 km^2. The model resolution was 371 x 142 x 44 in the x (alongshore), y (shore-normal), and z (bed-depth) directions, respectively, resulting in 2.3 million cells.

The MVS model used two-dimensional (2D) kriging for geological surfaces and 3D kriging for geotechnical and chemistry data. The kriging approach considered proximities of samples both in the areal and vertical directions (corrected from elevation to bed depth), as well as the heterogeneity of the data set being analyzed.

Themes’ model was used to derive values for various characteristics at PV Shelf, including average concentrations and total masses of COCs for both the entire modeled grid and the 0-8 cm sediment layer. Appendix A presents a detailed discussion of the MVS modeling effort and software parameters and provides a contextual analysis of input/output parameters and values.

3.0 RESULTS

This section presents the results of the sediment sampling program, including the coring efforts, geotechnical tests, and chemistry tests.

3.1 CORE RETRIEVAL

Aside from one bad weather day (heavy winds, high seas) on 13 October 2009, core retrieval operations went as planned. Daily cruises for core collection were conducted on 14-16 October and 19-20 October 2009. Core retrieval was difficult at location BA2B on the 150-m isobath, where two drops of the coring device resulted in lack of recovery (likely due to rocky substrate); a satisfactory core 25 cm in length was retrieved on the third drop. One of the 12-cm cores was retained and processed as the BA2B primary core; the 25-cm core was retained and processed as a replicate core (BA2BR). At BA7BC on the 100-m isobath, three drops were made to obtain a satisfactory core. At several locations, damage to the coring device or the liners in the coring device occurred during the operation, requiring additional drops. Daily coring success rates, defined as the number of retrieved cores divided by the number of drops, were 79, 86, 94, 100, and 89 percent for the 5 days of active coring.

Table 4 presents lengths of cores from the 2009 sediment sampling program. The maximum core length was 88 cm at location BA5DC, offshore of Portuguese Bend at a nominal ocean depth of 40 m. Other cores with lengths of 80 cm or greater were retrieved at locations BA4DC and BA5C, also offshore of Portuguese Bend, and at locations OA5 and OA11 near the LACSD outfall diffusers. The average length of successfully retrieved cores was about 50 cm. For the cores collected along the major isobaths, average core lengths were as follows: 51 cm for the 40-m isobath; 56 cm for the 60-m isobath; 33 cm for the 100-m isobath; and 44 cm for the 150-m isobath. For the 10 locations where replicates were collected, ratios of primary core lengths to replicate core lengths varied from 1:2 (BA2B) to 1:1 (BA4C) to 1:0.75 (OA22).

3.2 RESULTS OF PHYSICAL TESTS

Summary tables of grain size test results for baseline and outfall area samples are provided in Appendices B and C, respectively. Summary tables of test results for bulk density, moisture content, and specific gravity are provided in Appendices D and E, respectively.

3.2.1 Grain Size

Values of percent retained and cumulative percent retained were reported for standard sieve and hydrometer tests, along with corresponding phi scale values based on the Wentworth Classification System. The phi scale is a base-two logarithmic scale with the negative exponent of the grain size in millimeters (mm). Table 5 presents grain-size data for cores along the 60-m isobath, where the highest COC concentrations typically are centered (Lee, H.J., 1994). Cores collected northwest of the outfalls had lower average sand content and higher average clay content than cores collected southeast of the outfalls.

3.2.2 Bulk Density, Moisture Content, and Specific Gravity

Appendices D and E present tables showing values of wet bulk density and specific gravity as reported from the geotechnical laboratory and moisture content percentages as reported from the chemistry laboratory, for the baseline and outfall area samples, respectively. The specific gravity value is the ratio of the density of the dry-solids fraction of the sample to the density of water. The tables also report computed values of dry bulk density, calculated as follows:

$$\rho_{dry} = \frac{\rho_B}{1+W}$$

where:

ρ_B = wet bulk density of the sediment in grams per cubic centimeter (g/cm^3)
W = fractional moisture content (non-dimensional).

Ranges of values in single samples were as follows:

- Moisture content values ranged from about 19 percent in core BA7BC (located on the 100-m isobath, in the 8-12-cm bed-depth interval), to about 70 percent in core OA11 (on the 50-m isobath, in the 0-2 cm interval).

- Dry bulk density values ranged from 0.67 g/cm^3 in core OA03 (located on the 80-m isobath, near the LACSD outfall diffusers, in the 0-2 cm bed-depth interval), to 1.6 g/cm^3 in core BA6B (on the 150-m isobath, in the 36-40 cm interval).

- Specific gravity values ranged from 2.01 in core BA5B (located on the 150-m isobath, in the 12-16-cm bed-depth interval), to 2.99 in core BA6BC (on the 100-m isobath, in the 36-40-cm bed-depth interval).

For the 0-8-cm interval, average values over all cores were 41 percent for moisture content, 1.04 g/cm^3 for dry bulk density, and 2.69 for specific gravity. For the core intervals below 8 cm, the average values were 37 percent, 1.13 g/cm^3, and 2.56, respectively.

3.3 RESULTS OF CHEMISTRY TESTS

Appendices F and G present test results for TOC and DDT analyses of samples derived from the baseline and outfall area cores, respectively. Results for the DDT analytes were reported from the testing laboratory using three significant figures. Appendix H includes the complete laboratory reports from the analytical laboratory.

3.3.1 Total Organic Carbon

Reported values of TOC for single samples ranged from 0.44 percent in core BA10C (located on the 60-m isobath southeast of the LACSD diffusers, in the 20-22 cm bed-depth interval), to 13 percent in core OA05 (on the 60-m isobath, in the 36-40 cm interval). Table 5 lists the TOC values for cores collected along the 60-m isobath. Values were generally higher for cores northwest of the LACSD outfalls compared to cores southeast of the outfalls.

TOC values showed good (albeit non-linear) correlations with concentrations of Total DDT Compounds (R^2 = 0.76) and with Total PCBs (R^2 = 0.78). (R^2 is the correlation coefficient calculated by MS Excel, with 1.00 indicating a strong correlation, and 0 indicating no correlation – Appendix I includes graphic representations of these correlations).

3.3.2 DDTs

Results of individual DDT analytes were organized into two DDT groupings as follows:

- Total DDTs, i.e., the summation of the *o,p*'- and *p,p'*- isomers of DDD, DDE, and DDT. These forms of DDT have established toxicological criteria in EPA's Integrated Risk Information System (IRIS)
- Total DDT Compounds, i.e., the summation of Total DDTs plus *p,p*'-DDMU and *p,p*'-DDNU. The latter two substances have been reported as DDT breakdown products at PV Shelf (Eganhouse *et al*., 2008).

Appendices F and G present test results of individual DDT analytes, Total DDTs, and Total DDT Compounds in baseline and outfall area cores, respectively.

Total DDT Compounds were detected in all sample depth intervals in 31 out of 37 baseline cores and 30 out of 32 outfall area cores; they were detected in at least one depth interval of every sediment core collected during the 2009 sampling event. Values of reported detections of Total DDT Compounds for single samples ranged from 2.2 µg/kg in core BA4B (located on the 150-m isobath, in the 36-40 cm bed-depth interval) to 302,000 µg/kg in core BA8C (on the60-m isobath, in the 20-24 cm interval). The most prevalent DDT compounds were *p,p'*-DDE and *p,p'*-DDMU, both in terms of the number of detections and the range of concentrations. The parent compound DDT was reported only at low relative concentrations. This trend was evident for both the entire modeled grid and the upper 0-8 cm layer.

Table 6 shows average concentrations of the DDT groupings in the 0-8-cm bed interval of each core; carbon-normalized values are also indicated. Table 7 shows site-wide average concentrations for the main DDT groupings in both the total bed and the 0-8 cm interval for the baseline and the outfall areas, based on output of the MVS geostatistical model.

3.3.3 PCBs

Appendices J and K present test results of individual PCB congeners and Total PCBs for the samples generated from the baseline and outfall area cores, respectively. Results are presented with three significant figures.

PCB congeners were detected in at least one sample depth interval from every core collected. Reported values of Total PCBs in single samples ranged from 2.5 µg/kg in core OA09 (located on the 40-m isobath, in the 8-12-cm bed-depth interval) to 12,000 µg/kg in core BA8C (on the 60-m isobath, in the 28-36-cm interval). For several cores (BA1B, BA2B, BA10B, BA7BC, BA10C), PCBs were detected only in samples generated from the shallow (0-8 cm) bed-depth interval; for other cores (BA3B, BA8BC, BA9BC, BA4C, BA7C, BA8C, OA14, OA22, OA22R, OA24, OA25, BA1DC, BA6DC, and BA8DC), PCBs were detected in samples generated from every bed-depth interval in the core.

Table 8 shows average concentrations of Total PCBs in the 0-8-cm bed interval of each core; carbon-normalized values are also indicated. Table 7 shows site-wide average concentrations for Total PCBs in both the total bed and the 0-8 cm interval for baseline and outfall areas, based on output of the MVS geostatistical model.

3.4 RESULTS OF GEOSTATISTICAL MODELING

All chemical results were entered into ARC-GIS and MVS. The software packages were used to generate concentration contour plots and to calculate characteristics of the EA sediment bed, including mass of COCs. Table 9 lists the values of COC mass generated by the MVS geostatistical model. As indicated, values of the mass of Total DDTs were 14,000 kg (14 MT) for the entire bed, and 1,700 kg (1.7 MT) for the 0-8-cm bed interval. Values of Total DDT Compounds were 20,000 kg (20 MT) for the entire bed, and 2,200 (2.2 MT) for the 0-8-cm bed interval. Values of Total PCBs were 1,000 kg (1 MT) for the total bed and 110 kg (0.11 MT) for the 0-8-cm bed interval.

The computational approach used by the MVS model is described below.

- The 2009 sediment data set was used to extrapolate values of dry bulk density and COC concentrations at each of the 2.3 million individual cells. The MVS model used a computational approach called cell averaging.
- The model calculated a mass inventory volume (MIV) for each cell by multiplying the dry bulk density by the COC concentration. Eight DDT analytes were calculated individually; the PCBs congeners were grouped into a summation (Total PCBs) and then multiplied by the dry bulk density.
- The model extrapolated these MIV values to generate an MIV for each cell node.
- The nodal MIVs were summed.
- The respective summations were divided by the number of nodes to attain average MIV values.
- The average MIV values were then multiplied by the modeled volume to produce the total COC mass.

Estimates of contaminant mass provided by the geostatistical model were significantly lower than earlier estimates. This led EPA to conduct, through the Superfund Sediment Resource Center (SSRC), an independent review of the MVS model application. SSRC used the 2009 data set and MVS modeling software (using adaptive gridding in place of cell averaging) to derive select characteristics for the PV Shelf EA bed, including mass of *p-p'*-DDE and Total PCBs. Conclusions of SSRC's effort are summarized below.

- Mass estimates of *p-p'*-DDE are sensitive to the value of horizontal-to-vertical anisotropy.
- The SSRC mass estimates for *p-p'*-DDE and Total PCBs were in good agreement with the original MVS values.
- Applying the 2009 modeled domain to the USGS 1992 data set resulted in values of *p-p'*-DDE mass ranging from 38.5 MT to 53.1 MT, depending on the horizontal-to-vertical anisotropy. (Note that USGS values for *p-p'*-DDE mass for the 1992 data set ranged from 61.4 MT to 72 MT, depending on computational approach [see Section 4.4.3]).

Two technical memoranda were generated by SSRC contractors; these are included in an attachment to Appendix A.

4.0 DISCUSSION

This section presents discussions of the results of geotechnical tests, chemical tests, and the output of the geostatistical model. Topics include chemical data quality, vertical depth profiles, patterns of COC contamination, COC mass, and uncertainty.

4.1 QUALITY OF CHEMICAL DATA

Various efforts were made to validate the quality of chemical data gathered during this sampling event. These efforts are described below.

4.1.1 Results of Data Validation

As previously discussed, analytical data were reviewed and validated following procedures specified in the QAPP (ITSI Gilbane, 2013). Of the nearly 19,000 primary sample results for the baseline cores, one result (less than 0.1 percent) was rejected due to laboratory anomalies, rendering a completeness factor of 99.9 percent, well exceeding the QAPP goal of 90 percent. Of the nearly 18,000 primary sample results for the outfall area cores, five results (less than 0.1 percent) were rejected due to laboratory anomalies, rendering a completeness factor of 99.9 percent, again exceeding the QAPP goal of 90 percent.

The ITSI Gilbane project chemist conducted an overall QC review after receiving data validation reports and developed two Quality Control Summary Reports (QCSRs) to address the data for baseline samples and the data for the outfall area samples. The QCSRs indicate that project data quality objectives (DQOs) were met and that all data were useful. Copies of the QCSRs are included in Appendix H.

During sediment testing, a procedural improvement for preparing DDT samples was proposed by Calscience and reviewed and approved by EPA, as follows: implement a secondary cleanup step using a solid-phase extraction cartridge (in addition to the primary cleanup using solvent exchange) to remove interfering organic matter from samples. This step was an attempt to reduce the rate of DDT degradation (breakdown to DDE and DDE) observed occurring in the injection port liner or the gas chromatography/mass spectrometry (GC/MS) instrument during sample analysis. Calscience demonstrated that this secondary cleanup process allowed for a reduction in the frequency of cleaning the injection port, thereby enhancing the stability and performance of the GC/MS instrument, and ultimately resulting in improved data accuracy. A detailed description of this approach is located in Attachment 2 of Appendix H.5.

4.1.2 Interlaboratory Comparison Study

EPA, with cooperation from USGS and the EPA Quality Assurance Technical Services (QATS) program, sponsored an interlaboratory comparison using a site-specific reference material (SSRM) for PV Shelf. This comparison concluded that analytical results reported by Calscience for all DDT analytes were acceptable, based on the confidence intervals developed for the study. For this study, Calscience did apply the secondary cleanup step described in Section 4.1.1. A copy of the technical memorandum describing the interlaboratory comparison is included in Appendix H.

4.2 DISTRIBUTION OF CONTAMINANTS

Researchers have reported that the toxicity of nonionic organic chemicals (such as DDTs and PCBs) in sediment appears to correlate well with concentrations of contaminants in the sediment OC fraction, but does not correlate well with the overall dry weight concentrations of the chemicals, i.e., the bioavailability of contaminants is related to the OC fraction (DiToro *et al*., 1991; Michelsen, T.C., 1992). The selected remedy in the IROD is based on contaminant concentrations normalized for OC (EPA, 2009b). For these reasons, the 2009 sediment laboratory data were manipulated to provide normalization for OC. The OC normalization was calculated as follows:

$$\mu g / kg\, OC = \frac{\mu g / kg \ dry\, weight}{kg\, TOC / kg \ dry\, weight}$$

where:

µg/kg OC = micrograms of the chemical per kilogram of organic carbon
µg/kg dry weight = micrograms of the chemical per kilogram of dry weight sample
kg TOC/kg dry weight = percent TOC in dry weight sample expressed as a decimal, e.g., 1% TOC = 0.01

For example:

$$\frac{650\,\mu g\,Total\,DDTs/kg\ dry\,weight}{0.01\,kg\,TOC/kg\ dry\,weight}$$

$$=65{,}000\,\mu g\,Total\,DDTs/kg\,OC$$

Figure 6 (based on ARC GIS software output) is an interpretive rendering of concentrations of Total DDTs (in µg/kg OC) for the 0-8-cm bed interval. Figure 7 (based on output of the MVS model) shows a vertical profile of interpretive Total DDT concentrations along the 60-m isobath, i.e., the isobath where the diffuser portions of the 90-inch and 120-inch outfalls (the outfalls that LACSD typically operates) generally are located, and where concentrations typically are centered. Based on the data gathered during the fall 2009 coring event, the geometry of the DDT deposit conforms to geometries previously reported or postulated by other investigators, i.e., the pattern of DDT contamination displays a center of mass near the LACSD outfall diffusers, and the DDT concentrations generally diminish with distance from the diffusers. As depicted in Figure 4, a significant Total DDTs hot spot deposit appears in the 0-8-cm bed interval along the 60-m isobath near the eastern diffuser of the 90-inch outfall. Figure 7 illustrates the difference between the 0-8-cm bed interval and the intervals below 8 cm, where concentrations display hot spots along the 60-m isobath in areas northwest of the LACSD outfalls.

Figure 8 (based on ARC GIS software) is an interpretive rendering of concentrations of Total PCBs normalized for OC for the 0-8-cm bed interval. Figure 9 (based on output of the MVS model) is a vertical profile of interpretive Total PCB concentrations along the 60-m isobath. The pattern of interpretive PCBs in the 0-8-cm interval displays areas of elevated concentrations in the following areas:

- Near the LACSD outfall diffusers along the 60-m isobath
- At depths of 60 m and deeper along the diffuser section of LACSD's 120-inch (southernmost) outfall
- Approximately 1,500 m southeast of the 120-inch outfall, roughly centered on the 70-m isobath

Figure 9 illustrates the difference between the 0-8-cm interval and the intervals below 8 cm, where PCBs appear in elevated concentrations along the 60-m isobath in areas northwest of the LACSD outfalls.

4.3 DIMENSIONS OF THE EA SEDIMENT BED

Appendix L presents vertical profiles of the baseline cores and outfall area cores, showing depth in the core versus values of dry bulk density and the three COC groupings (Total DDTs, Total DDT Compounds, and Total PCBs). Profiles for most cores appear to corroborate the three-layer model described previously (Section 1.2), in that distinct differences in the dry bulk density values and COC concentrations can be noticed with depth.

Estimates of the thickness of the EA bed were made using the vertical profiles (Lee, H.J., 1994). The estimated thicknesses based on bulk density, DDTs, and PCBs were averaged to produce an estimated thickness (Appendix L and Table 4). In some cases where parameters did not exhibit distinct layering, the EA bed thickness was assumed to be equal to the core length.

The average bed thicknesses were input into the ARC-GIS file and the following steps were used to calculate a bed volume:

- To create a 3D shape of the EA bed, ESRI Spline Tension software was used to create a top and bottom surface of the bed. The following default settings were used: weight = 0.1; number of points = 12; cell size = 20 m by 20m. The resulting surfaces were smooth and passed through each data point.
- In some areas along the boundary of the modeled area, surfaces were calculated by interpolation.
- The ESRI Surface Volume software module was used to calculate the volume from each surface to the ocean surface (elevation = 0).
- The bed-top volume was subtracted from the bed-bottom volume to render an estimate of the EA bed volume.

This approach produced an estimated EA bed volume of 1.1 X 10^7 m^3. This value is lower than the volume used in the MVS model (1.5 X 10^7 m^3), which was based on actual lengths of retrieved cores.

4.4 TEMPORAL CHANGES IN THE EA DEPOSIT

4.4.1 Sediment Transport

Previous researchers have examined changes over time in the estimated values of the thickness and volume of the EA bed to assess whether a site along PV Shelf is erosional or depositional. Due to inconsistencies in methods between previous sediment sampling events and the fall 2009 sampling event, no meaningful assessment of erosion or deposition could be made based on a comparison of data sets. In future sediment sampling events, EPA will use the same methods used during the fall 2009 program to the greatest extent possible, so that meaningful comparisons between data sets can be made.

4.4.2 Changes in Spatial Distribution of Contaminants

As discussed previously, although the general shape of the EA deposit does not appear to have changed appreciably since previous sediment sampling events, concentrations of COCs appear to have dropped significantly in the surface sediment. As has been reported previously, location BA8C near the LASCD diffusers appears to represent the most contaminated area on PV Shelf; for the 2009 data set, maximum concentrations of both Total DDT Compounds and Total PCBs were also found in core BA8C. Figures 10 and 11 illustrate the differences in interpretive concentrations in the top 2 cm of the sediment bed between data collected in 2002/2004 and the data collected in 2009 for DDTs and PCBs, respectively. These figures again indicate that concentrations of both DDTs and PCBs appear to have decreased significantly.

4.4.3 Mass of Contaminants

Previous researchers have used *p,p'*-DDE in mass calculations. Table 10 summarizes estimates of the masses of *p,p'*-DDE and PCBs by various researchers and indicates the wide differences between studies. The 9.7 MT and 13.8 MT values for *p-p'*-DDE calculated by the two MVS models based on the 2009 data set are significantly less than previous mass estimates. These differences may be associated with:

- Different data sets (previous data sets were generated as much as 30 years ago)
- Ongoing MNR processes (see Section 5.0)
- The reduced area evaluated by the MVS model relative to the areas previously examined
- Differences between the computational approaches used in the MVS model and those used in previous approaches

4.5 COMPARISON TO IROD CLEANUP LEVELS

As previously described, the IROD calls out the following objectives of the isolation cap:

- Mean DDT concentration in surface sediment on the shelf will be reduced from 150 mg/kg OC to 78 mg/kg OC (in combination with MNR, the interim cleanup level of 46 mg/kg OC in surface sediment would be reached within 5 years of cap placement).
- Mean PCB concentrations in shelf surface sediment will be reduced to the cleanup level of 7 mg/kg OC.

Based on the 2009 data set, the model output value was 56 mg/kg OC (56,000 µg/kg OC; Table 7) for mean Total DDTs OC in the 0-8-cm bed interval; this value is less than the interim cleanup level, i.e., the interim cap objective has been met. For PCBs, the model output mean value of 0.23 mg/kg OC (230 µg/kg OC; Table 8) is below the cleanup level of 7 mg/kg OC.

4.6 UNCERTAINTIES AND POSSIBLE SOURCES OF ERROR

There are uncertainties related to several possible sources of error for this project, as described in the following subsections.

4.6.1 Coring Procedure

There are limitations inherent in collecting cores of a layered low-density (soft bottom) seabed at the ocean depths seen in this study. Some researchers have postulated that gravity corers provide incomplete samples of the surface of the sediment column (Lee, H.J., 1994; Lee *et al*., 2002). Vertical profiles for several cores indicate that the bottom of the EA bed may not have been reached, based on elevated COC concentrations reported for samples generated for the core bottom (Appendix L).

For the 2009 sampling event, the decision to terminate core penetration into the sediment was based on an observation of slack in the winch cable, attributed to refusal of the coring device. However, similarities between the results of geotechnical tests for the primary and replicate samples in the shallow (0-8 cm) and middle-depth intervals may indicate that the coring procedure was successful in recovering nearly similar cores through the top and middle intervals of the EA bed, and that the refusal noted by the winch operator resulted in variations in the amounts of material being recovered from deeper, relatively less contaminated depths. Correlation graphs comparing COC concentrations in primary and replicate cores are provided in Appendix I; R^2 values are 0.63 for Total DDTs, indicating good correlation, and 0.37 for Total PCBs, indicating moderate correlation.

4.6.2 Spatial Uncertainty

The coring frequency of the baseline sampling was 34 cores over a modeled area of 30 km^2, correlating to one core per 0.9 km^2. For the outfall area, the coring frequency (including the baseline cores from LACSD Transects 6 through 9) was 41 cores over a modeled area of 11 km^2, correlating to one core per 0.3 km^2. To address the spatial uncertainty in distributions of COCs in light of the sparse coring array, the MVS geostatistical model was used to calculate "confidence" for the 2009 sampling program. The software was programmed to determine the confidence for a predicted COC concentration to fall within a factor of two (i.e., 1/2-to-2X) of the actual concentration. Appendix A provides a detailed discussion of uncertainty based on model output, and concludes that the overall site is reasonably well characterized for COCs.

Although the bed demonstrates overall healthy spatial continuity, the area near the outfalls demonstrates significant variability. For example, core OA10 had an estimated bed depth of 31 cm, based on vertical profiles of COCs and bulk density, while BA8C, 280 m away, had an estimated bed depth of 64 cm (Table 4). Additionally, core OA11 had an average concentration of Total DDT Compounds in the 0-8-cm interval of $9.4 \text{ X } 10^4$ μg/kg OC, whereas nearby core BA8C had an average concentration of Total DDT Compounds of $1.9 \text{ X } 10^6$ μg/kg OC in the same interval (Table 6). The two cores are 300 m apart.

5.0 CONCLUSIONS

In summary, sediment cores were retrieved successfully from 34 locations for the baseline program and from an additional 25 locations in the area near the LACSD outfall diffusers. A significant amount of data was generated by testing more than 1,000 samples of recovered core material for both geotechnical and chemical parameters. The sample design and the methods of core collection, core cutting, and sample testing used during this study rendered high-quality data.

For the baseline sampling program, the approach used for this study provided a sufficient data set with a reasonable level of confidence that will allow for meaningful comparisons in the future in assessing the progress of cleanup of DDT and PCBs. The outfall area data set, in combination with other ongoing studies including a flux (pore water) study, will assist in the RD of an isolation cap for hot spot areas, if that effort goes forward.

The output from the geostatistical models indicated a widespread pattern of DDT contamination similar to the patterns reported by previous investigators, including LACSD and USGS. The model output also indicated a widespread pattern of PCB contamination with areas of higher concentrations at the LACSD outfalls and southeast of the outfalls.

Although interpretive patterns of COCs in the EA deposit have not changed appreciably over time, detected contaminant concentrations have dropped significantly. It is plausible that this phenomenon is related to several factors of MNR including dechlorination; sediment erosion; and sediment resuspension coupled with desorption of COCs from sediment into seawater. Output of the verified MVS model indicates that, based on the 2009 data set, the short-term objectives identified for the interim isolation cap have been met. If data from future sampling events continue to indicate that concentrations of COCs are below cleanup goals, then an interim cap likely will be rendered unnecessary.

It is acknowledged that the selected remedy in the IROD, in particular the isolation cap component, was based heavily on interpretations of COC concentrations detected in samples of sediment collected from the 0-2-cm interval of the EA bed; these sediment samples were obtained using a different collection method from that used in this 2009 program. Because the results of the 2009 program present a picture of environmental conditions at PV Shelf significantly different than what was previously understood, and to better understand the current conditions and contaminant degradation trends at the shelf, it is important to conduct additional sampling programs using techniques similar to the 2009 program.

Based on the findings from the fall 2009 sediment sampling program, the following approaches will be taken for PV Shelf:

- Regarding chemical data quality, the secondary cleanup procedure recommended and implemented by Calscience increased the accuracy of the DDT analyses and should be adopted as part of the preparation process for future sediment samples.
- An SSRM has been developed for PV Shelf and was used recently in an interlaboratory comparison study (mentioned in Section 4.1.2 and included in Appendix H). This study should be expanded to include more analytical laboratories and more replicate analyses by the participating laboratories.
- Based on the vertical profiles of bulk densities and COC concentrations versus core depths, many cores penetrated the entire EA sediment bed and advanced into the native sediment bed; in other cores, the delineation of the interface between the EA bed and the native bed was not discernible. Therefore, the volume of the EA sediment bed as reported is a rough estimate only. SPI or other diagnostic seafloor techniques or both should be considered if a precise estimate of the EA bed volume is considered crucial.
- The MVS model developed for this project is capable of computing COC mass based on both bed depth and area.
- If the RD of an isolation cap is performed in the future, the mapping techniques developed during this program could be used to evaluate the effects of different cap geometries and placements. For example, when assessing possible cap locations and dimensions, mapping and geostatistics could be used to calculate the surface (area) weighted average concentration (SWAC) of each COC grouping, allowing for a comparison to cleanup levels.
- In future sediment sampling events, an attempt should be made to reoccupy the coring locations used for the 2009 study, and the procedures for collecting and handling cores should be duplicated, to allow for meaningful comparison of data with regards to temporal trends, especially in assessing the effectiveness of MNR and whether DDT concentrations have reached the interim cleanup level of 46 mg/kg OC.

6.0 REFERENCES

California Regional Water Quality Control Board (Water Board), 2011. Waste Discharge Requirements for the County Sanitation Districts of Los Angeles County Discharge to the Pacific Ocean (Order No. R4-2011-0151, NPDES No. CA0053813). 01 September.

CH2M Hill, 2007. Final Palos Verdes Shelf Superfund Site Remedial Investigation Report. October.

Di Toro, Dominic M., C.S. Zarba, D.J. Hansen, W.J. Berry, R.C. Swartz, C.E. Cowan, S. P. Pavlou, H.E. Allen, N.A. Thomas, and P.R. Paquin, 1991. Technical Basis for Establishing Sediment Quality Criteria for Nonionic Organic Chemicals Using Equilibrium Partitioning, *Environmental Toxicology and Chemistry*, Vol.10, pp. 1541-1583, 1991.

Drake, D.E., C.R. Sherwood, and P.L. Wiberg, 1994. Predictive Modeling of the Natural Recovery of the Contaminated Effluent-Affected Sediment, Palos Verdes Margin, Southern California, expert report for U.S. vs. Montrose.

Eganhouse, Robert, and J. Pontolillo, 2007. Assessment of 1-chloro-4-[2,2-dichloro-1-(4-chlorophenyl)ethenyl]benzene (DDE) Transformation Rates on the Palos Verdes Shelf, CA. U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 2007-1362.

Eganhouse, Robert, and J. Pontolillo, 2008. DDE in Sediments of the Palos Verdes Shelf, California: *In Situ* Transformation Rates and Geochemical Fate, *Environmental Science & Technology*, Vol. 42, No. 17, 2008, pp. 6392-6398.

ITSI Gilbane Company (ITSI Gilbane), 2013. Final Site-Specific Work Plan, Pre-Design Investigation, Palos Verdes Shelf (OU-5 of the Montrose Chemical Corp. Superfund Site), Los Angeles County, California. March.

Kayen, R.E., H.J. Lee, and J.R. Hein, 2002. Influence of the Portuguese Bend landslide on the character of the effluent-affected sediment deposit, Palos Verdes Margin, southern California; in Sedimentation Processes, DDT, and the Palos Verdes Margin, *Continental Shelf Research*, Vol. 22, pp. 859-880. April/May.

Lee, H.J., 1994. The Distribution and Character of Contaminated Effluent-Affected Sediment, Palos Verdes Margin, Southern California, Expert Report, U.S. Geological Survey. October.

Lee, H.J., C.R. Sherwood, D.E. Drake, B.D. Edwards, F. Wong, and M. Hamer, 2002. Spatial and temporal distribution of contaminated, effluent-affected sediment on the Palos Verdes Margin, Southern California; in Sedimentation Processes, DDT, and the Palos Verdes Margin, *Continental Shelf Research*, Vol. 22, pp. 859-880. April/May.

Michelson, Teresa C., 1992. Organic Carbon Normalization of Sediment Data, Washington Department of Ecology Sediment Management Unit, Publication No. 05-09-050. December.

Murray, C.J., H.J. Lee, and M.A. Hampton, 2002. Geostatistical mapping of effluent sediment distribution on the Palos Verdes Shelf, *Continental Shelf Research*, Vol. 22, pp. 881-897. April/May.

Science Applications International Corporation (SAIC), 2004. Investigation Work Plan for the 2004 Oceanographic Measurement Program on the Palos Verdes Shelf. September.

SAIC, 2005a. Study Report for the Summer 2004 Bioturbation Measurement Program on the Palos Verdes Shelf. July.

SAIC, 2005b. Data Report for the Summer 2004 Geotechnical Measurement Program Conducted on the Palos Verdes Shelf. July.

SAIC, 2005c. Final Report for the Summer 2004 Sediment Displacement Study on the Palos Verdes Shelf. July.

Sanitation Districts of Los Angeles County (LACSD), 2006. Palos Verdes Ocean Monitoring Annual Report 2005. 30 June.

LACSD, 2012. 2010-2011 Joint Water Pollution Control Plant Biennial Receiving Water Monitoring Report. 01 August.

Sherwood, C.R., Ferré, Bénédicte, Eganhouse, Robert P., and Wiberg, Patricia L., 2006. “Evolution of the Contaminated Sediment Deposit on the Palos Verdes (CA) Shelf: Physical, Chemical, and Biological Processes,” presented at the Eastern Pacific Oceanography Conference, Mt. Hood, Oregon.

United States Environmental Protection Agency (EPA), 1995. Remedial Design/Remedial Action Handbook, EPA 540/R-95/059. June.

EPA, 2007a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846. Third Edition, Update IV.

EPA, 2007b. Final Palos Verdes Shelf Superfund Site Remedial Investigation Report. October.

EPA, 2009a. Feasibility Study, Palos Verdes Shelf, Operable Unit 5 of the Montrose Chemical Corporation Superfund Site. May.

EPA, 2009b. Interim Record of Decision, Palos Verdes Shelf, Operable Unit 5 of Montrose Chemical Corporation Superfund Site, Los Angeles County, California. September.

EPA, 2013. National Recommended Water Quality Criteria. Current information accessed at http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm. March.

TABLES

Table 1 – Coordinates and Water Depths of Baseline Sediment Cores
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location name (see Figure 3)	*Replicate collected?*	*Nominal coordinates*	*Nominal water depth* (meters)
BA1B	No	33° 44.97'/118° 26.81'	150
BA1C	No	33° 45.44'/118° 26.46'	60
BA1DC	No	33° 45.76'/118° 26.22	40
BA2B	Yes	33° 43.95'/118° 25.55'	150
BA2C	No	33° 44.26'/118° 25.39'	60
BA2DC	No	33 ° 44.39/118° 25.32'	40
BA3B	No	33° 43.43'/118° 24.44'	150
BA3C	No	33° 43.80'/118° 24.15'	60
BA3DC	No	33° 43.95'/118° 24.05'	40
BA4B	No	33° 43.00'/118° 23.24'	150
BA4C	Yes	33° 43.40'/118° 23.08'	60
BA4DC	No	33° 43.75'/118° 22.90'	40
BA5B	Yes	33° 42.54'/118° 22.08'	150
BA5C	No	33° 42.88'/118° 21.96'	60
BA5DC	No	33° 43.23'/118° 21.83'	40
BA6B	No	33° 42.18'/118° 21.35'	150
BA6BC	No	33° 42.24'/118° 21.32'	100
BA6C	No	33° 42.47'/118° 21.24'	60
BA6DC	No	33° 42.75'/118° 21.05'	40
BA7B	No	33° 42.05'/118° 21.09'	150
BA7BC	No	33° 42.11'/118° 21.05'	100
BA7C	No	33° 42.31'/118° 20.92'	60
BA7DC	No	33° 42.57'/118° 20.73'	40
BA8B	No	33° 41.53'/118° 20.24'	150
BA8BC	No	33° 41.63'/118° 20.21'	100
BA8C	No	33° 41.91'/118° 20.14'	60
BA8DC	No	33° 42.22'/118° 19.91'	40
BA9B	No	33° 40.89'/118° 19.31'	150
BA9BC	No	33° 41.01'/118° 19.25'	100
BA9C	No	33° 41.32'/118° 19.10'	60
BA9DC	No	33° 41.77'/118° 18.88'	40
BA10B	No	33° 39.73'/118° 17.90'	150
BA10C	No	33° 40.11/118° 17.81'	60
BA10DC	No	33° 41.13'/118° 17.49'	40

Notes

1. Coordinates are latitude/longitude shown in degrees-decimal minutes.

2. Coordinates for locations with “B” and “C” designations are from Appendix E of Order No. R4-2011-0151, NPDES Permit No. CA0053813 (California Regional Water Quality Control Board, Los Angeles Region, 01 September 2011).

Table 2 – Coordinates and Water Depths of Outfall Area Sediment Cores
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location name **(see Figure 4)**	***Replicate collected?***	***Nominal coordinates***	***Nominal water depth*** **(meters)**
OA01	No	33° 42.27'/118° 21.13'	70
OA02	No	33° 42.51'/118° 20.99'	50
OA03	No	33° 42.51'/118° 20.79'	80
OA04	No	33° 42.09'/118° 20.77'	70
OA05	Yes	33° 42.20'/118° 20.69'	60
OA06	No	33° 42.30'/118° 20.59'	50
OA07	Yes	33° 41.97'/118° 20.53'	70
OA08	No	33° 42.21'/118° 20.38'	50
OA09	No	33° 42.38'/118° 20.28'	40
OA10	Yes	33° 41.80'/118° 20.23'	70
OA11	Yes	33° 42.00'/118° 20.02'	50
OA12	Yes	33° 41.60'/118° 19.88'	70
OA13	No	33° 41.77'/118° 19.82'	60
OA14	No	33° 41.92'/118° 19.75'	50
OA15	No	33° 41.40'/118° 19.72'	80
OA16	Yes	33° 41.50'/118° 19.71'	70
OA17	No	33° 41.65'/118° 19.61'	60
OA18	No	33° 41.11'/118° 19.34'	90
OA19	No	33° 41.20'/118° 19.29'	75
OA20	No	33° 41.85'/118° 19.03'	40
OA21	No	33° 40.89'/118° 18.96'	80
OA22	Yes	33° 41.11'/118° 18.78'	60
OA23	No	33° 41.40'/118° 18.70'	50
OA24	No	33° 40.74'/118° 18.62'	70
OA25	No	33° 41.14'/118° 18.33'	50

Notes

1. Coordinates are latitude/longitude shown in degrees-decimal minutes.
2. The basis for selecting the planned cores was presented in the Field Sampling Plan (ITSI Gilbane, 2013).

Table 3 – Chemistry Test Methods, List of Analytes, and Reporting Limits
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Analytical group	*Analyte*	*CAS number*	*Project objective*[1] (µg/kg)	*Achievable quantitation limit*[2] (µg/kg)
EPA Method 8270SIM: SVOCs by GC/MS				
DDT	*p,p'*-DDT	50-29-3	5	5
DDT	*o,p'*-DDT	789-02-6	5	5
DDT	*p,p'*-DDE	72-54-8	5	5
DDT	*o,p'*-DDE	53-19-0	5	5
DDT	*p,p'*-DDD	72-55-9	5	5
DDT	*o,p'*-DDD	3424-82-6	5	5
DDT	*p,p'*-DDMU	1022-22-6	5	5
DDT	*p,p'*-DDNU	2642-81-1	5	5
EPA Method 8270SIM: SVOCs by GC/MS				
PCB	Congener 8	34883-43-7	5	5
PCB	Congener 18	37680-65-2	5	5
PCB	Congener 28	7012-37-5	5	5
PCB	Congener 44	41464-39-5	5	5
PCB	Congener 52	35693-99-3	5	5
PCB	Congener 66	32598-10-0	5	5
PCB	Congener 77	32598-13-3	5	5
PCB	Congener 81	70362-50-4	5	5
PCB	Congener 101	37680-73-2	5	5
PCB	Congener 105	32598-14-4	5	5
PCB	Congener 114	74472-37-0	5	5
PCB	Congener 118	31508-00-6	5	5
PCB	Congener 123	65510-44-3	5	5
PCB	Congener 126	57465-28-8	5	5
PCB	Congener 128	38380-07-3	5	5
PCB	Congener 138	35065-28-2	5	5
PCB	Congener 153	35065-27-1	5	5
PCB	Congener 156	38380-08-4	5	5
PCB	Congener 157	69782-90-7	5	5
PCB	Congener 167	52663-72-6	5	5
PCB	Congener 169	32774-16-6	5	5
PCB	Congener 170	35065-30-6	5	5
PCB	Congener 180	35065-29-3	5	5
PCB	Congener 187	52663-68-0	5	5
PCB	Congener 189	39635-32-9	5	5
PCB	Congener 195	52663-78-2	5	5
PCB	Congener 206	40186-72-9	5	5
PCB	Congener 209	2051-24-3	5	5
EPA Method 9060				
TOC	TOC	NA	0.1%	0.05%

Abbreviations

CAS	-	Chemical Abstracts Service	PCBs	-	Polychlorinated biphenyls
GC	-	Gas chromatography	QLs	-	Quantitation limits
GC/MS	-	Gas chromatography/mass spectrometry	SIM	-	Selective ion monitoring
MDL	-	Method detection limit	SVOCs	-	Semi-volatile organic compounds
MNR	-	Monitored natural recovery	TOC	-	Total organic carbon
NA	-	Not applicable	µg/kg	-	Micrograms per kilogram

Notes

[1] Sediment interim cleanup levels of 230 µg/kg DDT @ 1% TOC and 70 µg/kg PCBs @ 1% TOC have been set for the project (EPA, 2009b). However, because the data collected during this study will be used in evaluating MNR, project objectives have been set much lower.

[2] Achievable QLs are the laboratory reporting limits for a specific analytical method.

Table 4 - Sediment Core Lengths and EA Bed Thicknesses
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Core location	***Nominal water depth* (m)**	***Core length* (cm)**	***Number of slices generated***	***Estimated EA bed thickness* (cm)**
Transect 1				
BA1B	150	61	30	23
BA1C	60	47	23	46
BA1DC	40	27	13	27
Transect 2				
BA2B	150	12	6	12
BA2BR	150	24	12	24
BA2C	60	69	34	51
BA2DC	40	48	24	44
Transect 3				
BA3B	150	25	11	20
BA3C	60	60	30	55
BA3DC	40	64	32	52
Transect 4				
BA4B	150	52	26	32
BA4C	60	72	36	48
BA4CR	60	72	36	56
BA4DC	40	86	43	76
Transect 5				
BA5B	150	64	32	32
BA5BR	150	60	30	33
BA5C	60	80	40	52
BA5DC	40	88	44	85
Transect 6				
BA6B	150	64	32	36
BA6BC	100	54	27	39
BA6C	60	72	36	64
BA6DC	40	56	28	53
Transect 7				
BA7B	150	54	27	37
BA7BC	100	16	8	13
OA01	70	56	28	39
BA7C	60	50	25	50
OA02	50	70	35	66
BA7DC	40	26	13	26
Transect 7.5				
OA03	80	60	30	47
OA04	70	44	22	43
OA05	60	80	40	68
OA05R	60	78	40	67
OA06	50	76	38	72
OA07	70	42	21	31
OA07R	70	42	21	35
OA08	50	76	38	69
OA09	40	38	19	38
Transect 8				
BA8B	150	38	19	29
BA8BC	100	26	13	23
OA10	70	38	19	31
OA10R	70	54	27	35
BA8C	60	72	36	64
OA11	50	74	37	61
OA11R	50	84	42	67
BA8DC	40	42	21	44
Transect 8.5				
OA12	70	40	20	27
OA12R	70	44	21	31
OA13	60	46	23	39
OA14	50	54	27	53
OA15	80	50	25	32
OA16	70	30	15	27
OA16R	70	48	24	36
OA17	60	40	20	29
Transect 9				
BA9B	150	42	21	25
BA9BC	100	34	17	34
OA18	90	54	27	36
OA19	75	40	20	25
BA9C	60	28	14	25
BA9DC	40	50	26	50
OA20	40	48	24	48
Transect 9.25				
OA21	80	20	10	20
OA22	60	32	16	32
OA22R	60	24	12	24
OA23	50	54	28	56
Transect 9.5				
OA24	70	18	10	18
OA25	50	26	13	26
Transect 10				
BA10B	150	32	16	13
BA10C	60	22	11	14
BA10DC	40	42	21	42
GRAND TOTAL	**-**	**-**	**1,705**	**-**

Abbreviations:

cm - Centimeters
EA - Effluent-affected
m - Meters

Notes

1. Core lengths indicated are the lengths of cores used to generate samples during core cutting events. These lengths may differ from measurements made on-board at the time of core collection, due to: different measuring conditions; possible deformation during handling; and the discarding of core bottom portions.
2. EA bed thicknesses are based on interpretations of vertical profiles (Appendix L).

Table 5 – Sand, Silt, and Clay Contents and TOC Values for Cores along the 60-m Isobath
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Location name	***Nominal ocean depth* (m)**	***Length of core* (cm)**	***Average sand content* (%)**	***Average silt content* (%)**	***Average clay content* (%)**	***Average TOC* (%)**
Northwest of LACSD outfalls						
BA1C	60	46	37	59	4	2.0
BA2C	60	68	57	36	6	2.3
BA3C	60	60	47	47	6	2.3
BA4C	60	72	23	72	5	2.2
BA4CR	60	72	23	72	5	2.2
BA5C	60	80	18	66	15	3.2
BA6C	60	72	20	67	14	3.8
BA7C	60	50	29	53	17	4.4
OA05	60	80	21	73	6	5.8
OA5R	60	80	23	72	6	2.9
		Average	**29**	**63**	**17**	**4.4**
Between LACSD outfalls						
BA8C	60	72	41	40	17	7.8
OA13	60	46	26	69	5	3.2
OA17	60	40	30	67	3	1.4
		Average	**34**	**56**	**10**	**4.1**
Southeast of LACSD outfalls						
BA9C	60	28	35	54	11	1.6
OA22	60	32	44	54	2	2.0
OA22R	60	24	44	53	4	1.95
BA10C	60	22	40	49	9	0.9
		Average	**41**	**53**	**6**	**1.6**

Abbreviations

cm – Centimeters
km – Kilometers
LACSD – Sanitation Districts of Los Angeles County
m – Meters
TOC – Total organic carbon

Table 6 - Concentrations of DDT Groupings in 0-8 cm Bed Interval (by Core)
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Core location	***Nominal water depth* (m)**	***Average Total DDTs - 0-8 cm* (µg/kg)**	***Average Total DDT Compounds (carbon normalized) - 0-8 cm* (µg/kg OC)**	***Average Total DDT Compounds - 0-8 cm* (µg/kg)**	***Average Total DDTs (carbon normalized) - 0-8 cm* (µg/kg OC)**
Baseline cores					
1B	150	1,427	60,710	1,795	47,522
2B	150	851	49,916	1,083	39,142
2BR	150	525	29,311	610	25,228
3B	150	1,257	58,782	1,575	47,341
4B	150	4,223	138,437	6,246	94,689
5B	150	5,120	152,504	6,653	118,003
5BR	150	3,719	116,280	4,948	87,696
6B	150	4,030	156,457	6,395	101,133
7B	150	5,483	243,169	8,828	151,988
8B	150	5,840	175,502	9,428	112,497
9B	150	3,663	135,401	4,865	103,465
10B	150	844	82,989	979	71,195
6BC	100	1,857	63,208	2,646	44,120
7BC	100	1,455	115,720	2,538	67,946
8BC	100	2,288	92,030	4,440	49,252
9BC	100	1,379	64,662	1,745	50,967
1C	60	1,925	115,655	2,485	89,572
2C	60	1,071	73,812	1,540	51,298
3C	60	600	38,179	865	26,472
4C	60	1,314	86,256	1,880	60,230
4CR	60	1,000	61,360	1,403	43,777
5C	60	1,858	81,007	2,273	66,369
6C	60	736	35,110	908	28,528
7C	60	1,070	120,480	1,246	102,508
8C	60	100,750	1,897,359	108,400	1,770,414
9C	60	838	68,643	1,126	51,454
10C	60	517	51,390	567	46,866
1DC	40	495	34,223	628	27,072
2DC	40	136	17,239	183	12,757
3DC	40	485	38,948	705	26,967
4DC	40	336	15,848	473	11,277
5DC	40	482	25,735	644	19,292
6DC	40	465	36,144	581	28,915
7DC	40	301	21,191	352	18,095
8DC	40	1,978	96,957	2,130	89,806
9DC	40	607	41,350	709	35,414
10DC	40	272	22,817	313	19,805
Outfall area cores					
OA01	70	1,467	79,824	1,762	66,522
OA02	50	1,170	58,572	1,442	47,526
OA03	50	1,276	45,771	1,592	36,721
OA04	70	9,772	381,658	10,119	370,775
OA05	60	1,411	41,076	1,623	35,643
OA05R	60	1,880	119,936	2,290	98,658
OA06	50	1,420	90,681	1,680	76,758
OA07	70	5,435	125,858	7,688	91,847
OA07R	70	3,113	93,533	3,790	76,684
OA08	50	2,475	162,341	2,838	141,773
OA09	40	489	33,982	578	28,752
OA10	70	2,793	172,247	3,627	132,155
OA10R	70	1,357	108,959	1,629	90,869
OA11	50	2,400	93,745	2,883	78,005
OA11R	50	1,923	124,440	2,455	97,157
OA12	70	1,343	115,785	1,838	84,531
OA12R	70	712	62,915	970	46,097
OA13	60	1,225	64,076	1,426	54,870
OA14	50	1,551	132,336	1,895	108,248
OA15	80	4,173	258,246	6,095	177,952
OA16	70	3,645	274,597	5,270	191,298
OA16R	70	3,315	242,131	4,820	166,234
OA17	60	5,343	434,112	6,125	383,006
OA18	90	694	32,767	881	25,779
OA19	80	11,875	516,380	19,350	315,865
OA20	40	465	26,623	520	23,777
OA21	80	1,905	130,929	2,443	102,179
OA22	60	465	24,537	568	20,061
OA22R	60	1,878	137,305	2,400	107,622
OA23	50	1,161	77,058	1,433	62,413
OA24	70	2,958	216,619	3,710	172,622
OA25	50	762	74,799	921	61,883

Abbreviations
cm - Centimeters
ft - Feet
m - Meters
ug/kg - microgram per kilogram

Notes
1. "Total DDT Compounds" consists of both *o,p'* - and *p,p'* - isomers of DDD, DDE, and DDT, plus *p,p'* -DDMU and *p,p'* -DDNU.

Table 7 - Site-Wide Average COC Concentrations Based on MVS Model Output
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	Concentration of Total DDTs	***Concentration of Total DDT Compounds***	***Concentration of Total PCBs***
Full model (baseline)			
Total bed	1,600	2,300	120
0-8 cm interval	1,300	1,600	86
Outfall area			
Total bed	2,800	3,600	160
0-8 cm interval	1,900	2,400	110
Normalized for OC			
Full model (baseline)			
Total bed	58,000	85,000	410
0-8 cm interval	56,000	71,000	230
Outfall area			
Total bed	98,000	130,000	570
0-8 cm interval	83,000	100,000	300

Abbreviations
cm - Centimeter
OC - Organic carbon
PCBs - Polychlorinated biphenyls

Notes
1. All values are in micrograms per kilogram (parts per billion).

Table 8 - Concentrations of Total PCBs in 0-8 cm Bed Interval (by Core)
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

Core location	***Nominal water depth* (m)**	***Average Total PCBs - 0-8 cm* (µg/kg)**	***Average Total PCBs (carbon normalized) - 0-8 cm* (µg/kg OC)**
Baseline cores			
1B	150	112	3,682
2B	150	45	2,049
2BR	150	30	1,439
3B	150	80	2,989
4B	150	550	11,793
5B	150	530	11,876
5BR	150	385	8,913
6B	150	488	11,933
7B	150	349	9,588
8B	150	726	13,177
9B	150	352	9,458
10B	150	25	2,114
6BC	100	125	3,040
7BC	100	112	4,723
8BC	100	349	7,121
9BC	100	123	4,610
1C	60	104	4,829
2C	60	87	4,162
3C	60	34	1,536
4C	60	114	5,217
4CR	60	91	3,995
5C	60	132	4,678
6C	60	63	2,343
7C	60	74	7,134
8C	60	2,514	42,923
9C	60	130	7,459
10C	60	17	1,491
1DC	40	15	802
2DC	40	7	683
3DC	40	39	2,158
4DC	40	16	544
5DC	40	30	1,200
6DC	40	17	1,097
7DC	40	7	433
8DC	40	65	3,115
9DC	40	38	2,211
10DC	40	8	550
Outfall area cores			
OA01	70	62	2,705
OA02	50	75	3,042
OA03	50	61	1,814
OA04	70	168	4,508
OA05	60	127	3,169
OA05R	60	112	5,831
OA06	50	85	4,576
OA07	70	482	7,459
OA07R	70	153	3,806
OA08	50	97	5,498
OA09	40	9	566
OA10	70	157	7,506
OA10R	70	77	4,955
OA11	50	134	4,374
OA11R	50	291	14,854
OA12	70	118	7,405
OA12R	70	54	3,391
OA13	60	55	2,556
OA14	50	74	5,253
OA15	80	417	17,250
OA16	70	312	15,059
OA16R	70	209	9,910
OA17	60	130	7,720
OA18	90	36	1,329
OA19	80	1,091	29,436
OA20	40	7	370
OA21	80	132	7,108
OA22	60	18	734
OA22R	60	191	10,839
OA23	50	57	3,068
OA24	70	342	19,795
OA25	50	56	4,487

Abbreviations
cm - Centimenters
ft - Feet
m - Meters

Table 9 - Estimates of Mass Based on MVS Model Output (2009 Data Set)
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

	o,p'-DDD	***o,p'-DDE***	***o,p'-DDT***	***p,p'-DDD***	***p,p'-DDE***	***p,p'-DDT***	***Total DDTs***	***p,p'-DDMU***	***p,p'-DDNU***	***Total DDT Compounds***	***Total PCBs***
Baseline											
Total bed	290	1,900	120	1,300	9,700	530	14,000	5,200	940	20,000	1,000
0-8 cm interval	36	210	16	190	1,200	63	1,700	410	71	2,200	110
Outfall area											
Total bed	150	930	33	920	5,000	310	7,300	1,200	330	8,800	460
0-8 cm interval	19	110	5.8	140	600	37	910	210	33	1,200	58

Abbreviations
cm - Centimeter

Notes
1. All values are in kilograms and were rounded to two significant figures.
2. For results reported as non-detected, a value of 5 micrograms per kilogram (µg/kg) was used.
3. The baseline modeled area was 30 square kilometers (km^2). The outfall modeled area was 11 km^2.
4. The volume of the baseline modeled grid was 15 million cubic meters (m^3).
5. The volume of the 0-8 cm interval as modeled was 2.3 million m^3.

Table 10 – Summary of Mass Estimates for PV Shelf
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf (OU 5 of the Montrose Chemical Corp. Superfund Site)
Los Angeles County, California

***Mass of p,p'-DDE* (MT)**	***Mass of PCBs* (MT)**	***Modeled area* (km^2)**	***Data set***	***Computational approach***	***Reference***
119.6	NA	43.8	LACSD gravity cores collected between 1981-1989, plus 2 cores from 1991	Integration of five water-depth zones	Lee, H.J., 1994
72	12.3	22.1	1992 USGS box cores and gravity cores from 38 stations	Integration of five water-depth zones	Lee, H.J., 1994
66.8	NA	43.1	1992 USGS box cores and gravity cores from 38 stations	Integration of five water-depth zones	Lee, H.J., *et al*., 2002
71.9	NA	22.1	1992 USGS box cores and gravity cores from 38 stations	Integration of four "volume grids" using "E-type" estimate	Murray, C.J., *et al*., 2002
61.4	NA	22.1	1992 USGS box cores and gravity cores from 38 stations	Integration of four "volume grids" using median concentrations	Murray, C.J., *et al*., 2002
9.7	1.0	29.8	2009 gravity cores from 59 stations	Kriging using MVS with cell averaging	Appendix A (this report)
13.8	1.0	29.8	2009 gravity cores from 59 stations	Kriging using MVS with adaptive gridding	Appendix A (this report)

<u>Abbreviations</u>

km^2 – square kilometers
m^3 – cubic meters
MT – Metric tons = grams X 10^6
MVS – Mining Visualization System
NA – Not available

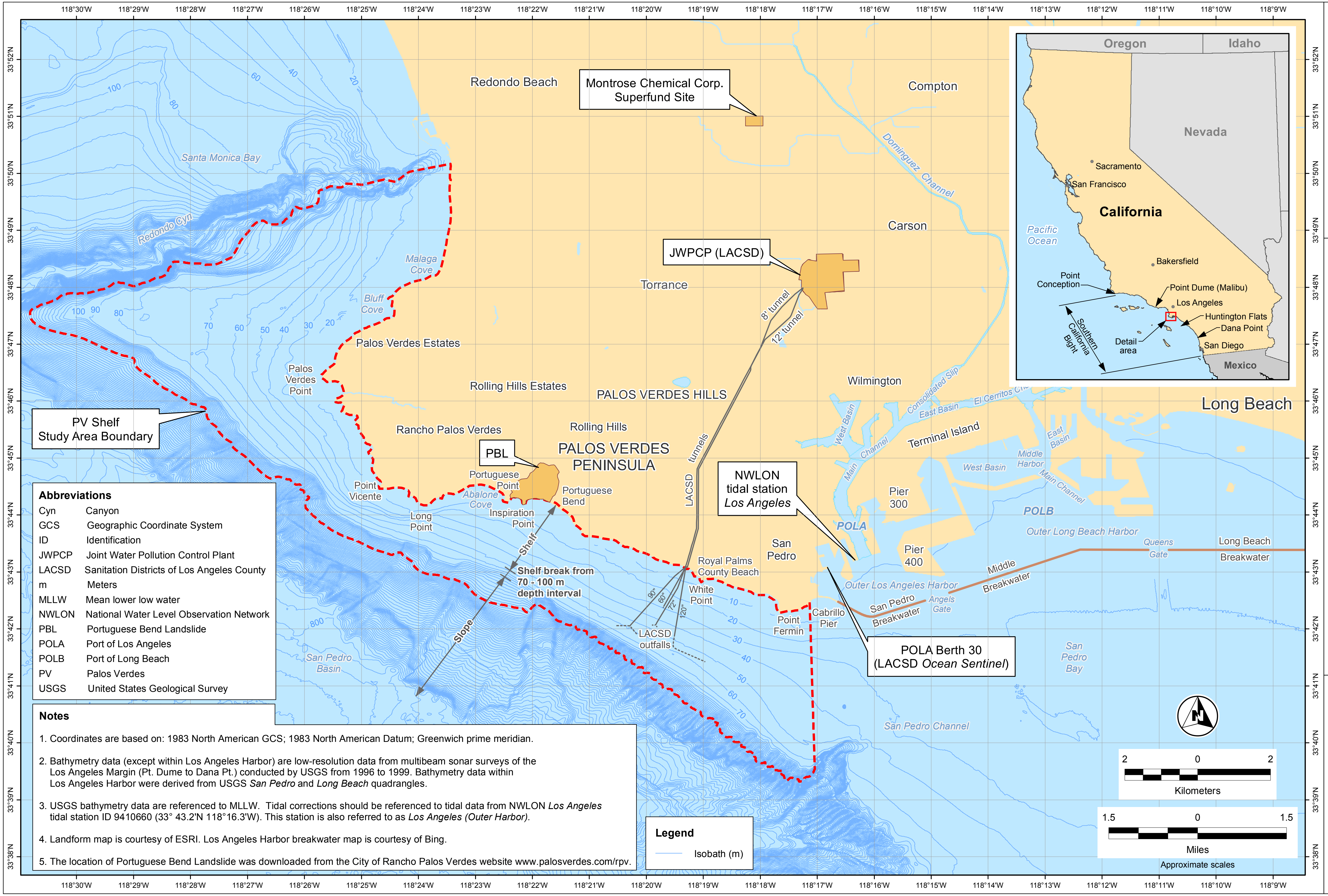
<u>Notes</u>

1. References are provided in Section 6.0 of this report.

FIGURES

FIGURE 1
Location Maps -
PV Shelf Study Area

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California



Abbreviations

Cyn	Canyon
GCS	Geographic Coordinate System
ID	Identification
JWPCP	Joint Water Pollution Control Plant
LACSD	Sanitation Districts of Los Angeles County
m	Meters
MLLW	Mean lower low water
NWLON	National Water Level Observation Network
PBL	Portuguese Bend Landslide
POLA	Port of Los Angeles
POLB	Port of Long Beach
PV	Palos Verdes
USGS	United States Geological Survey

Notes

1. Coordinates are based on: 1983 North American GCS; 1983 North American Datum; Greenwich prime meridian.
2. Bathymetry data (except within Los Angeles Harbor) are low-resolution data from multibeam sonar surveys of the Los Angeles Margin (Pt. Dume to Dana Pt.) conducted by USGS from 1996 to 1999. Bathymetry data within Los Angeles Harbor were derived from USGS *San Pedro* and *Long Beach* quadrangles.
3. USGS bathymetry data are referenced to MLLW. Tidal corrections should be referenced to tidal data from NWLON *Los Angeles* tidal station ID 9410660 (33° 43.2'N 118°16.3'W). This station is also referred to as *Los Angeles (Outer Harbor).*
4. Landform map is courtesy of ESRI. Los Angeles Harbor breakwater map is courtesy of Bing.
5. The location of Portuguese Bend Landslide was downloaded from the City of Rancho Palos Verdes website www.palosverdes.com/rpv.

Legend

—	Isobath (m)

EPA United States Environmental Protection Agency

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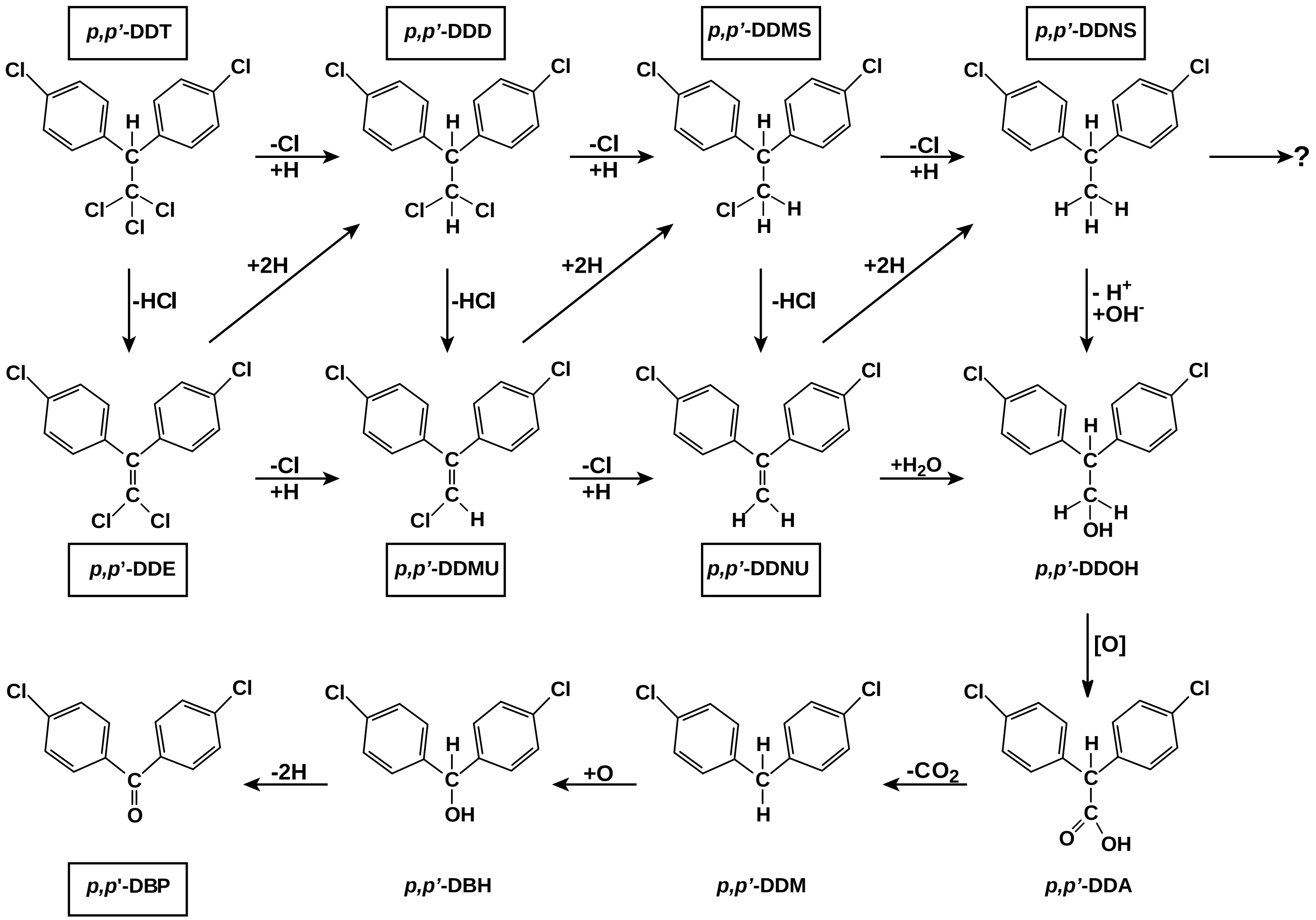

Notes

1. Chemicals with names enclosed in boxes have been detected in samples of PV Shelf sediment.
2. This figure is from Eganhouse *et al*., 2007.

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Palos Verdes Shelf
Los Angeles County, California

FIGURE 2
Pathways for DDT Degradation

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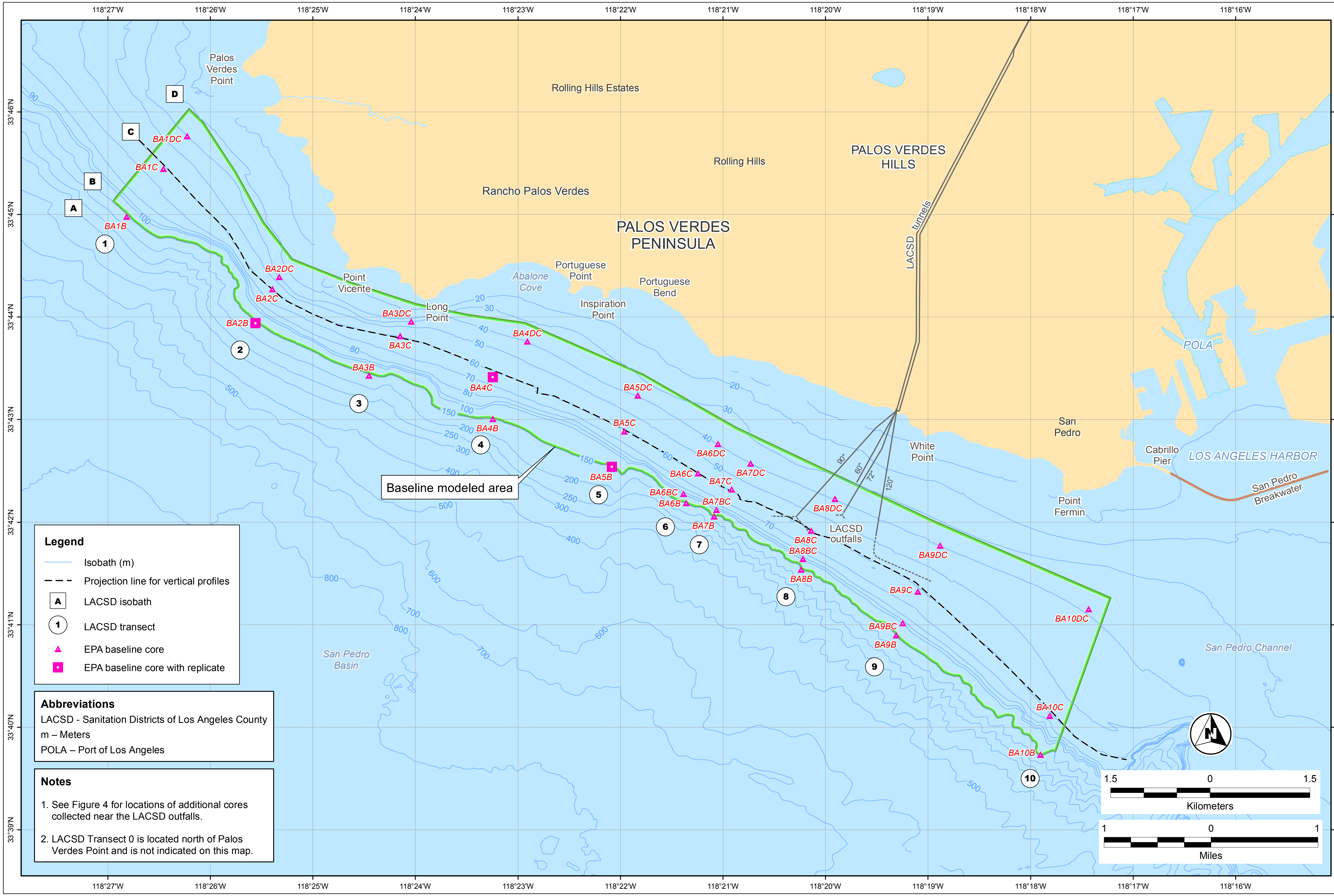
FIGURE 3
Locations of EPA
Baseline Sediment Cores

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

United States
Environmental Protection
Agency



Abbreviations

LACSD - Sanitation Districts of Los Angeles County

m – Meters

POLA – Port of Los Angeles

Notes

1. See Figure 4 for locations of additional cores collected near the LACSD outfalls.
2. LACSD Transect 0 is located north of Palos Verdes Point and is not indicated on this map.

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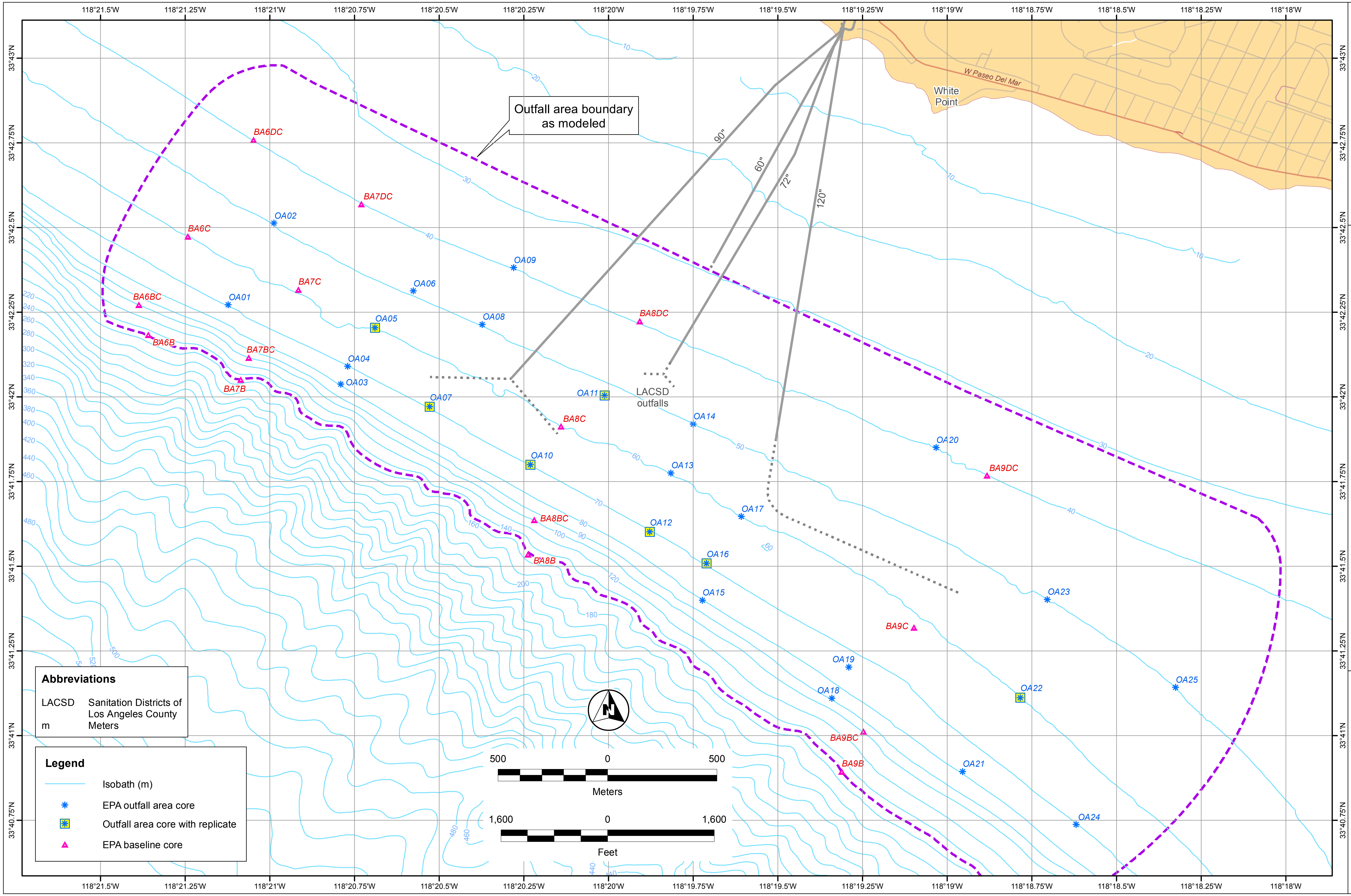
FIGURE 4
Locations of EPA
Outfall Area Sediment Cores



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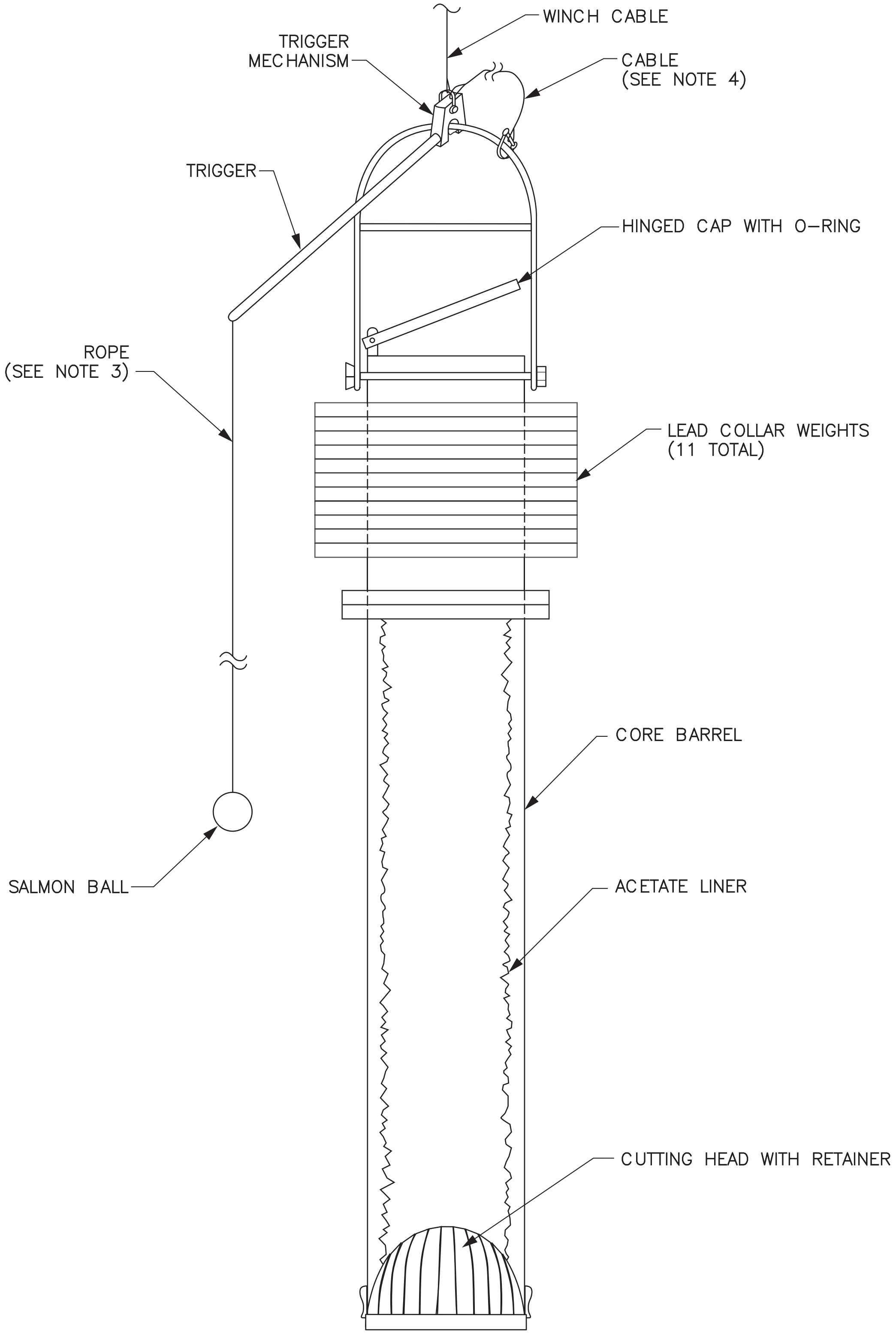
Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency



Notes

1. This drawing is not to scale.
2. The hinged cap is open during the drop through the water column. Upon impact with the sediment bed, the cap closes, forming a water-tight seal.
3. The rope is actually longer than the core assembly. When the salmon ball hits the sediment bed, the trigger mechanism is fired, releasing the trigger from the core assembly to allow additional free-fall into the sediment bed.
4. The cable keeps the trigger and core assembly attached after the trigger mechanism has fired.

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Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

FIGURE 5
Schematic of LACSD's
Gravity Corer

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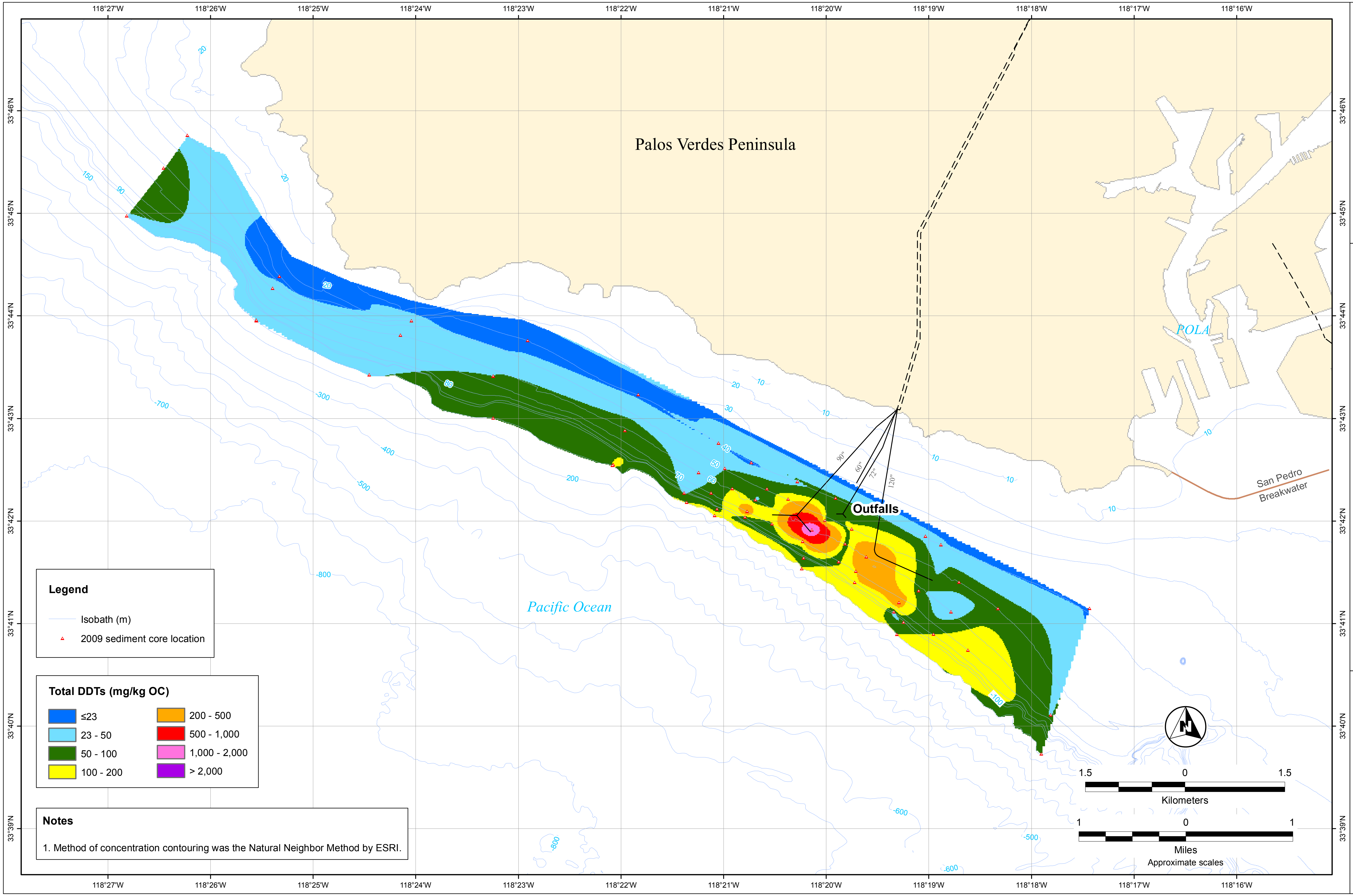

Legend

Isobath (m)

▲ 2009 sediment core location

Total DDTs (mg/kg OC)

🟦	≤23	🟧	200 - 500
🟦	23 - 50	🟥	500 - 1,000
🟩	50 - 100	🟪	1,000 - 2,000
🟨	100 - 200	🟪	> 2,000

Notes

1. Method of concentration contouring was the Natural Neighbor Method by ESRI.

FIGURE 6
Interpretive Carbon-Normalized
Total DDTs (0-8-cm Interval)

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

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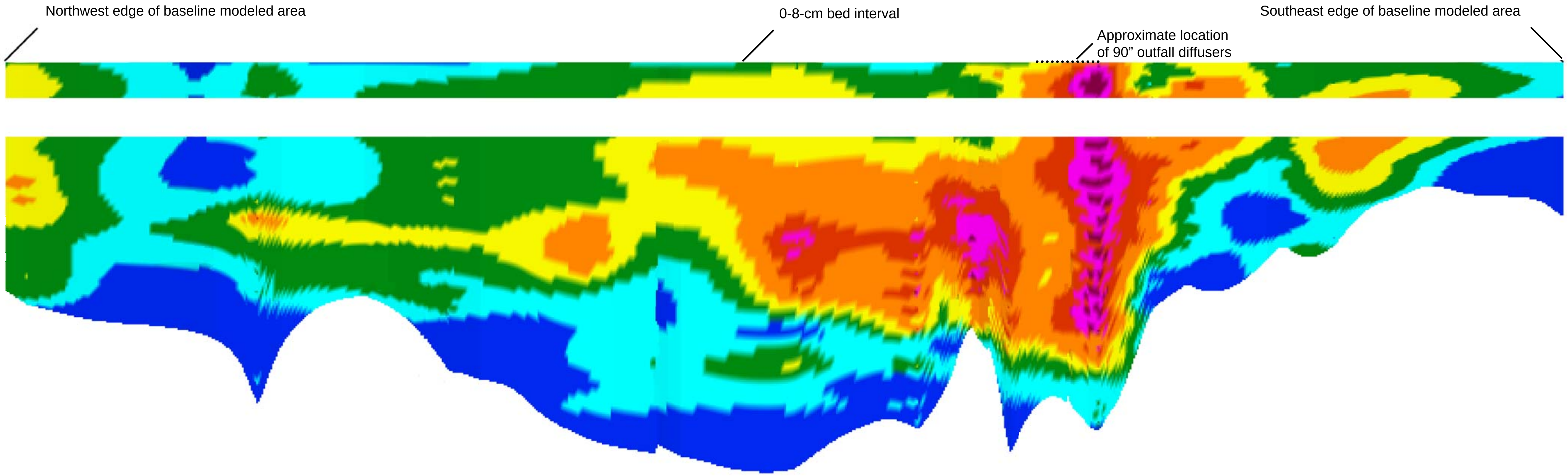
FIGURE 7
Vertical Profile: Interpretive
Total DDTs along 60-m Isobath

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency



0 1.37
Kilometers

Total DDTs (ug/kg)

🟦	<230	🟧	2,000 - 5,000
🟦	230 - 500	🟥	5,000 - 10,000
🟩	500 - 1,000	🟪	10,000 - 20,000
🟨	1,000 - 2,000	🟪	>20,000

Notes

1. Data were not normalized for organic carbon.
2. Vertical scale is in centimeters. Vertical scale is exaggerated by a factor of approximately 4,400.
3. Bed interval of 0-8 cm is shown separated from the remainder of the vertical profile.
4. View is from the Pacific Ocean towards the shoreline.
5. The profile is a flattened rendition of the 60-m isobath. The concentration isopleths may appear disjointed and irregular at bends in the actual 60-m isobath. (Bends appear as folds).
6. Edges of the baseline modeled area are shown on Figure 3.

Abbreviations

LACSD	Sanitation Districts of Los Angeles County
ug/kg	Micrograms per kilogram

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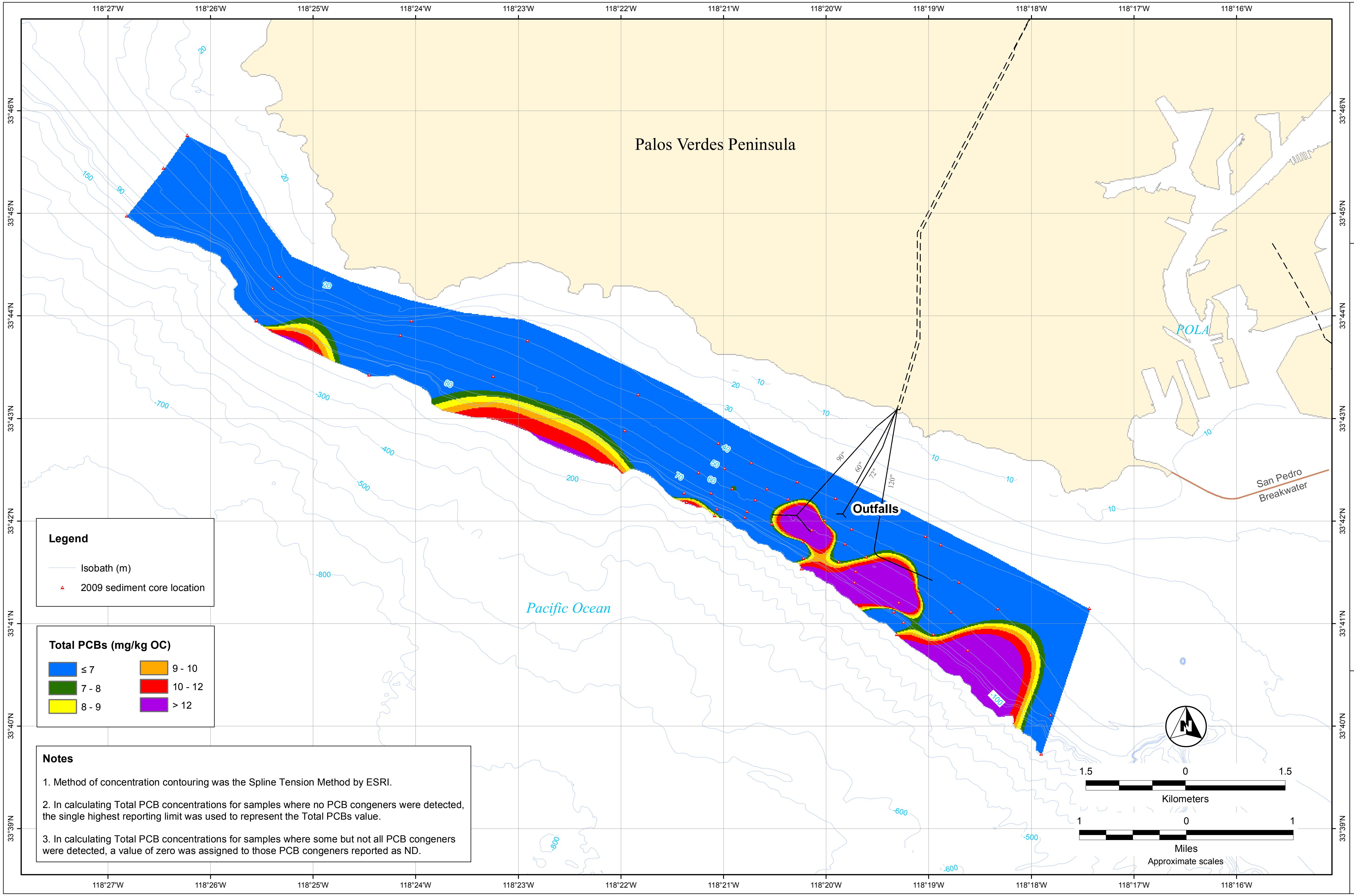
FIGURE 8

Interpretive Carbon-Normalized Total PCBs (0-8-cm Interval)

Fall 2009 Sediment Sampling Program

Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency



Legend

Isobath (m)

2009 sediment core location

Total PCBs (mg/kg OC)

🟦 ≤ 7	🟧 9 - 10
🟩 7 - 8	🟥 10 - 12
🟨 8 - 9	🟪 > 12

Notes

1. Method of concentration contouring was the Spline Tension Method by ESRI.

2. In calculating Total PCB concentrations for samples where no PCB congeners were detected, the single highest reporting limit was used to represent the Total PCBs value.

3. In calculating Total PCB concentrations for samples where some but not all PCB congeners were detected, a value of zero was assigned to those PCB congeners reported as ND.

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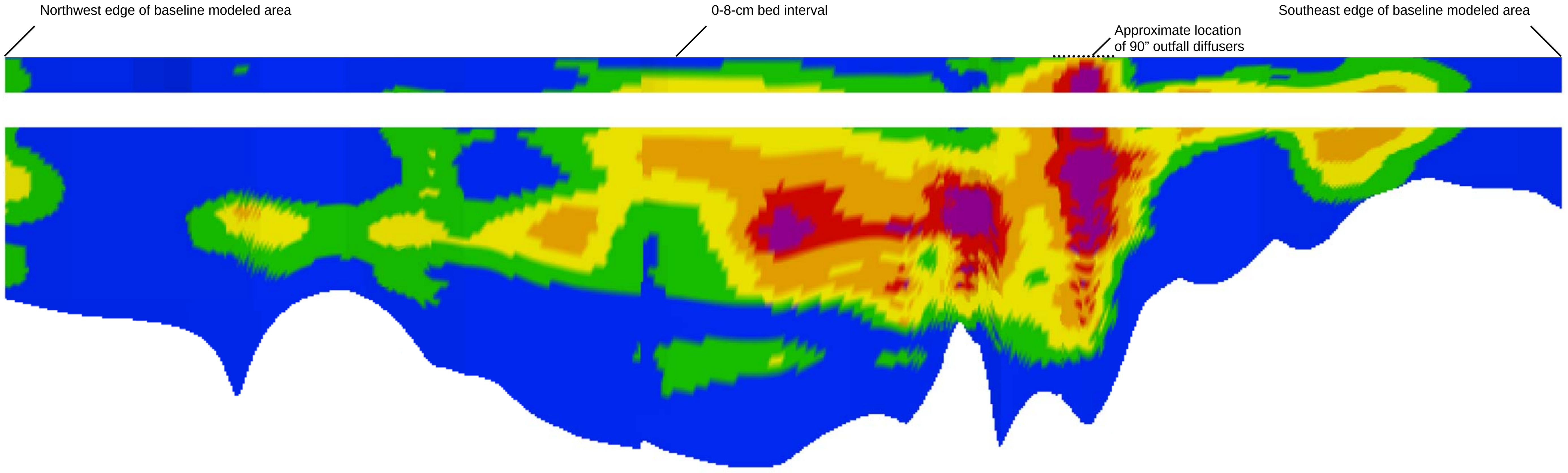
FIGURE 9
Vertical Profile: Interpretive
Total PCBs along 60-m Isobath



Total PCBs (ug/kg)

🟦	5 - 70	🟧	300 - 600
🟩	70 - 150	🟥	600 - 1,000
🟨	150 - 300	🟪	>1,000

Notes

1. Data were not normalized for organic carbon.
2. Vertical scale is in centimeters. Vertical scale is exaggerated by a factor of approximately 4,400.
3. Bed interval of 0-8 cm is shown separated from the remainder of the vertical profile.
4. View is from the Pacific Ocean towards the shoreline.
5. The profile is a flattened rendition of the 60-m isobath. The concentration isopleths may appear disjointed and irregular at bends in the actual 60-m isobath. (Bends appear as folds).
6. Edges of the baseline modeled area are shown on Figure 3.

0 1.37
Kilometers

Abbreviations

LACSD	Sanitation Districts of Los Angeles County
ug/kg	Micrograms per kilogram

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

EPA United States Environmental Protection Agency

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FIGURE 10
Interpretive DDTs in
0-2-cm Interval

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

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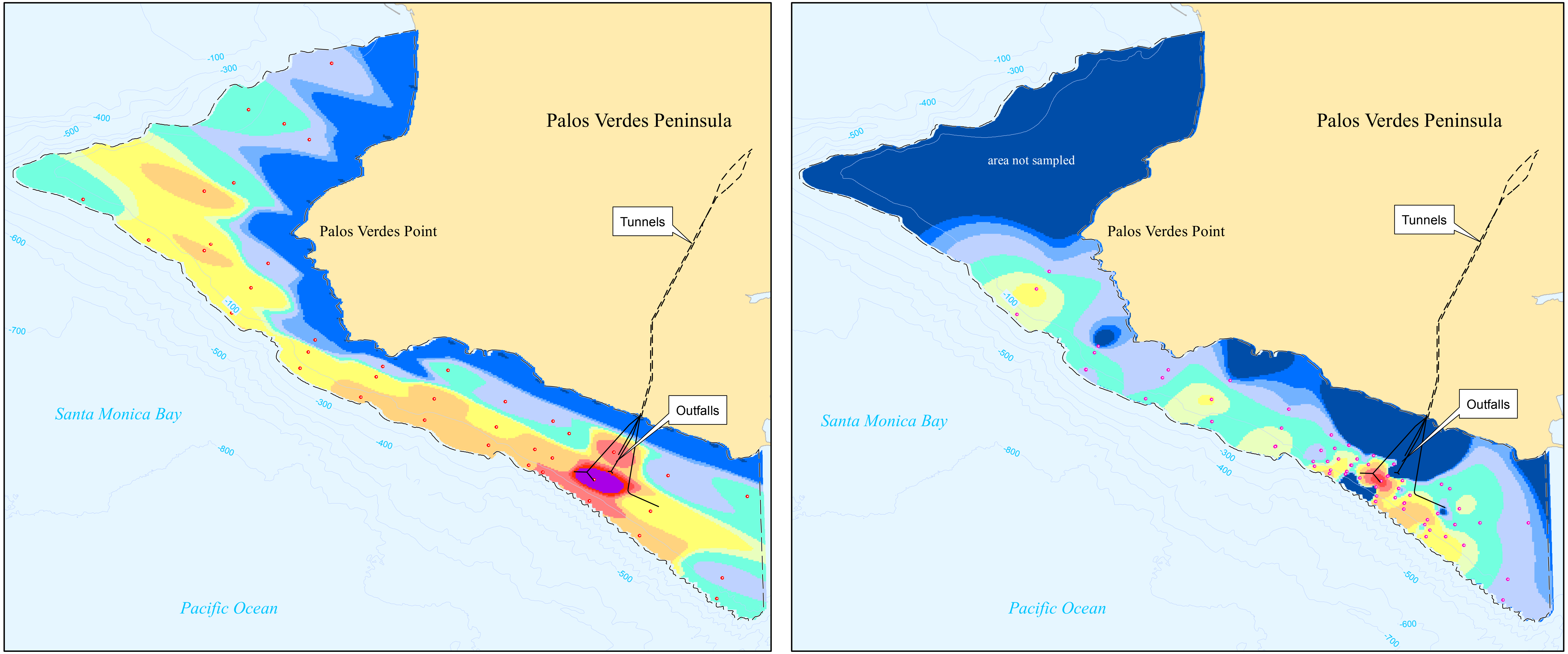
Environmental Protection
Agency



2002/2004 Data Set

2009 Data Set

DDTs (mg/kg)

0 - 0.05	0.5 - 1	10 - 25
0.05 - 0.1	1.0 - 1.5	25 - 50
0.1 - 0.2	1.5 - 3	50 - 90
0.2 - 0.5	3 - 10	90 - 155

Notes

1. Concentrations at shoreline locations were assumed to be 0.05 mg/kg for contouring purposes only.

2. The 2002/2004 data set was based on results of samples collected by LACSD using the Van Veen sampler. To provide data north of Palos Verdes Point, this data set also used results from four Bight 1994 samples; one 1993 LACSD sample; and two 1992 NOAA samples.

3. Concentrations are not normalized for organic carbon.

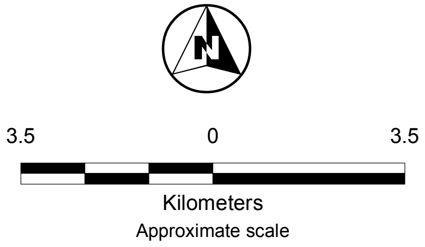
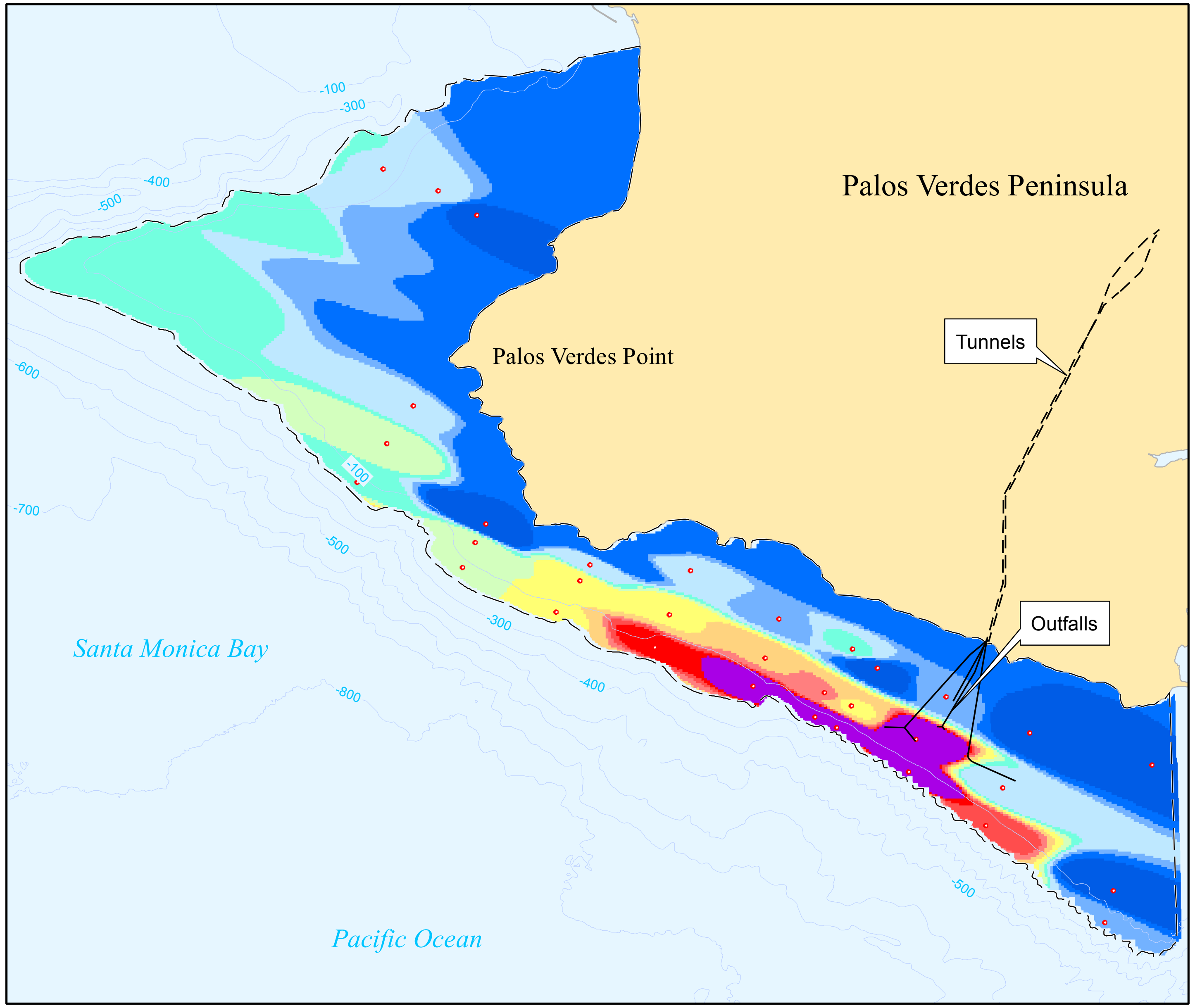


FIGURE 11
Interpretive PCBs in
0-2-cm Interval

Fall 2009 Sediment Sampling Program
Palos Verdes Shelf
Los Angeles County, California

United States
Environmental Protection
Agency



2002/2004 Data Set

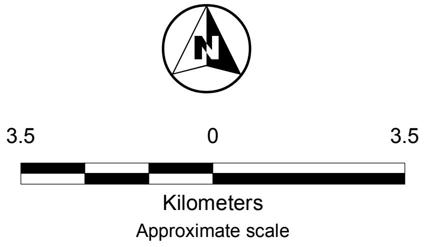
2009 Data Set

Total PCBs (mg/kg)

🟦	0 - 0.05	🟩	0.15 - 0.2	🟥	0.75 - 1
🟦	0.05 - 0.075	🟩	0.2 - 0.3	🟥	1 - 1.25
🟦	0.075 - 0.1	🟨	0.3 - 0.5	🟥	1.25 - 1.5
🟦	0.1 - 0.15	🟧	0.5 - 0.75	🟪	1.5 - 2

Notes

1. Concentrations at shoreline locations were assumed to be 0.05 mg/kg for contouring purposes only.
2. The 2002/2004 data set was based on results of samples collected by LACSD using the Van Veen sampler. To provide data north of Palos Verdes Point, this data set also used results from four Bight 1994 samples; one 1993 LACSD sample; and two 1992 NOAA samples.
3. Concentrations are not normalized for organic carbon.



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ATTACHMENT 1
EPA RESPONSES TO PVSTIEG COMMENTS ON DRAFT DATA REPORT FOR THE FALL 2009 SEDIMENT SAMPLING PROGRAM

EPA RESPONSES TO PVSTIEG COMMENTS
ON
DRAFT DATA REPORT FOR THE FALL 2009 SEDIMENT SAMPLING PROGRAM
PALOS VERDES SHELF (OPERABLE UNIT 5 OF THE MONTROSE CHEMICAL CORP. SUPERFUND SITE)
LOS ANGELES COUNTY, CALIFORNIA
JUNE 2013

No.	Page	Section	Para-graph	Comment	EPA Response
Comments from the Sanitation Districts of Los Angeles County (LACSD), dated 14 June 2013					
1	ES-1	ES	4	Regarding the sentence that reads “The White Point outfalls are operated by the LACSD, and are the recognized sources of DDTs and one of several possible sources of PCBs at PV Shelf”, would it be possible to clarify that the DDT and PCB contamination from the LACSD outfalls was a historical issue that ceased over 40 years ago and that LACSD effluent is not an ongoing source of these contaminants. Insert the word “historical” before the word “sources” stated twice in this sentence.	The word “historical” has been inserted as suggested in the comment. Text has been added to Section 1.1 of the main text to state that DDTs have not been detected in JWPCP effluent since 2002, and PCBs have not been detected in JWPCP effluent since 1985 (Biennial Receiving Water Monitoring Report, LACSD, 2012).
2	ES-2	ES	1	Change the maximum ocean depth of cores collected from 50 m to 150 m.	The correction has been made in the text.
3	ES-2	ES	1	Change the last sentence of the first paragraph on the page to: “Cores were collected using a gravity coring device dropped from LACSD’s ocean monitoring vessel, Ocean Sentinel.”	The last sentence of the first paragraph on page ES-2 has been replaced with the suggested text.
4	2	1.1	2	In the second bullet on the page, PCBs do not need to be defined; they were defined on the previous page.	Text has been corrected and PCBs are not defined in the document except for the time they are first mentioned.
5	3	1.1	1	In the last sentence of Section 1.1, please update the numbers stated to the following: -2.5 million southern California residents -2,300 industries -273 mgd of wastewater treated -Please source (LACSD, 2012)	The text has been edited as suggested. The following report was cited: LACSD, 2012. *2010-2011 Joint Water Pollution Control Plant, Biennial Receiving Water Monitoring Report.*

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6	3	1.2	1	Please insert “vast majority of the” in front of “EA deposit” in the last sentence of the first paragraph in this section.	This revision has been made to the text in the referenced sentence.
7	4	1.2	1	Regarding the statements made in the first full paragraph on this page, all these chemicals appear to have been detected in PV sediments per the legend in figure 2 (all enclosed in boxes). Is this correct?	The figure has been edited to accurately duplicate the figure from the Eganhouse reference. Four DDT forms have not been detected in samples of PV sediments; they are: p,p’-DDOH, p,p’-DBH; p,p’-DDM; and p,p’-DDA.
8	4	1.2	4	In the last two bullets on the page, remove “Region IX” from the reference to the EPA report for consistency.	“Region IX” has been removed from these references.
9	5	1.3	1	The sub-bullet in the second item in the list of IROD component states that “The interim cleanup level for DDT in surface sediment is 46 mg/kg OC.” How is this interim level different than the "interim" objective for the cap? How does the 23 mg/kg OC final target relate to these interim targets? Consider clarifying. This same value is referred to as a “median concentration” of Total DDTs further down on the page.	These cleanup levels and objectives were presented and described in the IROD. Please refer to IROD Page 3, where the objective of the (interim) cap is first described, and IROD Page 48, where specific RAOs are presented.
10	7	2.1	1	Revise the first sentence in Section 2.1 as follows: “From 16 through 20 October 2009, daily cruises were conducted to collect sediment cores from PV Shelf using LACSD’s monitoring vessel, *Ocean Sentinel*, crew, and scientists.”	The sentence has been revised as suggested.

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11	7	2.1.1	1	The first paragraph of 2.1.1 states that the core locations were selected by LACSD in the 1960s. Please confirm it was not the 1970s. LACSD sampling history went back to the 1950s. However, the NPDES permit program is authorized by CWA (section 402) in 1972. The earliest permits were issued in the 1970s to focus on POTWs. Also, please redefine NPDES as State of California National Pollutant Discharge Elimination System (not "Pollution").	The text in question has been edited as follows: "…these stations are typically used by LACSD to meet requirements in the State of California National Pollutant Discharge Elimination System (NPDES) permit…"
12	7	2.1.1	2	The last word of the first sentence of this paragraph should be "isobath", not "depth".	The word "depth" is correct in describing the D isobath; a correction to placement of the parentheses has been made.
13	7	2.1.1	3	To clarify the text in the last paragraph of Section 2.1.1, Station 2B was not planned to take two reps originally. When we visited 2B, the first two attempts appeared to be shorter than expected (12 cm and 11 cm) and the 3rd core is 25 cm. But the lab sliced two cores (12 cm and 25 cm) for this station. That is why there are 69 cores shown in the next page. Also, location BA2B is called a replicate in the 3rd paragraph of section 3.1.	Comment noted. No changes to the text have been made.
14	9	2.1.4	1	Add some coring device photos to help clarify what the weighted bar, cutting head, an array of sheet metal "fingers"....	Figure 5 shows an adequate level of detail for the purposes of this report.

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15	9	2.1.4	2	The 2nd paragraph in this section states that the lined corer was dropped to the ocean floor. The coring device was actually lowered to near the seafloor, maybe 10 meters above the bottom, and allowed to stabilize in a vertical position before being allowed to free fall into the sediment. Chi-Li to confirm details. After checking with Bill, we no longer allow the corer to free fall into seafloor because we use high speed winch. Also, only the winch is used to reverse the corer back to surface.	The text has been revised and reflects the approach used for collecting sediment core samples accurately.
16	9	2.1.4	3	The criteria listed here are not the only criteria when determining whether a retrieved core is successful or not. Checking my field worksheet, we ever hit areas with rocky bottom (BA7BC and BA10DC) and damage the cutting head.	The following two bullets have been added to this list of criteria for core acceptance: • Rocky conditions at the ocean floor ; or • Damage to the coring device possibly due to a rocky ocean floor.
17	15	3.1	1	The 25 cm core length described here, that was retrieved on the third drop at location BA2B does not match what is reported in Table 4. Other data look suspect in Table 4 and may require a double-check.	The sentence describing BA2B has been revised as follows to clarify that two cores were taken at this location – BA2B which was 12 cm, and BA2BR which was 24 cm: "Core retrieval was difficult at location BA2B on the 150-m isobath, where two drops of the coring device resulted in lack of recovery (likely due to rocky substrate); a satisfactory core 25 cm in length was retrieved on the third drop and was processed as a replicate core (BA2BR), with one of the 12 cm deep cores as the BA2B parent sample." Table 4 has been QCed and corrected and is believed to be accurate. Please see Note 1 at the bottom of the table stipulating that core lengths indicated are based on the

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					lengths of cores used to generate samples during core cutting events. These lengths may differ from measurements made on-board at the time of core collection, due to: different measuring conditions; possible deformation during handling; and the discarding of core bottom portions.
18	15	3.1	3	Here is more information about the statements made in the first sentence on the last paragraph on this page: both BA4C and OA22 are located along the 60-m isobath. OA22 is near station 9C where surface sediment mean grain size is ~ 4.6 phi.	Comment noted.
19	17	3.2.2	1	Any reason similar average values were not listed for specific gravity in the last sentence of this section?	Values have been added.
20	17	3.3.1	1	Location OA05 is near 7C. Isn’t the 13% TOC found in the 36-40 cm interval of core OA05 way too high? The average TOC at OA05 is 5.8% but is still questionable. Table 5 needs to add the standard derivation or range.	The 13% TOC value for the 36-40 cm interval at OA05 is relatively high in comparison with the rest of the core. TOC values for this location will be carefully re-examined during the 2013 sampling event. Standard deviations were considered for this report but not included, as spatial variability of sediment characteristics across PV Shelf is expected, i.e., values of standard deviation applied over the shelf would not affect the overall conclusions.
21	17	3.3.1	2	In response to the second paragraph of section 3.3.1: based upon my review of Appendix I, I do not see how you can get a perfect R-squared value of 1.0 even with a 3rd order polynomial. Suggest rerunning the stats. Also, what is the basis for using a 3rd order polynomial rather	Upon further examination of the data used, EPA agrees that polynomial trendlines should not be used. The statistics were rerun using linear models. The resulting R^2 values of 0.76 for TOC vs. DDTs and 0.78 for TOC vs. PCBs, implying correlations in both instances. It should

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				than a linear fit?	be noted that data set used in this analysis from the core collected at location BA8C had higher concentrations of TOC and DDTs/PCBs than the rest of the data being analyzed, and may have skewed the R^2 value to be higher (i.e. skewing the strength of the correlation). During the upcoming sediment sampling event (planned for 2013), a replicate sediment sample will be collected at location BA8C near the outfalls, the location where outlier data was reported.
22	21	4.1.1	3	The unique procedure by which Calscience prepared DDT samples described in this paragraph is an additional process that may impact the results. Would like to know more detail but can't find any info from appendix. Is the analyte from PVS sediment or surrogates ? The main concern is that surrogates only provide information about recovery and not extraction efficiency. Additional supporting information from this procedure should be included.	Please refer to Appendix H.5 Attachment 2 for a full description of the secondary cleanup step . This reference has been included in Section 4.1.1 text.

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23	22	4.1.2	1	It is stated here that "{The interlaboratory comparison study} concluded that analytical results reported by Calscience for all DDT analytes were acceptable, based on the confidence intervals developed for the study." It is unclear that Calscience adopted the additional cleanup procedure described above on Page 21 while running the inter-lab calibration. Although the SSRM results appeared to be comparable among six participating labs, archived 2009 sediment sample should be analyzed as the follow up.	Text has been added to reflect that Calscience did adopt the secondary cleanup procedure for the inter-lab calibration.
24	22	4.2	1	Regarding the calculation for OC normalization, all the interim and final limits are expressed and discussed in mg/kg OC. Suggest using same units as targets throughout document.	Where comparing results to cleanup goals, units have been changed to mg/kg OC.
25	25	4.5	1	When will the interim cleanup level of 46 mg/kg OC in surface sediment be reached? This is stated in the 1st bullet in Section 4.5. Also, change "Table 8" to "Table 7" in the next paragraph, I believe this was a typo.	The IROD estimated that the interim cleanup level of 46 mg/kg OC mean DDTs would be reached 5 years after cap installation. Text has been added to this sentence to clarify. The table numbering has been corrected.
26	28	5.0	4	Any chance you can include the information coming from Burgess's lab on flux rates to elaborate on this statement: "…desorption of COCs from sediment into seawater."	At this time, this information cannot be included because results from the flux study conducted by the EPA have not yet been published.
27	29	5.0	2	Could the reasons described in the first bullet (adoption of a secondary cleanup procedure by Calscience) be the cause of the huge loss of DDT? PCB mass also dropped dramatically.	No, the cleanup procedure was appropriate for the DDT analyses. The secondary cleanup step was proven to improve accuracy. This step was not used in PCB analyses, therefore, no relationship between this step and

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					PCB results exists.
28	Tbl 4	Tables	-	The estimates in the 5th column (estimated EA bed thickness [cm]), sometimes mislead the core length at certain sites. May try to see how good the estimated EA bed thickness is to correlate the actual core length? Also, I don't see a reason to sum the length of the individual cores at the bottom.	Core length and EA bed thickness refer to two different depths. Please refer to the vertical profiles in Appendix L for evidence of how the estimated EA bed thickness was calculated, also explained in Note #2 located below this table. Summation of core lengths has been removed.
29	Tbl 5	Tables	-	I suggest adding more columns of stats here (range, stdev, …).	A wide range of values would be expected at PV Shelf, considering spatial variability due to impacts of the outfalls. Calculations of standard deviation were not considered necessary for the purposes of this report.
30	Tbl 7	Tables	-	Add concentration unit (ug/kg?) to all columns.	Footnotes have been added to indicate units. The OC-normalized values have been converted to mg/kg OC for comparing to cleanup goals.
31	Fig 1	Figures	-	The Portuguese Bend Landslide is discussed in the Intro, but not labeled on these base maps. Consider adding the PBL landslide area.	The location of the Portuguese Bend Landslide (PBL), based on the City of Rancho Palos Verdes website, has been added to Figure 1.

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32	Fig 2	Figures	-	According to the text and legend, compounds detected on the PVS are "enclosed". Since all compounds appear enclosed does that mean all have been detected or was this an error?	The figure has been edited to accurately duplicate the figure from the Eganhouse reference. Please see response to comment no. 7 above.
33	Fig 6	Figures	-	The upper boundary of the contour should be along the 40-m isobath, to be consistent with the lower boundary along the 150 m isobath. I also suggest using the ranges defined as the cleanup goal (23, 46, 78....). Add a unit to Note 2 for organic carbon (%C?).	The contoured areas in Figures 6 and 8 were generated using the geostatistical models cited in the figure notes. The models generated the contours as shown based on actual data points; the models do not generate data outside the limits of the sample grid. The cleanup goals are based on site-wide average concentrations and contouring those goals would have limited value.
34	Fig 7 & 9	Figures	-	I suggest including the location of the outfall system on this figure. The gap here is somehow misleading, can this be reduced? Upper portion is the most biological available depth (0-8 cm). What are these blue lines/scales? Delete or label?	The locations of where the 90” outfall diffusers cross the 60-m isobath have been added. The gap is provided to dramatize the 0-8 cm layer. The blue lines have been deleted.
35	Fig 8	Figures	-	Scale only up to 12,000 results in losing detail information on the high end. It should be expanded more beyond 12,000. There are 8 levels in DDT (Figure 6).	Comment noted. The PCB delineations in Figure 8 are considered appropriate for purposes of this report. EPA will reconsider this issue in future reports.
36	Fig 10 & 11	Figures	-	Missing outfall layer. Please add. Leave "NS" at the area beyond transect 1.	Outfalls have been added. A callout has been added stating that the area beyond Transect 1 was not sampled for the 2009 data set.

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Comments from Bruce Joab, California Department of Fish and Wildlife (CDFW), dated 18 June 2013					
General Comments					
1	-	-	-	Historical data from the PVS is quite important for chemical residue trend analysis. Primarily, comparisons need to be made between the new data and the 2009 data set to evaluate whether it was anomalous in any way. Therefore, re-sampling the same array that was used in 2009 is important to be able to make that comparison, However, an overall evaluation of the recent data (both 2009 and 2013 results) with the earlier data is also critical. To that end, please include a summary of the various sediment sampling events that have occurred on the PVS area. Table 10 has information on p,p'dichloro-diphenyl-dichloroethane and PCB inventories from historical data sets, but the 2004 sampling results do not appear to be contained in this table. A more comprehensive table or map set, or combination of the two, would be helpful to elucidate what other data sets can be compared to the 2009 and 2013 data sets for a trend analysis.	Comment noted. Table 10 did not reference the 2004 data set (indicated in Figure 10), because the 2004 data were based only on Van Veen sampling events (during which only the top 2 cm of the sediment bed were retrieved – mass estimates based on these data sets are not typically derived). The 2013 sample design will include all 2009 sample points plus additional sample points. Comparisons between the 2009 and 2013 data will be made in a cleanup status report; the draft cleanup status report is planned for release in December 2014. A description of historical sampling events conducted at PV Shelf will be included in the upcoming Five-Year Review report, along with an analysis of trends. Due to CERCLA schedule requirements, the Five-Year Review report will be published before data from the 2013 sampling event will be ready.

2	-	-	-	Some additional information on how the data will be analyzed would be instructive. A paragraph or two that identifies the analyses, computations, or statistical comparisons to be made would be helpful. The objectives of this planned sampling event, including the analyses to be performed, should be clearly stated (per the data quality objectives process). For example, the calculation of mass inventory volume (MIV) on the PVS was performed with the results of the 2009 sediment sampling event. Will these MIV calculations be repeated based upon the 2013 data? Will other specific statistical comparisons or calculations be performed with this new data set?	For continuity, the sediment sampling event planned for fall 2013 will be designed to resemble the 2009 sampling event, with identical core locations plus additional locations. Comparisons between the 2009 and 2013 data will be made in a cleanup status report; the draft cleanup status report is planned for release in December 2014.
3	-	-	-	The 2013 results will be important in determining future actions. In particular, it would seem prudent to send splits of at least a subset of the sediment samples to a second fully accredited laboratory to help verify the data integrity. Some forethought will need to be given to how the samples are homogenized prior to such a split taking place to ensure that the results are comparable, and differences cannot be attributed to within-core heterogeneity alone.	Comment noted. The comment will be taken into consideration during sample design for the next round of sediment sampling, planned for fall 2013.
4	-	-	-	Some expert(s) have speculated that the sample locations selected for the 2009 sediment sampling event may have missed the areas that contain higher concentrations of the contaminants present on the PVS. In order to address potential spatial heterogeneity, we recommend adding additional sample locations proximal to some of the locations sampled in 2009 (i.e., "step-out" samples). Step-out samples should be collected both within and outside of the outfall area. While it appears unlikely that the 2009 samples were all taken in locations with relatively lower concentrations, such step-out sampling could help to	Comment noted. The comment will be taken into consideration during sample design for the next round of sediment sampling, planned for fall 2013.

				address questions about such spatial heterogeneity.	
-	-	-	-	Overview: We are in agreement with the fundamentals of this report and believe it to be well prepared. However, we recommend the following: (1) that step-out samples be included for a subset of the sediment sampling sites in the 2013 sampling event, (2) that a second laboratory analyze a subset of the samples to allow comparison of results between laboratories, and (3) that more detail be provided regarding the comparisons and calculations that will be performed with the data once it is collected . We also note that other matrices such as water and fish tissue are not addressed in this sampling report, and while we expect that they will be treated separately, we acknowledge the importance of sampling these matrices.	Comment noted. The comment will be taken into consideration during sample design for the next round of sediment sampling, planned for fall 2013.
Specific Comments					
1	7	2.1.1	2	This section makes reference to a transect 0 located north of Palos Verdes Point. On figure 3, it is not clear which transect is transect 0, as only transects 1-10 appear to be labeled. Please revise the text and/or figure to clarify the location of this transect.	Figure 3 is self-explanatory in that Note 2 states that Transect 0 is located north of Palos Verdes Point and is not indicated on the map. No samples were collected north of Palos Verdes Point.

2	25	4.4.3	1	The second bullet in this section identifies ongoing monitored natural recovery (MNR) processes as potentially associated with the significantly lower mass estimates that have been calculated from the 2009 data set. One point to consider is that the 2009 sampling may be among the first sediment sampling events since the Sanitation Districts of Los Angeles County converted to tertiary treatment of their effluent. This change significantly altered the discharge into this area according to Los Angeles County Sanitation District employees, and in particular has reduced the loading of organic matter onto the PVS. Any associated changes in the presence of microorganisms that degrade and/or mobilize sediment contaminants could alter the rate(s) of change associated with the contaminants in the site sediments. This concept is certainly captured within the concept of MNR, as stated in this bullet point. However, please consider specifically identifying this potential relationship between alterations in effluent treatment and sediment concentrations in the text.	Comment noted. However, there is not tertiary treatment at JWPCP. Full (100%) secondary treatment came online in November 2002; prior to that LACSD had been discharging a mix of 60% secondary and 40% advanced primary since about 1985. Although the loading of suspended solids (with associated organic nitrogen and carbon) from the current discharge is only 3% of what it was in 1970 (97% reduction), the greatest decline in mass emission of organic materials took place between 1970 and 1986, due to implantation of advanced primary treatment methods. The reduced rate of solids loading over several decades may have given the system a chance to process the legacy organics and revert back to a more natural condition, possibly resulting in a shift in the microbiological community on PV Shelf. No changes to the text were made.
Comments from Mr. Peter Gathungu, Department of Substances Control (DTSC), dated 11 July 2013					
1	ES-2	ES	1	The second sentence in this paragraph states that ocean depths at core locations ranged from 40 to 50 meters. However, the sample locations and contour depths shown in Figure 3, as well as the text in the third paragraph of Section 2.1.1 Locations for Baseline Cores indicates that ocean depths at core locations ranged from 40 to 150 meters. Please revise the report for consistency and to indicate accurate ocean depths at core locations.	The range of ocean depths from which sediment core samples were taken has been corrected to "40 to 150 meters".

2	ES-3	ES	2	The text in the second bullet listing the main conclusions of the sediment sampling program states that construction on an interim cap has been rendered unnecessary based on the fact that the concentrations of DDTs and PCBs measured are below cleanup levels. While the measured COC concentrations are below cleanup levels, data from a single sediment sampling effort may not be sufficient to conclude that an interim cap is unnecessary. DTSC recommends additional sampling, as recommended in the third bullet, to establish whether a sustained reduction/downward trend in COC concentrations is occurring prior to concluding that construction of an interim cap is unnecessary. In addition, we note that although the biologically active layer is defined as the 0 - 8 centimeter (cm) sediment depth interval, the vertical location of this layer likely will vary over time due to erosion and other forces. The declining COC concentrations may not be sustainable in the long term if continued erosion exposes what is described as heavily contaminated sediment in the second bullet in the fourth paragraph of Section 1.2 Site Description.	Sediment cores will be collected at all locations sampled in 2009 plus other locations during the September 2013 sampling event. Comment noted.

3	11	2.3.1	1	The text in the first paragraph states that sample preparation included thawing, mixing in original sample containers, and compositing. The text in the third paragraph lists the tests that were performed on the samples including bulk density (bullet 2). The test results presented in Appendices D and E include sample depths. As presented, it is not clear whether the bulk density tests were performed on "undisturbed" or remolded (disturbed) samples. Please expand the text in the second bullet (third paragraph) and discuss the nature of the bulk density test samples.	Bulk density analyses were performed on portions of frozen (undisturbed) samples using ASTM D 7263-09; the text was be modified to reflect this approach.
4	15	3.1	1	The text of the second sentence in the first paragraph states that cores were collected on 14 - 16 October and 19 - 20 October. However, the text in Section 2.1 Collection of Sediment Cores (page 7) states that daily cruises to collect sediment cores occurred 16 through 20 October, 2009. Please revise the text to clarify when sediment core collection occurred.	Text has been clarified.
5	16	3.2.2	1	The text in the first sentence on the first paragraph states that the reported bulk density was obtained from geotechnical testing, but the reported moisture content was obtained during chemical testing. With the reported sample preparation and compositing, it is not clear whether the samples tested for bulk density and moisture at two different laboratories were identical. Please revise/expand the text to indicate whether this is the case, and if so, how this was achieved.	As described in Section 2.2, each core sample was split into equal portions; one portion was sent to a chemical testing laboratory and two portions were sent to a geotechnical laboratory. As described in Section 2.3, moisture content (MC) was tested at the chemistry laboratory. Section 3.2 has been retitled “Results of Physical Tests” to reduce confusion that MC was tested at the chemistry laboratory.

6	9	App A – Section 3.2	1	MVS Model Output, Section 3.2 Methodology for Estimating Average Concentrations and Mass of COCs. The term Pow in the expression for the MIV equation is not defined, unlike the other variables. Please revise the text to include a definition of the Pow term.	The text has been edited to explain the Pow acronym as a power function, as in 10 to the power of 2 is 100 or 10^2=100 or POW(10,2) or Pow(base,exponent). By default, MVS takes the log(10) of the analytical results prior to doing the interpolation and stores the estimated value as the log(10) transformed number. Therefore, to use the nodal estimated value for mass calculations, it is necessary to calculate the inverse log of the model estimated value or Pow(10,An0) in order to get the non-log value. Text was edited to define the acronym “MIV” as mass inventory volume (in kg/cm3).
7	-	App B & C	-	In Appendix B Grain Size Results - Baseline and Appendix C Grain Size Results – Outfall Area, the tabulated particle size distribution data appears to define small pebble as material retained on the number 4 sieve, gravel as material retained on the number 10 sieve, and very fine sand as material passing the number 200 sieve and retained on the number 230 sieve. These definitions do not conform to the Unified Soil Classification System (USCS) in the use of term "pebble" as well as the divisions/descriptors and sizes of the fine and coarse fractions. Please revise the text so that the soil type definitions/descriptions, sieve numbers and sieve sizes conform to the USCS format.	Sieve sizes and the classification system used by the geotechnical laboratories for grain size analyses are based on the Wentworth Classification System (Phi scale), not the USCS. The Wentworth Classification System is typical for marine sediments and is appropriate for our application, allowing our data to be compared to data from similar marine environments. Text in Section 3.2.1 – Grain Size has been revised to clarify that grain size data conforms to this classification system. The references to USCS have been removed from the tables in Appendices B and C.
End of comments					